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ORBITAL DATA AND PRELIMINARY ANALYSES OF SATELLITES 1957 ALPHA AND 1957 BETA

Compiled by

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and G. F. Schilling

SMITHSONIAN INSTITUTION

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Foreword

The Smithsonian Institution has a long history of supporting and publishing astronomical research. This tradition began in 1848, when, two years after its founding, the Smithsonian published Sears C. Walker's "Researches Relative to the Planet Neptune," which presented an ephemeris for that planet, then newly discovered. Through the years before and after establishment of the Astrophysical Observatory in 1890 there appeared in various Smithsonian publications a succession of articles and monographs by such noted astronomers and physicists as Draper, Michelson, Morley, Shaler, Newcomb, and Ångström.

Of particular significance in the light of current events are two papers by Robert H. Goddard, the "father of modern rocketry," that appeared in Smithsonian Miscellaneous Collections. These two papers—"A Method of Reaching Extreme Altitudes," in 1919, and "Liquid-Propellant Rocket Development," in 1936—describe Smithsonian-supported researches that were basic to the development of modern rockets which made it possible to place the first artificial earth satellites in orbit. It is highly appropriate, therefore, that this first collection of optical observations of the 1957 satellites, and the resulting orbital data, should appear in the *Smithsonian Contributions to Astrophysics*.

LEONARD CARMICHAEL,
Secretary, Smithsonian Institution.

Preface

Since the first artificial earth satellite was successfully launched by the U. S. S. R. on October 4, 1957, the Astrophysical Observatory of the Smithsonian Institution has had to fill a dual role. To carry out our contract obligations to the U. S. National Committee for the International Geophysical Year, a majority of our staff has taken part in the visual acquisition and optical tracking of these satellites, in rapid analyses of the data to provide orbital predictions, and in precise analyses of the data as they relate to basic research projects. At the same time, we have attempted to discharge our equally important responsibility for communicating these data, as quickly as possible, to the scientific community.

During all the weeks and months since the first launching, we have made a concerted effort to share the data we acquired, rapidly and widely. Only 10 days after Satellite 1957 Alpha was in orbit, we had compiled, mimeographed, and distributed our first special report on its orbital characteristics. Since then, we have issued reports at roughly 2-week intervals, and have distributed them to staff members of institutions taking an active part in tracking the satellites, as well as to other scientists who requested these reports for use in various research projects.

Our primary object was to collect preliminary orbital data and other relevant information from all possible sources, and to make them available immediately, in a concise form, to our co-workers who were attacking the problems of orbit analysis. The urgency of our primary task—carrying out our contract obligations to track the satellites, analyze the data, and transmit orbital predictions to the observing stations—required that we arrange the contents strictly according to availability and relevance to the immediate problem. While this method did, indeed, meet the basic requirements, the need for haste made it impossible for us to organize the material as logically as we might have wished.

In the beginning, we supposed that new developments would make the material obsolete within a very short time, but we were mistaken. We soon realized that we had grossly underestimated both the current and the continuing demand for these reports. We had expected, originally, to have time to extract from these raw data those that we judged to be of permanent value, but because of the pressure of events we see no way to carry out this plan in the near future. The second U. S. S. R. satellite has been joined in its orbiting by the U. S. Explorer, and from now on consecutive launchings of other satellites will undoubtedly continue. Thus for some time to come many members of our staff will devote full time to optical tracking and orbital analyses.

Consequently, we are publishing the raw data so that they will be readily available to interested scientists for their various research projects. These data are presented very much as they appeared in the original reports; the spelling of place names has not been changed except for some obvious typographical errors.

Although we realize that this collection of reports can be considered only a stop-gap, to serve until the U. S. S. R. publishes in full the detailed scientific data resulting from its own measurements of Satellites 1957 Alpha and 1957 Beta, we hope, nevertheless, that it will accomplish its chief purpose. Inadequate though the material may be in comparison with the precise results of future treatment, the raw data will now be available to all, as intended by the International Geophysical Year. As the basis for new analyses, new facts, and new concepts, we hope that this collection will demonstrate the incalculable potential value of this new tool of science—the artificial earth satellite—in the study of our planet and the space surrounding it.

FRED L. WHIPPLE, *Director*,
Astrophysical Observatory,
Smithsonian Institution.

Cambridge, Mass., *March 15*, *1958*.

Contents

Introduction

By G. F. Schilling

The U. S. National Committee for the International Geophysical Year of the National Academy of Sciences assigned to the Astrophysical Observatory of the Smithsonian Institution the responsibility for carrying out the IGY Optical Satellite Tracking Program. The information contained in this collection of reports was obtained, in part, through the activities of this program. The National Science Foundation has given financial support in the form of grants to the Smithsonian Institution. Additional contributions toward the costs of administration and data analysis have been made by the Smithsonian Institution.

Dr. Fred L. Whipple, director of the Astrophysical Observatory, acts as project director. Dr. J. Allen Hynek, associate director of the Observatory, is in charge of the operation of the Optical Tracking Program, which includes three major activities: (1) Project Moonwatch, directed by Mr. Leon Campbell, Jr., operates and coordinates the activities of some 220 visual observing stations in the United States and abroad. The groups of amateurs who man these stations are volunteers who devote many hours, under sometimes arduous conditions, to the work of acquiring a satellite when it first goes into orbit, and of recording the final stages of its flight. (2) A world-wide network of 12 precision photographic stations set up by Dr. K. G. Henize and his staff is now almost completed. (3) A computations and analysis center, under the direction of Mr. R. M. Adams, receives and analyzes the data transmitted by the visual and photographic stations, and, in turn, supplies the stations with orbital predictions. A communications staff supervised by Mr. C. M. Peterson links these three aspects of the program and provides the vital channels for worldwide transmission of data.

In addition to the staff of the tracking program, senior members of the staff of the Astrophysical Observatory in Cambridge contribute to the scientific and statistical treatment of the data. Administrative assistance is given by a group at the Smithsonian Institution in Washington under the supervision of Mr. J. J. Love, who is directly responsible to the Assistant Secretary, Dr. J. L. Keddy.

The entire optical program, therefore, is an integral part of the research effort of the Smithsonian Astrophysical Obertvatory. The U. S. National Committee for the IGY, through its Technical Panel on the Earth Satellite Program and its Satellite Program Office, as well as through the Panel's Working Group on Tracking and Computation, offers advice and guidance in the direction of the program, which is closely coordinated with the analogous program of radio tracking and computations carried out at the Naval Research Laboratory.

It would be impossible to attempt to list by name the many thousands of scientists, technicians, amateurs, and laymen, in the United States and abroad, who have furnished observational data and in other ways contributed to this collection of reports. Their tireless efforts and enthusiastic cooperation have made possible the compilation of these data.

Particular appreciation goes to Mr. Paul H. Oehser and Mr. Ernest Biebighauser, of the Editorial and Publications Division, Smithsonian Institution, for their invaluable help in the publication of this collection of reports.

Notation system for satellites

The tentative system of notation, suggested by Whipple, identifies each artificial earth satellite in the following manner: the year of launching is followed by a letter of the Greek alphabet to indicate the order of the satellite's launching within the year, and, when more than one object is observed from one launching, a number is added to indicate relative brightness. When the orbiting rocket assembly or assemblies from one launching are referred to as a whole, or when the components are not distinguished nor considered separately, the Greek letter is spelled out and the succeeding number is omitted.

In these reports the first two Soviet satellites and their component parts are identified as follows: Satellite 1957 $\alpha 1$ designates the carrier rocket, the brightest component from the first Soviet launching (Sputnik I) on October 4, 1957; Satellite 1957 $\alpha 2$ refers to the satellite proper, the next brightest component; and Satellite 1957 $\alpha 3$ indicates a third, faint object which may be the nose cone that shielded the satellite during its launching.

Satellite 1957 $\beta 1$ designates the instrumented carrier rocket of the second satellite assembly (Sputnik II) launched into orbit by the U. S. S. R. on November 3, 1957; Satellite 1957 $\beta 2$ identifies an unconfirmed rocket component, or possibly the nose shield, also in orbit. There have been isolated reports, unconfirmed, which appear to indicate the existence in orbit of a third component from the 1957 Beta firing, which would be 1957 $\beta 3$.

Preliminary Orbit Information for U. S. S. R. Satellites 1957 $\alpha 1$ and $\alpha 2$ [1]

By G. F. SCHILLING [2] and T. E. STERNE [3]

The preliminary information contained in this report is presented in partial fulfillment of obligations of research contracts of the Astrophysical Observatory of the Smithsonian Institution with the U. S. National Committee for the International Geophysical Year of the National Academy of Sciences, and the National Science Foundation. While all statements and information presented at this time must be considered of an extremely tentative and, in part, even speculative nature, we nevertheless consider it desirable to collect these preliminary data in a concise form to make them rapidly available to the USNC–IGY.

It will be understood that current developments can be expected to make this report obsolete within a very short time.

General information

The U. S. S. R. announced the successful launching of an artificial earth satellite on Oct. 4, 1957. Original information [4] included the following basic data:

Orbit inclination	65°
Periodicity	$1^h\ 35^m$
Weight	83.6 kg
Diameter	58 cm
Radio transmission:	
Output	1 watt
High frequency	40.002 Mc
Low frequency	20.005 Mc
Passing over Moscow	0146 hours
	0642 hours

Note that these data on orbit inclination, periodicity, and time passages over Moscow are sufficient to determine, to a first approximation, the location in space of the orbital plane.

Immediate contact was established between the Office of the Director, Astrophysical Observatory, Smithsonian Institution, and the Control Center of Project Vanguard, Naval Research Laboratory.[5]

First reports on reception times of radio signals from the satellite were received from:

Naval Research Laboratory, Washington, D. C.	20:45 EDT October 4.
Radio Corporation of America, New York, N. Y.	21:00 EDT October 4.
Stanford University, Stanford, Calif.	19:30–19:47 PST October 4.
	20:41–21:20 PST October 4.

The first alerts.—Moonwatch stations in the Central and Western States had already been alerted at 19:30 EDT on October 4 by Dr. J. A. Hynek, in charge of the Optical Satellite Tracking Program at the Astrophysical Observatory. Station participation was excellent, but no reliable visual sightings were obtained throughout October 4 and 5.

The general alert for Moonwatch stations was terminated on October 5. When subsequent orbit computations predicted areas and periods of possible visual sightings, selected Moonwatch stations in the Eastern States were alerted and given observing instructions. The first confirmed U. S. Moonwatch sighting was reported from New Haven, Conn., at 5:23 EST on Oct. 10, 1957.

The satellite tracking camera under test at Pasadena, Calif., was alerted and ordered on standby operation.[6]

Four Super-Schmidt cameras of the Harvard

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 1, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; originally issued Oct. 14, 1957; re-issued Dec. 2, 1957.

[2] Executive Assistant to the Director, Smithsonian Astrophysical Observatory, and Research Associate, Harvard College Observatory.

[3] Associate Director, Smithsonian Astrophysical Observatory, and Professor of Astrophysics, Harvard College Observatory.

[4] Telephone, Dr. R. W. Porter, Washington, D. C., to Dr. G. F. Schilling, Cambridge, Mass., 21:40 EDT, and 22:10 EDT, Oct. 4, 1957.

[5] Telephone, Dr. G. F. Schilling, Cambridge, Mass., to Dr. H. E. Newell, Washington, D. C., 20:10 EDT; Dr. Newell to Dr. Schilling, 22:25 EDT, October 4; and subsequently direct operational TWX connection.

[6] Telephone, Drs. J. A. Hynek and G. F. Schilling, Cambridge, Mass., to Dr. K. G. Henize, Pasadena, Calif., 19:30 EDT, Oct. 4, 1957.

Meteor Project, located at stations in New Mexico, were alerted and ordered on stand-by operation.[7] In addition, the Sacramento Peak Observatory was alerted.[8]

The Agassiz Station of the Harvard College Observatory at Harvard, Mass., was alerted for radio reception and possible tracking on radio frequencies.[9]

The first official reports.—At 06:00 EDT, Oct. 5, 1957, the U. S. National Committee for the IGY was informed [10] that analysis of all information received by this time at the Astrophysical Observatory led to the following conclusions: The orbital plane of the U. S. S. R. satellite was located in space with respect to the sun in such a way that visual and optical observations were not possible at this time from the U. S. mainland. Favorable areas for possible visual sightings were Alaska, northwestern Canada, and possibly Antarctica. However, it could be expected that possibly within one week, definitely within two weeks, twilight observations could be made in the United States.

The above information was then also transmitted by telegrams to Dr. L. Carmichael, Secretary, Smithsonian Institution, and Dr. L. V. Berkner, CSAGI Coordinator for Rocket and Satellite programs.

Since analysis of twilight visibility indicated that the first likelihood of optical sightings in the United States would occur along and off the U. S. East Coast, arrangements with the Geophysics Research Directorate, AFCRC, were initiated by Dr. John S. Rinehart, Assistant Director, Smithsonian Astrophysical Observatory, with Dr. G. R. Miczaika, Geophysics Research Directorate, to utilize special aerial cameras for this purpose. Subsequently, several good photographs were obtained of the last rocket stage and analyzed and measured by Dr. G. Van Biesbroeck.[11]

Soviet orbit predictions

Tables 1 to 8 contain information released by Moscow Tass and Moscow Soviet Home Service. The values are predictions of times of satellite passages over world points. All times are Moscow time throughout.[12]

Optical sightings

Harvard Announcement Cards (reproduced in fig. 1.) list confirmed optical sightings out of a wealth of information supplied by stations around the world. In addition, the cards give preliminary information on orbit characteristics. The information contained on these cards does not establish priority nor is the listing complete.

Computing and predicting the orbit

The computation and analysis center of the Optical Satellite Tracking Program at the Astrophysical Observatory has been in continued operation since Oct. 4, 1957. From incoming data, rapid analysis provided orbit information which was successively released to the participating IGY stations and astronomical observatories on a priority basis depending on operational needs. In addition, simplified information was released to the general public through the news media of press, radio, and television.

Earliest precise predictions were made on October 5 for the Minook Meteor Station in Alberta, Canada, with the objective of obtaining photographs with a Super-Schmidt camera located at this point. Unfortunately, inclement weather made this impossible.

Apart from specific predictions for selected stations no general orbit predictions were distributed between October 5 and October 10. First sightings in both the southern hemisphere and Alaska reported visual magnitudes brighter than could be reasonably expected from the U. S. S. R. data. In addition, the sightings occurred at times in advance of the predicted satellite passages. After careful analysis, the conclusion was reached by Dr. R. E. McCrosky that the reported optical sightings were of the last rocket stage rather than of the satellite itself. This fact was later confirmed by Soviet statements.

Commencing October 10, precise orbit predictions were made for dozens of stations every day, upon request. This service is still continuing.

Sample copies of telegrams and TWX mes-

[7] Dr. R. E. McCrosky, Cambridge, Mass., to Mr. G. Schwartz, Sacramento Peak, N. Mex., 21:00 EDT, October 4.

[8] Dr. R. E. McCrosky, Cambridge, Mass., to Sacramento Peak, N. Mex., 21:05 EDT October 4.

[9] Dr. G. F. Schilling, Cambridge, Mass., to Drs T. K. Menon and G. R. Miczaika.

[10] Telephone, Drs. F. L. Whipple and G. F. Schiliing, Cambridge, Mass., to Dr. R. W Porter, Washington, D. C., Oct. 5, 1957.

[11] Consultant, Smithsonian Astrophysical Observatory.

[12] Note: GMT plus 3 hours: Moscow time; EST plus 5 hours: GMT; EST plus 1 hour: EDT; Moscow time minus 8 hours: EST.

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1374

Satellite 1957α—Since artificial earth satellites are short-lived astronomical bodies they should, presumably, be handled observationally and orbitally as are comets. As a tentative system of notation, pending IAU agreement, we shall identify each one by the year of its launching, followed by a letter of the Greek alphabet, to indicate successive order of launching. When more than one object is observable from one launching, a number shall follow the Greek letter in inverse sequence of brightness; the brightest component shall be α1, the next brightest α2, etc.

From press and radio accounts, Satellite 1957α was launched by the USSR during the night of October 3-4. Observations of only two components have been reported to the Astrophysical Observatory of the Smithsonian Institution. All estimates of brightness for α1 (both visual and photographic) give the second magnitude. Estimates of α2 range from the 4th to the 6th magnitude. From USSR reports of the satellite's dimensions, α2 is probably the radio satellite and α1 is the last rocket stage.

The following optical observations of Satellite 1957 α1 and α2 have been received:

Source	Date October	Time U.T.	Position		Type of Obs.
Geophysics Institute, College (Fairbanks), Alaska					
	6	$5^h 01^m 00^s$	65° N	180° E	vis.
			Alt.	Az.	
Mt. Stromlo, Canberra, Australia					
	8	$9^h 37^m 31^s$	$13^h 37^m$	−65°	pg.
			R.A.	Dec.	
Sydney, Australia					
Wood	8	$9^h 39^m 8^s$	$15^h 50^m.7$	−62°.8	vis.
			R. A.	Dec.	
Woomera Range, Australia Lat. 30° 55′.8 S Long. 136° 46′.8 E					
	8	$11^h 15^m 25^s$	25° 30′.9 N	266° 17′.9 E	vis.
			Alt.	Az.	
New Brook, Alberta, Canada Lat. 54° 19′ 28″ N Long. 112° 57′ 16″.3					
Beals	9	$11^h 52^m 11^s$	$15^h 37^m$	49°.1 N	pg.
			R. A.	Dec.	

1957 October 11 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1375

Satellite 1957α1.—Mr. Jack W. Slowey, Dr. Don A. Lautman, and Dr. Richard E. McCrosky of the Astrophysical Observatory of the Smithsonian Institution in Cambridge, Massachusetts, have obtained the following equatorial elements and perturbations for Satellite 1957α1:

a = 1.0890751 Earth
e = 0.0510696
i = 64°.26012
Argument Perigee = 61°.77894
Ω = 327°.33288
True Anomaly 266°.40725
Instant Osculation 1957 October 9.40466

The period appears to be shortening appreciably.

October 15, 1957 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1376

Satellite 1957α1.—One of the photographs of the last stage of the rocket obtained by the Physical Laboratories of Boston University, Boston, Massachusetts, has been reduced. It yields the following data:

Time U.T. 1957 October 14	R.A. (1950)	Dec. (1950)
$10^h 10^m 42^s.05$	102°.182	73°.890
43.27	104.052	73.201
44.50	105.768	72.503
46.88	108.785	71.088
48.26	110.347	70.246

Longitude $4^h 44^m 25^s.5$
Latitude 42°21′0″.6
Accuracy: Time ±0s.06 Position ±0°.006

The reductions were made by Drs. Hawkins and Aschenbrenner of Boston University.

October 21, 1957 FRED L. WHIPPLE

FIGURE 1.—Harvard Announcement Cards giving preliminary orbital characteristics for Satellites 1957 α1 and α2.

sages distributing pertinent information are given below.

07 OCT 1957
ALL IGY STATIONS BETWEEN 35 AND 75 DEGREES NORTH AND SOUTH LATITUDE
TO IGY WORLD WARNING CENTER
SATELLITE OR THIRD STAGE REPORTED SECOND MAGNITUDE. REPORT VISUAL POSITION OBSERVATIONS BY THEODOLITE OR SMALL TELESCOPE IN SUN RISE SKY NORTH OF LATITUDE 35 DEGREES OR SUN SET SKY SOUTH OF 35 DEGREES LATITUDE WITH ACCURATE TIME TO SMITHSONIAN ASTROPHYSICAL OBSERVATORY THROUGH IGY WORLD WARNING CENTER, FT. BELVOIR. (SMITHSONIAN ASTROPHYSICAL OBSERVATORY).

— — —

5:30 PM EST 7 OCTOBER 1957
ASTRONOMICAL OBSERVATORIES IN THE NORTHERN HEMISPHERE SATELLITE OR THIRD STAGE REPORTED SECOND MAGNITUDE STOP PLEASE REPORT COLLECT VISUAL FIELD THEODOLITE OR SMALL TELESCOPE POSITION OBSERVATIONS SUNRISE (SUNSET IN TELEGRAMS TO SOUTHERN HEMISPHERE) SKY ACCURATE TIME TO SATELLITE CAMBRIDGE VIA DR WHIPPLE.

— — —

OCT 7, 1957
DR RICHARD PORTER
COPY TO MR REID
ACCORDING USSR INFO THIRD STAGE TRAILED BY 600 MILES. WE BELIEVE RADIO TRACKS SATELLITE BUT VISUAL SIGHTINGS ARE THIRD STAGE. HAVE ALERTED IGY WORLD WARNING CENTER FOR IGY STATIONS 35° TO 65° LATITUDES NORTH SUNRISE AND SOUTH SUNSET TO OBSERVE SECOND MAGNITUDE OBJECT. OUR COMPUTATION CENTER IN FULL OPERATION.
SCHILLING

— — —

OCT 8, 1957 1800EDT
DR BUTLER
ROYAL OBSERVATORY
EDINBURGH SCOTLAND
CROSSING NORTH 40 LATITUDE DIRECTION TIME UT LONGITUDE OCT 8 SWNE 2255 04 EAST OCT 9 SWNE 0031 20 WEST SWNE 0207 45 WEST NWSE 0542 23 EAST NWSE 0718 02 WEST SWNE 2258 02 FAST SHIFT LONGITUDE 3 DEGREES WEST PER DAY AND TIME 3 MINUTES LATER SIGNED GAUSTAN SATELLITE CAMB MASS.

— — —

OCT 8, 1957 1715EDT
DR ERICH P HEILMAIER
DIRECTOR DEL INSTITUTO DE FISICA Y ASTRONOMICA DE LA UNIVERSIDAD CATOLICA DE CHILE.
SANTIAGO, CHILE.
FREDERICO RUTTLANT
DIRECTOR DEL OBSERVATORIO ASTRONOMICO DE LA UNIVERSIDAD DE CHILE SANTIAGO, CHILE RUSSIAN SATELLITE PREDICTED POSITIONS EASTERN STANDARD TIME AT 40 DEGREES NORTH LATITUDE.

October 9th

0530	50 degrees west long NW to SE
0707	74
0843	98
1820	116
1956	92
2132	68
0644	170 East Long SW to NE
0820	146
0957	122
1934	23 West Long
2110	48
2246	72

SIGNED HYNEK

— — —

OCT 9, 1957 1214 EDT
FROM SATELLITE CAMBRIDGE MASS SMITHSONIAN ASTROPHYSICAL OBS
TO BYRD STATION VIA AGIWARN BUSTAN FT. BELVOIR VA.

AGIWARN BUSTAN FT. BELVOIR VA. PLEASE PASS TO BYRD STA X SATELLITE POSITIONS OF OCT 10TH. 1714 UT 103 DEG 50 MINS WEST 51 DEG 55 MINS SOUTH. 1717 UT 89 DEG 32 MINS WEST 59 DEG 18 MINS SOUTH. 1722 UT 52 DEG 01 MINS WEST 65 DEG 07 MINS SOUTH. 1727 UT 14 DEG 36 MINS WEST 59 DEG 14 MINS SOUTH. 96m2 MINS REGRESSION 3 DEG. PER DAY MAGNITUDE ESTIMATE SECOND END.

— — —

TDB CAMBRIDGE MASS OCTOBER 10 1957
C S BEALS
DOMINION OBSERVATORY OTTAWA ONT
NEXT FAVORABLE PASSAGE OF SATELLITE AT 1019 UT AZIMUTH FIFTY DEGREES ALTITUDE THIRTY TWO DEGREES APPRECIATE DATA AND PHOTO SMITHSONIAN ASTROPHYSICAL OBSERVATORY

— — —

TDB CAMBRIDGE MASS OCT 10, 208AME
DR GORDON LITTLE
GEOPHYSICAL INSTITUTE COLLEGE ALASKA
SATELLITE PREDICTIONS OCTOBER TENTH. 1323 UT 163 DEGREES. 07 MINUTES WEST 64 DEGREES 52 MINUTES NORTH. 1325 UT 147 DEGREES 13 MINUTES WEST 62 DEGREES 54 MINUTES NORTH. 1327 UT 134 DEGREES. 08 MINUTES WEST 59 DEGREES 19 MINUTES NORTH. PERIOD 96.2 MINUTES. INCLINATION 65 DEGREES. REGRESSION 3 DEGREES PER DAY. ANOTHER PASSAGE 1501 UT 171 DEGREES 30 MINUTES WEST 62 DEGREES 54 MINUTES NORTH. SHIFT PATH ACCORDINGLY. APPRECIATE ACCURATE OBSERVATION
WHIPPLE SMITHSONIAN ASTROPHYSICAL OBSERVATORY

— — —

PLEASE PASS FOLLOWING MSG TO U S NATIONAL COMMITTEE IGY WASHINGTON DC ATTN MR RUTTENBERG PHONE EXECUTIVE 3-8100 EXT 402 AND ALSO DIRECT TO WILKES STATION ANTARCTICA X
SATELLITE ORBITAL PLANE HAS MOST SOUTHERN POINT SLIGHTLY NORTH OF WILKES LAND ANTARCTICA AT ABOUT 0610Z CLOSEST APPROACH X SINCE THIS CORRESPONDS TO A LOCAL SOLAR ANGLE OF ONE HOUR THIRTY FIVE MINUTES OR ABOUT NINETY MINUTES AFTER LOCAL NOON THERE, SATELLITE AND VERY LIKELY THIRD STAGE ALSO, WILL REMAIN INVISIBLE IN NOON SKY FOR SOME TIME X SATELLITE REPORTED FOURTH TO FIFTH MAGNITUDE X THIRD STAGE REPORTED SECOND MAGNITUDE X ADDITIONAL ORBIT POINTS AND SOLAR ANGLES FOLLOW

0253Z	22H 23 M
0434Z	0H 00 M
0610Z	01. 35 M
0746Z	03H 11 M

VISIBILITY PROBLEMS FOR OTHER US ANTARCTIC STATIONS NOW ON COMPUTER X WILL ADVISE OF POSITIVE RESULTS IF ANY X SCHILLING.
OCT 11, 1957

— — —

Moonwatch

The immediate alert on October 4 of all U. S. (and selected foreign) Moonwatch stations was abrogated because of the fact that in the United States Satellites $\alpha 1$ and $\alpha 2$ could not be expected to be observed in the morning twilight period for the next several mornings. The following operational policy was then adopted: Since Moonwatch teams represent entirely volunteer efforts, it was decided to alert a limited number, about a dozen stations each morning, so as to distribute the work load as evenly as possible. The stations alerted were chosen on the basis of greatest likelihood of visibility of $\alpha 1$; weather predictions were taken into account in the selection process.

Operational tests earlier in the year had determined that, in the United States, communication by telephone was the best method, leading most directly to positive alerts. In addition, telegrams were used for confirmation and for the dissemination of general information to groups of stations. Sample telegrams are given below:

MESSAGE FOLLOWED BY 12 ADDRESSES
PCS R PD LO OCTOBER 10 OCTOBER 1957
OBSERVE MORNING TWILIGHT 11 OCTOBER NW TO SE PASSAGE EXPECTED 0524 EST PLUS OR MINUS 5 MINUTES X IMPORTANT TO OBSERVE BOTH BRIGHT OBJECT AND FAINT SATELLITE FOLLOWING ABOUT TWO MINUTES SIGNED ARMAND SPITZ SATELLITE CAMBRIDGE MASS

NEW YORK MOONWATCH COMMITTEE CARE OF ROBERT S WHITE NATIONAL BDTNG COMPANY ROOM 582 EXTENSION 2241 NEW YORK CITY X

FOLLOWING DAYLITE CROSSINGS IN U. S. OCT 12 57

EST	LONG WEST OF GREENWICH	NO LAT
0521	AUGUSTA ME OVERHEAD	
0521	66	40
0523	62	35
0525	59	30
0655	GREAT FORKS ND OVERHEAD	
0658	90	40
0659	87	35
0701	NASHVILLE AND MIAMI OVRHD	
*0835	111	35
0701	83	30
0834	BOISE IDAHO OVRHD	
0835	114	40
*0837	108	30
1010	138	40
1011	135	35
1013	132	30

SIGNED J ALLEN HYNEK

Current information

It must be emphasized that the information presented below is rather speculative at this time. With more and more reports of precise visual and photographic observations becoming available, the computation and analysis center is concentrating on calculating and refining the precise orbit characteristics as data come in.

However, these tentative conclusions may be helpful in assisting stations to calculate approximate parameters for individual needs on the basis of general predictions issued.

The U. S. S. R. satellite ($\alpha 2$) has been reported as ranging from the brightness of a fourth magnitude to that of a sixth magnitude star.

Fourth magnitude corresponds approximately to the brightness of the three fainter stars in the handle of the Little Dipper (Ursa Minor). Sixth magnitude is just visible to the naked eye under extremely favorable conditions.

The last rocket stage ($\alpha 1$) has been reported as an object of magnitude -2 (about the same as Jupiter) to $+2$ (Polaris). It is observed in advance of the satellite proper in approximately the same orbital plane. It can be easily photographed.

Unconfirmed observations report a third, faint object which may be a rocket component which shielded the satellite during the launching phase.

All two—or possible three—objects are reported to be in elliptical orbits with inclinations of about 65° to the earth's equator. Projected on the celestial sphere, the orbital planes (on October 12) could be visualized as passing near Cassiopeia, Castor and Pollux in Gemini, and the Southern Cross.

The nodal period of Satellite $\alpha 1$ was 95.75 minutes on October 13, and appears to be decreasing at a rate of about 4 seconds per day. The approximate apogee and perigee distances on this day were about 450 miles and 130 miles, respectively.

It can be expected that the U. S. S. R. satellite proper ($\alpha 2$) will stay in its orbit for at least several months. The orbital elements of the last rocket stage ($\alpha 1$) are changing rapidly. From the change in period, it can be inferred that its apogee distance is decreasing at a rate of about 4 miles per day, if the perigee distance is constant. It is expected that the last rocket stage may stay up until some time in December.

Table 1.--Predictions received Oct. 5, 1957

Satellite 1957 Alpha

October 5 Place	Time	October 6 Place	Time
Magadan	1552	Yakutsk	0025
Calcutta	1916	Prague	0149
Ulan Bator	1923	Riga	0151
Karachi	2054	Moscow	0152
Alma-Ata	2058	Oslo	0327
Baghdad	2322	Rangoon	0528
Halifax	1452	Bandung	0535
Detroit	1630	Leningrad (0549?)	0649
Washington	1633	Moscow	0560
		Bombay	0703
		Damascus	0834
		Manchester	1005
		Paris	1006
		Rome	1009

Table 2.--Predictions received Oct. 7, 1957

Satellite 1957 Alpha

October 7

Place	Time
Zomba	1026
Wellington	1100
Apia	1108
Honolulu	1118
Coral Harbor	1134
(Kaneralik?)	1138
Canary Isles	1148
Accra	1156
Capetown	1209
Sydney	1239
Selkrik	1306
Battle Harbor	1317
Cape Verde Isles	1328
Aleutian Islands	1439
Dawson	1445
Quebec	1455
Boston	1456
Bermuda Isles	1500
Belem	1510
San Salvador	1514
Kemp Land	1538
Onslow	1555
Tokyo	1610
Shelton, Alaska	1622
Dawson	1624
Minneapolis	1633
Saint Louis	1634
Jacksonville	1637
Havana	1639
Montevideo	1658
Southern Sandwich Isle	1607
(Kergelen Isles?)	1722
Bangkok	1741
Hanoi	1743
Pering	1749
Okhotsk	1754
Sitka	1804
Vancouver	1807
Mexico	1816
Puerto Decardo	1838
South Orkneys	1843
Madras	1917
Hyderabad	1919

Table 3.--Predictions received Oct. 8, 1957

Satellite 1957 Alpha

October 8 Place	Time	October 9 Place	Time
Oakland	1104	Tunis	0013
Honolulu	1120	Rome	0015
Coral Harbor	1136	Budapest	0016
Melbourne	1238	Minsk	0018
Newfoundland	1321	Moscow	0019
Kemp Land	1402	Kotlas	0021
Marianas Islands	1432	Khabarovsk	0033
Ottawa	1457	Tokyo	0037
New York	1459	London	0154
Rio de Janeiro	1518	Goeteborg	0156
Jakarta	1601	Archangel	0159
Manila	1607	Yeniseisk	0205
Hiroshima	1612	Ulan Bator	0209
Yuzhno Sakhalinsk	1616	Peking	0212
Panama	1645	Sydney	0235
Rangoon	1744	Santiago	0305
Lanchow	1749	Shetland Islands	0333
Okhotsk	1756	Archangel	0338
San Francisco	1812	Omsk	0343
Bombay	1920	Borneo	0401
Delhi	1924	Panama	0453
Irkutsk	1930	Newfoundland	0505
Vilsk	1933	Reykjavik	0511
Graham Land	2024	Petrozavodsk	0517
Ashkhabad	2102	Gorky	0518
Barabinsk	2107	Aralsk	0522
Cairo	2235	Stalinabad	0525
Krasknodar	2239	Kabul	0526
Stalingrad	2240	Delhi	0528
Kuibyshev	2241	Detroit	0639
Sverdlovsk	2243	Oslo	0651
Vilyuisk	2251	Vilnyus	0659
South Shetland Islands	2342	Moscow	0656
		Kiev	0657
		Kerch	0658
		Batumi	0659
		Baghdad	0702
		Los Angeles	0812
		Winnipeg	0818
		Dortmund	0833
		Venice	0835
		Madagascar	0855

Table 4.--Predictions received Oct. 9, 1957

Satellite 1957 Alpha

October 9 Place	Time	October 10 Place	Time
Addis Ababa	0845	Rome	0017
Madrid	1012	Budapest	0018
Algiers	1014	Minsk	0019
Fiji Islands	1111	Moscow	0021
Canary Islands	1153	Oslo	0022
Melbourne	1242	Khabarovsk	0035
Newfoundland	1322	Tokyo	0038
Cherbourg	1448	Rio de Janeiro	0134
Ottawa	1459	London	0155
New York	1500	Goteborg	0157
Jakarta	1620	Archangel	0201
Manila	1600	Eniseisk	0207
Nagasaki	1613	Irkutsk	0210
Vladivostok	1615	Ulan Bator	0211
New Orleans	1640	Peking	0214
Rangoon	1745	Sydney	0237

Table 4.--Predictions received Oct. 9, 1957 (continued)

Satellite 1957 Alpha

October 9 Place	Time	October 10 Place	Time
San Francisco	1814	Santiago	0307
Los Angeles	1815	Archangel	0339
Bombay	1922	Omsk	0343
Delhi	1925	Semipalatinsk	0346
Bratsk	1932	Hanoi	0355
Johannesburg	2045	Panama	0454
Ashkhabad	2104	Petrozavodsk	0518
Honolulu	2131	Vologda	0519
Krashnodar	2241	Kuibyshev	0521
Saratov	2243	Stalinabad	0526
Perm	2245	Kabul	0527
Yakutsk	2254	Madras	0533
Samoan Islands	2318	Mexico	0634
		Detroit	0641
		Oslo	0655
		Vilnyus	0657
		Minsk	0658
		Kiev	0659
		Kerch	0700
		Baghdad	0704
		Los Angeles	0814
		Winnipeg	0819
		Glasgow	0832
		Brussels	0834
		Munich	0835
		Madagascar	0856

Table 5.--Predictions received Oct. 10, 1957

Satellite 1957 Alpha

October 10 Place	Time	October 11 Place	Time
Cordoba	1010	Algiers	0012
Fiji	1108	Genoa	0015
Coral Harbor	1136	Vienna	0016
Adelaide, Australia	1239	Warsaw	0017
Port Harrison	1316	Leningrad	0019
Kemp Land	1403	Vladivostok	0035
(Name Indistinct)		Tokyo	0036
Australia	1422	Montevideo	0128
The Comodores	1441	Rio de Janeiro	0132
Fairbanks	1447	Manchester	0154
Detroit	1457	Oslo	0156
Washington	1459	Archangel	0200
Haiti	1504	Ulan Bator	0209
Bandung	1600	Canberra	0236
Shanghai	1610	Archangel	0338
Vladivostok	1614	Nizhniy Tagil	0341
Sakhalin	1617	Bangkok	0355
Maryland	1623	Bandung	0401
Denver	1635	Newfoundland	0504
Santiago	1658	Reykjavik	0512
Chita	1753	Leningrad	0516
Ugolnaya	1801	Moscow	0517
San Francisco	1812	Ashkhabad	0524
Tierra del Fuego	1842	Bombay	0529
Madagascar	1908	Chicago	0638
Karachi	1922	Reykjavik	0648
Addis Ababa	2053	Oslo	0651
Teheran	2100	Kalingrad	0654
Aralsk	2103	Odessa	0659
Omsk	2106	Baghdad	0701
Ust-Kamchatsk	2117	Los Angeles	0812
Graham Land	2203	London	0832
Ankara	2237	Paris	0833
Kerch	2239	Rome	0835
Perm	2243	Madagascar	0854
Turukhansk	2247		
Ayan	2253		
The Kuriles	2257		
Samoan Islands	2315		

Table 6.--Predictions received Oct. 11, 1957

Satellite 1957 Alpha

October 11 Place	Time	October 12 Place	Time
Vancouver	0950	Freetown	0002
Coral Harbor	0957	Marseilles	0012
Frederikshbab, Greenland	1000	Munich	0013
Lisbon	1009	Riga	0015
Casablanca	1011	Leningrad	0016
Port Elizabeth, Africa	1032	Kharbin	0030
Portville	1107	Osaka	0033
Carcross	1129	Wellington	0058
Coral Harbor	1135	Buenos Aires	0125
Green Cape Islands	1152	Liverpool	0150
Adelaide	1239	Oslo	0153
Townsville, Australia	1243	Archangel	0156
Dillingham	1305	Kizyl	0204
Dawson	1308	Hangkow	0210
Halifax	1319	Melbourne	0230
Joa Pesoa	1335	Lapaz, So. America	0307
Kemp Land	1401	Bridgetown	0306
Augusta	1414	Belomor	0334
The Kuriles	1436	Nizhniy Tagil	0338
Fairbanks	1445	Karaganda	0341
Port Arthur, Canada	1454	Lhasa	0347
Detroit	1455	Rangoon	0351
Georgetown	1458	Bandung	0358
Caracas	1505	Albany, Australia	0407
Cuyritiba, So. America	1517	San Jose	0405
Singapore	1600	Newfoundland	0502
Canton	1606	Reykjavik	0507
Hangchow	1608	Leningrad	0513
Pyongyang	1610	Moscow	0514
Khabarovsk	1614	Guryev	0517
Magadan	1617	Ashkhabad	0519
Waylen	1621	Karachi	0524
Denver	1633	Bombay	0526
San Antonia	1636	Guadalajara	0528
Santiago	1656	Oklahoma	0633
Calcutta	1742	Chicago	0635
Ulan Bator	1749	Reykjavik	0646
Chita	1750	Bergen	0648
Ugolnaya	1758	Goeteborg	0649
Graham Land	1843	Warsaw	0652
Madagascar Island	1905	Odessa	0654
Karachi	1919	Los Angeles	0808
Alma-Ata	1924	Port Nelson	0815
Krasnoyarsk	1923	London	0828
Vilyuisk	1932	Paris	0829
Dutch Harbor, Alaska	1940	Zomba	0848
Graham Land	1022		
Capetown	2038		
Baghdad	2057		
Krasnovodsk	2059		
Omsk	2104		
Magadan	2113		
Ust-Kamshatsk	2115		
Graham Land	2201		
Batw	2224		
Istanbul	2235		
Sebastopol	2236		
Kharkov	2238		
Perm	2241		
Okha, Sakhalin	2252		
The Kuriles	2254		

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Table 7.--Predictions received Oct. 12, 1957

Satellite 1957 Alpha

October 13

Place	Time
Wellington, New Zealand	0925
Samoa Islands	0932
Honolulu	0942
Fort Nelson	0953
Coral Harbor	0958
Mogador	1013
Accra	1020
Capetown	1033
Sydney	1103
Carmacks, Canada	1130
Kemp Coast	1223
Pegane	1240
Aleutian Islands	1303
Dawson	1308
Quebec	1319
Belem	1333
Rio de Janeiro	1340
Kemp Land	1402
Onslow	1418
Tokyo	1434
Petropavlovsk-Kamchatsky	1440
Ugolnaya	1443
Dawson	1447
Winnipeg	1454
Saint Louis	1457
Jacksonville Precisely	1600
F. Montevideo	1620
Bangkok	1604
Peking	1612
Okhotsk	1617
Anadyr	1621
Vancouver, Canada	1630
Mexico	1640
Puerto Deseado, South America	1701
Madras	1740
Irkutsk	1751
Yakutsk	1754
Ugolnaya	1800
Graham Land	1845
Maskat	1919
Stalinabad	1924
Barnaul	1928
Vilyuisk	1932
Aleutian Islands	1940
Graham Land	2023
Windhoek, Africa	2042
Damascus	2057
Erevan	2059
Astrakhan	2101
Chelyabinsk	2103
Okhotsk	2114
Petropavlovsk-Kamchatsky	2117
Accra	2226
Tripoli	2233
Sofia	2235
Kiev	2238
Moscow	2239.5
Yuzhno Sakhalin	2254

October 14

Place	Time
Mogador	0009
Madrid	0011
Paris	0013.5
Copenhagen	0015
Leningrad	0017
Archangel	0019
Chita	0028
Mukden	0032
Moresby	0047
Hamilton, New Zealand	0100
Rosario	0126
Azore Islands	0146
Orkney Island	0153
Archangel	0158
Chungking	0212
Penang	0231
Lima	0309
Caracas	0315
Petrozavodsk	0335
Frunze	0343
Calcutta	0350
Guatemala	0452
Washington	0459
Montreal	0500
Reykjavik	0509
Tallinin	0513
Moscow	0515
Baku	0519
Denver	0634
Duluth	0636
Reykjavik	0647
Berlin	0652
Sofia	0656
Cairo	0659
Spokane	0812
Barcelona	0831

Table 8.--Predictions received Oct. 13, 1957

Satellite 1957 Alpha

October 14

Place	Time
Auckland, New Zealand	0925
Honolulu	0942
Port Nelson	0954
Abijan, Africa	1019
Melbourne	1100
Newfoundland	1141
Kemp Land	1223
Berden, Australia	1243
Fairbanks	1308
Ottawa	1319
New York	1320
Bele JL	1333
Rio de Janeiro	1340
Manila	1428
Osaka	1434
Yuzhno-Sakhalinsk	1437
Ugolnaya	114443
Fairbanks	1446
Kansas City	1457
Hcana	1502
Panama	1506
Buenos Aires	1520
Banrkok	1604
Chunghsien	1608
Taiwan	1610
Okhotsk	1617
Anadyr	1621
Cordova, Alaska	1625
Vancouver	1630
Guadalajara	1638
Tierra del Fuego	1702
Bombay	1741
Yakutsk	1751
Ugolnay	1759
Graham Land	1843
Johannesburg	1903
Tashkent	1923
Novosibirsk	1927
Aleutians	1940
Honolulu	1950
Graham Land	2023
Cairo	055
Damascus	057
Tbilisi	2059
Kuibyshev	2102
Sver--- S Erdlopsk	2103
Vilyuisk	2110
Okhotsk	2113
Petropavlovsk-Kamchatsky	2116
Accra	2225
Tripoli	2232
Naples	2234
Belgrade	2236
Kiev	2238
Moscow movement from SW to NE	2239
Syktyvkar	2241
Khabarovsk	2252
Sapporo	2254
Tierra del Fuego	2342
Rio de Janeiro	2352

October 15

Place	Time
Lisbon	0009
London	0013
Stockholm	0016
Archangel	0019
Ulan London	0013
Stockholm	00016
Archangel	0019
Ulan-Ude	0028
Peking	0031
Brisbane	0053
Santiago	0125
Hebrides	0151
Archangel	0157
Novosibirsk	0202
Chengtu	0210
Derby, Australia	0225
Quito	0310
Petrozavodsk	0335
Tashkent	0343
Delhi	0346
Knoxville	0456
Cleveland	0457
Ottawa	0459
Reykjavik	0507
Stockholm	0512
Riga	0513
Minsk	0514
Moscow movement from NW to SE	0515
Kharkov	0516
Tbilisi	0518
Muscat	0524
Phoenix	0631
Denver	0633
Port Harrison	0639
Reykjavik	0645
Berlin	0651
Athens	0655
Cairo	0658
Addis Ababa	0705
Madagascar	0711

Additional Orbit Information for U. S. S. R. Satellites 1957 $\alpha 1$ and $\beta 1$ [1]

By J. S. Rinehart [2] and G. F. Schilling

Preliminary orbital information on Satellite 1957 Alpha was presented in the preceding report. The present report expands and brings up to date the material which we judged to be of immediate interest to co-workers involved in problems of orbit analysis.

The tentative system of notation identifies each satellite by the year of its launching, followed by a letter of the Greek alphabet to indicate successive order of launching. A number follows the Greek letter in inverse sequence of brightness; the brightest component shall be $\alpha 1$, the next brightest $\alpha 2$, etc.

Satellite 1957 $\alpha 1$, therefore, designates the rocket stage of the first satellite launched, and Satellite 1957 $\alpha 2$ designates the satellite proper. Unconfirmed observations report a third, faint object which may be a rocket component which shielded the first satellite during the launching phase. Satellite 1957 $\beta 1$ designates the U. S. S. R. carrier rocket launched into orbit on Nov. 3, 1957.

Again we realize that the information is of an extremely tentative and, in part, even speculative nature. Furthermore, current developments can be expected to make this report obsolete within a very short time.

Launching information for Satellite 1957$\beta 1$

The U. S. S. R. announced the successful launching of a second artificial earth satellite on Nov. 3, 1957. Original information contained the following basic data:

Orbit inclination	Approx. 65°
Periodicity	102 to 104 min
Weight of instrumentation	508.3 kg
Satellite configuration	Last rocket stage
Radio transmission output:	
High frequency	40.002 Mc
Low frequency	20.005 Mc
Apogee distance	In excess of 1500 km
Passing over Moscow	0330 Nov. 3
	0905 Nov. 3
Instrumentation	Solar radiation (UV and X-ray)
	Cosmic rays
	Internal temperature and pressure
	Female dog in air-conditioned capsule with food supply
	Biophysical parameters

[More detailed information was released later and excerpts can be found on page 219 of this publication. Photographs of some of the instrumentation as well as a schematic diagram were made available by the U. S. S. R. Embassy, Washington, D. C., and have been widely printed in journals and magazines. Refer, e. g., to "Satellite Talk," Sky and Telescope, vol. 17, p. 129, 1958; and a critical analysis by Friedman (1958), listed in the bibliography.]

On Nov. 5, 1957, Drs. C. A. Whitney, L. G. Jacchia, and G. Veis derived the following orbital elements for Satellite 1957 Beta, from U. S. S. R. announcements and three optical sightings:

Epoch and time of osculation (at ascending node).	Nov. 4.3952 UT
Inclination	$i=63°.8\pm1°$
Period	$P=103.6\pm0.05$ min
Right ascension of node	$\alpha_{\Omega}=111°.0\pm0.°1$
Eccentricity	$e=0.105$
Semi-major axis (in equatorial radii).	$a=1.1463$
Argument of perigee	$\omega=44°+0.°6$/day

Orbital characteristics

Preliminary information on orbital characteristics for Satellites 1957 $\alpha 1$, $\alpha 2$, and Beta was distributed on Harvard Announcement Cards shown in figures 1 and 2. Earlier satellite information was released on Cards 1374, 1375, and 1376 [3] (see p. 193).

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 2, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Nov. 5, 1957.

[2] Assistant Director, Smithsonian Astrophysical Observatory, and Research Associate, Harvard College Observatory.

[3] Cards 1377 through 1379 did not refer to artificial satellites.

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1380

Satellite 1957α2. — Dr. Paul Herget, Dr. Gerald M. Clemence, and Dr. Raynor L. Duncombe of the Naval Research Laboratory in Washington, D.C., have reported the following ephemeris for Satellite 1957α2: Satellite at ascending node October 25.1007 at longitude 153.°5 W with period 95.44^m. Daily variation of period −.040^m. Westward motion of equatorial crossing 24.°16 per period.

EPHEMERIS

Time	Long.	Lat.	Height (Kilometers)
m	°	°	
0.0	153.5W	0.0	280
4.0	147.4W	14.9N	240
8.0	140.2W	29.7N	220
12.0	130.1W	43.8N	230
16.0	113.8W	56.1N	260
20.0	85.9W	64.1N	310
24.0	50.1W	63.8N	380
28.0	23.9W	55.9N	460
32.0	8.8W	44.5N	540
36.0	0.5E	32.0N	630
40.0	7.1E	19.1N	700
44.0	12.5E	6.1N	770
48.0	17.4E	6.6S	830
52.0	22.6E	19.2S	870
56.0	28.7E	31.3S	890
60.0	36.9E	43.0S	890
64.0	49.2E	53.5S	870
68.0	69.1E	61.8S	830
72.0	98.9E	65.1S	760
76.0	128.9E	61.4S	690
80.0	149.3E	52.4S	600
84.0	161.9E	40.5S	510
88.0	170.4E	27.2S	420
92.0	177.1E	13.0S	340
96.0	177.8E	1.7N	280

November 1, 1957 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1381

Satellite 1957α1. — Dr. Charles A. Whitney, Dr. Richard E. McCrosky, and Dr. Luigi G. Jacchia, of the Astrophysical Observatory of the Smithsonian Institution in Camhridge, Massachusetts, have obtained the following two search ephemerides for operational use for Satellite 1957α1:

Nomenclature: Zero points of the two ephemerides below are determined in the following manner:

Rocket at ascending equatorial node October 29.2121(T_o) U.T. at longitude 151.°9 (A_o) east with period 94.68 minutes.

T_n = time of nth succeeding nodal passage

A = terrestrial longitude (east from Greenwich) of ascending node.

$T_n = T_o + 0.0657520\ n - 1.1172 \times 10^{-6}\ n^2 - 7.747 \times 10^{-10}\ n^3$

$A = A_o - 364.07\ ^{\circ}/^{d}(T^{d} - \text{Oct. } 29.2121)$

Scales of the ephemerides are the following:
Period is divided into 24 equal time intervals
Longitudes measured east from the ascending node and are computed for a rotating earth. Heights are above geoid

EPHEMERIS (1)
Period = 94^m

Time	Long.	Lat.	Height (Kilometers)
m	°	°	
0.00	0.0	0.0	271
3.92	5.9	14.5N	235
7.83	12.9	29.0N	217
11.75	22.4	42.9N	219
15.67	37.6	55.1N	241
19.58	63.5	63.5N	279
23.50	98.7	64.4N	329
27.42	126.7	57.4N	387
31.33	143.0	46.4N	449
35.25	152.9	33.9N	513
39.17	159.9	21.0N	574

(To be continued on H.A.C. 1382

November 1, 1957 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1382

Satellite 1957α1. — (Continued from H.A.C. 1381)

Time	Long.	Lat.	Height (Kilometers)
m	°	°	
43.08	165.4	7.9N	630
47.00	170.5	5.0S	677
50.92	175.7	17.8S	712
54.83	181.8	30.2S	734
58.75	189.9	42.1S	740
62.67	201.9	52.9S	729
66.58	221.5	61.5S	702
70.50	251.2	65.1S	658
74.42	281.6	61.7S	602
78.33	302.4	52.9S	535
82.25	315.2	41.3S	463
86.17	323.8	28.2S	391
90.08	330.4	14.4S	325
94.00	336.2	0.0	271

EPHEMERIS (2)
Period = 93^m

Time	Long.	Lat.	Height (Kilometers)
m	°	°	
0	0.0	0.0	244
3.88	5.9	14.4N	220
7.75	12.7	28.7N	214
11.62	22.0	42.4N	224
15.50	36.6	54.5N	248
19.38	61.4	63.2N	285
23.25	96.0	64.7N	330
27.12	124.6	58.3N	379
31.00	141.6	47.7N	431
34.88	151.9	35.4N	481
38.75	159.1	22.6N	528
42.62	164.8	9.5N	569
46.50	169.9	3.5S	603
50.38	175.1	16.4S	627
54.25	181.1	29.0S	639
58.12	189.1	41.1S	638
62.00	200.9	52.2S	624
65.88	220.3	61.1S	597
69.75	250.0	65.1S	558
73.62	281.2	61.9S	508
77.50	302.4	53.0S	451
81.38	315.4	41.3S	391
85.25	324.1	28.2S	333
89.12	330.7	14.3S	282
93.00	336.5	0.0	244

November 1, 1957 FRED L. WHIPPLE

FIGURE 1.—Harvard Announcement Cards giving preliminary information on orbital characteristics for Satellites 1957 α1 and α2 (for No. 1381, note that from additional observations, Dr. C. A. Whitney obtained on Nov. 2, 1957, a refined value for the coefficient of the cubic term, i. e., 1.162×10^{-9} instead of 7.747×10^{-10}).

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1383

New Supernova. — A letter from Dr. I. S. Bowen, Director of Mount Wilson and Palomar Observatories, reports: "Mr. H. S. Gates, on an 18-inch Schmidt film of October 19, found a supernova in a spiral arm of NGS 1365. Location of the supernova is 99 seconds of arc northwest of nucleus. Discovery confirmed by Carpenter and Luyten at Steward Observatory and Haro at Tonansintla. A film taken on October 2 did not show the star."

Position of NGC 1365 follows:

R.A.	(1950)	Dec.
3^{h}31^m.8		−36°18′

Satellite 1957α1. — Dr. F. Dow Smith reports simultaneous photographs from two stations obtained by the Physical Research Laboratories of Boston University in Boston, Massachusetts. The parallactic angle was 1.°6 and a reduction of the plates yields the following heights and positions for the rocket:

U.T. October 17, 1957	Subsatellite Point Longitude	Subsatellite Point Latitude	Height above Sea Level (Statute miles)
9^h 53^m 21^s.0	74° 49′ 15″ W	40° 13′ 28″ N	332.7
23.0	74 44 55	40 06 48	334.2
24.0	74 40 22	40 02 10	333.4

Accuracy: Time ± 0.1 seconds
Height ± 1.5 miles
Longitude ± 1′.7
Latitude ± 1′.3

The reduction was made by Drs. Aschenbrenner and Hawkins of Boston University.

Errata In announcement card 1376 the longitude and latitude of Boston University Observatory was given instead of the position of the Physical Laboratories. This position is:
Longitude 71°06′ 19.″4 W
Latitude 42 20 56. 8 N

November 5, 1957 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY
ANNOUNCEMENT CARD 1384

Satellite 1957β. — The second artificial earth satellite was launched, according to Radio Moscow, by the USSR on November 3, 4^h 40^m U.T. in a highly inclined orbit.

Dr. Leland E. Cunningham, of the Leuschner Observatory, University of California, Berkeley, has computed, for the Astrophysical Observatory of the Smithsonian Institution in Cambridge, Massachusetts, the following equatorial elements and perturbations for Satellite 1957β:

a = 1.1463 Earth
e = 0.105
i = 62°.5

Argument of Perigee = 44° − 0°.6 (per day)
Mean Anomaly at Epoch = 151°
Epoch and Osculation 1957 November 4.0 U.T.
Right Ascension of Ascending Node
on Equator = 118° − 3°.1 (per day)

A cable from Dr. J. Hopmann at Vienna has reported the following positions for Satellite 1957β as observed by Purgathofer and Jackson:

Time (Nov. 5 U.T.)	Altitude	Azimuth
4^h 41^m 9^s.6	16°.7	S 58°.5 E
4 42 5.8	12.9	S 83.9 E

The Moonwatch Station of Los Altos, California, Latitude +37°.399 N; Longitude 122°.124 W, has reported the following position for Satellite 1957β:

November 5, 13^h 15^m 58^s U.T.

Right Ascension	Declination
170°	−20°

November 7, 1957 FRED L. WHIPPLE

FIGURE 2.—Harvard Announcement Cards giving preliminary information on orbital characteristics for Satellites 1957 α1 and 1957 Beta.

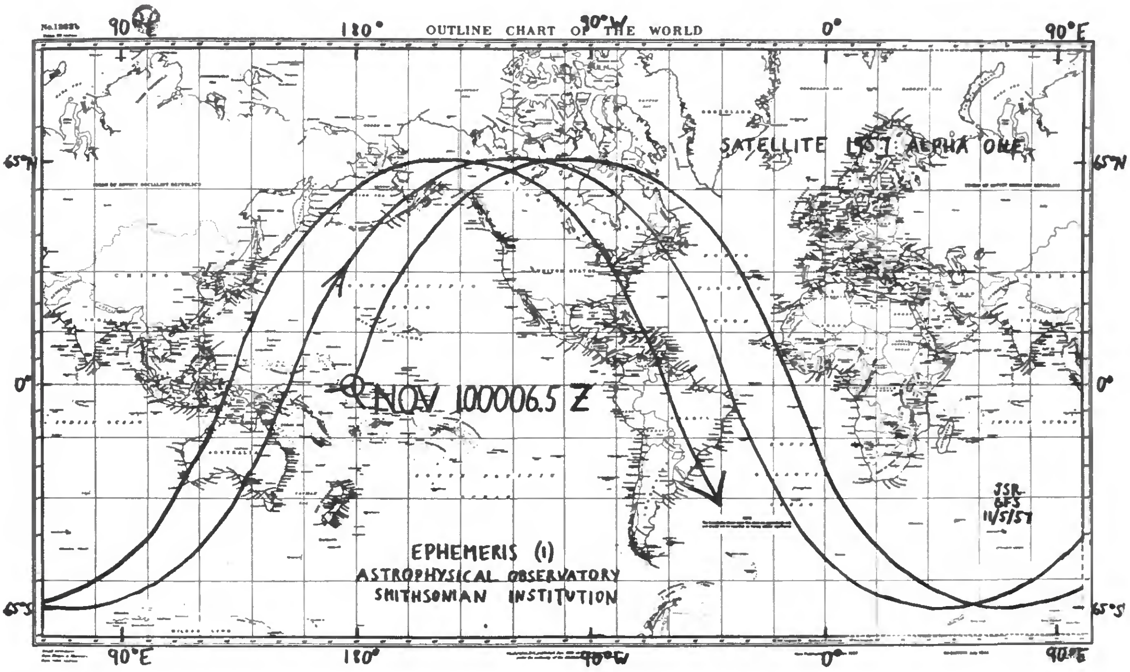


FIGURE 3.—Earth track of Satellite 1957 α1 plotted on Mercator projection of world.

[The original issue of this report contained tables of Soviet predictions for satellite passages of both α1 and β1, over or near world points. The period covered ranged from Nov. 3 to Nov. 6, 1957. The tables have been omitted here, but will be found, in context, on pp. 225–228.]

The earth track of Satellite 1957 α1 is plotted on a world chart in Mercator projection in figure 3. The ephemeris, Oct. 29.2121 UT, obtained by the Smithsonian Astrophysical Observatory (Harvard Announcement Card No. 1381, fig. 1) was used to make the plot. The refined value for the cubic term, as calculated by Dr. Whitney, was applied. Approximately 2½ revolutions are shown. The period is assumed to be constant for the duration of these revolutions.

The specific date and time of the start of the plot, Oct. 41.0045 UT,[4] corresponds to an orbital period of exactly 94 minutes. This time and the precise longitude of the ascending equatorial node were determined from solutions of the orbital equations given in the announcement card. Note that the first derivative of the cubic equation for the time of the nth succeeding nodal passage is the orbital period for that passage.

Deviations from this plotted projection, predicted here 12 days in advance from the date of the ephemeris, will have to be expected. Such deviations will be principally due to atmospheric drag effects on the rocket. Neither the mass-area ratio nor the shape, and hence, the drag coefficient, are yet known to any degree of certainty (refer also to p. 202 of this report).

If, as viewed by an observer in space, the orbital plane of a satellite is inclined at an angle with respect to the equatorial plane of the earth, then an observer stationed on the earth would not see the satellite cross the equator at this angle, because he would be moving with the earth. The two situations of passage from the Southern Hemisphere into the Northern Hemisphere, and vice versa, are basically the same. The situation is illustrated vectorially in figure 4.

Based on the orbital characteristics of Satel-

[4] Oct. 41.0045 UT = Nov. 100006.5 Z = 19:06:30 EST on Nov. 9, 1957.

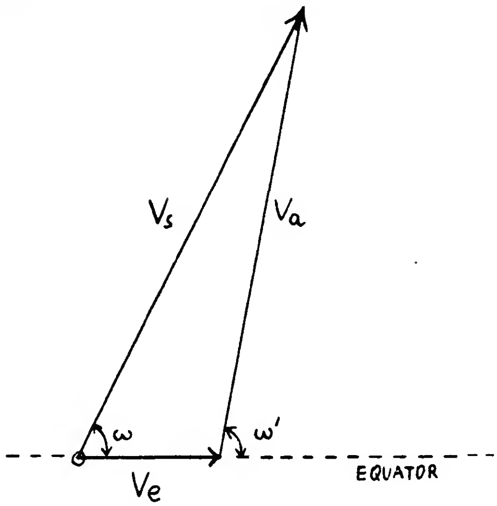


FIGURE 4.—Orbital plane of Satellite 1957 α1 in relation to equatorial plane of earth; ω, angle between orbital plane and equatorial plane; ω', apparent angle of equatorial crossing; V_e, mean linear velocity of rotation of the earth's surface at the equator (approximately 0.465 km/sec); V_s, satellite velocity projected on a stationary earth; V_a, apparent satellite velocity for an observer on the earth's surface.

lite 1957 α1, ω' is approximately 67.7° for crossings of the equator in both directions. For an elliptic orbit, the two angles may differ slightly depending upon the positions of apogee and perigee.

Satellite camera

Plate 1 is a photograph of Satellite 1957 α1 obtained with a Smithsonian Satellite Tracking Camera on Oct. 23, 1957, at Pasadena, Calif. A detailed description of the camera and its complex operational use has been published by Dr. K. G. Henize (1957). Only a simplified account is given below.

The camera (F/1, 20-inch apochromatic, triple-element correcting system, 31-inch spherical mirror, 35-micron images with luminous flux density intensification of 3 × 10^8) has a field of 5 by 30 degrees, which is photographed on a strip of 55-mm film. The time presentation is photographed on this film and readable to 1/10,000 second.

The camera operates in a cyclic manner so that it alternately tracks at the satellite rate and at the rate of sidereal motion parallel to the satellite orbit. In this way, exposures of the satellite and of the star background, including the fainter stars, can be made on a single film. The satellite position and motion can then be determined relative to nearby star images by measuring the relative positions between the "star-exposure" images and the "satellite-exposure" images of these same stars. Sharp breaks in the trail, produced by a rotating barrel shutter, provide precise time reference points for measurement.

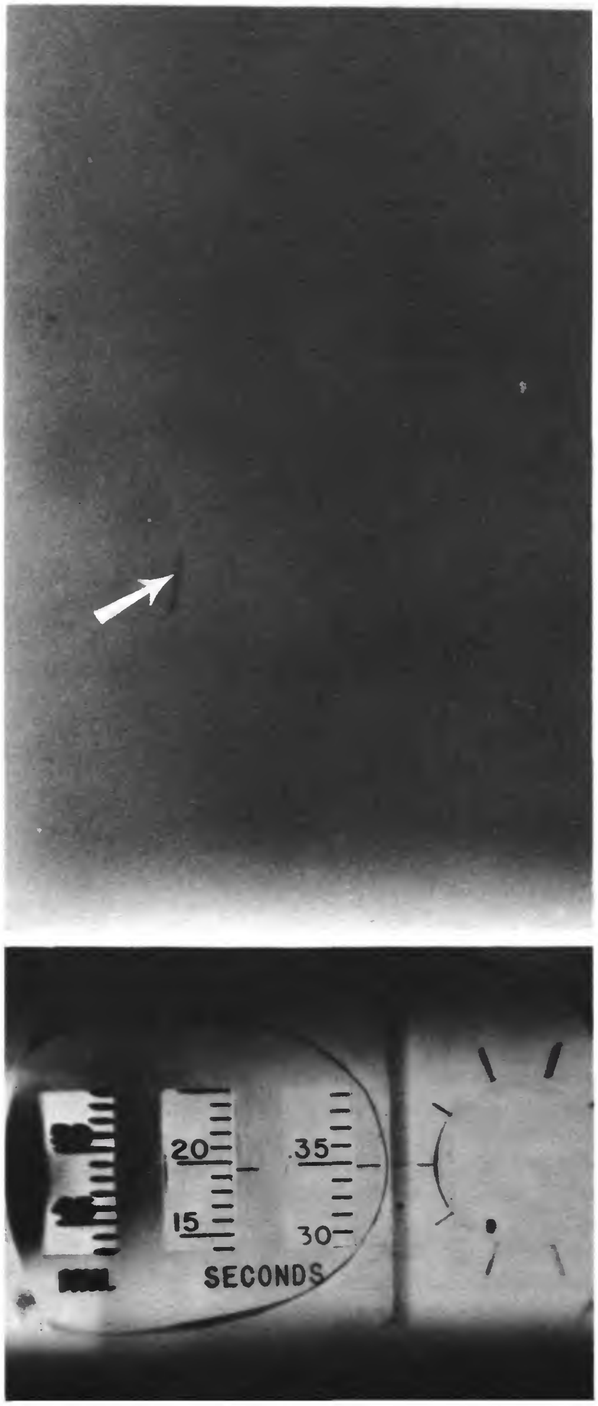
In plate 1 the rocket (α1) appears as a trail (indicated by arrow), interrupted several times by the camera shutter. Its movement against the star background can be seen. The initial camera settings were: azimuth 309°, altitude 037°.3; the final settings were: azimuth, 304°, altitude 047°.5; 20 photographs were obtained between 17:48 and 17:49.5, Pacific Standard Time.

Estimate of size

In order to make precise predictions for artificial satellites in elliptical orbits relatively close to the earth's surface, the effect of atmospheric drag has to be taken into account. For accurate computations, a knowledge of the mass-area ratio, the exact shape of the rocket, and its orientation, including rates of tumbling and spin, would be necessary (Rinehart, 1952). None of these quantities are really known to date.

Since drag effects can be expected to influence most severely the orbit characteristics of Satellites 1957 α1 and β1, attempts were made to arrive at rough estimates, even if based on necessarily speculative information.

On the basis of visual and photographic observations of α1 and α2, including both low and high frequency variations in brightness, ratios of relative luminous intensities were derived, depending on estimated altitudes. If we assume that the cross-sectional area of α2 is known (sphere of diameter 58 cm), the corresponding area for α1 should then be roughly 26 m^2. This figure would apply rather well to the U. S. S. R. single stage, liquid-propellant rocket T–1 (M–101), in case a forward section (α3?) of the rocket shell was blown away to free the satellite proper. The T–1 is an improved version of the old German A4 (V–2), the shape of which can be assumed to



Trail of Satellite 1957 $\alpha 1$ photographed on Oct. 23, 1957, at Pasadena, Calif.; trail indicated by arrow.

be known within limits of reasonable accuracy (Kaplan, Schilling, and Kallmann, 1955).

Before considering this shape and a corresponding empty weight as the most likely ones to use for preliminary drag calculations, we also checked the degree of realism of such an assumption by applying known technical parameters of rocket propulsion and operating procedures. These considerations were checked and corroborated by Mr. Maurice Dubin.[5] Without discussing the details here, which included calculations of the necessary thrust and impulse values for the whole system, we feel confident in assuming—for our purpose—$\alpha 1$ to have the approximate shape and empty weight indicated above, and to be spinning around its long axis. On the basis of preliminary sightings of $\beta 1$, we would further assume $\beta 1$ to be of almost identical shape and size, with the complete shell intact.

However, we want to emphasize the rather speculative aspects involved, and one major fact which would throw doubt on our conclusions. If $\alpha 1$ has the approximate shape—and size—of a T–1, it would appear unlikely that it was not fitted with a radio transmitter of its own.

[Since the appearance of the above estimates of size and weight of the Soviet satellite rockets, a number of detailed articles on this subject have been published in the technical literature; see Bibliography, Koelle (1957), and Summerfield, (1957). The principal conclusions reached by most authors indicate a much lower weight and size than the estimates given above.]

Orbit predictions

The computation and analysis center of the Optical Satellite Tracking Program at the Astrophysical Observatory is continuing the operations described in the preceding report. The senior scientists participating are Drs. Luigi G. Jacchia, R. E. McCrosky, C. A. Whitney, D. A. Lautman, and J. W. Slowey.

Search ephemerides are transmitted for national and international distribution to the IGY World Warning Center of the National Bureau of Standards at Fort Belvoir, Va. Release is made by the USNC–IGY in accordance with Resolution No. 8 of the 1957 Comité Spécial de l'Année Géophysique Internationale (CSAGI) Conference on Rockets and Satellites in Washington, D. C. Upon release, the ephemerides are printed on Harvard Announcement Cards and distributed by the Harvard College Observatory to regular subscribers as well as to the IGY Data Coordination Office at the National Academy of Sciences for distribution to the IGY World Data Centers.

Specific orbit predictions and precise sighting data are computed for certain stations selected on a basis of operational needs. Predictions are sent to alerted Moonwatch stations, with due allowance for probable weather conditions.

In addition, a routine program computes predicted crossings of latitude 40° N. approximately four days in advance. This information is sent to the Secretariat of the USNC–IGY and is also made available locally. Prediction tables for $\alpha 1$ for Oct. 23, 1957, and Nov. 4, 1957, are given in tables 1 and 2.

This simplified form enables a rough and rapid determination of the approximate time positions of a satellite on the day given without any further computations by assuming an orbit inclination of 65°. On a world-wide basis, the use of a Mercator projection chart will be found advisable. For local use, gnomonic projection charts are preferable.

All exact determinations of orbital elements are carried out with the help of IBM electronic computers. Dr. D. A. Lautman is Mathematician in Charge, and Dr. L. Cunningham is Senior Consultant.

[5] Chief, Meteor Physics Section, Geophysics Research Directorate, Air Force Cambridge Research Center, ARDC, Bedford, Mass.

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Table 1.--Satellite 1957 α1, 40th parallel crossings, Oct. 23, 1957

Northwest to southeast			Southwest to northeast		
EST	Longitude	Nearest place	EST	Longitude	Nearest place
0039	37W	North Atlantic	0151	121E	North Pacific
0214	61W	South of Nova Scotia	0326	147E	East of Japan
0350	85W	Cincinnati	0502	123E	Korea
0530	109W	Roosevelt, Utah	0637	99E	Inner Mongolia
0700	133W	West of San Francisco	0812	75E	North India
0821	157W	North Pacific	0933	51E	Caspian Sea
1011	179E	North Pacific	1122	26E	Bucharest
1146	155E	North Pacific	1258	02E	Barcelona
1322	130E	Sea of Japan	1434	22W	Azores
1457	106E	Siam	1609	46W	Southeast of Newfoundland
1632	82E	Caspian Sea	1744	70W	East of New York City
1808	58E	Aral Sea	1920	94W	Des Moines
1943	34E	Black Sea	2055	118W	Lovlock, Nevada
2118	10E	Corsica	2230	142W	Pacific
2254	14W	West of Portugal	2406	167W	Pacific

Boston crossing, A. M.

Rocket not illuminated
Satellite difficult

Boston crossing, P.M.

Time, EDT	Altitude	Azimuth
6:40	0°	180° South
6:44	40°	120° SE 100 Miles
6:48	0°	45° NE

Table 2.--Satellite 1957 α1, 40th parallel crossings, Nov. 4, 1957

North to south			South to north		
EST	Longitude	Nearest place	EST	Longitude	Nearest place
0130	95W	Kansas City	0107	141E	Japan
0304	119W	Reno	0242	117E	Peking
0438	143W	Pacific	0416	93E	China
0613	167W	Pacific	0550	69E	U.S.S.R.
0747	170E	Pacific	0724	45E	Armenia
0921	146E	Pacific	0859	21E	Greece
1056	122E	China	1033	3W	Madrid
1230	98E	China	1207	26W	East Azores
1404	74E	Russian Chinese Bound	1342	50W	Atlantic
1538	51E	Baku	1516	74W	New York
1713	21E	Turkey	1650	98W	Grand Island, Nebraska
1847	3E	Balearic Island	1825	122W	Sacramento
2021	21W	Atlantic	1959	145W	Pacific
2155	45W	Atlantic	2133	169W	Pacific
2330	69W	East of Boston	2307	167E	Pacific

Some Preliminary Values of Upper Atmosphere Density from Observations of U. S. S. R. Satellites [1]

By T. E. STERNE and G. F. SCHILLING

Some of the major scientific results which can be expected from ground-based observations of artificial earth satellites will consist of extensive data on atmospheric density at high altitudes. To date, our numerical estimates for density values above an altitude of about 150 km are based on indirect methods of computation rather than on direct measurements. On the other hand, the orbital movements of satellites under the influence of atmospheric drag will, for the first time, resemble much more closely a direct means of probing the earth's atmosphere with an artificially created tool.

At the time of this writing, only preliminary data on the orbital characteristics of Satellites 1957 $\alpha1$, $\alpha2$, and β are available. However, making precise orbit predictions for these satellites requires that the effect of atmospheric drag be taken into account. Furthermore, any *a priori* prediction of expected lifetimes is based on derived values of atmospheric density. The present report was prepared with these operational necessities in mind. We do not claim any degree of accuracy or reliability of the results beyond the limitations explicitly described throughout the text.

Conventional techniques

The method of calculating densities from orbital elements is described on p. 208. The importance of this new and easily applied technique can best be illustrated through a comparison with what we may call conventional techniques. It will be worthwhile to review, in brief, the principal methods of investigations which have been utilized heretofore to estimate values of upper atmospheric densities (Kaplan, Schilling, and Kallmann, 1955).

Rocket methods.—The high-altitude research rocket permits the direct measurement of atmospheric pressure by means of special pressure gauges located at various points at the surface of the rocket. The ambient atmospheric pressure, i. e., the true pressure in the absence of the moving rocket, can be measured at selected openings in the tail section. In addition, the ram pressure, measured at an opening in the nose of the rocket, and surface pressures (Pitot tubes) in the nose section can be used to compute the ambient pressure. Direct values have also been obtained from sampling bottles which were opened at predetermined altitudes, exposed, and resealed again. However, this sampling technique is open to criticism, such as that ram pressure influences the results, or that bottles leak.

The fundamental relation between the atmospheric parameters is essentially that given by the ideal gas law and the barometric equation. By use of the latter, ambient air densities can be calculated directly from the measured pressure-altitude curve. This method does not require a knowledge of the molecular weight, but the differentiation required is a possible source of large errors.

Other methods make use of nonambient pressure measurements by applying either the Rayleigh equation (Newell, 1953) or a kinetic theory formula derived by Havens, Koll, and LaGow (1952).

Meteor observations.—While various means of investigation, notably the searchlight technique, lead to derived values of atmospheric density, meteor observations have in the past represented the major data source. The results are based on physical theories of meteor phenomena and involve assumptions about the density of meteoritic material, luminous efficiency, and shape factors. For radar observa-

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 3, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Nov. 15, 1957.

tions, ionizing efficiency must also be estimated. It should be noted that comparison with rocket data shows fair agreement between the results obtained at lower altitudes; at higher altitudes the densities obtained from meteor data are higher.

Model atmospheres.—A number of authors have conducted theoretical studies which have resulted in model atmospheres and numerical listings of the altitude variations of atmospheric parameters. Models have been published by Warfield (1947), Grimminger (1948), the Rocket Panel (1952), Kallmann (1952), Minzner and Ripley (1956), Sterne (1958), and others. Values for higher altitudes are extrapolated upward by making reasonable physical assumptions and using indirect evidence from, e. g., observations of aurorae, ionospheric measurements, and related studies. It might be mentioned that, when complete numerical tables are given, the numerical calculations of atmospheric parameters are based essentially on the hydrostatic equation in combination with measured or assumed values of pressure and composition.

Method of calculation

The basic method followed here, to derive density values from satellite observations, has been described in detail by one of us (Sterne, 1958). The procedure calculates initially the expected daily change in the mean orbital distance, a, for a standard model atmosphere. For this purpose, the ARDC Model Atmosphere (Minzner and Ripley, 1956), as extended by Sterne (1958), was used.

If this change per day is $\dot{a}$, and if P is the period, then it follows from Kepler's third law that

$$\dot{P}/P=3\dot{a}/2a$$

so that the expected change in period per day is

$$\dot{P}_e=3\dot{a}P/2a.$$

If ρ_s (z) is the standard model density of the atmosphere at altitude z, and if the observed change in period per day is $\dot{P}_0$, then an atmospheric structure whose density is $(\dot{P}_o/\dot{P}_e)\rho_s$ (z) would lead to the observed change of period. Thus one can infer from the observed change of period, $\dot{P}_0$, that the density near the altitude of perigee is $(\dot{P}_o/\dot{P}_e)$ ρ_s (z') where z' is the altitude of perigee. It is predominantly the altitude of perigee at which the density determines the change in period, since other parts of the orbit contribute but slightly to the definite integral whose value determines $\dot{a}$.

The equations used to find $\dot{a}$ are

$$\Delta a=-ca^2 2\int_0^\pi \frac{\rho}{\rho_0}\frac{1+e\cos E)^{3/2}}{1-e\cos E)^{1/2}}dE$$

where c is the dimensionless quantity

$$c=C_D A\ \rho_0\ a_e/m\ .$$

In these equations a is the mean distance in units of the earth's equatorial radius, Δa is the change in a per period, ρ is the standard air density, ρ_0 is the air density at sea level, e is the orbital eccentricity, E is the eccentric anomaly, C_D is the aerodynamic drag coefficient, A is the average cross section of the satellite as projected on a plane normal to the direction of motion, a_e is the earth's equatorial radius, and m is the mass of the satellite.

The integral has been evaluated by Simpson's rule. C_D has been assigned the value 2, which it is expected to have for spherical satellites when the mean free path of the air molecules is very large compared to the diameter, regardless of whether the molecules are perfectly reflected or are captured. For shapes other than spheres, the cross section A is obtained by estimating the total superficial area and dividing by 4, on the assumption of random orientations during flight of the nonspherical satellites. It can be proved generally that the value of A, averaged over all orientations, of any convex body is exactly one-fourth of the total superficial area. The value of C_D is expected to be 2 for sticking molecules, and all shapes; for perfectly reflected molecules and nonspherical shapes the value need not be 2, but calculations have indicated that for typical rocket-like shapes the average value over all orientations of $C_D A$ is close to the figure $2(A_{total})/4$. Thus the value of C_D has been taken to be 2 in all cases.

Observational data

The data used for numerical solutions were taken from the two preceding reports as well as from precisely timed local observations made by one of us (Sterne).

For Satellite 1957 $\alpha 2$, the data on Harvard Announcement Card 1380 (1957b), as derived by Herget, Clemence, and Duncombe, gave:

$$a=1.086$$
$$e=0.0482$$
$$\dot{P}=-2^{s}.4 \text{ per day}$$
$$\text{Altitude at perigee}=220 \text{ km}.$$

The mass of the satellite was taken as 83.6 kg and the diameter as 58 cm. The value of 6.378×10^8 cm was used for a_e, and ρ_0, the density at sea-level, was taken as 1.225×10^{-3} gm/cm^3. With allowance for antennas, an average cross-sectional area of 3470 cm^2 was used.

For Satellite 1957 $\alpha 1$, the last rocket stage of the first U. S. S. R. satellite, the observations of one of us (Sterne) indicated a period change of $-4^s.0$ per day, when a was 1.089 and e was 0.051; compare the values obtained by Slowey, Lautman and McCrosky, Harvard Announcement Card 1375 (1957a). This orbit was so close to that of Satellite 1957 $\alpha 2$ that the same definite integral could be used, with a different c.

A value of 3.4×10^6 gm was used for the mass of the rocket, and A was taken as 1.86×10^5 cm^2, a fourth of the estimated total area of the rocket. These last two values are based on speculative assumptions and estimates described in the preceding report and must be considered of low reliability and accuracy.

For Satellite 1957 $\beta 1$, again of rocket shape, Dr. Whitney's determination of $-1^s.44$ per day for $\dot{P}$, his a of 1.146 and his e of 0.0965 were used (private communication). On the basis of the previously mentioned considerations, the same c was used as for Satellite 1957 $\alpha 1$.

Preliminary results

Using the observational data given above, we obtained approximate correction factors (shown below) for the ARDC model atmosphere for air density near the altitudes of perigee:

Object	Altitude of perigee, z'	Correction factor $\rho(z')/\rho_s(z')$	Absolute density, $\rho(z')$
1957 $\alpha 2$	220 km	8.7	4.5×10^{-13} gm/cm^3
1957 $\alpha 1$	220 km	11	5.7×10^{-13} gm/cm^3
1957 β	233 km	6.7	2.2×10^{-13} gm/cm^3.

While little reliability can be claimed for the densities inferred from Satellites 1957 $\alpha 1$ and β, since the shape and size of these rockets are matters of speculation, the result based on observations of $\alpha 2$ is believed to be reliable. The numerical values are considerably higher than those given by most model atmospheres, although they are smaller than the densities computed by Grimminger (1948) predominantly on the basis of the available information from meteor observations. We shall also want to note that, during the last few years, ideas about high altitude density have been influenced greatly by an isolated measurement of density at an altitude of 219 km, obtained during the Viking flight of Aug. 7, 1951, at White Sands, N. Mex. This flight gave a value of 1×10^{-13}-gm/cm^3 at 219 km.

Conclusions

We have shown that available information on orbital characteristics for Satellites 1957 $\alpha 1$, $\alpha 2$, and β implies that the values of atmospheric density at altitudes of 220 km and 233 km are higher than are expected on the basis of the ARDC Model Atmosphere (Minzner and Ripley, 1956). The orbital data stem from ground-based satellite observations made by radio, visual, and photographic means. Although the calculations involve speculative assumptions, the numerical results are reasonably consistent among themselves.

We expect that future period changes and orbital data will permit the inference of atmospheric density over a range of altitudes, and the devising of an improved atmospheric model.

Acknowledgments

We wish to stress that our study has made use of the efforts and data contributed by a large number of people. The many scientists, technicians, amateur astronomers and laymen who furnished observational data are certainly too numerous to mention by name. The brunt of the work of calculating orbital elements and ephemerides was performed by Drs. R. E. McCrosky and C. A. Whitney with their computer staff. Dr. F. L. Whipple has contributed valuable suggestions on selecting most reasonable basic data as well as on taking antenna drag effects into account.

Our acknowledgment and appreciation must go to all our co-workers in this task of observing satellites, computing orbital data, and attempting to derive scientific results.

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Abstract

On the basis of available orbital data for the U. S. S. R. Satellites 1957 α1, α2, and β1, preliminary values of atmospheric density have been calculated for the respective perigee altitudes. The computations necessarily involve a number of speculative assumptions with regard to mass-area ratios, but the results show a reasonable consistency in numerical values derived from the three satellites independently.

It would appear that the atmospheric density at altitudes between 220 km and 230 km is higher than has often been assumed. While the values derived here must be considered as being of an extremely tentative nature, it is expected that similar methods of calculation will in future permit the inference of atmospheric density over a wide range of altitudes from orbital data.

Glossary of Astronomical Terms for the Description of Satellite Orbits[1]

By J. ASHBROOK,[2] G. F. SCHILLING, and T. E. STERNE

The present report contains simple explanations of some astronomical terms, notations, and symbols frequently used to describe the orbital motions of artificial earth satellites. This terminology seems little known to non-astronomical researchers, but the advent of artificial satellites has brought these terms to our daily attention.

In addition we include the reprint of a recent article by Sterne, discussing various aspects of the celestial mechanics of artificial satellites. It is hoped that the report will be found useful for reference purposes.

List of Terms

Index of Symbols

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 4, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Nov. 30, 1957.

[2] Research associate, Harvard College Observatory.

Glossary

Time.—**1.** In astronomical usage, time is ordinarily expressed as *Universal Time* (UT). This is identical with Greenwich civil time, and is counted from 0 to 24 hours, beginning with Greenwich midnight. Very frequently the astronomer uses a decimal subdivision of the day, instead of hours, minutes, and seconds. Thus,

November 30. 75 UT=
November 30^d 18^h 00^m UT=
November 301800 Z=
November 30, 1:00 p. m. EST.

Celestial sphere.—**2.** The *celestial sphere* may be regarded as a sphere of infinite radius whose center is the center of the earth, and upon which appear projected the stars and other astronomical bodies. This sphere is fixed in space, and thus, because of the earth's rotation, appears to rotate from east to west.

3. The *celestial equator* is the great circle on the celestial sphere formed by its intersection with the plane of the earth's equator. The *north celestial pole* is the point of intersection of the earth's axis of rotation with the celestial sphere.

4. The *ecliptic* is the great circle on the celestial sphere formed by its intersection with the plane of the earth's orbit. The ecliptic is hence the apparent annual path of the sun among the stars.

5. The *vernal equinox* is the point of intersection of the celestial equator with the ecliptic through which the sun passes the equator from south to north. Roughly speaking, it is the position of the sun about March 21 of each year.

Coordinates on the celestial sphere.—**6.** Polar coordinates are useful for specifying the location of a star (or other heavenly body) on the celestial sphere.

7. The *declination* (δ) of a star is its angular distance north or south of the celestial equator.

8. The *right ascension* (α) of a star is the angular arc measured eastward along the celestial equator from the vernal equinox to the great circle passing through the north celestial pole and the star. Right ascension is often expressed not in degrees but in hours, minutes, and seconds ($1^h=15°$), because clocks are used in the fundamental measurement of a star's right ascension.

9. For an artificial satellite, or other relatively nearby heavenly body, we must distinguish between *geocentric coordinates*, as would be seen from the center of the earth, and *topocentric coordinates*, as seen from a position on the earth's surface. A directly observed position of a satellite is topocentric.

10. The difference between the geocentric and topocentric positions of a satellite in the sky is called the *topocentric parallax* of the satellite.

Orbital elements of a satellite.—**11.** The elliptical orbit of a satellite attracted by an exactly central inverse-square force can be unambiguously specified by a set of 7 parameters known as the *elements* of the orbit. Let the lengths of the longest and shortest diameters of the ellipse be $2a$ and $2b$, respectively; call the center of the ellipse C, and let F be the focus occupied by the earth, which for the time being we shall regard as a point mass.

12. Two elements specify the size and shape of the ellipse—the *semi-major axis*, a, often called the *mean distance*, and the eccentricity, e. The semi-major axis of an earth satellite orbit is usually expressed in units of the equatorial radius of the earth (about 6378 km). The eccentricity is numerically equal to $\overline{FC}/a$ or to $(a^2-b^2)^{1/2}/a$. For a circular orbit $e=0$; for an elliptical orbit $0\leq e\leq 1$; for a parabola e would be unity.

13. Two elements specify the orientation in space of the orbital plane of the satellite—the *inclination*, i, and the *right ascension of the ascending node*, Ω. The inclination is the angle between the orbital plane and the earth's equatorial plane (or celestial equator). The two intersection points of the orbit plane and the celestial equator are the *nodes* of the satellite orbit; the *ascending node* is that intersection at which the satellite passes the equator from south to north. Hence Ω is the arc, measured eastward along the celestial equator, from the vernal equinox to the ascending node.

14. A fifth orbital element, the *argument of the perigee*, ω, is the angle, as seen from the focus F of the ellipse, from the ascending node to the perigee point (closest approach of satellite to focus). The angle ω lies in the orbital plane, and is measured in the direction of the satellite's motion.

15. A sixth element, T, is the time of passage through perigee, or *epoch of perigee.*

16. Lastly, P is the orbital *period.* If the orbit is ideal and unchanging, the period is simply the interval between successive passages through any fixed point of the orbit. However, if the orbit is not ideal, we must specify which point (see below, p. 216).

17. Instead of the period, we may use for the seventh element the *mean motion*, $n=2\pi/P$. It is sometimes designated by μ. The mean motion is related to a by *Kepler's Third Law,* which for a satellite of negligible mass is $n^2 a^3=mG$. Here m is the mass of the earth, and G the gravitational constant.

18. Two comments on the elements ☊, i, and ω should be made. First, the plane of reference by which these have been defined is the earth's equator; i. e., we use *equatorial elements.* However, the same symbols are habitually used in celestial mechanics textbooks for *ecliptic elements*, defined in terms of the ecliptic as the reference plane.

19. Second, the vernal equinox is shifting about 50″ eastward along the equator per year (*precession of the equinoxes*). Hence, to specify ☊, i, and ω unambiguously, a published set of orbital elements will attach a date (e. g., 1957.0) to these elements for identifying the location of the equinox.

Relation between place in orbit and time.—**20.** The *radius vector*, r, of the satellite is its distance, at a specified time, from the center of the earth. The minimum value of r is the *perigee distance*, $a(1-e)$; its maximum value is the *apogee distance*, $a(1+e)$.

21. The satellite's position in its orbit at any time, t, is specified by the polar coordinates r and v. The latter is the angle at the focus between the perigee point and the satellite, and is known as the *true anomaly* of the satellite. It is also often called w. Radius vector and true anomaly are related:

$$r=a(1-e^2)/(1+e\cos v).$$

22. To find the true anomaly at time t we may first compute the *mean anomaly*, M.

$$M=n(t-T)$$

23. Next, the co-called *eccentric anomaly*, E, is computed by *Kepler's equation*:

$$M=E-e\sin E$$

From E, we get the true anomaly by

$$\tan\frac{1}{2}v=(1+e)^{1/2}(1-e)^{-1/2}\tan\frac{1}{2}E.$$

(For a systematic explanation of these matters, consult F. R. Moulton, "An Introduction to Celestial Mechanics," 2nd edition, pp. 158–172.)

Perturbations of a Satellite Orbit.—**24.** Because of noncentral forces arising from the nonsphericity of the earth and from atmospheric drag, the motion of a close earth satellite will deviate from an ellipse. These deviations are called *perturbations.*

25. It is often convenient to consider the orbital motion to be in an ellipse whose elements are changing with the time. These changes, or perturbations, can be *secular* or *periodic.* The effect of the earth's oblateness on the satellite's ascending node is, primarily, to cause it to move irregularly westward, so that ☊ is decreasing. The steady part of this motion is an example of a secular perturbation. There are also periodic perturbations of ☊ that can be expressed analytically by the sum of trigometric terms in which time is the independent variable. The effect of air resistance on ☊ is to cause small periodic perturbations.

26. If we regard the satellite at any date as occupying a position in some ellipse changing continually in size, shape, and orientation, then the ellipse most commonly considered is one called the *osculating orbit* for the date, or *epoch of osculation*, t. The osculating orbit is defined as the ellipse that the satellite would follow after t, if all forces other than central inverse-square forces ceased to act from time t on. The osculating orbit can be specified by a set of 7 parameters, the *osculating elements.*

27. In the absence of perturbations, the period, P, defined as the interval between successive passages of the satellite through the same point in its orbit would be the same no matter which point was chosen. But if there are non-central or non-inverse square forces, the orbit is perturbed, and the numerical value of the period will depend on the reference point selected. Three different periods are of practical importance. The *anomalistic period* is the interval between successive perigee passages. The *nodical period* is measured from one return of the satellite through its ascending node to the next. The *sidereal period* is the interval which elapses between two successive returns of the satellite to the same geocentric right ascension.

Celestial Mechanics of Artificial Satellites

An article by T. E. Sterne entitled "Celestial Mechanics of Artificial Satellites" (Sky and Telescope, vol. 17, p. 66, 1957) is reprinted here with the permission of Sky Publishing Company:

Vast numbers of people have been following the careers of the new astronomical bodies launched into space on October 4, 1957. The motions of the faint satellite and its associated bright rocket have provided excellent illustrations of celestial mechanics, and have aroused a widening interest in that astronomical specialty.

Were Isaac Newton still alive today, he would appreciate this practical application of the conclusions he reached nearly 300 years ago, concerning the precise dependence of the orbit of a projectile on its launching conditions. He would have welcomed the physical realization of some of the drawings in his *Principia Mathematica*, in one of which a satellite is launched from a cannon on a mountain-top. Doubtless his remarkable geometrical insight would have enabled him to make some very early predictions by ruler, compass, and pencil, without reliance on a digital electronic computer.

A basic concept of celestial mechanics is that the path of a lightweight body or satellite around a massive particle is a conic section with the massive particle at its focus, if the light body is attracted by a gravitational force varying as the inverse square of the distance and directed toward the massive particle.

Motion in an Elliptical Orbit

Unless the launching velocity is too great, the orbit is an ellipse, such as that diagrammed here [Fig. 1*a*], with the *semimajor axis* BC denoted by a. The distance from the center, C, to the focus, F, is ae, where e, a number less than one for an ellipse, is called the *eccentricity* of the orbit. The length of the *semiminor axis*, CD, is then $a\ (1-e^2)^{1/2}$. The end A of the major axis that is closer to the focus is called the *pericenter*, and the other end B is the *apocenter;* for an earth satellite we may use the more specific names *perigee* and *apogee*.

When the satellite is at any point, P′, in its orbit, the angle AFP′ is called the *true anomaly*, measured in the direction of motion and often denoted by w. As the satellite moves, the area AFP′ (bounded by two straight lines and an elliptical arc) increases uniformly with the time—an illustration of Kepler's second law. The complete time, P, for one revolution is called the *period*, and $2\pi/P$ is the *mean motion*, n; it is the average angular motion, here expressed in radians, of the satellite during the unit of time.

Kepler's third law gives us a simple relation between the mean motion and the length of the semimajor axis of the orbit.

$$n^2a^3=mG. \tag{1}$$

Here m is the mass of the massive particle and G is the constant of gravitation. If the particle has the earth's mass, if we express distance in units of the earth's equatorial radius (6,378,388 meters), and if time is put into units of 806.83 seconds, then the numerical value of mG is unity.

The distance, FP′, of the satellite from the center of the earth, is called the *radius vector*, r. It is related to w, a, and e by the equation,

$$r=a(1-e^2)/(1+e\cos w). \tag{2}$$

If T is the time of the satellite's perigee passage and t is any other moment of time, the product $n(t-T)$ is called the *mean anomaly*, M. We may visualize it as an angle that is zero at perigee and increases uniformly at a rate of 360 degrees per orbital period.

Forecasts of w and r can now be made for any instant t by means of the three formulae

$$M=E-e\sin E, \tag{3}$$

$$\tan \tfrac{1}{2}w=(1+e)^{\frac{1}{2}}(1-e)^{-\frac{1}{2}}\tan \tfrac{1}{2}E, \tag{4}$$

$$r=a(1-e\cos E). \tag{5}$$

The angle E, which is calculated as an intermediate step by Equation 3, known as Kepler's equation, is called the *eccentric anomaly*.

The Orbit in Space

So far we have discussed only motion in the orbital plane. The next step is the description of the orientation of the orbit in space. For an earth satellite, the most convenient reference system is the set of rectangular axes in the above figure [Fig. 1*b*]. The origin, O, is the center of the earth; XOY is the plane of the earth's equator; OX points to the vernal equinox and OZ toward the north celestial pole.

The satellite's orbit plane intersects the equatorial plane in the line of nodes, ON, and if N is where the satellite crosses the equator from south to north it is called the *ascending node*. The angle XON is the right ascension of the ascending node, and is denoted by Ω. Furthermore, if OZ′ is the pole of the orbit, in which the satellite's motion appears clockwise to someone sighting upward along OZ′, then the angle ZOZ′ is the *inclination*, i, of the orbit. Thus, the two angles, Ω and i, specify the orientation of the orbital plane in space.

The angle NOA, measured in the direction of the orbital motion, defines the position of the perigee, A, and is called ω. The *elements* of the satellite orbit are

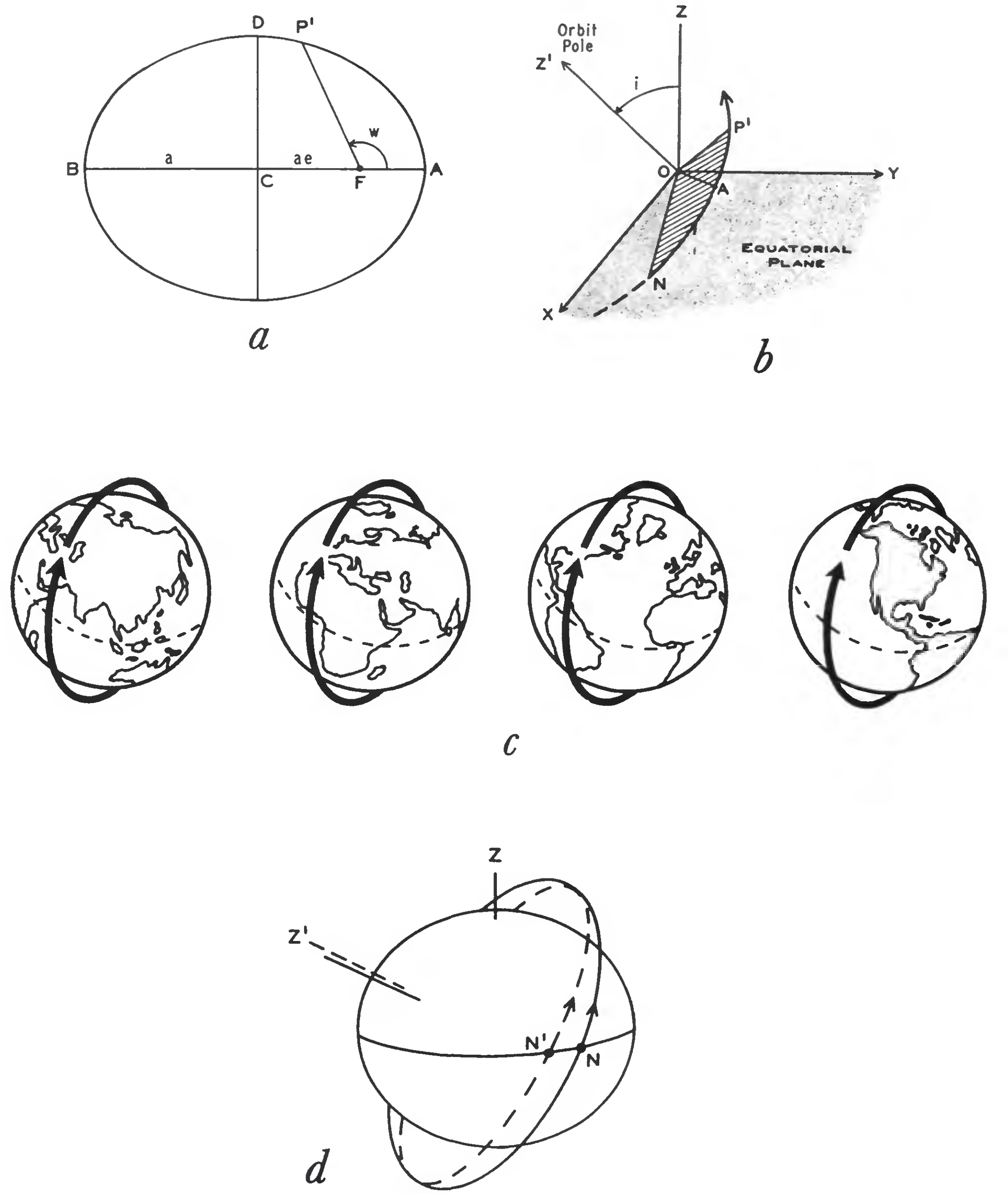

FIGURE 1.—Satellite orbits. *a:* The elliptical orbit of a particle *P′* around mass point *F* is the simplest model of an artificial satellite's motion. *b:* The arc *NAP′* is a portion of the satellite's orbit, specified by the orbital elements defined in the text. The angle *AOP′* is the true anomaly, corresponding to *AFP′* in the diagram of figure 1*a*. *c:* The plane of the satellite orbit remains fixed in space (except for the effects of perturbations) while the earth turns on its axis within the orbit. These diagrams, based on releases from Moscow, show every third circuit of the first artificial satellite over Russia, western Africa, United States, and the eastern Pacific Ocean. *d:* Our globe's spheroidal shape causes the satellite's orbital plane to turn slowly westward around the earth's axis. Thus, if one revolution about a nonrotating earth carries the satellite over the equator at *N*, on its next circuit it will cross at *N′*.

the numbers a, e, T, Ω, i, and ω, which describe it completely and unambiguously.

An early set of elements determined for the third-stage rocket of the first satellite is reproduced below (Harvard College Observatory Announcement Card 1375). Instead of T, the time of perigee passage, the true anomaly w is given for a time called the *instant of osculation*, whose significance will be discussed later. These elements are referred to the earth's equator, and thus are equatorial elements; for comets and asteroids the same symbols are used for the corresponding elements referred to the plane of the ecliptic. By convention, the elements were given on the card to more digits than observational accuracy demanded.

Predicting a Satellite's Position

The six elements are the same in number as the three co-ordinates of position and the three components of velocity required to specify the launching conditions completely. Newton showed how the elements could be inferred from the circumstances of launching.

Conversely, once the elements are known, the right ascension α, the declination δ, and the radius vector r of the satellite can be predicted for any time. We have already seen the equations for calculating w and r. Next, the right ascension and declination of the satellite are given by

$$\alpha=\Omega+\arctan\,[\cos i \tan(\omega+w)], \tag{6}$$

$$\sin\delta=\sin i \sin(\omega+w). \tag{7}$$

It should be emphasized that the two formulae just given apply only for an observer at the center of the earth, or to one directly beneath the satellite. But we wish to predict its position at any particular time for an observer at any selected place on the earth's surface. To do this we must find the x, y, z co-ordinates of the satellite and subtract them from the x', y', z' co-ordinates of the observer in the same equatorial system of co-ordinates. From the differences of these quantities, we can obtain the apparent right ascension and declination of the satellite.

HARVARD COLLEGE OBSERVATORY

ANNOUNCEMENT CARD 1375

Satellite 1957α1.—Mr. Jack W. Slowey, Dr. Don A. Lautman, and Dr. Richard E. McCrosky of the Astrophysical Observatory of the Smithsonian Institution in Cambridge, Massachusetts, have obtained the following equatorial elements and perturbations for Satellite 1957α1:

a = 1.0890751 Earth
e = 0.0510696
i = 64°.26012
Argument Perigee = 61°.77894
Ω = 327°.33288

True Anomaly 266°.40725
Instant Osculation 1957 October 9.40466

The period appears to be shortening appreciably.

October 15, 1957 Fred L. Whipple

The equatorial co-ordinates of the observer on the surface of a spherical earth of unit radius are

$$x'=\cos\phi\cos\theta, \tag{8}$$
$$y'=\cos\phi\sin\theta, \tag{9}$$
$$z'=\sin\phi, \tag{10}$$

where ϕ is his latitude and θ is his local sidereal time.

The co-ordinates of the satellite are

$$x=r\cos\delta\cos\alpha, \tag{11}$$
$$y=r\cos\delta\sin\alpha, \tag{12}$$
$$z=r\sin\delta. \tag{13}$$

Then the apparent right ascension α', apparent declination δ', and the distance ρ of the satellite from the observer are computed from

$$x-x'=\rho\cos\delta'\cos\alpha', \tag{14}$$
$$y-y'=\rho\cos\delta'\sin\alpha', \tag{15}$$
$$z-z'=\rho\sin\delta'. \tag{16}$$

These formulae do not allow for the earth's flattening or the observer's elevation above sea level, but these considerations merely make his co-ordinates slightly harder to calculate.

Perturbations of a Satellite

In our discussion of Equation 1, we assumed the massive particle at the center of attraction to have the earth's mass. The application of the formulae would not be changed by the earth's finite size, if the earth were spherical. In reality, however, the earth is not a sphere, and its equatorial radius exceeds its polar radius by about one part in 297. Consequently, the satellite is attracted to the earth by a net force that does not vary exactly as the inverse square of the distance from the earth's center, and the force is not directed exactly toward the center of the planet.

Therefore, it is only as a first approximation that the satellite is attracted as if our planet were replaced by a particle at its center with the same mass as the earth. For an improved, second approximation, we must allow for the attraction by the extra matter near the earth's equator and for the missing matter near the poles. Qualitatively speaking, the extra material attracts the satellite toward the equator, trying to rotate the orbit in the sense of decreasing the inclination about the line of nodes.

As with a gyroscope, however, the resultant effect is not to decrease the inclination, but to cause the axis of the orbit to revolve slowly about the earth's polar axis. In consequence, the right ascension of the node, Ω, gradually decreases. Refer to the diagram [Fig. 1*d*] above, where during the course of one revolution of the satellite the node has shifted from N westward to N′.

Another effect of the earth's oblateness is to cause the perigee point to move along the orbit, so that ω is not constant. Consequently, the satellite has three different periods instead of one, yet none of these periods corresponds to what would be predicted from the value of a given by Equation 1.

1. Radial or *anomalistic* period, from one perigee passage to the next, 95.98492 minutes for the orbital elements cited above.

2. *Nodical* period, between successive passages of

the satellite through the ascending node, 95.98863 minutes.

3. *Sidereal period*, of a complete revolution in right ascension, 96.04659 minutes.

Astronomers have in general two ways of studying the effects of disturbing forces on planet and satellite motions: special and absolute perturbations. In special perturbations, the exact equations of motion are integrated step by step by numerical methods, perhaps with large electronic digital computing machines that make the work much less tedious. For an artificial satellite, rapid calculation is necessary to keep up with the changing characteristics of the orbit.

Without disturbing forces, the orbital elements would be true constants, but when such forces are acting the elements vary with time. If, at a moment to be called the instant of osculation, all disturbing forces were removed, the satellite would travel in an elliptical orbit described by *osculating elements*. The elements of Harvard Announcement Card 1375 are of this sort.

In reality, the continued action of the disturbing forces causes the osculating elements to fail to represent the actual motion, but the theory of absolute perturbations allows the calculation of the changes of the elements with time. Thus, the position of the satellite can be computed by the usual formulae for a later time, using the changed values of the elements.

Some of these changes in the elements are periodic, others gradual. For the third-stage rocket of the first satellite, the predicted change in Ω is -3.25 degrees per day, calculated on the assumption that the earth's flattening is 1/297. A discrepancy between the observed and predicted behavior would mean that this value for the flattening could be improved. There is no convincing evidence of this yet.

Air resistance or *drag* can have marked effects on the motion of a satellite near the earth's surface, as observations of the first rocket show. Paradoxically, air resistance speeds up a satellite, by forcing it to fall into a smaller orbit, where the decreased value of a requires the period to be shorter. Thus, the nodical period of the Soviet rocket had been decreasing by roughly four seconds per day during the month of October.

For an atmosphere like the earth's whose density decreases markedly with elevation, the apogee distance, $a(1+e)$, will decrease much more rapidly than the perigee distance $a(1-e)$. The mean distance a decreases with time, the eccentricity e also decreases, but the position of the perigee is subjected by air drag to small periodic perturbations only.

Near the end of October, the apogee height of the third-stage rocket was about 500 miles, the perigee about 130, and the mean height about 315. There has not been a good separation of apogee rate from perigee rate, but the rate of change of the mean distance is well determined from the decreasing period. If the time decrease of the perigee distance was very much slower than that of apogee, as theory indicates it should be, then the apogee was falling at a rate of nearly four miles a day.

Calculations showed that the apogee would continue to descend faster and faster, until the orbit was nearly circular. Thereafter, perigee and apogee should descend at nearly equal rates, and the end of the rocket's celestial career would be near. The details of these progressive changes in the orbital elements caused by drag may yield valuable information about atmospheric densities at great heights, when analyzed by those who know the size and shape of the rockets.

Soviet Orbit Predictions and Orbital Information For Satellites 1957 α1, α2, and Beta [1]

By G. F. Schilling and E. S. Fergusson [2]

This report continues the collection and presentation of orbital information released by the U. S. S. R. Consecutive tables list Soviet predictions of satellite passages over or near world points, as received at the Astrophysical Observatory. Pertinent data on orbital characteristics are summarized in tabular form, classified for different parameters. In addition, a few excerpts from general technical information are collected separately.

It will be understood that our principal purpose is to make available raw data which may be considered of lasting significance with respect to orbit evaluation. It should be emphasized, however, that the information listed must not be considered a complete compilation.

Soviet orbit predictions

Tables 1 to 39 contain information released by Moscow radio and newspaper services. The values are predictions of satellite passages over or near world points. All times and dates are Moscow time throughout (GMT plus 3 hours).

Orbital information from U. S. S. R.

Number of revolutions and distance travelled.—On October 13 the U. S. S. R. started releasing information about the number of revolutions, the distance between α1 and α2, and the distances travelled; in general the values are stated as approximate (see table 40). On November 5 the U. S. S. R. started releasing similar information on satellite 1957 Beta (see table 41). In the tables, the available data are posted against the date and approximate time for which the statement or prediction is made, and not against the release date. The explicit methods of analysis and computations applied by Soviet scientists to prepare this information are not known to us.

Satellite periods.—On October 20 the first of a series of occasional releases on the periods of the various satellites appeared (see table 42). No numerical information has been given about period changes.

Zones of visibility.—On October 28 the U. S. S. R. started what later became a series of daily releases giving the latitude zones for twilight passages, first for α1, and later also for Beta (see table 43).

The tabular listing of all data is not necessarily complete since it is based on information available at the present time. In order to conserve the full nature of the raw data, typographical errors have not been corrected, except where the nature of the error was such that correction could be made with complete assurance.

Information released by U. S. S. R.

Since the launching of the first artificial earth satellite, the U. S. S. R. has issued numerous press releases containing material of interest to the general reader. Excerpts from some of these are given here because they contain technical comments and information relating to orbit characteristics.

Pravda articles

On Oct. 9, 1957, the Moscow newspaper "Pravda" published a long article of general interest on the first artificial earth satellite, 1957 Alpha; it included limited orbital information and general descriptive material on the satellite, radio and optical tracking programs, and the various experiments undertaken.

On Nov. 13, 1957, "Pravda" published a long article on the second artificial earth satellite, 1957 Beta, which also contained a number of references to the first satellite. This article specified that the second satellite was launched

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 5, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Dec. 4, 1957.

[2] Executive Officer, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory (now Project Engineer, Harvard Radio Meteor Project, Harvard College Observatory).

"in accordance with the plan of scientific work carried out under the IGY program."

According to this article:

> . . . it became possible to make and place into an orbit a satellite with a useful weight of 508.3 kg, six times heavier than the first satellite. Moreover, the second satellite was launched into an orbit considerably further removed from the surface of the earth than the orbit of the first.

The apogee distance is given as some 1700 km, almost twice that of the first satellite, and the initial period as 103.7 minutes.

From data gathered by Nov. 10, 1957, the period of $\alpha 1$ (carrier rocket) was approximately 74 seconds less than that of $\alpha 2$ (the satellite) and its apogee lower by over 100 km. An altitude of 100 km is given as the approximate height for the death of these bodies. A life of three months—until the end of 1957—is predicted for the satellite, with a substantially shorter life predicted for the carrier rocket. It is further predicted, on the basis of the longer initial period and smaller resistance effects because of a different mass-area relationship, that 1957 Beta will have a considerably longer life than $\alpha 2$. It is stated that study of orbital data will yield important information about upper atmosphere densities.

> As a result of optical observations, it has emerged that the carrier rocket changes in brightness. This is due to the changes of its orientation in space. The shortest recorded visual period of change in brightness amounts to approximately 20 seconds.

It is stated that 66 "Soviet Optical Observation Stations," all Soviet astronomical observatories, and some 30 foreign observatories ". . . are systematically taking part in the optical observations . . ." of $\alpha 1$, $\alpha 2$, and Beta. The brightness of $\alpha 1$ and Beta permits the use of balloon theodolites as aerological stations. Photo tracking by Soviet and foreign observatories is also being used. In addition, there is extensive radio tracking.

Scientific apparatus of Satellite 1957 Beta.—The satellite has a "useful weight of 508.3 kg, six times heavier than the first satellite." It is equipped with apparatus to study:

- Cosmic rays
- Ultraviolet and x-ray part of solar radiation
- Hermetically sealed cabin containing an experimental animal—a dog
- Radio telemetrical apparatus
- Radio transmitting equipment
- Necessary sources of electrical power.

Additional information stated:

> The total weight of the equipment of the experimental animal and of the sources of electric power supply on the second artificial satellite represents 508.3 kg.
>
> In the front, it has a special frame with instruments to study the sun's radiation in the ultraviolet and Roentgen bands of the spectrum, a spherical container with transmitter and other equipment, and a pressurized cabin containing an experimental animal. The instruments for studying cosmic rays are mounted on the rocket's body.
>
> The instrument and container mounted on the frame were protected from aerodynamic and thermal influence by a special protective cone which was jettisoned.
>
> The transmitters were placed in a spherical container. The electric pile for it, the system of thermal controls, as well as the sensitive elements registering the fluctuations of temperature and other parameters were also enclosed there. The design of the spherical container resembles the first Sputnik.

A description of the animal container was as follows:

> The pressurized cabin containing the experimental animal is cylindrical in form. It contained food and an air-conditioning system consisting of a regenerative installation and a temperature control device. The cabin also contained instruments for registering pulse, respiration, blood pressure, equipment for taking electrocardiograms, and sensitive elements for measuring several parameters characterising the condition in the cabin.

The systems of temperature control mounted in the spherical container and the animal's cabin maintained the temperature within them at a set level through forced circulation of gas. The temperature on the outer surface, and within the animal's cabin, as well as the temperature of the instruments and the parts of the Sputnik was determined with special temperature recorders mounted on them.

Three special photoelectronic multipliers placed at an angle of 120 degrees to each other serve as radiation receivers. The electrical signals given by the photomultiplier trained on the sun were amplified by radio circuits and transmitted to earth. To economize electricity, the devices were switched on only when the sun came into the field of vision of one of the three light receivers.

Launching sequence.—Editorial comments in *Pravda* contained the following statements with regard to the placement of the satellites into orbits: The rocket was launched vertically upward for the first 1 to 2 km, then gradually inclining toward the horizon. When speed reached 5 km/sec, the rocket was flying almost horizontally. Only after reaching the set height, did it develop a speed in the range of 8 km/sec.

The second satellite was launched by multistage rocket. Speed imparted to the last stage exceeded that necessary for the satellite's movement along a circular orbit at a constant altitude corresponding to that at which it was placed into the orbit. Therefore, the satellite moves in an elliptical orbit.

Rocket bodies.—The body of the first Sputnik was made of aluminum alloys, sufficiently resistant, polished, and subjected to special processing. Heat resisting alloys were used for the lining of the rocket to overcome aerodynamic over-heating (during launching).

Both the animal's cabin and the spherical container of the second Sputnik were made of aluminum alloys. Their outer surfaces were polished and subjected to special treatment intended to give them the necessary coefficients of radiation and absorption of solar rays.

Interviews

On Nov. 22, 1957, Vitaly Ginsburg stated that the artificial earth satellites present important opportunities for study of relativistic effects; he believes it will be possible to check the following effects and the General Theory of Relativity:

1. Cosmic time lag relative to earth.
2. Displacement of elliptical orbits of heavenly bodies resulting from gravitational disturbances.
3. Existence of extragravitational fields resulting from rotation of large bodies on their own axes.
4. Gravitational displacement of the frequency of electromagnetic waves.

On Dec. 4, 1957, Professor Stanyukovich asserted that 1957 Beta was launched at 65 degrees so ". . . it will be least affected by the earth's gravity. Furthermore . . . this makes it possible to observe it all over the world."

He gives a lifetime for 1957 Beta extending at least until February 1958, and possibly much longer.

Table 1.--Predictions issued Oct. 23, 1957

Satellite 1957 Alpha (?)

October 24

Place	Time
Port Harrison	0909
Newfoundland	0913
Albany, Australia	1008
The Aleutians	1033
Ottawa	1050
New York	1051
Sao Paulo	1111
Bandung	1153
Manila	1159
Hiroshima	1204
Kansas City	1227
Rosario	1250
Rangoon	1335
Los Angeles	1404
Tierra del Fuego	1432
Bombay	1511
Delhi	1514
Yakutsk	1524
Johannesburg	1633
Ashkhabad	1651
Novosibirsk	1655
The Aleutians	1709
Graham Land	1752
Cairo	1825
Kuibyshev	1831
Yakutsk	1840
Samoa Islands	1905
Harper	1953
Budapest	2005
Moscow	2007
Khabarovsk	2021
Tokyo	2025
Tierra del Fuego	2110
Rio de Janeiro	2120

Table 2.--Predictions issued Oct. 25, 1957

Satellite 1957 $\alpha 2$

October 26

Place	Time
Kennecott	0846
Port Harrison	0853
Albany, Australia	0953
Fairbanks	1022
Washington	1034
Bridgetown, S. America	1043
Sao Paulo	1054
Bandung	1136
Shanghai	1146
Fort Nelson	1204
Lima	1226
Ulan Bator	1326
Los Angeles	1347
Delhi	1457
Vilyuisk	1507
Graham Land	1557
Johannesburg	1617
Addis Ababa	1626
Teheran	1634
Omsk	1638
Aleutian Islands	1652
Honolulu	1701
Ankara	1810
Rostov	1812
Perm	1815
Samoa Islands	1848
Vienna	1948
Warsaw	1949
Vladivostok	2006
Tokyo	2008

October 27

Place	Time
Panama	0023
Reykjavik	0039
Leningrad	0045
(Kabul)	0054
Madras	0100
Mexico City	0200
Chicago	0207
Reykjavik	0217
Oslo	0220
Kiev	0224
Baghdad	0230
Lake Harbor	0349
Madagascar	0420
Vancouver	0521
Coral Harbor	0526
Madrid	0539
Johannesburg	0559
Lake Harbor	0705
Dakar	0721
Melbourne	0806

Satellite 1957 $\alpha 1$

October 26

Place	Time
Carcross	0733
Adelaide, Australia	0842
Dutch Harbor	0906
Halifax, Canada	0922
Pernambuco	0939
Kurile Islands	1039
Petropavlovsk-Kamchatsky	1040
Cleveland	1058
Caracas	
Saigon	1203
Nanking	1210
Khabarovsk	1215
Anadyr	1220
Denver	1233
Santiago	1256
Calcutta	1342
Chita	1349
Anadyr	1357
San Francisco	1108
Alma-Ata	1522
Krasnoyarsk	1525
Dutch Harbor	1537
Capetown	1635
Teheran	1655
Omsk	1700
Magadan	1711
Ankara	1832
(----)	1835
Kazan	1838
Nikolayevsk	1848

October 27

Place	Time
Jose	0042
Reykjavik	0057
Leningrad	0103
Moscow	0104
Bombay	0116
Mexico City	0219
Chicago	0225
Oslo	0238
Kiev	0242
Los Angeles	0357
London	0416
Paris	0417
Lisbon	0555
Port Elizabeth	0618
Adelaide	0822
Aleutian Islands	0848

Table 2.--Predictions issued Oct. 25, 1957 (continued)

Satellite 1957 α2

October 26 Place	Time	October 27 Place	Time
Rio de Janeiro	2104		
London	2125		
Oslo	2127		
Ulan Bator	2140		
Nanking	2145		
Sydney	2206		
La Paz	2241		
Archangel	2307		
Saigon	2328		

Satellite 1957 α1

October 26 Place	Time	October 27 Place	Time
Algiers	2006		
Munich	2009		
Vladivostok	2026		
Tokyo	2028		
Wellington	2052		
Montevideo	2120		
Glasgow	2144		
Oslo	2146		
Archangel	2150		
Wuhan	2204		
Melbourne	2225		
La Paz	2300		
Bangkok	2343		

Table 3.--Predictions issued Oct. 26, 1957

Satellite 1957 α2

October 27

Place	Time
Kennecott	0835
Port Harrison	0842
Juan Pessoa	0903
Albany	0942
Fairbanks	1013
Washington	1025
Caracas	1033
Bandung	1126
Hangchow	1136
Khabarovsk	1141
Santiago	1223
Rangoon	1308
Chita	1317
Anadyr	1325
San Francisco	1336
Los Angeles	1337
Tierra del Fuego	1406
Delhi	1447
Vilyuisk	1456
Dutch Harbor	1505
Capetown	1603
Addis Ababa	1615
Ashkhabad	1624
Omsk	1628
Ust-Kamchatsk	1640
Ankara	1800
Rostov	1802
Perm	1804
Samoan Islands	1837
Algiers	1934
Vienna	1937
Moscow	1941
Vladivostok	1955
Tokyo	1957
Rio de Janeiro	2053
London	2114
Archangel	2119
Ulan Bator	2129
Nanking	2134
Canberra	2155
La Paz	2230
Archangel	2257
Omsk	2302
Saigon	2316

October 28

Place	Time
Panama	0013
Reykjavik	0028
Leningrad	0035
Moscow	0036
Madras	0050
Mexico	0151
Chicago	0157
Reykjavik	0206
Oslo	0209
Kiev	0213
Baghdad	0219
Los Angeles	0329
London	0349
Madagascar Island	0411
Vancouver	0510
Lisbon	0527
Johannesburg	0549
Coral Harbor	0653
Leek Harbor	0655
Adelaide	0756

Satellite α1

October 27

Place	Time
Dillingham	0848
Halifax	0902
Pernambuco	0919
Perth, Australia	0958
Petropavlovsk-Kamchatsky	1030
Detroit	1038
Caracas	1047
Kwangchow	1148
Nanking	1101
Chenyang	1153
Monterrey	1217
Santiago	1236
Calcutta	1322
Ulan Bator	1329
Anadyr	1337
Madagascar Island	1444
Karachi	1458
Alma-Ata	1502
Dutch Harbor	1517
Cape Town	1615
Baghdad	1634
Omsk	1639
Magadan	1650
Bata, Africa	1801
Istanbul	1812
Moscow	1815
Kirov	1816
Nikolayev	1827
Algiers	1945
Milan	1947
Berlin	1949
Leningrad	1950
Vladivostok	2004
Tokyo	2007
Buenos Aires	2059
Glasgow	2123
Archangel	2129
Taiyuang	2141
Wuhan	2143
Melbourne	2204
La Paz	2239
Archangel	2305
Karaganda	2111
Bangkok	2323

October 28

Place	Time
San Jose	0021
Reykjavik	0037
Leningrad	0043
Moscow	0044
Bombay	0057
Chicago	0205
Reykjavik	0214
Oslo	0218
Kiev	0222
Baghdad	0227
Baghdad	0227
Los Angeles	0337
Leek Harbor	0346
London	0355
Paris	0356
Madagascar Island	0419
Kanortalik	0526
Lisbon	0534
Lagos	0544
Port Elizabeth	0557
Coral Harbor	0659
Adelaide	0801

Table 4.--Predictions issued Oct. 27, 1957

Satellite 1957 α1

October 28

Place	Time
Dutch Harbor	0827
Pernambuco	0900
Albany	0938
Petropavlovsk-Kamchatsky	1001
Detroit	1019
Caracas	1028
Saigon	1125
Shenyang	1134
Khabarovsk	1136
Magadan	1138
Denver	1154
Santiago	1217
Calcutta	1303
Lanschow	1307
Ulan Bator	1310
Chita	1311
Anadyr	1318
Tierra del Fuego	1359
Madagascar	1425
Alma-Ata	1443
Vilyuisk	1449
Dutch Harbor	1458
Capetown	1556
Omsk	1620
Magadan	1631
Bata	1738
Ankara	1748
Moscow	1754
Kazan	1755
Kurile Islands	1810
Algiers	1922
Vienna	1925
Leningrad	1931
Vladivostok	1946
Tokyo	1949
Wellington	2011
Rio de Janeiro	2040
London	2103
Archangel	2110
Ulan Bator	2119
Melbourne	2144
Archangel	2247
Omsk	2252
Bangkok	2304
Albany	2318
San Jose	2358
Reykjavik	0018
Leningrad	0024
Moscow	0025
Madras	0037
Mexico	0135
Chicago	0142
Reykjavik	0155
Kiev	0202
Baghdad	0207
Los Angeles	0314
London	0335
Rome	0338
Vancouver	0452
Madrid	0514
Johannesburg	0532
Pearl Harbor	0638
Adelaide	0738

Table 5.--Predictions issued Oct. 28, 1957

Satellite 1957 α1

October 29

Place	Time
Dutch Harbor	0807
Tokyo	0934
Petropavlovsk-Kamchatsky	0939
Rio de Janeiro	1018
Shenyang	1110
Khabarovsk	1113
Santiago	1154
Hanchow	1244
Chita	1248
Tierra del Fuego	1337
Alma-Ata	1420
Krasnoyarsk	1424
Askhabad	1552
Omsk	1600
Ankara	1728
Rostov	1731
Moscow	1732
Kazan	1734
Algiers	1901
Vienna	1904
--ington	----
London	2040
Melbourne	2123
Newfoundland	2348

October 30

Place	Time
Chicago	0121
Los Angeles	0253
Winnipeg	0259
Madagascar	0336
Vancouver	0431
Port Elizabeth	0514
Kemp Land	0702
Dutch Harbor	0742

Table 6.--Predictions issued Oct. 29, 1957

Satellite 1957 α1

October 30

Place	Time
Dillingham	0747
Kemp Land	(0839)
Petropavlovsk-Kamchatsky	0919
Rio de Janeiro	0956
Pyongyang	1057
Vladivostok	1049
Khabarovsk	1051
Magadan	1055
Santiago	1133
Hanchow	1221
(Batotou)	1223
Erlian	1224
Ulan Bator	1225
Chita	1227
Kyzyl	1400
Ashkhabad	1530
Aralsk	1534
Omsk	1537
Ankara	1705
Rostov	1708
Kazan	1711
Tunis	1838
Vienna	1841
Moscow	1846
Wellington	1927
London	2017
Oslo	2022
Kalgoorlie	2233
Newfoundland	2325

October 31

Place	Time
Chicago	0058
San Francisco	0231
Winnipeg	0237
Vancouver	0412
Pretoria	0450
Kemp Land	0639
Dutch Harbor	0719

Table 7.--Predictions issued Oct. 30, 1957

Satellite 1957 α1

October 31

Place	Time
Kemp Land	0815
Petropavlovsk-Kamchatsky	0854
Rio de Janeiro	0933
Vladivostok	1025
Kiamusze (China)	1026
Magadan	1032
Buenos Aires	1110
Peking	1200
Erlian	1201
Ulan Bator	1202
Chita	1203
Tierra del Fuego	1250
Alma-Ata	1332
Krasnoyarsk	1338
Ashkhabad	1507
Omsk	1513
Ankara	1641
Stalingrad	1644
Perm	1649
Rome	1817
Budapest	1819
Moscow	1823
Wellington	1903
London	1954
Stockholm	1958
Canberra	2036
Melbourne	2212

November 1

Place	Time
Detroit	0034
Ottawa	0035
Winnipeg	0213
Seattle	0345
Port Elizabeth	0427
Capetown	0603

Table 8.--Predictions issued Oct. 31, 1957

Satellite 1957 α1

November 1

Place	Time
Dutch Harbor	0657
Kurile Islands	0825
Petropavlovsk-Kamchatsky	0830
Montevideo	0910
Shenyang	0950
Vladivostok	1000
Mutankiang, Harbin, Chiamsu	1001
Khabarovsk	1002
Magadan	1007
Buenos Aires	1045
Peking, Tientsin, Chinchow	1134
Hailar, Shiwei	1136
Chita	1138
Yakutsk	1140
Tierra del Fuego	1225
Alma-Ata	1307
Bratsk	1314
Aralsk	1443
Omsk	1448
Ankara	1616
Stalingrad	1619
Perm	1623
Naples	1750
Budapest	1753
Moscow	1757
Wellington	1837
Lisbon	1927
London	1930
Oslo	1932
Sydney	2101
Faroe Islands	2107
Kalgoorlie	2143
Newfoundland	2235
Reykjavik	2243
Augusta	2319

November 2

Place	Time
New York	0009
Frederikshaab	0017
Denver	0142
Winnipeg	0145
Lake Harbor	0151
Seattle	0318
Johannesburg	0359
Dease Lake	0458
Capetown	0537

Table 9.--Predictions issued Nov. 1, 1957

Satellite 1957 α1

November 2

Place	Time
Graham Land	1339
Port Elizabeth	1355
Alma-Ata	141
Novosibirsk	1422
Tbilisi	1551
Stalingrad	1553
Kuibyshev	1557
Belgrade	1726
Budapest	1727
Kiev	1728
Moscow	1731
Wellington	IQW
Marseilles	OPP
Paris	190
London	1904
Berlin	1905
Copenhagen	1906
Sydney	1944
Orkney Islands	2041
Adelaide	2118
Melbourne	2120
Albany	2253
Ottawa	2343
Quebec	2344
Frederikshaab	2351

November 3

Place	Time
Winnipeg	0119
Lake Harbor	0124
Seattle	0252
Fort Fraser	0255
Pretoria	0333
Port Elizabeth	0335
Capetown	05P
Dutch Harbor	0602

Table 10.--Predictions issued Nov. 2, 1957

Satellite 1957 α1

November 3

Place	Time
Carcross	0607
Kemp Land	0656
Petropavlovsk-Kamchatsky	0734
Montevideo	0817
Chiamussu, Harbin (Hutow)	0907
(Tunuhsien)	0908
Petropavlovsk-Kamchatsky	0912
Buenos Aires	0951
(Taonan) Harbin	1042
(Hailar, Mergen)	1043
(Huma)	1044
Agadan	1048
Tierra del Fuego	1130
Urumchi, (Gucheng)	1214
Ulan Bator	1216
Kyzyl	1217
Yakutsk	1223
Graham Land	1311
(Chuguchak)	1350
Omsk	1353
Tomsk	1354
Astrakhan	1524
Chakalov	1525
Sverdlovsk	1529
Budapest	1658
Kiev	1659
Warsaw	1701
Moscow	1702
Kirov	1703
Wellington	1743
Paris	1832
Berlin	1836
Copenhagen	1837
Tallinn	1838
Petrozavodsk	1840
Sydney	1915
Glasgow	2011
Oslo	2013

November 3 (continued)

Place	Time
Adelaide	2049
Melbourne	2050
Newfoundland	2140
Faroes	2148
Augusta	2224
Kanortalik	2320
Reykjavik	2303

November 4

Place	Time
Winnipeg	0049
Port Harrison	0054
Reykjavik	0101
Vancouver	0223
(Athabaska)	0226
Vancouver	0358
Fort Fraser	0410
Capetown	0440
Dutch Harbor	0532

Table 11.--Predictions issued Nov. 3, 1957

Satellite 1957 Beta

November 3

Place	Time
Melbourne	2043
Pearl Harbor	2121
Kemp Land	2213
(Cowderly)	2230
Ottawa	2311
Washington	2312
Rio de Janeiro	2335

November 4

Place	Time
Jakarta	0019
Pusan	0032
Vladivostok	0034
Dawson	0047
Quito	0110
Santiago	0121
Rangoon	0211
Chengtu	0215
Lanchow	0216
Ulan Bator	0219
Los Angeles	0243
Madagascar	0343
Delhi	0358
Alma-Ata	0402
Krasnoyarsk	0406
Baghdad	0543
Omsk	0549
Petropavlovsk-Kamchatsky	0602
Athens	0728
Kharkov	0731
Moscow	0733
Nikolayevsk	0747
Madrid	0909
Berlin	0916
Leningrad	0919
Ulan-Ude	0930
Shenyang, Chanchun	0934
Pyongyang	0935
Wellington	1005
Buenos Aires	1035
Oslo	1104
Archangel	1105
Lanchow	1121
Chungking, Chengtu	1123
Melbourne	1147
Sverdlovsk	1256
Alma-Ata	1301
Lhasa	1306
Rangoon	1311
Bandung	1318
Washington	1423
Reykjavik	1433
Stockholm	1438
Moscow	1441
Makhach-Kala	1445
Teheran	1447
Winnipeg	1603
Glasgow	1624
Berlin	1626
Cairo	1633
Addis Ababa	1641
Vancouver	1754
Madrid	1814
Freetown	2008
Melbourne	2056
Halifax	2139
Pernambuco	2158
Tokyo	2301
Petropavlovsk-Kamchatsky	2306
Detroit	2324
Caracas	2335

November 5

Place	Time
Kwangchow	0041
Nanking	0043
Shenyang	0047
Magadan	0053
Mexico	0116
Santiago	0134
Madras	0223
Calcutta	0225
Ulan Bator	0232
Kabul	0412
Alma-Ata	0414
Barnaul	0418
Windhoek	0539
Baghdad	0556
Tbilisi	0558

Satellite 1957 α1

November 4

Place	Time
Carcross	0537
Kemp Land	0627
Aleutians	0706
Dawson	0713
Khabarovsk	0839
Petropavlovsk-Kamchatsky	0842
Montevideo	0923
Tsitsikar Mailun-Tunusiany	1013
Okhotsk	1018
Tierra del Fuego	1101
Ulan Bator	1147
Irkutsk	1149
Graham Land	1241
Chuguchak	1321
Karaganda	1322
Krasnoyarsk	1325
Stalingrad	1455
Chkalov	1456
Chelyabinsk	1458
Budapest	1628
Kiev	1630
Moscow	1633
Kirov	1634
Wellington	1714
Paris	1803
London	1804
Berlin	1806
Tallinn	1808
Leningrad	1809
Canberra	1846
Glasgow	1941
Oslo	1943
Adelaide	2020
Melbourne	2022
Faroe Islands	2119
Albany	2155
Reykjavik	2252

November 5

Place	Time
Fort Harrison	0024
Fort Nelson	0158
Fort Fraser	0330

Table 12.--Predictions issued Nov. 4, 1957

Satellite 1957 β1

November 5

Place	Time
Chkalov	0600
Chelyabinsk	0601
Vilyuisk	0609
Petropavlovsk-Kamchatsky	0614
Graham Land	0705
Tripoli	0738
Bucharest and Belgrade	0742
Kiev	0743
Moscow	0745
Khabarovsk	0800
Sapporo	0802
Tierra del Fuego	0854
Rio de Janeiro	0906
Lisbon	0924
Paris	0926
London	0927
Stockholm	0930
Archangel	0933
Chan Chung-tian Chin	0945
(Dalian)	0946
Moresby	1003
Sydney	1011
Santiago	1046
Belomorsk	1119
Barnaul	1126
Iuimyn	1130
Chendu, Chuntsin	1134
Hanoi	1136
Panama	1242
Reykjavik	1259
Petrozavodsk	1306
Tashkent	1313
Delhi	1318
Detroit	1436
Frederikshaab	1443
Oslo	1450
Kiev	1454
Yerevan	1458
Baghdad	1500
Los Angeles	1617
Port Nelson	1624
London	1636
Naples	1641
Mozambique	1700
Wellington	1736
Vancouver	1806
Lisbon	1825
Capetown	1850
Carcross	1953
Moresby	2116
Dawson	2139
Quebec	2150
Fortaleza	2207
Tokyo	2312
Petropavlovsk-Kamchatsky	2318
Chicago	2335

November 6

Place	Time
Montevideo	0002
Bangkok	0049
Chansha	0054
Wuhan	0055
Okhotsk	0104
Seattle	0118
Mexico	0127
Madras	0233
Hami	0242
Irkutsk	0246
Ugolnaya	0255
Yakutsk	0249
Tashkent	0426
Novosibirsk	0429
Graham Land	0529
Cairo	0605
Stalingrad	0610
Kuibyshev	0612
Yakutsk	0622
Tunis	0751
Budapest	0754

Satellite 1957 α1

November 5

Place	Time
Carcross	0504
Aleutian Islands	0634
Georgetown	0638
Petropavlovsk-Kamchatsky	0808
Ugolnaya	0812
Huma Ikon Honyan	0942
Magadan	0945
Tierra del Fuego	1028
Ulan-Ude	1116
Yakutsk	1120
Barnaul	1251
Rasnoyarsk	1252
Chkalov	1423
Chelyabinsk	1424
Kursk	1557
Moscow	1558
Kirov	1559
Berlin	1730
Riga	1732
Leningrad	1733
Petrozavodsk	1734
Wellington	1813
Dublin	1905
Glasgow	1906
Melbourne	1946
Faroe Islands	2043
Portland	2120
Battle Harbor	2212
Reykjavik	2217
Port Harrison	2347
Frederikshaab	2350

November 6

Place	Time
Port E Nelson	0122
Lake Harbor	0125
Fort Fraser	0255
Fort Nelson	0256
Kemp Land	0345
Carcross	0431
Kemp Land	0521
Dillingham	0604
Georgetown	0605
Dawson	0607
Kemp Land	0656
Ust-Kamchatsk	0737
Ugolnaya	0739
Mar del Plata	0817

Table 13.--Predictions issued Nov. 5, 1957

Satellite 1957 β1

November 6

Place	Time
Warsaw	0756
Moscow	0758
----	0812
Tokyo	0816
----	0843
----	0939
--- Bator	0955
Tientsin, Peking	0958
----, Shanghai	1000
La Paz	1102
Faroe Islands	1127
Archangel	1132
Chauguchak	1139
Urumchi	1141
Lhasa	1145
Saigon	1151
Jakarta	1157
San Jose	1252
Reykjavik	1312
Petrozavodsk	1318
Kabul	1328
Bombay	1332
Mexico City	1442
Chicago	1448
Frederikshaab	1455
Oslo	1502
Warsaw	1505
Damascus, Baghdad	1511
Los Angeles	1628
Port Nelson	1637
London	1649
Paris	1650
Tripoli	1655
Wellington	1750
Port Fraser	1819
Arka	1849
Capetown	1902
Sydney	1936
(Carcross?)	2005
Battle Harbor	2016
Moresby	2127
Dawson	2152
Ottawa	2202
New York	2203
Rio de Janeiro	2225
Manila	2317
Tokyo	2325
Shelton	2336
Kansas City	2342
Panama	2358

November 7

Place	Time
Buenos Aires	0014
Rangoon	0103
Kunming	0105
Chungking, Chengtu	0107
Okhotsk	0117
Georgetown	0124
San Francisco	0132
Bombay	0248
Delhi	0250
Irkutsk	0257
Yakutsk	0301
Dutch Harbor	0310
Johannesburg	0416
Addis Ababa	0427
Ashkhabad	0436
Magadan	----
Graham Land	0542
Alexandria	0618
Rostov	0623
Saratov	0624
Nikolayevsk-on-Amur	0638
Apia	0701
Freetown	0754
Genoa	0806
Vienna	0807

Satellite 1957 α1

November 6

Place	Time
Kemp Land	0833
Magadan	0912
Penzhino	0915
Tierra del Fuego	0955
Aldan	1046
Graham Land	1134
Krasnoyarsk	1218
Vilyuisk	1221
Graham Land	1310
Chelyabinsk	1350
Moscow	1525
Perm	1526
Vilyuisk	1659
Leningrad	1700
Petrazavodsk	1701
Kotlas	1702
Wellington	1740
Glasgow	1832
Oslo	1834
Archangel	1838
Melbourne	1913
Faroe Islands	2009
Reykjavik	2144
Frederiskhaab	2316

November 7

Place	Time
Port Nelson	0048
Lake Harbor	0052
Port Fraser	0221
Coral Harbor	0226
Caracas	0357
Fort Ray	0359
Kemp Land	0446
Dillingham	0530
Dawson	0533
Ugolnaya	0705

Table 14.--Predictions issued Nov. 6, 1957

Satellite 1957 β1 — November 7

Place	Time
Warsaw	0805
Leningrad	0808
Tokyo	0825
Wellington	0853
Montevideo	0923
Glasgow	0949
Archangel	0955
Kyzyl	1003
Wuhan	1010
Kuanchow	1012
Melbourne	1034
Georgetown	1119
Faroe Islands	1136
Sverdlovsk	1145
Alma-Ata	1149
Lhasa	1154
Singapore	1204
San Salvador	1305
Washington and New York	1312
Reykjavik	1321
Helsinki	1326
Moscow	1328
Astrakhan	1331
Ashkhabad	1334
San Jose	1451
Minneapolis	1457
Port Harrison	1501
Copenhagen	1512
Berlin	1513
Bucharest	1516
Beirut	1520
San Francisco	1639
Coral Harbor	1647
Barcelona	1700
Tunis	1702
Fort Nelson	1829
Sydney	1945
Dutch Harbor	2011
Dawson	2015
Kemp Land	2113
Kalgoorlie	2129
Fort Ray	2203
Washington	2212
Sao Paulo	2234
Bandung	2319
Seoul	2333
Vladivostok	2334
Khabarovsk	2336
Ugolnaya	2343
Shelton	2345
San Antonio	2359

Satellite 1957 β1 — November 8

Place	Time
San Jose	0006
Santiago	0021
Camilla	0113
Lanchow	0116
Ulan Bator	0119
Chita	0120
Georgetown	0131
Los Angeles	0141
Tierra del Fuego	0212
Hyderabad	0256
Chuguchak	0303
Vilyuisk	0309
Dutch Harbor	0318
Graham Land	0405
Capetown	0422
Baghdad	0442
Omsk	0448
Magadan	0459
Athens	0627
Kharkhov	0630
Moscow	0632
Nikolayevsk-on-Amur	0645
Freetown	0802

Satellite 1957 α1 — November 7

Place	Time
Magadan	0837
Anadyr	0840
Tierra del Fuego	0920
Aldan	1011
Seimchan	1014
Tierra del Fuego	1055
Graham Land	1059
Krasnoyarsk	1143
Yakutsk	1147
Graham Land	1235
Tomsk	1317
Vilyuisk	1322
Kazan	1450
Perm	1451
Moscow and Leningrad	1625
Syktyvkar	1627
Wellington	1705
Copenhagen	1758
Oslo	1759
Helsinki	1800
Archangel	1802
Hobart, Australia	1839
Faroe Islands	1934
Melbourne	2013
Reykjavik	2108
Albany	2146
Frederikshaab	2241

Satellite 1957 α1 — November 8

Place	Time
Port Nelson	0012
Lake Harbor	0015
Coral Harbor	0149
Fort Nelson	0321
Fort Ray	0323
Dillingham	0454
Kennecott	0456
Kemp Land	0546
Fairbanks	0631

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Table 15.--Predictions issued Nov. 7, 1957

Satellite 1957 β1 — November 8

Place	Time
Berlin	0815
Leningrad, Helsinki	0818
Changchun	0832
Shenyang	0833
Rosario	0933
Glasgow	0959
Oslo	1002
Archangel	1005
Omsk, Novosibirsk	1011
Wanchow	1018
Sian	1019
Kwangchow	1022
Melbourne	1044
Caracas	1129
Petrozavodsk	1152
Chelyabinsk	1156
Frunze	1200
Calcutta	1206
Washington	1322
Reykjavik	1331
Stockholm	1336
Tallinn	1337
Moscow	1339
Teheran	1345
Port Harrison	1512
Berlin	1524
Vienna, Budapest	1525
Belgrade	1526
Cairo	1530
Addis Ababa	1538
Vancouver	1652
Madrid	1710
Johannesburg	1734
Freetown	1905
Dawson	2024
Pernambuco	2054
Kemp Land	2123
Fairbanks	2210
Washington	2222
Kwangchow	2330
Nanking, Shanghai	2341
Changchun	2344
Khabarovsk	2346
Magadan	2349
Shelton	2354

Satellite 1957 β1 — November 9

Place	Time
Santiago	0030
Lhasa	0123
Ulan Bator	0129
Aldan	0133
Graham Land	0229
Stalinabad	0310
Frunze	0311
Krasnoyarsk	0315
Vilyuisk	0319
Baghdad	0452
Makhachkala	0454
Magnitogo	0458
Petropavlovsk-Kamchatsky	0511
Tripoli	0635
Bucharest	0639
Kiev	0640
Moscow	0641
Syktyvkar	0644
Komsomolsk-na-Amure	0656
Tierra del Fuego	0750

Satellite 1957 α1 — November 8

Place	Time
Magadan	0803
Aldan	0936
Tierra del Fuego	1020
Vilyuisk	1112
Graham Land	1200
Tomsk	1242
Sverdlovsk, Perm	1416
Yaroslav	1549
Vologda	1550
Stockholm	1724
Helsinki, Leningrad	1725
Archangel	1727
Abergin	1857
Bergen	1858
Reykjavik	2033
Kanortalik	2205
Reykjavik	2207
Port Harrison	2338
Lake Harbor	2340

Satellite 1957 α1 — November 9

Place	Time
Coral Harbor	0114
Fort Nelson	0245
Kennecott	0419
Kemp Land	0509
Georgetown	0554
Fairbanks	0555

Table 16.--Predictions issued Nov. 8, 1957

Satellite 1957 β1 — November 9

Place	Time
Paris	0822
Hamburg	0824
Stockholm	0826
Helsinki	0827
Petrozavodsk	0828
Shenyang	0841
Moresby	0859
Santiago	0941
Archangel	1014
Barnaul	1020
Urumchi	1023
Kunming	1029
Tashkent	1208
Delhi	1212
Detroit	1331
Frederikshaab (sic)	1337
Oslo	1344
Riga	1346
Minsk	1347

Satellite 1957 β1 — November 10

Place	Time
Ugolnaya	0001
Mexico City	0019
Tierra del Fuego	0046
Madras	0128
Irkutsk	0138
Yakutsk	0142
Graham Land	0236
Tashkent	0319
Semipalatinsk	0321
Barnaul	0322
Cairo	0458
Beirut	0500
Astrakhan	0503
Chkalov	0505
Sverdlovsk	0507
Vilyuisk	0514
Naples	0545
Belgrade	0647
Lvov	0648

Satellite 1957 α1 — November 9

Place	Time
Okhotsk	0859
Tierra del Fuego	0943
Yakutsk	1034
Graham Land	1121
Vilyuisk	1209
Nizhniy Tagil	1338
Kirov	1513
Stockholm	1646
Helsinki	1647
Petrozavodsk	1648
Hamilton (New Zealand)	1727
Orkney Islands	1819
Faroe Islands	1955
Reykjavik	2129
Frederikshaab	2302

Satellite 1957 α1 — November 10

Place	Time
Coral Harbor	0036
Fort Smith	0207
Carcross	0341
Kemp Land	0431
Georgetown	0514
Dawson	0516
Ugolnaya	0649

Table 16.--Predictions issued Nov. 8, 1957 (continued)

Satellite 1957 β1				Satellite 1957 α1			
November 9		November 10		November 9		November 10	
Place	Time	Place	Time	Place	Time	Place	Time
Yerevan	1352	Moscow	0650				
Los Angeles	1511	Khabarovsk	0704				
Reykjavik	1527						
London	1531						
Trieste	1534						
Madagascar	1557						
Vancouver	1700						
Fort Fraser	1702						
Lisbon	1720						
Port Elizabeth	1745						
Kemp Land	1944						
Georgetown	2031						
Dawson	2033						
Tokyo	2206						
Petropavlovsk-Kamchatsky	2212						
Chicago	2229						
Montevideo	2255						
Hanoi	2346						
Wuhan	2349						
Tientsin	2351						
Changchun	2353						
Okhotsk	2357						

Table 17.--Predictions issued Nov. 9, 1957

Satellite 1957 β1 (?)		Satellite 1957 α1			
Date unknown		November 10		November 11	
Place	Time	Place	Time	Place	Time
Tunis	0653	Magadan	0820	Coral Harbor	0129
Bratislava	0655	Anadir	0823	Carcross	0300
Krakow	0656	Yakutsk	0955	Kemp Land	0315
Warsaw	0657	Graham Land	1042	Dillingham	0433
Vilnyus	0658	Vilyuisk	1130	Dawson	0436
Moscow	0659	Kirov	1433	Fairbanks	0609
Blagoveshchensk	0712	Leningrad	1607	Magadan	0739
Vladivostok	0714	Petrozavedsk	1608	Nadir	0742
Tokyo	0717	Oslo	1741		
		Archangel	1743		
		Faroe Islands	1915		
		Kanortalik	2048		
		Reykjavik	2050		
		Frederikshaab	2222		
		Lake Harbor	2356		

Table 18.--Predictions issued Nov. 10, 1957

Satellite 1957 β1				Satellite 1957 α1	
November 11		November 12		November 11	
Place	Time	Place	Time	Place	Time
London	0838	Ugolnaya	0016	Yakutsk	0914
Oslo	0841	Kyzyl	0151	Graham Land	1001
Canberra	0923	Graham Land	0251	Vilyuisk	1049
Faroe Islands	1025	Omsk	0336	Kondinskoye	1353
Archangel	1030	Benza	0519	Berezovo	1530
Reykjavik	1210	Perm	0521	Belomorsk	1702
Coral Harbor	1722	Riga	0705	Archangel	1703
Capetown	1800	Leningrad	0704	Faroe Islands	1833
Kennecott	1902	Wellington	0748	Reykjavik	2007
Kemp Land	2001			Frederikshaab	2140
Dawson	2048			Lake Harbor	2315
Rio de Janeiro	2121				
Shelton	2232				
Buenos Aires	2310				

Table 19.--Predictions issued Nov. 11, 1957

Satellite 1957 β1

November 12

Place	Time
Glasgow	0846
Oslo	0848
Faroe Islands	1033
Battle Harbor	1212
Reykjavik	1217
Port Harrison	1357
Coral Harbor	1543
Mircqi	1640
Wellington	1654
Fort Ray	1725
Melbourne	1838
Dutch Harbor	1906
Kemp Land	2008
Albany	2023
Dawson	2055
Shelton	2239

November 13

Place	Time
Chita	0015
Verkhne Kolymsk	0021
Kyzyl	0159
Bratsk	0200
Vilyuisk	0204
Graham Land	0300
Capetown	0316
Omsk	0342
Moscow	0525
Kirov	0527
Berlin	0708
Helsinki	0711
Petrozavodsky	0712
Buenos Aires	0826

Satellite 1957 α1

November 12

Place	Time
Vilyuisk	1006
Graham Land	1054
Tura	1140
Surgut	1311
Syktyvkar	1444
Archangel	1619
Faroe Islands	1750
Reykjavik	1924
(Frederikshaab)	2057
Lake Harbor	2230

November 13

Place	Time
Coral Harbor	0004
Fort Ray	0136
Dawson	0309
Kemp Land	0359
Georgetown	0442
Fairbanks	0443
Ugolnaya	0616
Shelton	0618
Seimchan	0749

Table 20.--Predictions issued Nov. 13, 1957

Satellite 1957 β1

November 14

Place	Time
Faroe Islands	0900
Belomorsk	0905
Reykjavik	1044
Frederikshaab	1227
Lake Harbor	1410
Wellington	1521
Coral Harbor	1556
Mirny	1653
Canberra	1716
Carcross	1736
Dillingham	1919
Dawson	1922
Kemp Land	2020
Shelton	2105
Magadan	2247
Anadyr	2249

November 15

Place	Time
Yakutsk	0030
Krasnoyarsk	0211
Tyumen	0354
Surgut	0356
Turukhan	0358
Graham Land	0458
Yaroslav	0537
Kotlas	0539
Tierra del Fuego	0645
Stockholm	0721
Kholmogory	0724

Satellite 1957 α1

November 14

Place	Time
Yakutsk	0826
Anadyr	0831
Georgetown	0833
Tierra del Fuego	0910
Graham Land	0913
Vilyuisk	1000
Irpy	1005
Tura	1133
Seimchan	1138
Kodinskoye	1305
Yakutsk	1311
Petrozavodsk	1437
Vereshchagino	1443
Oslov	1610
Belomorsk	1612
Beryozov	1616
Faroe Islands	1743
Archangel	1747
Syktyvkar	1749
Reykjavik	1916
Varsa	1921
Petrozavodsk	1922
Frederikshaab	2049
Amajuak	2221
Coral Harbor	2355

November 15

Place	Time
Simpson	0126
Lake Harbor	0132
Kennecott	0300
Dawson	0435
Fort Ray	0438
Penzhino	0605
Fairbanks	0609
Seimchan	0738
Anadyr	0742
Georgetown	0744

Table 21.--Predictions issued Nov. 14, 1957

Satellite 1957 β1

November 15

Place	Time
Faroe Islands	0904
Belomorsk	0908
Reykjavik	1048
Frederikshaab	1231
Amadjuak	1414
Wellington	1524

November 16

Place	Time
Yakutsk	0033
Tomsk	0213
Vilyuisk	0218
Graham Land	0314
Peru	0357
Vereshchagino	0401

Satellite 1957 α1

November 15

Place	Time
Tierra del Fuego	0820
Penzhino	0915
Ugolnaya	0916
Seimchan	1048
Vilyuisk	1221
Yakutsk	1222

November 16

Place	Time
Amajuak	0040
Frederikshaab	0042
Coral Harbor	0214
Kengua	0215
Fort Ray	0347
Dawson	0519

Table 21.--Predictions issued Nov. 14, 1957 (continued)

Satellite 1957 β1				Satellite 1957 α1			
November 15		November 16		November 15		November 16	
Place	Time	Place	Time	Place	Time	Place	Time
Port Nelson	1554	Tura	0402	Okhotsk	1223	Simpson	0520
Coral Harbor	1559	Yaroslav	0540	Vereshchagino	1352	Shelton	0651
Hobart	1706	Tierra del Fuego	0649	Tura	1353	Kennecott	0653
Carcross	1740	Oslo	0724	Harampur	1525		
Georgetown	1923	Belomorsk	0727	Archangel	1658		
Fairbanks	1924	Archangel	0728	Kkonginskee	1659		
Kemp Land	2021			Belomorsk	1831		
Ugolnaya	2107			Petrozavodsk	1832		
Shelton	2109			Helsinki	2006		
Okhotsk	2248			Reykjavik	2135		
Seimchan	2250			Faroe Islands	2137		
Markovo	2252			Bergen	2138		

Table 22.--Predictions issued Nov. 15, 1957

Satellite 1957 β1				Satellite 1957 α1			
November 16		November 17		November 16		November 17	
Place	Time	Place	Time	Place	Time	Place	Time
Faroe Islands	0908	Vilyuisk	0037	Ugolnaya	0824	Coral Harbor	0121
Umea (Sweden)	0911	Tura	0220	Graham Land	0906	Lake Harbor	0122
Kanorthalik	1050	Graham Land	0318	Seimchan	0957	Fairbanks	0424
Reykjavik	1052	Solikamsk	0401	Vilyuisk	1128	Dawson	0425
Frederikshaab	1235	Vereshchagino	0405	Magadan	1131	Fort Ray	0427
Amajuak	1419	Leningrad	0544	Vereshchagino	1300	Shelton	0557
Wellington	1529	Petrozavodsk	0545	Stalino	1426	Kennecott	0600
Fort Ray	1600	Tierra del Fuego	0652	Archangel	1605	Carcross	0601
Coral Harbor	1603	Oslo	0727	Kindinskoye	1608	Anadyr	0730
Hobart	1711	Belomorsk	0730	Belomorsk	1738	Georgetown	0732
Kennecott	1743	Archangel	0731	Syktyvkar	1740	Tierra del Fuego	0809
Georgetown	1926			Vaasa	1912		
Fairbanks	1928			Helsinki	1914		
Dawson	1929			Faroe Islands	2044		
Ugolnaya	2110			Bergen	2046		
Shelton	2112			Reykjavik	2217		
Okhotsk	2251			Frederikshaab	2350		
Seimchan	2253						
Anadyr	2256						

Table 23.--Predictions issued Nov. 16, 1957

Satellite 1957 β1				Satellite 1957 α1			
November 17		November 18		November 17		November 18	
Place	Time	Place	Time	Place	Time	Place	Time
Reykjavik	1056	Vilyuisk	0039	(Penzhino)	0902	Coral Harbor	0024
Frederikshaab	1238	Turya	0223	Graham Land	0946	Amadjauk	0025
Coral Harbor	1421	Graham Land	0321	Vilyuisk	1032	(Kirgua?)	0159
Amadjauk	1422	Vereshchagino	0407	Seimchan	1035	Fort Ray	1330
Wellington	1532	Tierra del Fuego	0654	Tura	1205	Fairbanks	0501
Fort Ray	1604	Bahia Blanaca	0700	Irkutsk	1207	Dawson	0502
Hobart	1715	Vaasa	0731	Vereshchagino	1339	Anadyr	0632
Melbourne	1716	Archangelsk	0733	Kondinskoye	1511	Georgetown	0635
Dawson	1747			Archangel	1842	Cordoba	0636
Fairbanks	1931			Syktyvkar	1644	Tierra del Fuego	0712
Ugolnaya	2113			Vaasa	1816	Ugolnaya	0807
Shelton	2115			Petrozavodsk	1817	Graham Land	0849
Seimchan	2256			Oslo	1950		
				Reykjavik	2120		
				Frederikshaab	2253		

Table 24.--Predictions issued Nov. 17, 1957

Satellite 1957 β1

November 18 Place	Time	November 19 Place	Time
Belomorsk	0918	Vilyuisk	0041
Reykjavik	1058	(Penzhino)	0047
Faroe Islands	1246	Tura	0225
Coral Harbor	1423	Turukhansk	0409
Wellington	1534	Harampur	0554
Amadjuak	1610	Tierra del Fuego	0656
Lake Harbor	1611	Bahia Blanca	0702
Melbourne	1718	Vaasa	0733
Dawson	1749	Belomorsk	0735
Fairbanks	1934	Archangel	0736
Dawson	1935	Kondinskoe	0739
Anadir	2116		
(Shelton)	2118		
Seimchan	2259		
Ugolnaya	2302		

Satellite 1957 α1

November 18 Place	Time	November 19 Place	Time
Seimchan	0939	Coral Harbor	0101
Vilyuisk	1110	Lake Harbor	0102
Yakutsk	1111	Dawson	0404
Magadan	1113	Fairbanks	0537
Tura	1243	Kennecott	0538
Harampur	1415	Anadir	0708
Archangel	1547	Georgetown	0710
Kondinskoe	1549	Tierra del Fuego	0747
Belomorsk	1719	Graham Land	0751
Syktyvkar	1721		
Helsinki	1854		
Reykjavik	2023		
Faroe Islands	2025		
Bergen	2026		
Amadjuak	2328		
Frederikshaab	2330		

Table 25.--Predictions issued Nov. 19, 1957

Satellite 1957 β1

November 20 Place	Time	November 21 Place	Time
Petrozavodsk	0925	Seimchan	0050
Dombas	1107	Vilyuisk	0232
Reykjavik	1250	Yakutsk	0233
Faroe Islands	2151	Tura	0415
Wellington	1355	Tierra del Fuego	0517
Frederikshaab	1433	Harampur	0559
Coral Harbor	1615	Valdivia S. America	0706
Amadjauk	1616	Archangel	0741
Portland	1722	Troitsko-Pecherskoye	0742
Fort Ray	1942		
Kennecott	2125		
Anadyr	2306		
Ugolnaya	2307		

Satellite 1957 α1

November 20 Place	Time	November 21 Place	Time
(Berelekh)	0911	Coral Harbor	0030
Vilyuisk	1032	Port Nelson	0204
Yakutsk	1043	Dawson	0333
Okhotsk	1045	Fairbanks	0505
Vereshchagino	1214	Kennecott	0506
Aldan	1218	(Dis Lake)	0508
Laryak	1348	Tierra del Fuego	0542
Boguchany	1350	Anadyr	0636
Archangel	1518	Dillingham	0639
Troitsko-Pecherskoye	1519	Kamenskoye	0810
Tobolsk	1521	Graham Land	0854
Belomorsk	1650		
Syktyvkar	1653		
Perm	1654		
Helsinki	1824		
Leningrad	1825		
Moscow	1826		
Reykjavik	1953		
Faroe Islands	1955		
Bergen	1956		
Copenhagen	1958		
Glasgow	2130		
Amadjauk	2257		
Frederikshaab	2259		
(Kanortalik)	2300		

Table 26.--Predictions issued Nov. 20, 1957

Satellite 1957 β1

November 21 Place	Time	November 22 Place	Time
Petrozavodsk	0926	Seimchan	0051
Faroe Islands	1108	Vilyuisk	0232
Oslo	1109	Yakutsk	0233
Reykjavik	1250	Graham Land	0329
Wellington	1355	Vereshchagino	0415
Frederikshaab	1433	Tierra del Fuego	0517
Hobart	1537	Montevideo	0523

Satellite 1957 α1

November 21 Place	Time	November 22 Place	Time
Berelyakh	0943	Port Harrison	0101
Magadan	0944	Battle Harbor	0104
Ust-Kamchatsk	0945	Kemp Land	0145
Vilyuisk	1113	Fort Ray	0230
Yakutsk	1114	Port Nelson	0233
Okha	1117	Carcross	0403
Vereshchagino	1245	Athabaska	0406

Table 26.--Predictions issued Nov. 20, 1957 (continued)

Satellite 1957 β1

November 21

Place	Time
Coral Harbor	1616
Lake Harbor	1617
Portland	1723
Dawson	1941
Fort Ray	1943
Shelton	2124
Georgetown	2125
Kennecott	2126
Markovo	2307
Ugolnaya	2308

November 22

Place	Time
Harampur	0559
Laryak	0600
Archangel	0741
Syktyvkar	0743

Satellite 1957 α1

November 21

Place	Time
Mama	1248
Chita	1250
Wellington	1319
Laryak	1418
Krasnoyarsk	1421
Kyzyl	1422
Hobart	1451
Archangel, Syktyvkar	1549
Nizhniy Tagil	1551
Akmilinsk	1553
Petrozavodsk	1721
Leningrad	1722
Moscow	1723
Kuibyshev	1725
Aktyubinsk	1726
Oslo	1854
Riga	1856
Kiev	1858
Reykjavik	2024
Glasgow	2027
The Hague	2029
Luxembourg	2030
Frederikshaab	2155
Amadjuak	2327

November 22

Place	Time
Georgetown	0534
Vancouver	0539
Tierra del Fuego	0611
Ugolnaya	0705
Dutch Harbor	0789
Graham Land	0749

Table 27.--Predictions issued Nov. 21, 1957

Satellite 1957 β1

November 22

Place	Time
Petrozavodsk	0926
Vologda	0927
Reykjavik	1106
Faroe Islands	1108
Oslo	1110
Wellington	1356
Amadjuak	1432
Frederikshaab	1434
Hobart	1538
Canberra	1540
Coral Harbor	1616
(Olbani)	1722
Fort Ray	1758
Fairbanks	1941
Simpson	1943
Anadyr	2123
Georgetown	2125
Markovo	2306
Ugolnaya	2307

November 23

Place	Time
Berflak	0050
Vilyuisk	0233
Yakutsk	0234
Vereshchagino	0416
Tierra del Fuego	0517
Laryak	0610
Belomorsk	0740
Archangel	0741
Syktyvkar	0742

Satellite 1957 α1

November 22

Place	Time
Berlyakh	0834
Yakutsk	1005
Okhotsk	1007
Petropavlovsk-Kamchatsky	1010
Tura	1137
Khabarovsk	1143
Wellington	1210
Laryak	1309
Boguchany	1311
Chita	1313
Changchung	1315
Sydney	1339
Troitsko-Pechorskoye	1440
Tobolek	1442
Novosibirsk	1444
Kyzyl	1446
Adelaide	1512
Melbourne	1513
Hobart	1515
Petrozavodsk	1611
Koriv	1613
Chelyabinsk	1615
Kustanai	1616
Frunze	1619
Albany	1643
Helsinki	1745
Leningrad	1746
Moscow	1747
Tambov	1748
Stalingrad	1749
Astrakhan	1750
Faroe Islands	1914
Copenhagen	1918
Berlin	1919
Budapest	1920
Bucharest	1921
Dublin	2050

November 23

Place	Time
Quebec	0126
Simpson	0253
Winnipeg	0258
Minneapolis	0259
Montevideo	0323
Kennecott	0424
Fort Fraser	0427
Seattle	0429
Santiago	0455
(Villendem)	0557
(Penzhino)	0726
Dutch Harbor	0731
Graham Land	0811

November 22 (continued)

Place	Time
London	2051
Paris	2052
Lyons	2053
Frederikshaab	2218
Capetown	2248
Lake Harbor	2350
Battle Harbor	2354

Table 28.--Predictions issued Nov. 22, 1957

Satellite 1957 β1

November 23 Place	Time	November 24 Place	Time
Helsinki	0925	Port Elizabeth	0013
Leningrad	0926	Nizhniy Seichan	0050
Reykjavik	1106	Vilyuisk	0232
Faroe Islands	1107	Yakutsk	0233
Bergen	1108	Vereshchagino	0415
Wellington	1355	Tierra del Fuego	0515
Amadjuak	1432	Montevideo	0522
Frederikshaab	1434	Belomorsk	0739
Hobart	1537	Archangel	0740
Melbourne	1539		
Sydney	1540		
Coral Harbor	1615		
Albany	1721		
Fort Ray	1758		
Fairbanks	1940		
Dawson	1941		
Anadyr	2122		
Georgetown	2125		
Penzhino	2306		
Ugolnaya	2307		

Table 29.--Predictions issued Nov. 23, 1957

Satellite 1957 β1

November 24 Place	Time	November 25 Place	Time
Helsinki	0924	Capetown	0012
Leningrad	0925	Vilyuisk	0046
Reykjavik	1105	Magadan	0049
Faroe Islands	1107	Yakutsk	0231
Bergen	1108	(Harampur)	0412
Wellington	1353	Tierra del Fuego	0513
Amadjuak	1430	Bahia Blanca	0519
Frederikshaab	1432	Buenos Aires	0520
Hobart	1535	Jandinskoye	0556
Melbourne	1537	Belomorsk	0737
Sydney	1539	Archangel	0738
Coral Harbor	1615	Syktyvkar	0739
Albany	1721		
Kalgoorlie	1722		
Fort Ray	1757		
Fairbanks	1938		
(Karmaks)	1940		
Anadyr	2120		
Georgetown	2123		
Penzhino	2305		
Ugolnaya	2306		

Satellite 1957 α1

November 24 Place	Time	November 25 Place	Time
Magadan	0913	Port Harrison	0023
Petropavlovsk-Kamchatsky	0916	Pernambuco	0043
Aldan	1044	Port Nelson	0155
Bogorodskoye	1047	Detroit	0159
Fiji Islands	1108	Washington	0200
Chita	1218	Sao Paulo	0218
(Changchen)	1220	Athabaska	0326
(Shenyang)	1221	Dallas	0333
Kyoto	1224	New Orleans	0334
Port Moresby	1236	Quito	0343
Wellington	1246	Santiago	0352
Tomsk	1347	San Francisco	0303
Kyzyl	1349	Los Angeles	0505
Sian	1355	Tierra del Fuego	0530
Wuhan	1356	Dutch Harbor	0628
Melbourne	1416	Graham Land	0707
Perm	1518	Aleutian Islands	0800
Chelyabinsk	1519		
Alma-Ata	1523		
Lhasa	1527		
Bandung	1537		
Albany	1546		
Leningrad	1648		
Moscow	1649		
Kuibyshev	1651		
Ashkhabad	1655		
Kabul	1657		
Oslo	1819		
Copenhagen	1820		
Warsaw	1822		
Kiev	1823		
Odessa	1824		
Baghdad	1828		
Glasgow	1952		
London	1953		
Paris	1954		
Rome	1956		
Tripoli	1959		
Mozambique	2013		
Lisbon	2128		
Windhoek	2146		
Port Elizabeth	2149		

Table 30.--Predictions issued Nov. 24, 1957

Satellite 1957 β1

November 25 Place	Time	November 26 Place	Time
Helsinki	0922	Capetown	0011
Leningrad	0923	Magadan	0047
Reykjavik	1104	Vilyuisk	0228
Faroe Islands	1105	Yakutsk	0229
Bergen	1106	Harampur	0411
Wellington	1352	Bahia Blanca	0517
Coral Harbor	1428	Rosario	0519
Amadjuak	1429	Archangel	0551
Melbourne	1535	Belomorsk	0736
Sydney	1537	Korov	0738
Port Harrison	1614		
Albany	1719		
Fort Ray	1755		
Shelton	1935		
Fairbanks	1937		
Carcross	1939		
Anadyr	2118		
Georgetown	212-		
Kamenskoye	2303		

Satellite 1957 α1

November 25 Place	Time	November 26 Place	Time
Okhotsk	0927	Quebec	0036
Severo-Kurilsk	0931	Boston	0038
Khabarovsk	1102	Pernambuco	1153
Sapporo	1104	Winnipeg	0208
Ulan Bator	1233	Chicago	0210
Peking, Tientsin	1256	Birmingham	0213
Shanghai	1230	Caracas	0220
Sydney	1257	Vancouver	0339
Novosibirsk	1401	Monterrey	0346
Urumchi	1404	Mexico	0340
Lanchow	1407	Dillingham	0506
Kunming	1410	Tierra del Fuego	0540
Adelaide	1428	----	----
Chelyabinsk	1532	Magadan	0806
Frunze	1536	Ust-Kamchantsk	0807
Calcutta	1542		
Albany	1600		
Leningrad	1701		
Moscow	1702		
Tambov	1704		
Stalingrad	1705		
Teheran	1709		
Bergen	1831		
Copenhagen	1833		
Berlin	1834		
Budapest	1835		
Sofia	1837		
Damascus	1840		
Sana	1845		
Dublin	2005		
London	2006		
Paris	2007		
Barcelona	2008		
Johannesburg	2028		
Lisbon	2140		
Accra	2149		
Capetown	2200		
Battle Harbor	2306		

Table 31.--Predictions issued Nov. 25, 1957

Satellite 1957 β1

November 26 Place	Time	November 27 Place	Time
Tallinn	0921	Magadan	0044
Faroe Islands	1102	Vilyuisk	0226
Wellington	1349	Aldan	0227
Amadjuak	1427	Harampur	0408
Melbourne	1533	Rosario	0516
Port Harrison	1612	Troitske-Pechorskoye	0550
Albany	1716	Belomorsk	0733
Fort Ray	1752	Kotlas	0734
Kennecott	1937	Korov	0736
Dillingham	2119		
Kamenakoe	2301		
Capetown	2408		

Satellite 1957 α1

November 26 Place	Time	November 27 Place	Time
Yakutsk	0936	Ottawa	0045
Vladivostok	1113	Rio de Janeiro	0105
Tokyo	1115	Winnipeg	0215
Wellington	1138	St. Louis	0218
Achinsk	1239	Montevideo	0240
Kyzyl	1241	Vancouver	0345
Peking, Tientsin	1245	Mexico	0354
Uhan, Shanghai Nanking	1248	Tierra del Fuego	0415
Canberra	1307	Anadyr	0509
Omsk	1410	Graham Land	0550
Semipalatinsk	1412	Kamenskoe	0640
Urumchi	1414	Magadan	0812
Kunming	1420	Petropavlovsk-Kamchatsky	0815
Bangkok	1422		
Petrozavodsk	1537		
Gorky	1539		
Kuibyshev	1540		
Chkalov	1541		
Stalinabad	1545		
Kabul	1546		
Madras	1553		
Tallinn	1710		
Moscow	1711		
Kiev	1712		
Kharkov	1713		
Rostov	1714		
Tbilisi	1715		

November 26 (continued)

Place	Time
Baghdad	1718
Berlin	1842
Prague	1846
Cairo	1849
Addis Ababa	1855
Madrid	2017
Pretoria	2036
Freetown	2156
Port Harrison	2310

Table 32.--Predictions issued Nov. 26, 1957

Satellite 1957 β1

November 27

Place	Time
Stockholm	0918
Riga	0919
Reykjavik	1058
Faroe Islands	1059
Glasgow	1101
Frederikshaab	1241
Lake Harbor	1423
Adelaide	1530
Port Harrison	1609
Augusta	1714
Fort Ray	1930
Stanley	1752
Fairbanks	1931
Kennecott	1932
Dillingham	2116
Gizhiga	2256

November 28

Place	Time
Capetown	0005
Irkutsk	0039
Magadan	0041
Tura	0222
Aldan	0224
Harampur	0403
Bratsk	0407
Santiago	0512
Ukhta	0547
Tobolsk	0549
Petrozavodsk	0730
Vologda-Kotlas	0731
Kirov, (Kazan)	0732

Satellite 1957 α1

November 27

Place	Time
Mikolayev-on-Amur	0950
Chita	1120
Chanchung	1123
Vladivostok	1124
Pyongyang	1125
Kyoto	1126
Wellington	1149
Kyzyl	1251
Hsian	1256
Wuhan-Nanking	1258
Kwangchow	1259
Melbourne	1317
Akmolnoygfn	1421
Karaganda	1422
Alma-Ata	1423
Lhasa	1428
Bandung	1438
Ogata	1446
Penza-Ulyanovsk	1550
Kuibyshev, Saratov	1551
Ashkhabad	1555
Bombay	1600
Madras	1603
Vilnyus	1720
Kiev, Zhitomir	1721
Kishinev	1722
Sebastopol	1723
Baghdad	1727
The Hague	1852
Rome	1855
Mozambique	1911
Lisbon	2026
Port Elizabeth	2047
Mirny	2101
Freetown	2204
Kemp Land	2230
Pernambuco	2339

November 28

Place	Time
Washington	0055
Georgetown	0108
Rio de Janeiro	0114
Kansas City	0226
San Jose	0234
Buenos Aires	0248
Los Angeles	0357
Tierra del Fuego	0424
Graham Land	0559

Table 33.--Predictions issued Nov. 27, 1957

Satellite 1957 β1

November 28

Place	Time
Stockholm	0914
Tallinn	0915
Riga, Novgorod	0916
Minsk, Moscow	0917
Reykjavik	0955
Glasgow	1058
London	1059
Frederikshaab	1238
Lake Harbor	1421
Adelaide	1528
Port Harrison	1606
Augusta	1700
Fort Ray	1746
Fairbanks	1928
Carcross	1930
Dillingham	2130
Kamenskimoye-Gizyga	2254

November 29

Place	Time
Windhoek	0005
Yakutsk	0036
Okhotsk	0038
Aldan	0221
Rio de Janeiro	0329
Yeniseysk	0403
Bratsk	0404
Santiago	0509
Ukhta	0543
Tobolsk	0545
Omsk	0546
Moscow, Kotlas	0728
Gorky	0729
Kuibyshev	0730

Satellite 1957 α1

November 28

Place	Time
Pyongyang	1124
Hiroshima	1125
Lanchow	1255
Hsian	1256
Kwangchow	1259
Melbourne	1317
Lhasa	1427
Jakarta	1437
Augusta	1445
Ashkhabad	1554
Karachi	1558
Ankara	1723
Damascus	1724
Naples	1853
Mozambique	1909
Lisbon	2023
Port Elizabeth	2044
Mirny	2059
Freetown	2202
Kemp Land	2228
Pernambuco	2335

November 29

Place	Time
Washington	0052
Caracas	0100
Sao Paulo	0110
Dallas	0224
San Jose	0243
San Francisco	0351
Tierra del Fuego	0419
Graham Land	0556

Table 34.--Predictions issued on Nov. 29, 1957

Satellite 1957 β1

November 30		December 1	
Place	Time	Place	Time
Oslo	0905	(Yakutsk)	0025
Stockholm	0906	Okhotsk	0027
Kaliningrad,		Petropavlovsk-	
Vilnyus	0907	Kamchatsky	0030
Gomel	0908	Tura	0208
Reykjavik	1046	Vitim	0210
Glasgow	1050	Blagoveshchensk	0213
London	1051	Montevideo	0314
Wellington	1150	Rio de Janeiro	0319
Frederikshaab	1229	Eniseisk	0352
Sydney	1355	Krasnoyarsk	0353
Coral Harbor	1411	Irkutsk	0355
Battle Harbor	1415	Santiago	0458
Penang	1519	Archangel	0532
Fort George	1557	Syktyvkar	0534
Geraldton	1702	Serovsk	0535
Simpson	1737	Tyumen, Tobolsk	0536
Georgetown	1918	Omsk	0537
Ugolnaya	2101	Leningrad	
Dutch Harbor	2104	Petrozavodsk	0716
Johannesburg	2210	Yaroslavl	0717
(Gijiga)	2244	Gorky	0718
		Kuibyshev	0719

Satellite 1957 α1

November 30		December 1	
Place	Time	Place	Time
Bogota	1336	Tokyo	008-
Caracas	1337	Jakarta	0125
Salvador	1507	(Hangchow)	0133
San Antonio	1641	Nanking	0136
Mirny	2038	Pyongyang	0138
Kemp Land	2206	Komsomolsk-on-Amur	0142
		Calcutta	0302
		Lhasa	0304
		Ulan Bator	0309
		Hyderabad	0431
		Urumchi	0437
		Johannesburg	0546
		Addis Ababa	0555
		Teheran	0602
		Ashkhabad	0603
		Cairo	0730
		Ankara	0732
		Rostov-on-Don	0734

Table 35.--Predictions issued Nov. 30, 1957

Satellite 1957 β1

December 1		December 2	
Place	Time	Place	Time
Faroe Islands	0857	Vilyuisk	0019
Oslo	859-	Yakutsk	0020
Warsaw, Minsk	0901	Okhotsk	0022
Reykjavik	1039	Vereshchagino	0201
London	1044	Vitim	0203
Wellington	1144	Montevideo	0308
Kanortalik	1224	Rio de Janeiro	0312
Sydney	1329	Krasnoyask	0347
Coral Harbor	1404	Irkutsk	0349
Battle Harbor	1408	Santiago	0452
Penong	1512	Archangel	0526
Fort George	1551	Syktyvkar	0527
Onslow	1658	Serov	0528
Dawson	1728	Tyumen	0529
Shelton	1911	Omsk	0530
Fort Fraser	1917	Karaganda	0532
Ugolnaya	2054	Petrozavodsk	0709
Dutch Harbor	2058	Yaroslavl	0711
Johannesburg	2204	Penza	0712
Seimchan	2236	Pugachev	0713

Satellite 1957 α1

December 1		December 2	
Place	Time	Place	Time
Abidjan	0852	Singapore	0108
Naples	0902	Kwangchow	0114
Budapest	0904	Nanking	0116
Lvov	0905	Pyongyang	0110
Tierra del Fuego	1004	Khabarovsk	0121
Rio de Janeiro	1014	Komsomolsk-on-Amur	0122
Lisbon	1030	Calcutta	024-
Paris	1033	Lhasa	0244
Santiago	1140	Ulan Bator	0249
Bogota	1319	Hyderabad	0412
Caracas	1321	Urumchi	0417
San Salvador	1451	Johannesburg	0527
Washington	1457	Addis Ababa	0535
Montreal	1459	Teheran	0542
Minneapolis	1627	Ashkhabad	0543
San Francisco	1754	Cairo	0710
Wellington	1902	Ankara	0712
Geraldton	2332	Rostov-on-Don	0714
Tokyo	2349		
Severo-Kurilsk	2352		

Table 36.--Predictions issued Dec. 1, 1957

Satellite 1957 β1				Satellite 1957 α1	
December 2		December 3		December 3	
Place	Time	Place	Time	Place	Time
Oslo	0853	Blagoveshchensk	0200	Kwancho	0050
Copenhagen	0854	Vladivostok	0202	Nanking, Shanghai	0053
Kaliningrad	0855	Yeniseysk	0340	Vladivostok	0056
Dublin	1017	(Iakten)	0342	Khabarovsk	0057
London	1038	Nizhniy Tagil	0522	Magadan	0059
Paris	1039	Karaganda	0524	Lhasa	0220
Wellington	1138	(Balmash)	0525	Chita	0224
Frederikshaab	1217	----	----	(Accra)	0226
Sydney	1323	----	----	Hyderabad	0347
Battle Harbor	1403	----	----	Urumchi	0351
Fort George	1544	Guryev	07--	Kyzyl	0352
Simpson	1724	Albijan	0831	Bratsk	0353
Vancouver	1911	Rome, Naples	0841	Ashkhabad	0518

Table 36.--Predictions issued Dec. 1, 1957 (continued)

Satellite 1957 β1

December 2		December 3	
Place	Time	Place	Time
Johannesburg	2158	Budapest	0843
(Ijiga)	2231	Lvov	0844
		Rio de Janeiro	0953
		Lisbon	1009
		Paris	1011
		Copenhagen	1013
		Stockholm	1014
		Helsinki	1015
		Santiago	1118
		Guatemala	1427
		Washington	1435
		Quebec	1436
		Minneapolis	1605
		Lake Harbor	1609
		----	1731
		Port Nelson	1736
		Wellington	1836
		Fort Fraser	1903
		Mirny	1957
		Penong	2138
		Dutch Harbor	2200
		Geraldton	2307
		Yokohama	2324
		Petropavlovsk-Kamchatsky	2328

Satellite 1957 α1

December 3	
Place	Time
(Djezkazgan)	0519
Karangada	0520
Novosibirsk	0521
Cairo	0643
Stalingrad	0647
Naples	0714
Budapest	0715

Table 37.--Predictions issued Dec. 2, 1957

Satellite 1957 β1

December 2		December 3	
Place	Time	Place	Time
Dublin	1037	Bodaibo	0158
London	1038	Blagoveshchensk	0200
Paris	1039	Vladivostok	0202
Wellington	1138	Yeniseisk	0340
Frederikshaab	1217	Irkutsk	0342
Sydney	1323	Nizhniy Tagil	0522
Battle Harbor	1403	Karaganda	0524
Fort George	1544	Balkhash	0525
Simpson	1724	Leningrad	0704
Vancouver	1911	Moscow	0705
Johannesburg	2158	Penza	0706
Gijiga	2231	Guryev	0708

Satellite 1957 α1

December 2		December 3	
Place	Time	Place	Time
Rio de Janeiro	0953	Canton	0050
Lisbon	1009	Shanghai	0053
Paris	1011	Vladivostok	0056
Copenhagen	1013	Khabarovsk	0057
Stockholm	1014	Magadan	0059
Helsinki	1015	Lhasa	0220
Santiago	1118	Lanchow	0222
Guatemala City	1427	Chita	0224
Washington	1435	Aldan	0226
Quebec	1436	Hyderabad	0347
Canorthalic	1440	Urumchi	0351
Minneapolis	1605	Kyzyl	0352
Lake Harbor	1609	Bratsk	0355
San Francisco	1731	Ashkhabad	0518
Port Nelson	1736	Jeskazgan	0519
Wellington	1838	Karaganda	0520
Fort Fraser	1093	(Novhirsk)	0521
Mirny	1957	Cairo	0643
Carcross	2034	Stalingrad	0647
Penang	2138	Kuibyshev	0649
Dutch Harbor	2200	Sverdlovsk	0650
Geraldton	2307	Surgut	0691
Yokohama	2324	Naples	0714
Petropavlovsk-Kamchatsky	2328	Budapest	0715

Table 38.--Predictions issued Dec. 3, 1957

Satellite 1957 β1

December 3		December 4	
Place	Time	Place	Time
Copenhagen	0844	Yakutsk	0003
Warsaw	0846	Severo-Kurilsk	0008
Kishinev	0847	Bodaibo	0147
Dublin	1027	Hailun	0150
London	1028	Montevideo	0251
Paris	1029	Sao Paulo	0255
Wellington	1128	Krasnoyarsk	0330
Canorthalic	1208	Kyzyl	0332
Canberra	1313	Ulan Bator	0333
Battle Harbor	1353	Solikamsk	0511
Port Nelson	1533	Sverdlovsk	0512
Ottawa	1537	Akmolensk	0514
Athabaska	1717	Balkhash	0515
Georgetown	1856	Helsinki	0652
Vancouver	1901	Leningrad	0653
Dutch Harbor	2041	Moscow	0654
Capetown	2144	Saratov	0656
Johannesburg	2147	Astrakhan	0657
Magadan	2221		

Table 39.--Predictions issued Dec. 4, 1957

Satellite 1957 β1

December 5		December 6	
Place	Time	Place	Time
Berlin	0828	Bodaibo	0120
Bucharest	0831	Hailun	0132
Dublin	1010	Vladivostok	0133
London	1012	Montevideo	0233
Paris	1013	Rio de Janeiro	0237
Wellington	1111	Tomsk	0311
Kanortalik	1151	Krasnoyarsk	0312
Canberra	1255	Kyzyl	0313
Battle Harbor	1335	Sverdlovsk	0453
Augusta	1437	Chelyabinsk	0454
Port Nelson	1515	Karaganda	0455
New York	1520	Leningrad	0634
Dutch Harbor	2023	Moscow	0635
Capetown	2126	Saratov	0637
Magadan	2203	Astrakhan	0639
Nikolayevsk-on-Amur	2347		

Table 40.--Number of revolutions and distance travelled by Satellites 1957 α1 and 1957 α2; based on Soviet releases

Date	Moscow time	Number of revolutions α1	Number of revolutions α2	Distance travelled by α2 (in km)	Time that α1 leads α2 in revs	Time that α1 leads α2 in min	Distance that α1 leads α2 in revs	Distance that α1 leads α2 in km	Remarks
Oct. 13	1800	130	130	5,700,000					
14	0600					5		2,500	
14	1800	145	145	6,300,000					
15	0600					6		3,000	
15	1800	160	160	6,900,000		10			
16	0600					11		5,300	
16	1800	175	175	7,600,000		13			
17	0600					14		6,700	
17	1800	190	190	8,300,000		17		8,000	
18	0600					19.7		9,000	Daily lead increase quoted as 5.7 minutes or 2,300 km.
18	1800	205	205	9,000,000		22		10,000	
19	0600					24		11,000	
19	1800	220	220	9,600,000		27		12,400	
20	0600					29		13,200	
20	1800		235			32		14,600	
21	1800					39		18,000	
22	0600		258	11,250,000					
22	1800					46		21,000	
23	0600		273	11,900,000					
23	1800					53.2		24,300	
24	0600		288	12,560,000					
24	1800					50*		27,400	*Obvious typographical error.
25	0600		303	13,200,000					
25	1800				1 minus	28.8	1 minus	13,900	At this time, USSR shifted to reporting how far the carrier rocket was behind the satellite while overtaking it.
26	0600		319	13,850,000					
26	1800						1 minus	9,940	In the evening release on 26 October, it was announced the radio had stopped working.
27	0600		333	14,452,000					
27	1800		341	14,800,000	1 minus	10.5	1 minus	4,800	
28	1800				1		1		
29	0600			15,841,000*					*This distance quoted for α1.
29	1800				1 plus	12.5	1 plus	5,650	
30	0600	•380	379						
30	P.M.*				1 plus	17			*Quoted as "afternoon".
31	0600	395			1.22				
	1800				1 plus	26.5	1 plus	12,000	
Nov. 1	0600	410			1.35				
1	1800				1 plus	38			
3	0600	441							
3	1800				2 minus	30			Carrier rocket α1 1.69 revolutions ahead of satellite α2.
6	1800				2 plus	17			
7	0600	502	500						
7	1800				2 plus	34			
9	0600	533	530		3 minus	27.5			Carrier rocket 2.7 revolutions ahead.
11	1800				3 minus	21.7*			*This figure could be a typographical error.

Table 40.--Number of revolutions and distance travelled by Satellites 1957 α1 and 1957 α2; based on Soviet releases (continued)

Date	Moscow time	Number of revolutions α1	α2	Distance travelled by α2 (in km)	Time that α1 leads α2 in revs	min	Distance that α1 leads α2 in revs	km	Remarks
Nov.									
12	0600	579	576						
12	1800				3	plus 44.4			
14	0600	610	606						
15	0600	625	621						
16	0600	641	637						
17	0600	656	652						
18	0600	672	667						
20	0600	703	698						
21	0600	719	713						
22	0600	734	728						
23	0600	751	744						
23	0600		744						
24	0600	766	759						
25	0600	781	774						
26	0600		790						
27	0600		805						
28	0600	830	821						
30	0600	862	851						
Dec.									
1	0600	878	867						
2	0600	894	882						
3	0600		898						
5	0600		929						

Table 41.--Number of revolutions and distance travelled by Satellite 1957 Beta based on announcements by the U.S.S.R.

Date	Moscow time	Number of revolutions	Distance travelled (km)	Remarks
Nov.				
6	0600	40		
7	0600	54		
8	0600	68		
9	0600	82	3,800,000	
10	1800	103	4,740,000	Cessation of radio signals from Beta announced.
12	0600	124		
14	0660	152		
15	0600	166		
16	0600	180		
17	0600	194		
18	0600	208	9,535,000	
20	0600	236		
21	0600	250		
22	0600	264		
24	0600	292		
25	0600	306		
26	0600	320		
27	0600	334		
28	0600	348		
30	0600	376		
Dec.				
1	0600	390		
2	0600	404		
3	0600	418		
5	0600	446		

Table 42.--Satellite Periods Announced by the U.S.S.R.

Release date (Moscow time)	Satel-lite	Period (minutes)	Remarks
20 Oct. (afternoon)	α1	95.12	
20 Oct. "	α2	95.55	
23 Oct. (0600)	α1	95.01	
23 Oct. "	α2	95.49	
26 Oct. (afternoon)	α1	94.68	
26 Oct. "	α2	95.31	
6 Nov.	Beta	103.6	It was stated that Beta's period diminished more slowly than that of α1, and its life would be longer.

Table 43.--Twilight visibility zones predicted by the U.S.S.R.

	Northern Hemisphere				Southern Hemisphere				
	α1		β1		α1		β1		
Date	Degree latitude	Time	Degree latitude	Time	Degree latitude	Time	Degree latitude	Time	Remarks
Oct. 29	30-60	Sunset			18-65	Sunrise			α1 passages quoted SW-NE in north and NW-SE in south said to be visible within 1,000 km of trajectory in north 2,000-2,500 km in south.
30	35-62	"			22-65	"			
31	38-63	"			26-65	"			
Nov. 1	40-62	"			30-65	"			Sunset northern visibility within 1,000 km. Sunrise southern within 2,000 km.
3	45-63	"			32-65	"			
12	62-67	"	54-68	Sunrise	47-70	"	30-70	Sunset	
14	61-65	"	57-65	"	49-63	"	38-65	"	
15	60-63	"	58-65	"	50-64	"	40-65	"	
16	60-65	"	60-65	"	48-63	"	38-63	"	
17	60-65	"	62-65	"	46-63	"	38-62	"	
18	60-65	"	63-65	"	46-63	"	38-62	"	
20	56-64	"	62-65	"	44-65	"	38-61	"	
21	50-63	"	61-65	"	43-65	"	37-61	"	
22	45-63	"	60-65	"	30-65	"	36-60	"	
23	40-52*	"	60-65	"	20-65	"	35-59	"	*Probable typographical error; 40-62 seems more reasonable.
24	30-60	"	59-65	"	0-65	"	30-58	"	
25	0-62	"	59-65	"	0-65	"	28-58	"	
26	0-60	"	58-64	"	0-65	"	27-57	"	
27	0-55	"	57-64	"	0-65	"	27-56	"	
28			55-63	"	0-65	"	26-52	"	
30	0-30	Sunrise	52-62	"	40-65	Sunset	24-50	"	
Dec. 1	0-50	"	51-65	"	0-65	"	24-50	"	
2	10-55	"	50-63	"	10-65	"	23-49	"	
3			48-62	"			23-47	"	
5			43-60	"			20-43	"	

Visual Observations of Satellite 1957 α1 Made by Moonwatch Stations[1]

By L. CAMPBELL, JR,[2] and J. A. HYNEK[3]

The fall of the world's first artificial satellite marks a significant epoch. A report on the visual observations of the components of this launching, Satellites 1957 α1 and α2, is appropriate at this time. The great majority of scientifically valuable visual observations of these objects were furnished by stations in the world-wide network of more than 200 Moonwatch teams. Indeed, without their observations the existence of α1 and α2 would have been far less fruitful, scientifically; for instance, the first attempts to obtain values of air densities at satellite heights would hardly have been possible without the significant visual observations furnished by these teams.

In this report we give a brief review of the scope and performance of the Moonwatch operation and a chronological listing of significant Moonwatch observations. During the 8-week life of Satellite 1957 α1, 131 teams contributed a total of 391 observations of α1 as well as of α2. These were rapidly transmitted by telephone and telegraph to Moonwatch headquarters at Cambridge, Mass., where they were analyzed and fed to the Computations and Analysis Division for orbital computations. (During this period these 131 stations as well as others furnished an estimated 50 observations of Satellite 1957 Beta and its components.)

The distribution, by countries, of Moonwatch teams associated with the Smithsonian Astrophysical Observatory in the visual observing program, is as follows:

Argentina	4
Australia	4
Belgian Congo	1
Chile	3
Japan	71
Mexico	1
Netherlands Antilles	1
Peru	1
Uruguay	1
Union of South Africa	4
United States	114
Total	205

The preparation, training and organization of teams have been described in the series of Bulletins for Visual Observers of Satellites issued by the Smithsonian Astrophysical Observatory. Only a brief description, therefore, of the organization and performance of a typical Moonwatch team will be given here.

Purpose and scope of Moonwatch

Immediately after the launching by any nation of an artificial earth satellite, it is of utmost importance to obtain a rough determination of the orbit as quickly as possible so that the satellite can begin its useful life as a scientific vehicle. Some satellites will be equipped with radios while others will not. Since there also exists the possibility of initial or early radio failure in the instrumented satellite, precision optical and photographic tracking of earth satellites may not be possible until a preliminary orbit is determined.

While the present report lists primarily observations of the satellite rocket carrier,

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1957 $\alpha 1$, it should be pointed out that with very few exceptions the only scientifically valuable visual observations of the satellite proper, 1957 $\alpha 2$, were obtained by Moonwatch teams.

The primary objective of Moonwatch is to provide early systematic observations to an accuracy of better than a degree of arc and a second of time. To effect this, there have been organized more than 200 teams of volunteer observers, drawn largely from the ranks of amateur astonomers and other scientifically inclined laymen who are giving freely of their time and who, for the most part, have fabricated or furnished their own observing equipment, including small telescopes, radio receiving sets, tape recorders, and other instruments. The investment represented by a typical Moonwatch station is estimated to be about $2,000, exclusive of special equipment and expenses incidental to the operation of the station. It should be emphasized that no salaries are given to Moonwatch teams anywhere.

Each team comprises from 20 to 100 or more members. To allow for fatigue of individuals during an often long and tedious observing period, teams must have more observers than actually serve during any one satellite crossing.

Observing techniques

A Moonwatch team constitutues an optical fence, or gauntlet, across which a satellite must pass when its orbit intersects the twilight zone at a given station. When a satellite is first launched, all teams must be alerted until enough data have been collected to show that certain regions of the earth will not be productive of observations.

Each observer on a team is assigned a relatively small portion of the sky along the chosen observation line, and patrols his sector during the entire observation period. Although only one or two members will see the satellite at any one passage, the entire team must observe to make sure that the satellite is acquired as it crosses the chosen observation line.

When an observer sees the satellite entering his field, he records this by voice on tape, by buzzer, or other recording aid, along with the WWV time signals which are recorded continuously during the entire observing period. When played back, such a recording permits the accurate determination of the time when the satellite entered the field, its crossing of the meridional marker, and its exit from the field. Its position on the celestial sphere is determined from the pre-set orientation of the observer's telescope or from the satellite's passage through a recognizable field of stars. Angular rate and magnitude are noted.

Primary Uses of Observations.—Moonwatch observations received at the Smithsonian Astrophysical Observatory are used primarily for the construction of search or location ephemerides, to be used at precision photographic stations and other scientific stations, including astronomical observatories. Such ephemerides also are requested by scientists interested in performing special experiments, such as infrared observations. Currently, more than 350 predictions for as many geographical localities are requested daily from Smithsonian Astrophysical Observatory. Also, large groups of amateur and professional photographers organized under the Society of Photographic Scientists and Engineers and the Civil Air Patrol, as well as other groups and agencies, request satellite search data.

The second stage of the Moonwatch program occurs during the last phase of the existence of any particular satellite. Observations made of a satellite's earthward plunge are of obvious value, both for possible recovery and to record the luminescence and other physical factors of re-entry.

Members of Moonwatch teams also perform important work in disseminating and interpreting the satellite data, as well as information about the whole IGY program, to their own communities. A Moonwatch team becomes in itself a center of considerable local interest and its members are constantly called upon to interpret the satellite program to the community, particularly to school groups, as well as to church and other adult groups. Thus, they have a unique opportunity to encourage participation and interest in the total IGY program, and particularly to stimulate interest in science among the young people.

History of Moonwatch teams

It is estimated that there are more than 5,000 amateur astronomers in the United States alone, many of whom are organized through the Astronomical League. Shortly after the Smithsonian Astrophysical Observatory was given the responsibility for the optical tracking of the IGY satellites, it was determined to call upon these groups in this and other countries to serve as nuclei of visual observation teams. Dr. Armand N. Spitz, long noted for his work with these groups, the American Astronomical League, and the Association of Western Amateurs, was asked to assist in the organization.

A National Advisory Committee composed of nominees from these two organizations, under the guidance of Dr. Spitz, studied the problems of organization, techniques, and instruments. The Moonwatch telescope was devised as a result of the research by this committee under the chairmanship of G. R. Wright of Silver Spring, Maryland. A basic consideration in devising instruments and techniques was that there was no budget provision for the operation of Moonwatch teams and that all activities had, therefore, to be on a volunteer basis.

Since individual team members were to be asked to purchase or fabricate their own telescopes, the Committee set about to devise a low-cost optical instrument consistent with the observing techniques desired. The resulting Moonwatch telescope is now so familiar, and has been so adequately described in the popular literature, that further description is not necessary here. It is appropriate, however, to point out that the Russian visual observation effort was closely patterned after the U. S. IGY Moonwatch operation. Plans of instruments, techniques and organization were published in *Sky and Telescope*, an internationally distributed magazine devoted largely to amateur astronomy.

The Moonwatch Operation was from the outset intended to be complementary to the Precision Photographic Tracking Program. However, the coming of the sputniks before all precision tracking cameras were ready placed an added responsibility on the Moonwatch teams: to serve as interim tracking teams. As has already been mentioned, after the cessation of radio signals from the sputniks, the Moonwatch teams became one of the primary means of day-to-day tracking.

The coming of the Russian satellites in their highly inclined orbits forced an alteration in some of the observing techniques of Moonwatch teams. For instance, it became necessary to establish an east-west optical fence, instead of the north-south, meridional fence first planned. In many cases this required additional expense of funds, time, and effort on the part of the teams to reorganize their station layouts. It is appropriate to mention, likewise, the very great cooperation and enthusiasm shown by the vast majority of Moonwatch teams.

Many teams have felt the pressure of the financial burden, since most amateur astronomy groups operate on very limited budgets, but have been helped by local sponsors from civic groups, commercial organizations, and educational institutions.

The organization and training of many stations and teams was assisted by the efforts of Col. Owen Clarke, USAF, who directed the system of "fly-bys," airplanes trailing a small light to simulate the passage of a satellite.

Many Moonwatch teams in this and other countries deserve special mention, either for exemplary operation or for the development of special and ingenious techniques of observation. Indeed, the policy of the Smithsonian Astrophysical Observatory has been at all times to encourage the initiative and inventiveness of the individual teams. It would be beyond the scope of the present report to detail the many innovations and special operations contributed by such teams.

A chronological listing of all significant observations of $\alpha 1$ and $\alpha 2$ made by Moonwatch teams through Nov. 30, 1957, is given in table 1.

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957

Date (U.T.) Station name Code number	Station coordinates	Satel-lite 1957	Time observed	Right as-cension or azimuth	Declin-ation or altitude	Direc-tion	Angular velocity	Magnitude and color
October 8								
Sydney,								
Australia	151°05'41"E	α1	$09^h36^m34^s$	12^h38^m ^{s}	-60° ' "			+2
602 124 331	33 54 43 S	α1	09 37 31	13 37	-65			
		α1	09 38 28	15 25	-69			+2
		α1	09 38 52	16 45	-69			+2
		α1	09 39 08.0	15 50.7	-62.8		0.35°/s	+1
		α1	09 39 43	20 10	-55			+2
		α1	09 40 14	21 41	-16.7			+2
		α1	09 40 43.5	20 15	-28.5		0.35°/s	+1
		α1	09 40 42.25	20 15	-28.5			
October 9								
Sydney,								
Australia	151 05 41 E	α1	09 41 25.5	18 30 16	-10°40'		0.375°/s	+2.5
602 124 331	33 54 43 S	α2	09 41 30.5	18 35 00	- 9°00'			+2
Santiago,								
Chile	70 41 12 W		00 40 40	19 04	-37°.4			
805 124 071	33 33 42 S		00 05 17	20 16	-13.5			
			00 05 54	21 02	+07.6			
			00 06 54	21 52	+27.9			
Perth,								
Australia	115 51 10 E		11 17 14	101°20'A	36°08'A			
601 122 296	32 00 07 S		11 18 15	66 56 A	20°26'25"A			
October 10								
Santiago,								
Chile	70 41 12 W		00 03 48	17 11.0	-23°24'			
805 124 071	33 33 42 S		00 05 45	21	+04.5			
			00 07 01	20 57.9	+42°15'			
Sydney,								
Australia	151 05 41 E	α2	09 39 31	15 18	+44.8			Faint
602 124 331	33 54 43 S		09 41 15.5	18 30 16	-10			
		α1	09 41 18.5	18 11 13.5	+14°46'			Bright
			09 41 30.5	18 35 00	- 9			
New Haven,								
Conn.	72 56 50 W		10 23	45°A	40A			+3
087 072 042	41 19 58 N							
Niigata,								
Japan	139 00 39 E		19 58 04	{65°A	08.5A}			+5, Red-orange
238 038 319	37 54 26 N			{13 07	24°49}			
October 11								
Perth,								
Australia	115 51 10 E		11 16 30	19°33'00"A	48°19'29"A			Bright
601 122 296	32 00 07 S		11 16 45.8	21°15'00"A	40°09'52"A			"
			11 16 55	21°29'40"A	36°02'41"A			"
			11 16 59.5	21°52'00"A	35°15'15"A			"
			11 17 16.8	22°13'00"A	28°38'14"A			"
Adelaide,								
Australia	138 36 14 E		09 39 12.5	20 18 36	-14 55 07			
600 125 319	34 55 14 S							
October 12								
Niigata,								
Japan	139 00 39 E		19 53 39	65°A	17.5A			+2
238 038 319	37 54 26 N							
Suwa,								
Japan	138 07 43 E		19 53 54	45°A	11.5A			+4
248 036 318	36 00 13 N		19 54 00	45°A	16.5A			+4
Perth,								
Australia	115 51 10 E		11 11 50.5	231°35'00"A	30°05'20"A			
601 122 296	32 00 07 S		11 12 39.5	245°52'00"A	43°45'59"A			
			11 13 27.3	293°10'20"A	52°54'16"A			
			11 14 43.5	350°46'20"A	33°10'31"A			
			11 15 57	05°52'00"A	16°23'25"A			
			11 16 12.7	07°36'10"A	13°47'49"A			

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 13								
New York,								
N. Y.	73°58'45"W		10h12m16s	22h00m s	+58° ' "			0 to 4.5
046 041 074	40 45 30 N		10 14 01	15 32.5	+71			"
			10 14 26	14 00	+65			"
			10 14 51	12 42.5	+57			
Cambridge,								
Mass.	71 07 46 W		10 14 39.6	23°A	47A			
099 042 071	42 22 48 N		10 14 59.4	40°A	53A			
			10 15 04.6	43°A	52.5A			
			10 15 10.0	50°A	51.5A			
Millbrook,								
N. Y.	73 37 27 W	α1	10 15 00	10 54	31°26'			
045 043 079	41 51 30 N	α2	10 17 28	10 54	31°26'			Faint
Baltimore,								
Md.	76 35 25 W	α1	10 16 42	11 44	+15.5			+2 varying
088 039 077	39 24 28 N	α2	10 20 23	11 43	+15.5			+5
Osaka Yomiru,								
Japan	135 30 30 E		19 47 28	18 19	+68			+3
241 035 316	34 41 51 N							
Perth,								
Australia	115 51 10 E		11 08 08.8	235°44'20"A	19°18'16"A			
601 122 296	32 00 07 S		11 09 21.6	255°40'00"A	28°25'53"A			
			11 09 59	274°54'30"A	30°39'22"A			
			11 10 57.8	310°35'40"A	31°41'46"A			
			11 11 25.8	324°44'00"A	27°44'10"A			
Suwa,								
Japan	138 07 43 E		19 48 15	16 23	+62			+2
248 036 318	36 00 13 N							
Sendai,								
Japan	140 51 56 E		19 48 57	15 02	+65			+3
246 038 321	38 15 22 N							
Musashino,								
Japan	139 34 35 E		19 50 02	13 30	+51			+2
233 036 320	35 42 58 N							
Takada,								
Japan	138 15 22 E		19 50 03.5	13 37	+51			4 to 1.5
250 037 318	37 06 38 N		19 50 19	12 05	+38			+4
Osaka,								
Japan	135 31 01 E		19 50 06	49°A	12A			+3
240 035 316	34 38 36 N							
Chunichi,								
Japan	136 54 14 E		19 49 51	51°A	17A			+3
204 035 317	35 10 23 N							
Nagoya,								
Japan	136 59 11 E		19 49 57	40.6°A	12.8A			+4
236 035 317	35 08 57 N							
Antofagasta,								
Chile	70 25 07 W	α1	23 59 04.3	16 57	09.2			
804 114 070	23 39 11 S							
October 14								
Woomera,								
Australia	136 46 59 E		09 32 29	346°10'44"A	19°42'26"A			
603 121 216	31 06 13 S		09 33 17	352°14'58"A	15°19'36"A			
North Canton,								
Ohio	81 27 19 W		10 07 47	{Meridian	+60°16'}		16.5'/s	4 to 3
053 041 081	40 55 55 N			{0°A	11°12'A}			
				(Above corrected for refraction)				

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 14 (continued)								
Greensboro, N.C.	79°52' "W		10h 09m 50s	15h 25m s	+59° ' "			+3
049 036 080	36 04 N		10 11 40	12 45	+39			+3
(Not at Station - 2 miles SW)								
Cambridge, Mass.	71 07 46 W		10 10 57.5	22.5°A	67.5A			
099 042 071	42 22 48 N		10 11 01.1	24°A	71A			
			10 11 03.5	27°A	71A			
			10 11 08	31.5°A	72A			
			10 11 11	31.5°A	71.5A			
			10 11 15	45°A	72A			
			10 11 08	69.5°A	72.5A			
			10 11 20	78A	70.5A			
Ft. Monmouth, N.J.	74 05 W	α1	10 11 08	46°A	42.5A			
040 040 074	40 17 40 N							
New Haven, Conn.	72 56 50 W		10 11.25	60°A	60A			
087 041 072	41 19 58 N							
Bristol, Tenn.	82 09 29 W		10 11 24	40°A	18A			
097 037 082	36 35 03 N		10 13 07	90°A				
State College, Pa.	77 53.4 W	α1	10 10 25	12 52	+56.25			
060 041 078	40 44.0 N	α2	10 18 12	12 17	+57			Faint
Perth, Australia	115 51 10 E		11 06 25	292°01'00"A	23°04'44"A			Bright
601 122 296	32 00 07 S		11 06 29.5	293°08'40"A	23°06'04"A			"
			11 07 03.4	307°44'00"A	21°16'52"A			"
			11 07 46.2	323°33'00"A	17°19'11"A			"
			11 08 01.3	328°03'40"A	15°33'45"A			"
Akita, Japan	140 07 02 E		19 44 18	14 58	+74			+2
200 040 320	39 41 42 N		19 45 14	11 40	+56			+2
Sapporo, Japan	141 22 13 E		19 44 53	09 21	+52			+1
245 043 321	43 04 49 N							
Otaru, Japan	141 00 23 E		19 45 30	63.5°A	51.6A			+1.5
243 043 321	43 11 27 N							
Sendai, Japan	140 51 56 E	α1	19 45 28	12 09	+58			+2
246 038 321	38 15 22 N	α2	19 56 43	13 11	+55			+4
Toyama, Japan	137 11 07 E		19 45 36	50.3°A	21.5A			+2
254 037 317	36 42 13 N							
Kanazawa, Japan	136 41 01 E		19 45 43	12 40	+47			+2
221 037 317	36 32 45 N							
Kurume Machi, Japan	139 31 48 E		19 45 47	45.5°A	27A			+3
227 036 320	35 45 18 N							
Shizuoka, Japan	138 23 18 E		19 45 59	13 12	+54			+2
247 035 318	34 58 25 N							
Takaoka, Japan	137 01 39 E		19 46 04	54.5°A	22A			+2
270 037 317	36 44 23 N							

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 14 (continued)								
Musashino, Japan 233 036 320	139°34'35"E 35 42 58 N	α1	19h46m13s	54.1°A	27°.4A			+1.5
		α3	19 48 13.8	00.0°A	13.2A			+6
		α2	19 52 04.5	00.0°A	10.7A			+7
Nagoya, Japan 236 035 317	136 59 11 E 35 08 57 N		19 47 49	90°A	16.7A			+3
October 15								
State College, Pa. 060 041 078	77 53.4 W 40 44.0 N	α1	10 04 10	18h27m	+72°25'			
		α1	10 05 41	11 27	+54.5			
		α2	10 26	11 27	+54.5			
Harrisburg, Pa. 057 040 077	76 54 40 W 40 15 42 N		10 05 (10° under Polaris and to the SE)		40A			3-5
Greensboro, N. C. 049 036 080	(79 52 02 W) (36 04 39 N)		10 05 54 (Not at Station but 3 miles SW)	13 20	+55			+2
Washington, D. C. 014 039 077	77 12 30 W 38 45 37 N		10 06 09	11 46	+53°28'			+4.5
New Haven, Conn. 087 041 072	72 56 50 W 41 19 58 N		10 06 14	66°30'A	72A			
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N		10 06 16.4	237°A	85A			
			10 06 18.8	225.5°A	85.5A			
			10 06 22.8	221°A	85A			
Millbrook, N. Y. 045 042 074	73 37 27 W 41 51 30 N	α1	10 07 04	09 12	+10			
		α1	10 08 12	09 12	+02°30'			
Harrisonburg, Va. 072 038 079	78 52 W 38 28 20 N		10 07 18	11 19 10	+20°50'			
Los Alamos, N. Mex. 043 036 106	106 19 20 W 35 52 30 N	α1	13 17 55	11 05	+62			
Oakland, Calif. 066 038 122	122 12.0 W 37 46 00 N	α1	13 18 05	11 30 (approx.)	+55	NW-SE		-1
			13 18 22	10 16	+42.5			
Portland, Oreg. 076 045 123	122 37 33 W 45 29 19 N		13 19 to 13 20	0°A	70-75A	To SE		+2
Takada, Japan 250 037 318	138 15 22 E 37 06 38 N		19 38 50	16 00	+74			
			19 39 59	12 15	+57			+3
			19 40 25	11 45	+48			+3
			19 40 45	11 19	+37.3			
		α3	19 43 45	10 10	-16			+6
Takaoka, Japan 270 037 320	137 01 39 E 39 41 42 N		19 39 43	125.5A	23.0A			+2
Kanazawa, Japan 221 037 317	136 41 01 E 36 32 45 N		19 39 48	12 45	+57			+2
			19 41 42	11 10	+16°20'			+2

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satel-lite 1957	Time observed	Right as-cension or azimuth	Declin-ation or altitude	Direc-tion	Angular velocity	Magnitude and color
October 15 (continued)								
Sendai, Japan 246 038 321	140°51'56"E 38 15 22 N		$19^h40^m09^s$	$16^h51^m\ \ ^s$	+30° ' "			+2
Musashino, Japan 233 036 320	139 34 35 E 35 42 58 N		19 40 53.5	53.9A	36.0A			+2
Kurume Machi, Japan 227 036 320	139 31 48 E 35 45 18 N	α2	19 48 57	45.0A	34A			
October 16								
Ft. Belvoir, Va. 077 039 077	77 11.3 W 38 45.5 N	α1	09 59	0°A	32°A			
New Haven, Conn. 087 041 072	72 56 50 W 41 19 58 N	α1	10 00 01	Zenith				
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N	α1	09 59 50.2	275°A	59.5A			
			10 00 00.2	266°A	62.5A			
			10 00 23.4	227°A	64.5A			
			10 00 24.8	226°A	64.5A			
			10 00 28.6	221°A	63.5A			
			10 00 29.2	222°A	64.0A			
			10 00 35.6	208°A	60.5A			
			10 00 37.6	205.5°A	58.5A			
			10 00 42.8	201°A	57.5A			
			10 00 50.2	199°A	59.5A			
Dover, N. J. 039 041 075	74 31 45 W 40 57 30 N	α1 α2	10 00 08.4 10 08	10 30 0°A	+49.75 82A			
Bristol, Tenn. 097 037 082	82 09 29 W 36 35 03 N		10 00 00 10 01 47	45°A 90°A	27A 29A			
Bryn Athyn, Pa. 055 040 075	75 04 W 40 08 N	α1	10 14 17	180°A	80A			
Red Bank, N. J. 040 040 074	74 05 W 40 17 40 N	α1	10 00 16	51°A	75.5A			
Millbrook, N. Y. 045 042 074	73 37 27 W 41 51 30 N	α1 α1	10 00 02 10 00 45	02 03 07 22	+64°35' +28 50			
Lincoln, Nebr. 038 041 097	96 39.2 W 40 50.3 N	α1	11 36 25.4	07 01	+20.6	NW-SE		+2 to +3
Sacramento, Calif. 007 039 121	121 16.59 W 38 38.43 N	α1 α2	13 13 02.9 13 27 27	08 42.5 07 25.5	+6.7 +0.91			 +6
Las Cruces, N. Mex. 042 032 107	106 50 50 W 32 19 42 N	α1	11 38 14	11 40	+18	N-SE	0.3°/s	+2 max.

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 17								
Cambridge, Mass.	71°07'46"W	α1	h m s 09 52 51.2	268°A	47A° ' "			Bright
099 042 071	42 22 48 N		09 52 55.6	264.5°A	47.5A			
			09 53 05.8	243.5°A	50A			
			09 53 10.8	241°A	50A			
			09 53 18.4	235°A	51A			
			09 53 38.6	213.5°A	50.5A			
			09 53 48.8	207°A	48A			
		α2	10 22 20.5	268°A	48A			Faint
			10 22 30	269.5°A	48A			
			10 23 39	202°A	38A			
Washington, D. C.	77 12 30 W	α1	09 52	45A	65A (approx.)			
014 039 077	38 45 37 N							
Schenectady, N. Y.	73 56.5 W	α1	09 53 02	h m s 05 35	+21°00' "			
081 043 074 (Not at Station)	42 54.6 N	α1	09 53 18	06 02	+13			
Wichita, Kans.	97 14 41 W		11 26	06 40	+40			
028 038 097	37 41 44 N							
Las Cruces, N. Mex.	106 50 50 W	α1	11 28 15	23°A	12A			2.5
042 032 107	32 19 42 N							
Lincoln, Nebr.	96 39.2 W	α1	11 29 34.5	06 30	+07.5	NW-SE		2 or 3
038 041 097	40 50.3 N	α1	11 29 46.2	06 42	+02.0			
Manhattan, Kans.	96 28.85 W	α1	11 29 34	05 56	+21°40'			+1
027 039 096	39 09.75 N		11 30 11	07 01	+04°05'			+1
			11 30 20	07 15	+00°40'			+1
			11 31 55	08 16	-23°20'			+3
San Francisco, Calif.	122 27 53 W	α1	13 04 37	0°A	58°	NW-SE		
008 038 122	37 46 10 N							
Oakland, Calif.	122 12.0 W	α1	13 04 40	06 37	+54°45'			
006 038 122	37 46 00 N							
Sacramento, Calif.	121 16.59 W	α1	13 05 05	06 43.5	+27.1			
007 039 121	38 38.43 N	α2	13 24 48	07 07.8 (Meridian passage)	-21.3			+6
Whittier, Calif.	118 01 35 W	α1	13 07 59	06 53	+19			+1
012 034 118	33 58 40 N							
Osaka-Yomiuri, Japan	135 30 30 E		19 24 08	18 28	+70			+4
241 035 316	34 41 51 N							
Kanaya, Japan	135 15 10 E		19 24 21	18 12	+69			+2
220 034 315	34 03 46 N							
Kiryu, Japan	139 19 54 E		19 25 15	06 32	+88			+2
223 036 319	36 24 22 N							
Kashiwara, Japan	135 48 15 E		19 26 06	27°A	29A			+2
222 034 316	34 30 24 N							
Yokkaichi, Japan	136 39 00 E		19 26 39	37.5A	38.3A			+2
258 035 317	35 00 15 N							

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 17 (continued)								
Nagoya, Japan 236 035 317	136°59'11"E 35 08 57 N		$19^h27^m34^s$	90°A	41°.9A			+2
Higashim, Japan 210 036 319	139 23 54 E 36 02 22		19 29 03	$09^h24^m.9^s$	-08			+2
Hofu, Japan 213 034 312	131 33 56 E 34 03 13 N		19 29 15	12 47	+15			+3
October 18								
Milwaukee, Wis. 074 043 088	88 08 54 W 42 58 08 N	α1 α2	09 45 46.5 10 04 53.5	09 47 09 47	-03°20' +54 00			+2 +5
Manhattan, Kans. 027 039 096	96 28.85 W 39 09.75 N	α1 α1 α1	11 20 37 11 21 38 11 22 45	03 56 05 36 06 48	+39°12' +10 -14°42'			+2 +2 Varying
Tulsa, Okla. 054 036 096	95 57 W 36 03 N	α1 α1	11 21 04.5 11 22 42.5 11 22 52.5	02 20 04 58 05 21	+56°00' +33°40' +28°15'			0 +1 +1.5
Wichita, Kans. 028 038 097	97 14 41 W 37 41 44 N	α1	11 22 06	06 39 51	+09°20'			
Bryan, Tex. 065 031 096	96 20 01 W 30 38 15 N	α1 α1 α1 α1 α3	11 22 27.5 11 23 19 11 23 22 11 24 53 11 40	06 04 07 13 07 19 08 08.5 03 54	+68 +29°54' +28°18' +09°58' +79°30'			+2 +2 +2 +2 Faint
			("Last object possibly a nose cone")					
Lincoln, Nebr. 038 041 097	96 39.2 W 40 50.3 N	α1	11 22 23	06 38	-16.7			
Yankton, S. Dak. 061 043 097	97 23 26 W 42 52 42 N		11 22 31.1	06 35	-17.5			+3.5
Ft. Worth, Tex. 069 044 097	97 22 09 W 32 42 42 N	α1 α1	11 22 45 11 22 52	07 47 07 50	+33.5 +29			
San Antonio, Tex. 089 024 098	98 29 11 W 29 27 25 N	α1 α1	11 23 22	09 33	+41			+2
New Orleans, La. 031 030 090	90 07 W 29 56 N	α1	11 23 42	04 35 42	+24			Bright as Sirius
Edinburg, Tex. 066 026 098	98 10.35 W 26 18.34 N	α2	11 23 45	45°A	44A			+4
Portland, Oreg. 076 045 123	122 37 33 W 45 29 19 N	α1	12 56 30	06 23	-17°42'			
Oakland, Calif. 006 038 122	122 12.0 W 37 46 00 N	α1	12 57 08.9	06 37	+18°20'			
Los Altos, Calif. 005 037 122	122 07 26 W 37 23 56 N	α1	12 57 11	180°A	73°A			

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satel-lite 1957	Time observed	Right as-cension or azimuth	Declin-ation or altitude	Direc-tion	Angular velocity	Magnitude and color
October 18 (continued)								
Sacramento, Calif. 007 039 121	121°16'59"W 38 38.43 N	α1 α2	12h57m34.8s 13 21 33.6	06h35.7m s 06 40.5	-03° ' " -31			 +6.5
Saga, Japan 244 033 310	130 17 59 E 33 14 35 N		19 15 00	340°0A	22.0A			+3
Hiroshima, Japan 211 034 312	132 28 10 E 34 22 08 N	 α2	19 16 17 19 40 23	17 54 06 18	+66 +81			+7 +8
Takaoka, Japan 270 037 317	137 01 39 E 36 44 23 N		19 16 20	90°A	36.8A			+2
Kashiwara, Japan 222 034 316	135 48 15 E 34 30 24 N		19 16 33	18 04	+78			+3
Konko, Japan 224 035 314	133 37 40 E 34 32 31 N		19 16 33 19 17 46	15 00 11 25	+73.5 +55.0			+3
Asahigawa, Japan 201 044 322	142 21 50 E 43 46 27 N		19 16 42	225.0°A	42.0A			+2
Nagano, Japan 234 036 318	137 50 44 E 35 30 50 N		19 17 05	02 00	+04			+2
Tadotsu, Japan 249 034 314	133 45 16 E 34 16 20 N		19 17 09	11 33	+61			+2
Mt. Fuji, Japan 232 036 319	138 48 50.3 E 35 31 20.8 N		19 17 23.3	04 15	+85			+2
Manazuru, Japan 228 035 319	139 08 46 E 35 09 23 N		19 18 15.7	09 20	+53.3			+2
Nagoya, Japan 236 035 317	136 59 11 E 35 08 57 N		19 19 06	90°A	47A			+3
Kanagawa, Japan 219 035 319	139 21 16 E 35 26 34 N		19 21 00	215°A	45A			+4
Kurume Machi, Japan 227 036 320	139 31 48 E 35 45 18 N	α3	19 28 41.9	270°A	81.5A			+6
Miyazaki, Japan 230 032 311	131 25 24 E 31 55 23 N		19 34 44	65°A	25A			+8
October 19								
Albuquerque, N. Mex. 041 035 107	106 38 36 W 35 05 03 N	α1	09 11 50	10 25	+40.5			2 to 2.5
Greensboro, N. C. 049 036 080	79 52 02 W 36 04 39 N	α1 α2	09 36 32 09 58 00	09 00 08 40	+48 +79			+1 +6
Ft. Belvoir, Va. 077 039 077	77 11.3 W 38 45.5 N	α1	09 37	Meridian	84A			+2

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 19 (continued)								
Chattanooga, Tenn. 062 035 085	85°15'37"W 35 01 02 N	α1	10h 14m s	13h 44m s	+49°.5 ' "			
Arlington, Va. 071 039 077	77 61 30 W 38 51 30 N	α1	10 36 00	06 18	+34	NW-SE		
Edinburg, Tex. 066 026 098	98 10.35 26 18.34	α1	11 14 38.2	45°A	55A			+1
		α1	11 14 39.2	45°A	53.5A			+1
		α1	11 14 41.2	45°A	55A			+1
		α1	11 14 44.0	45°A	53A			+1
		α2	11 25 35.2	45°A	79A			+6
		α2	11 25 40	45°A	79A			+6
Sunnyvale, Calif. 078 037 122	122 30 W 37 22.45 N	α1	12 48 08	05 55	+08			+1
		α2	13 01 47	06 44 42	+27			Very faint
Yokkaichi, Japan 258 035 317	136 39 00 E 35 00 15 N		19 07 38	39.8°A	57.4A			+2
Otsu, Japan 269 035 316	135 52 08 E 35 00 24 N		19 08 25.3	37°A	53A			+2
Kashiwara, Japan 222 034 316	135 48 15 E 34 30 24 N		19 08 35	27°A	55A			+2
Osaka-Yomiuru, Japan 241 035 316	135 30 30 E 34 41 51 N		19 08 56	06 05	+88			+2
Milwaukee, Wis. 074 043 088	88 08 54 W 42 58 08 N	α1	11 12 45	03 54	-14	N-S		+1
		α1	11 12 58	03 56	-17	N-S		+2
		α1	11 13 30	03 40	-13	N-S		+1
		α1	11 14 49	04 16	-20	N-S		+2
		α1	11 17 08	05 38	-27	N-S		+3
		α2	11 35	03 59	-00°20'	N-S		+5 to +6
Manhattan, Kans. 027 039 096	96 28.85 W 39 09.75 N	α1	11 12 03.5	04 12	+14°40'			+1.5
		α1	11 12 21.3	04 48	+04°15'			+1.5
			11 13 03.5	05 42	+10.05			
Tulsa, Okla. 054 036 096	95 57 W 36 03 N	α1	11 12 12	03 05 15	+28			+1
		α1	11 13 09	05 25	+07°20'			+1
		α1	11 14 44	05 43	-00°20'			+2.5
		α1	11 14 58	07 04	-26°30'			+3
		α2	11 45 39	07 35±10m	-37 to -41			+5
Kansas City, Mo. 036 039 095	94 34 52 W 39 02 02 N	α1	11 12 43	04 34	-02°30'			+2
Lincoln, Nebr. 038 041 097	96 39.2 W 40 50.3 N	α1	11 12 30	05 25	-09.0			+3 to +6
		α1	11 12 53	05 42	-14.8			
Peoria, Ill. 023 041 090	89 35 51 W 40 45 19 N	α1	11 12 52	230°A	22.5A			+1.5 max.
Bryan, Tex. 065 031 096	96 20 01 W	α1	11 13	05 47	+48°06'			+2
Ft. Worth, Tex. 068 033 097	97 22 10 W 32 44 40 N	α1	11 13 38	(06 30 (0°A	+35) 88A)			+2

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 19 (continued)								
Ft. Worth, Tex. 069 033 097	97°21'45"W 32 42 27 N	α1	11h12m19s 11 12 27	06h14m s 06 25	+35° ' " +30°30'			
New Orleans, La. 030 030 090	90 01 W 29 57 N	α1	11 13 42	270°A	60A			+1 to 2
New Orleans (Tulane) 031 030 090	90 07 W 29 56 N	α1	11 14 18	{ 04 40 270A	+19.5 } 42A			+2
San Antonio, Tex. 089 029 098	98 29 11 W 29 27 25 N	α1	11 14 08	08 12	+38.5			+2
Akita, Japan 200 040 320	140 07 02 E 39 41 42 N		19 09 10	06 17	-02			+1
Kanayamachi, Japan 220 034 315	135 15 10 E 34 03 46 N		19 09 35	85.8°A	44.1A			+2
Sendai, Japan 246 038 321	140 51 56 E 38 51 22 N		19 10 11	06 57	-14			+2
October 20								
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N		09 26 53.6 09 50 07.2 09 54 31.8 10 24 20.5 10 24 37.5	211°A 236°A 232.5°A 278°A 272.5°A	24A 12A 30A 20A 20A			Bright Faint " " "
New Haven, Conn. 087 041 072	72 56 50 W 41 19 58 N	α1	09 27 13 09 28 41	180°A 05 44	60A -35			
St. Louis, Mo. 080 039 090	90 11 50 W 38 37 59 N	α1 α1	09 31 56 11 05 19	10 23.0 05 32.0	+33.7 -35.1	NW-SE NW-SE		+4, White +2, White
Chattanooga, Tenn. 062 035 085	85 15 37 W 35 01 02 N		10 26	01 20	+46			+4.5
Peoria, Ill. 023 041 090	89 35 51 W 40 45 19 N	α1	11 02 42	230°A	20A			+3 varying
Bryan, Tex. 065 031 096	96 20 01 W 30 38 15 N	α1	11 02 41.2 11 03 12.3 11 03 36 11 03 37 11 04 19.4 11 05 07.8 11 05 54.7 11 05 55.3	04 30 04 31 05 51 05 49 06 01 07 02 07 35 07 44	+64°12' +65°18' +37°36' +37°54' -14°24 -15 -26°12' -28°54'			+2 +2 +2 +2 +4 +3, Reddish
Ft. Worth, Tex. 069 033 097	97 21 45 W 32 42 27 N		11 02 52.5 11 02 58 11 03 02.5 11 03 03	04 50 05 09 05 09 05 08	+32°45' +28 15 +28 15 +28 45			
Manhattan, Kans. 027 039 096	96 28.85 W 39 09.75 N	α1 α1 α1	11 03 04 11 03 22 11 04 31	05 33 05 47 06 40	-17 -22 -32°50'			2.5 3 3.5

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 20 (continued)								
Kansas City, Mo. 036 039 095	94°34'52"W 39 02 02 N	α1	$11^h03^m20^s$	$03^h26^m30^s$	-07° ' "			2 to 4
		α1	11 06 26	06 38	-43°20'			2 to 4
		α2	11 44 26	07 10	+41			7 to 8
New Orleans, La. 030 030 090	90 01 W 29 57 N		11 03 46	270°A	35A			
Ft. Worth, Tex. 068 033 097	97 22 10 W 32 44 40 N	α1	11 03 53	06 39	+03			Varying
		α2	11 30 19	06 59	+28			
New Orleans, La. 031 030 090	90 07 W 29 56 N	α1	11 03 56	{270°A 04 19	38A +18}	NW-S		
Dayton, Ohio 082 040 084	84 15 W 39 50 N	α1	11 04	240°A	20A		0.5°/s	2 to 2.5
Edinburg, Tex. 066 026 098	98 10.35 W 26 18.34 N	α1	11 04 28.8	225°A	66A			3
Tulsa, Okla. 054 036 096	95 57 W 36 03 N	α1	11 04 35	06 32	-26°25'			3
		α1	11 05 04	06 45	-32°40'			4.5 to 7
Des Moines, Iowa 026 042 094	93 41 30 W 42 00 N	α1	11 07 16	180°A	04.5A			
Waco, Tex. 093 032 097	97 05.5 W 31 38.5 N	α3	11 24 27	180°A	28°31'30"			+6
Albuquerque, N. Mex. 041 035 107	106 38 36 W 35 05 03 N	α1	12 40 33	295°A	20A			2 to 3
October 21								
Nagano, Japan 234 036 318	137 50 44 E 35 30 50 N		08 48 29	155°A	09.0A			1
Honjo, Japan 212 036 319	139 11 05 E 36 14 25 N		08 48 34	144°A	14A			
Mitake, Japan 229 036 320	139 32 31 E 35 40 20 N		08 48 57	23 20	-11			+2
Musashino, Japan 233 036 320	139 34 35 E 35 42 58 N		08 48 58	137.7°A	13.7A			+2
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N		11 06 35.8	120°A	18A			
			11 06 54.4	114°A	18A			
Philadelphia, Pa. 058 040 075	75 00 42 W 39 57 28 N	α1	23 22 00	0°A	40A			+1.5, Reddish
October 22								
Manhattan, Kans. 027 039 096	96 28.85 W 39 09.75 N	α1	00 43 04	22 48 30	-14 14			+1
Las Cruces, N. Mex. 042 032 107	106 50 50 W 32 19 42 N	α2	01 20 56	122°A	70A		1.3°/s	+5 or +6

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 22 (continued)								
Toyama, Japan 254 037 317	137°11'07"E 36 42 13 N		08h 36m 15s	90.0°A	5A' "			+3
Higashim, Japan 210 036 319	139 23 54 E 36 02 22 N		08 36 29	22h 33m s	-24			0
Musashino, Japan 233 036 320	139 34 35 E 35 42 58 N		08 36 38.7	135°A	21.4A			+1
			08 36 50	120.5°A	22.5A			+1
		α2	09 23 51.7	315°A	22.5A			+7 to +8
		α3	09 29 20.6	315°A	27A			+3 to +4
Manazuru, Japan 228 035 319	139 08 46 E 35 09 23 N		08 36 40	123.5°A	21A			
			08 36 52.4	108.5°A	21°40'A			
			08 37 53.1	75°A	15A			
Toyohashi, Japan 255 035 317	137 24 37 E 34 45 09 N		08 37 08	90°A	16A			+1
Takada, Japan 250 037 318	138 15 22 E 37 06 38 N		08 37 23	23 15	-25			+1
Suwa, Japan 248 036 318	138 07 43 E 36 00 13 N		08 37 38	01 34	+10.5			+1
Sapporo, Japan 245 043 321	141 22 13 E 43 04 49 N		08 37 52	22 38	-27.9			+3.5
Kurume Machi, Japan 227 036 220	139 31 48 E 35 45 18 N	α2	09 24 21.8	14 07	+55.9			+6
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N		11 36 10	306°A	40A			
			11 36 42	302°A	56A			
Silver Spring, Md. 032 039 077	77 00 23 W 39 05 50 N	α1	22 54	95°A	20A			
		α2	23 50 02.5	90°A	80A			+4 to +5
		α2	23 50 54	00 35	+55 15			
Dover, N. J. 039 041 075	74 31 45 W 40 57 30 N	α1	22 53 52	00 07	-10	E-N		0
Millbrook, N. Y. 045 072 074	73 37 27 W 41 51 30 N	α1	22 54 05	23 03	-17°20'	SE-NE		+2, Yellow-orange
			22 54 34	00 02	-07°50'			
New Haven, Conn. 087 041 072	73 W 41 N	α1	22 55	120°A	35A	S-NE		+1
		α2	23 17	120°A	37-38A	S-NE		+3 or +4
	(Observed by 4 people at home of R. Brown, Team Leader in Milford, Conn.)							
Bryn Athyn, Pa. 055 040 075	40 08 N	α1	22 55	135°A	20A	SE-NE		+1 or +2
		α3	23 29 48	18 30	+45	SW-NE		+4
		α3	23 30 09	0°A	71A			+4
	75 04 W	α3	23 30 53	01 30	+58			+4
Roanoke, Va. 073 037 080	79 56 W 37 19 N	α2	23 29 10	21 25	+48	SW-NE		+6
Washington, D. C. 014 039 077 (Not at station)	77 11 34 W 38 53 18 N	α2	23 48 45	Zenith	90A	SW-NE		

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satel-lite 1957	Time observed	Right as-cension or azimuth	Declin-ation or altitude	Direc-tion	Angular velocity	Magnitude and color
October 23								
Santa Barbara, Calif. 009 034 120	119°41'30"W 34 24 30 N	α1	$02^h03^m11^s$	$19^h43^m38^s$	+45°01'30"	SW-NE		Bright
			(Zenith to horizon in 1m 44s. Haze and clouds.)					
Los Angeles, Calif. 100 034 118	118 14 17 W 33 59 41 N	α1	02 03 50	0°A	45A	SW-NE		+1 to +2
Nagano, Japan 234 036 318	137 50 44 E 35 30 50 N		08 23 15	112°A	23A			+2
Mitake, Japan 229 036 320	139 32 31 E 35 40 20 N		08 23 26	105°A	22A			-1
Kurume Machi, Japan 227 036 320	139 31 48 E 35 45 18 N	α1	08 23 34	98.1°A	23.9A			+1
		α2	09 13 15	315°A	21A			+5
		α3	09 24 25	315°A	17A			+4
Sendai, Japan 246 038 321	140 51 56 E 38 15 22 N		08 24 49	01 36	+22			+1
Waco, Tex. 070 032 097	97 07 W 31 34 N (Temporary location)	α1	23 14 00	18 25	+38			+1.5
		α2	00 08 00	18 25 (Oct. 24 U.T.)	+38			
October 24								
San Antonio, Tex. 089 029 098	98 29 11 W 29 27 25 N	α1	00 12 12	18 45	+28°34'		3°/s	+2
		α3	00 57 00	16 45	+10°50'			Very faint
Ft. Worth, Tex. 069 033 097	97 21 45 W 32 42 27 N	α1	00 12 49	200°A	35A			-3
		α1	00 13 00	{19 49 180°A}	{+19 76A}			+1
	(Second observation a meridian transit, altitude 76° S.)							
St. Louis, Mo. 080 039 090	90 11 50 W 38 37 59 N	α1	00 13 59	16 34.5	-10.4			+2.5, Yellow
Whittier, Calif. 012 034 118	118 01 35 W 33 58 40 N	α1	01 49 02	15 33	+77.5	W-N		0 to +1
		α1	01 49 07	15 03	+77.75			(Varying)
		α1	01 49 08	14 55	+78.5			
Los Angeles, Calif. 100 034 118	118 14 17 W 33 59 41 N	α1	01 49 22	0°A	29A			+1 to +4
		α2	03 01 31		Zenith			+3
Asahigawa, Japan 201 044 322	142 21 50 E 43 46 27 N	α2	09 07 02	275°A	26.0A			+4
Hofu, Japan 213 034 312	131 33 56 E 34 03 13 N		09 44 43	314.5°A	09.2A			+4
Roanoke, Va. 073 037 080	79 56 W 37 19 N	α2	23 19	20 45	78A	SW-NE		+7
October 25								
Whittier, Calif. 012 034 118	118 01 35 W 33 58 40 N	α1	01 30 36	15 46 280°A	+21.5 40A (fade out position)	SW-N		+2

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
October 25 (continued)								
Cambridge, Mass.	71°07'46"W		10h08m44s	214°A	13A° ' "			
099 042 071	42 22 48 N							
Milwaukee, Wis.	88 08 54 W	α1	23 43 57	22h40m s	+88° ' "			
074 043 088	42 58 08 N	α1	23 44 55	05 10	+57			
Los Angeles, Calif.	118 14 17 W	α1	01 33 42	0°A	27A			+2
100 034 118	33 59 41 N							
October 28								
Struthers, Ohio	80.5 W		22 55	180°A	30A	NE-S		+7, White
075 041 081	41 07.5 N							
October 29								
Adelaide, Australia	138 36 14 E	α1	04 15 16.5	54°A	48A			+2 to +1
600 125 319	34 55 14 S							
Perth, Australia	115 51 10 E	α1	19 57 05	46°15'A	51°17'A			
601 122 296	32 00 07 S		19 58 11	91 05 A	51 01 A			
			19 59 25	120 04 A	36 57 A			
October 31								
Perth, Australia	115 51 10 E	α1	19 09 09	63°58'A	37 24A			
601 122 296	32 00 07 S		19 09 40	77 51 A	37 50A			
			19 10 18.5	93 36 A	34 43A			
			19 15 51	140 13 A	02 48A			
November 9								
Ft. Worth, Tex.	97 22 10 W		09 33 35	06 55	+67	SSW-NNE		+7 or +8
068 033 097	32 44 40 N							
Chattanooga, Tenn.	85 15 37 W		10 39 01	03 05	+51	SW-NE		+3
062 035 085	35 01 02 N							
Sydney, Australia	151 05 41 W	α1	15 18 27	08 42	19.8			
602 124 331	33 54 43 S		17 02 08	01 58.3	-13°38'			
November 12								
Sydney, Australia	151 05 41 W	α1	15 26 13	17 10	-67			
602 124 331	33 54 43 S							
November 23								
Sydney, Australia	151 05 41 E	α1	11 00 19	08 30	-62.5			+1
602 124 331	33 54 43 S							
November 24								
Columbus, Ohio	83 01 15 W	α1	00 16 40	17 54	+19			Over +3
051 040 083	39 58 45 N		00 16 43	18 05	+19			
			00 16 48	18 08	+16			
Sacramento, Calif.	121 00.36 W	α1	01 45 23.6	10 12.3	+65.24			
007 039 121	38 41.33 N		01 47 19.1	03 42.1	+47.46			
			01 47 19.9	03 39.9	+47.56			

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 24 (continued)								
Portland,								
Oreg.	122°37'33"W	α1	$01^h45^m53^s$	$01^h22^m59^s$	+60°01' "			0 to +1
076 045 123	45 29 19 N			(Occulted Delta Cassiopeia)				
			01 46 13	01 22 30	+60			
Boise,								
Idaho	116 27 30 W	α1	01 46 25	Zenith	90A	NW-SE		+2
018 044 116	43 36 30 N							
Phoenix,								
Ariz.	112 04 W	α1	01 48 27	13 15	+68			+3, Dull red
022 033 112	33 27 N		01 48 57	17 00	+85			
			01 49 12	00 15	+61			
Oakland,								
Calif.	122 12.0 W	α1	01 48 56	03 16	+25°30'			
006 038 122	37 46 00 N							
Hofu,								
Japan	131 33 56 E	α1	09 23 25	0°A	34A			+1
213 034 312	34 03 13 N							
Hiroshima,								
Japan	132 28 10 E	α1	09 23 33	22 26	+77			0
211 034 312	34 22 08 N							
Mitake,								
Japan	139 32 31 E	α1	09 24 22	18 35	+21.5			+2
229 036 320	35 40 20 N		09 24 43	19 00	+12.48			+2
			09 26 04	21 24	-23.00			+6
Himeji,								
Japan	134 41 24 E	α1	09 24 23	16 10	+62			+1
262 035 315	34 50 25 N							
Otsu,								
Japan	135 52 08 E	α1	09 24 32	253.7°A	58.2A			+2
269 035 316	35 00 24 N							
Musashino,								
Japan	139 34 35 E	α1	09 24 32.7	270°A	32A			+2
233 036 320	35 42 58 N							
Kanayamachi,								
Japan	135 15 10 E	α1	09 24 41	20 55	+47			+1
220 034 315	34 03 46 N							
Yokkaichi,								
Japan	136 39 00 E	α1	09 24 52	20 37	+15			+2
258 035 317	35 00 15 N							
Niigata,								
Japan	139 00 39 E	α1	09 24 52	240°A	30A			+1
238 038 319	37 54 26 N							
Miyazaki,								
Japan	131 25 24 E	α1	09 24 56	02 24	+50			+1
230 032 311	31 25 53 N		09 25 32	02 06	+23			+3
Takada,								
Japan	138 15 22 E	α1	09 25 06	20 41	-10			+2
250 037 318	37 06 38 N							
Kochi,								
Japan	133 30 35 E	α1	09 25 09	00 09	+29			+1
264 034 314								
Sendai,								
Japan	140 51 56 E		09 25 04	20 10	-14			+1
246 033 321	38 15 22 N	α1	09 25 19	208.8°A	23.3°A			+1
			09 25 34	21 00	-32			+2

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 24 (continued)								
Perth, Australia 602 124 042	115°51'10"E 32 00 07 S	α1	14h18m37s.0 14 19 00.7 14 20 30.1	246°43'A 241°16'A 219 35 A	07°20'A " 08 20 A 07 45 A			
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N	α2 α2 α1 α1 α1	22 48 07.2 22 48 11.0 23 03 13 23 04 23.4 23 04 32.8	339°A 312°A 197°A 176°A 174.5°A	85.5A 88A 23A 12A 11A			Faint " Bright " "
North Canton, Ohio 053 041 081	81 27 19 W 40 55 55 N	α1	23 01 31	01h12m s	+35.5			0
Bryn Athyn, Pa. 055 040 075	75 04 W 40 08 N	α1	23 01 36 23 02 39 23 04 30 23 05 17	19 35 22 24 161°A 116°A	+44 -01 15A 09A			+1
Ft. Belvoir, Va. 077 039 077	77 11.3 W 38 45.5 N	α1	23 01 45	180°A	51A	NW-SE		-1
Columbus, Ohio 051 040 083	83 01 15 W 39 58 45 N	α1	23 01 49	02 12	+22			
Washington, D. C. 014 039 077	77 06.5 W 38 58.5 N	α1	23 01 55	2° (NW of Delta Cephei)				+1
(These three observations not at station)	77 06 W 38 49 N 77 03.2 W 38 54.2 N	α1 α1	23 02 02 23 02 21	60°A 23 40	80A +28.5	 NW-SE		+1 varying +1
Silver Spring, Md. 032 039 077	77 00 23 W 39 05 50 N	α1	23 02 11.5 23 02 32.5 23 02 43.5	90°A 00 07 00 36	87A +25 +30.7			-2
Arlington, Va. 071 039 077	77 61 30 W 38 51 30 N	α1	23 02 16 23 02 39	308°52.6' 358°20'	+36°25' +14.75	NNW-SSE		+1 to +2
New Haven, Conn. 087 041 072	72 56 50 W 41 19 58 N	α1	23 03 31.5	176°A	21A	NW-SE		1 varying, Yellow-orange
November 25								
Idaho Falls, Idaho 019 043 112	112 03 25 W 42 30 01 N	α1	00 31 58 (Not at station)	90°A	25 to 30A			1
Milwaukee, Wis. 074 043 088	87 58 45 W 42 59 25 N	α1	00 36 28 (Not at station)	19 30	-18	NW-SE		3
Denver, Colo. 013 040 105	(104 56 36 W) (39 44 52 N)	α1	00 34 00 40 (One mile south of station)	125°A 90°A	15.5A 30A	NW-SE		2
Lemont, Ill. 022 042 088	87 59 41 W 41 41 48 N	α1	00 33 40 00 34 09	19 02 19 44	-09.8 -17.5	N-S		

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 25 (continued)								
North Canton, Ohio	81°27'19"W	α1	00h21m17s	19h27m s	-22°.4 ' "			3, Orange
053 041 081	40 55 55 N		00 21 41	20 41	-17.8			3, Yellow
		α2	00 35 24	19 32	-21.8			5
			00 35 43.5	19 52	-27.9			
Tucson, Ariz.	110 56 09 W	α1	00 43 45		Zenith			1
003 032 111	32 13 59 N		00 44 42	314°A	36A			
			01 50 22	90°A	40A			1, Orange
	(These are three separate objects)		01 51 00	290°A	43A			
			01 51 56	316°A	26A			0
			02 07 04	04°A	13A			
			02 08 59	44°A	28A	NNW-SSE		0
Oakland, Calif.	122 12.0 W	α1	02 03 15	22 19	58°05'	NW-SE		-1
006 038 122	37 46 00 N		02 03 54.4	22 10 07	62			
					(Meridian observation)			
			02 04 27.8	23 35	28°25'			
Sacramento, Calif.	121 16 59 W	α1	02 03 50	20 40.6	+50.17	NW-SE		0
007 039 121	38 38 43 N		02 04 36.3	22 51.7	+08.88			
			02 05 19.2	23 40.8	-14.80			
Whittier, Calif.	118 01 35 W	α1	02 05 54	22 48	+08.3			0
012 034 118	33 58 40 N							
Walnut Creek, Calif.	122 04 30 W	α1	02 04 17	22 32	+38	NNW-SSE		1, Yellow-white
011 038 122	37 55 30 N							
Asahigawa, Japan	142 21 50 E	α1	08 05 34	20 52	+48			0
201 044 322	43 46 27 N		08 06 25	22 53	+13			
Sendai, Japan	140 51 56 E	α1	08 05 46	06.7°A	24.6A			1
246 038 321	38 15 22 N		08 07 17	76.0°A	35.9A			
			08 08 38	116.7°A	19.6A			
			08 09 06	01 34	-13			
		α3	0[illegible] 41 15	19 40	-26			
Kurume Machi, Japan	139 31 48 E	α1	08 06 59	45.0°A	24.0A			2
227 036 320	35 45 18 N							
Mitake, Japan	139 32 31 E	α1	08 07 47	03 10	+28			4
229 036 320	35 40 20 N							
Takada, Japan	138 15 22 E	α1	09 39 03	17 38	+14			3
250 037 318	37 06 38 N							
Otsu, Japan	135 52 08 E	α1	09 40 32	258°A	18A			2
269 035 316	35 00 24 N							
Sydney, Australia	151 05 41 E	α1	09 59 22	04 03	-13			
602 124 331	32 00 07 N							
Perth, Australia	115 51 10 E	α1	13 01 32.0	202°17'A	33°14'A			+1 max.
601 122 296	32 00 07 S		13 01 48.4	197 38	31 53			
			13 01 51.6	196 01	31 15			
			13 04 42.1	165 38	06 26			
Rantoul, Ill.	88 09 04 W		23 14 06.5	02 05	44.8	NW-SE		1 or 2
092 040 088	40 17 51 N							

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satel-lite 1957	Time observed	Right as-cension or azimuth	Declin-ation or altitude	Direc-tion	Angular velocity	Magnitude and color
November 25 (continued)								
Evansville, Ind. 094 038 088	87° 31' 51" W 37 58 15 N	α1	$22^h15^m00^s$	90°A 1.5° (Below Alpha Andromedae)		NNW-SSE		1 varying
Las Cruces, N. Mex. 042 032 107	106 50 50 W 32 19 42 N	α1	22 46 33 22 47 03	02^h50^m s 01 52	+41° ' " +20	N-S		1, Yellow
Danville, Ill. 021 040 088	87 37 34 W 40 08 57 N		23 14 10	90°A	49A	NW-SE		1, White
Wilmore, Ky. 029 038 085	84 39 54 W 37 51 36 N	α1	23 14 30 (See November 26 for second observation)	0°A	85A			2, Red-orange
St. Louis, Mo. 080 039 090	90 11 50 W 38 37 59 N	α1	23 13 41	02 56	+49.3	NW-SE		1.5, White to yellow
		α2	23 42 14	90°A	57A			4, Deep yellowish
		α3	23 42 22	90°A	59.3A	NW-SE		4
Terre Haute, Ind. 025 039 087	87 23 50 W 39 31 38 N	α1 α2	23 14 26 23 49 28	90°A 270°A	43°28'A 77A	NNW-SSE	1.16°/s 1.05°/s	1 6
Cincinnati, Ohio 050 039 085	84 42 35 W 39 11 30 N	α1	23 14 27 (3° down from center of Square of Pegasus, on E-W line)			NNW-SSE		-1, Yellow-red
Silver Spring, Md. 032 039 077	77 00 23 W 39 05 50 N	α1	23 14 28	270°A	26A	NW-SE		0 to +1
Bristol, Tenn. 097 037 082	82 09 29 W 36 35 03 N	α1	23 15 23 23 18 00	270°A 149 A	87A 17A			1
Washington, D. C. 014 039 077 (Not at station)	77 03.2 W 38 54.2 N	α1	23 15 36	245°A	35A	NW-SE	1°/s	1, Blue-white
Greensboro, N. C. 049 036 080	79 52 02 W 36 04 39 N	α1	23 15 10	180°A	46A	NNW-SSE		-1, White
Roanoke, Va. 073 037 080	79 56 W 37 19 N	α1	23 16	22 00	+27°51'	NNW-SSE		+2, White
Sylacauga, Ala. 001 033 086	86 15 13 W 33 09 45 N	α2	23 16 14	90°A	25°51'A	N-SE	12°/9s	+1
W. Palm Beach, Fla. 016 027 080	80 04 40 W 26 39 30 N	α1	23 16 17	90°A	35A	NW-SE		-1, Orange
Ft. Belvoir, Va. 077 039 077	77 11.3 W 38 45.5 N	α1	23 18 50	180°A	15A	NW-SE		+1, Yellow-white
Amarillo, Tex. 064 035 102	101 50 W 35 13 30 N	α1	23 46 13.5	270°A	61.5A	To SSE		+1
November 26								
Big Spring, Tex. 083 032 101	101 26 33 W 32 15 11 N	α1	00 32 43 00 47 07	59°A 270°A	70A 85A			1, Reddish 0

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 26 (continued)								
Spokane, Wash. 086 048 118	117°21'01"W 47 37 37 N	α1	$00^h41^m30^s$	3°E of Polaris		NW-SE		-1 to +2, White
San Angelo, Tex. 105 031 100	100 27 47 W 31 27 19 N	α1	00 42 02 00 48 50	20^h40^m ^{s} 00 05 00	+31°27'19" -29.5		0.6°/s	0 +1.3
Idaho Falls, Idaho 019 043 112	112 03 35 W 43 30 01 N	α1	00 43 37	90°A	80° to 85°A	NW-SE		-1, Orange
Wilmore, Ky. 029 038 085	84 39 54 W 37 51 36 N	α1	00 43 30	225°A	20A			+2, Red-orange
Denver, Colo. 013 040 105	104 56 36 W 39 44 52 N	α1	00 44 15	18 35	+40	NNE-SSW		+2, White
Manhattan, Kans. 027 039 096	96 28.85 W 39 09.75 N	α1	00 44 19 00 46 13 00 47	16 32 18 57 32 16 33	+22 -08°02' +20			
Yankton, S. Dak. 061 043 097	97 23 26 W 42 52 42 N	α1	00 44 29	17 48	+06	NW-SE		+2 to 2.5, White
Lawton, Okla. 110 035 098	98 24 12 W 34 39 45 N	α1	00 44 58	Meridian	20A		0.71°/s	+1.3
Kansas City, Mo. 036 039 095	94 34 52 W 39 02 02 N	α1	00 45 07	17 25	+10	NNW-SSE	0.19°/s	+2 to +5, Yellow-orange
Albuquerque, N. Mex. 041 035 107	106 38 36 W 35 05 03 N	α1	00 45 46	00 46.1	+57°33'	NW-SE		+1
New Orleans, La. 030 030 090	90 01 W 29 57 N	α1	00 46	270°A	20A	NNW-SSE		+2, White
Tulsa, Okla. 054 036 096	95 57 W 36 03 N	α1	00 46 14 00 49 54	18 06 22 22	+9°30' -45 40	NNW-SSE		+3 +2
Los Alamos, N. Mex. 043 036 106	106 19 20 W 35 52 30 N	α1 α2	00 46 16 01 25 01	00 30 21 14	+20 +10.8	NW-SE NW-SE	0.5°/s 2°/s	+1 to +6 +6
Waco, Tex. 070 032 097	97 13 W 31 37 N	α1	00 47 44	21 05	09.3	NW-SE		0.8
Wichita, Kans. 028 038 097	97 14 41 W 37 41 44 N	α1	00 47 42.8	Tangent to bottom of Moon		NW-SE		3, Orange
San Antonio, Tex. 089 029 098	98 29 11 W 29 27 25 N	α1	00 47 55	20 12	25°30'	NW-SE		+1
Ft. Worth, Tex. 068 033 097	97 22 10 W 32 44 40 N	α1	00 47 54	20 12	-17	NW-SE		1 to 2

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 26 (continued)								
Edinburg, Tex. 066 026 098	98°10!35"W 26 18.34	α1	$00^{h}48^{m}57^{s}$	45°A	80A° ' "	NNW-SSE		2
		α1	00 48 57	45°A	78A			2
		α1	00 50 39	339.5°A	23A			
		α2	01 28 39	45 A	40A		1.8°/s	+6, White
Bryan, Tex. 065 031 096	96 20 01 W 30 38 15 N	α1	00 49 42	$21^{h}42^{m}00^{s}$	-33°32'	NW-SE		0 to 1, Red
			00 47 59.5	19 34	+07.4			Red
Sacramento, Calif. 007 039 121	121 16.59 W 38 38.43 N	α1	02 15 46.2	17 32 34	+16.54			White
			02 16 06.1	18 05 10	+09.66			
			02 17 11.7	20 35 10	-25.16			
		α2	03 05 06	21 15 28	-32.42	To SW		+8
Oakland, Calif. 006 038 122	122 04 30 W 37 46 00 N	α1	02 16 53	19 18 00	-01°15'	NW-SE		1 and 2, White
			02 17 22.5	20 22	-17 30			White
San Francisco, Calif. 008 038 122	122 27 53 W 37 46 10 N	α1	02 17 14	20 21	-13	NW-SE		0 max., White
			02 17 19	20 21	-15			
Whittier, Calif. 012 034 118	118 01 35 W 33 58 40 N	α1	02 17 24	18 19	+10.3			2 to 6, Reddish
Walnut Creek, Calif. 011 038 122	122 04 30 W 37 55 30 N	α1	02 17 25.5	20 22	-17°30'	NW-SE		1 to 2, Yellow-white
China Lake, Calif. 098 036 118	117 38 19 W 35 43 39 N	α1	02 17 44.54	265°276A	19°706A	NW-SE		
	117 36 44 W 35 40 43 N	α1	02 17 45	240°A	25A			
	(Not at station but at coordinates shown. First observation, Askania data.)							
Los Angeles, Calif. 100 034 118	118 14 17 W 33 59 41 N		02 18 59	19 04	-05	NW-SE		1 to 3
Santa Barbara, Calif. 009 034 120	119 41 30 W 34 24 30 N	α1	02 20 18	180°A	14.5A	NW-SE		+2, White-yellow
Asahigawa, Japan 201 044 322	142 21 50 E 43 46 27 N	α1	08 17 57	20 14	-16			2
			08 20 00	22 45	-34			
Kumamoto, Japan 225 033 311	130 44 34 E 32 46 57 N	α1	09 52 05	19 34	-24			2
Kagoshima, Japan 218 032 311	130 31 47 E 31 31 34 N	α1	09 52 18	19 35	-23			2
Sydney, Australia 602 124 331	151 05 41 E 33 54 43 S	α1	10 10 01	20 15	-48			
Perth, Australia 601 122 296	115 51 10 E 32 00 07 S		11 38 09.2	63°02'A	20°01'A			+1 max.
			11 38 17.8	67 06 A	20 16 A			
			11 38 44.0	78 11 A	20 00 A			
Red Bank, N. J. 040 040 074	74 05 W 40 17 40 N		21 50 16	43°A	33.5A	NW-SE		

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 26 (continued)								
Cambridge, Mass. 099 042 071	71°07'46"W 42 22 48 N		21^h 50^m 18^s 21 50 39.2 23 09 45 23 13 32.8	34.2°A 100A 267A 220.5A	73°.5A ' " 72A 10A 07A			Bright " Faint "
Baltimore, Md. 088 039 077	76 35 25 W 39 24 28 N	α1	22 28 00	.5° directly below Fomalhaut		To SSE		3
Cleveland, Ohio 052 042 082	81 47 44 W 41 29 46 N	α1	23 05 20	270°A	22A	SW-N	1/3°/s	4, Reddish
Harrisonburg, Va. 072 038 079	77 11.3 W 38 45.5 N	α1	23 15 52	270°A	51A	NNW-SSE		7 or 8
Terre Haute, Ind. 025 039 087	87 23 50 W 39 31 38 N	α1 α1	23 21 40 23 22 55	270°A 180°A	47A 44°28'A	NNW-SSE	10°/7.4s 1.18°/s	1, White 1
North Canton, Ohio 053 041 081	81 27 19 W 50 55 55 N	α1	23 22 59	19^{h}23^m ^{s}	-17°50'	NNW-SSE		1
Danville, Ill. 021 040 088	87 37 34 W 40 08 57 N	α1	23 22 03	19 55	+08	WNW-SSE	1°/s	0 to 2
Lemont, Ill. 022 042 088	87 59 41 W 41 41 48 N	α1	23 22 20	270°A	54A	NW-SE		-1 or -2, Reddish
Dayton, Ohio 082 040 084	84 15 50 W 39 50 52 N	α1	23 22 18	282°A	03A	NW-SE		3
Bristol, Tenn. 097 037 082	82 09 29 W 36 35 03 N	α1	23 22 40 23 23 44	270°A 214 A	26A 27A			1, Reddish
Roanoke, Va. 073 037 080	79 56 W 37 19 N	α1	23 22 07	19 28	+24°	NNW-SSE		2
Evansville, Ind. 094 038 088	87 31 51 W 37 58 15 N	α1	23 22 16	270°A	62A	NNW-SSE		1 to 5, Yellow-white
St. Louis, Mo. 080 039 090	90 11 50 W 38 37 59 N	α1	23 22 03 23 56 50	22 13 18 22	+37.4 +21.9	NW-SE		0, White 4, Red-orange
Athens, Ga. 079 034 083	83 19 25 W 33 57 06 N	α1	23 23±30	270°A	45A	NW-SE		+2 or +3, White
Wilmore, Ky. 029 038 085	84 39 54 W 37 51 36 N	α1	23 23 25	214°06'A	34°53'A	NW-SW		+3, Orange-white
Hapeville, Ga. 017 034 084	84 17 03 W 33 47 27 N	α1 α1	23 23 23 23 23 30	18 37 30 19 32 30	+38°45' +27 30	NW-SE		+1 to +4
Greensboro, N. C. 049 036 080	79 52 02 W 36 04 39 N	α1	23 24 18	225°A	17A	NNW-SSE		+1 to +2
Sylacauga, Ala. 001 003 086	86 15 20 W 33 10 20 N	α1	23 24 31	90°A	81°33'54"A	NW-SE		+1 to +3

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 26 (continued)								
W. Palm Beach, Fla. 016 027 080	80°04'40"W 26 39 30 N	α1	$23^h25^m30^s$	270°A	71A° ' "	NNW-SSE		+1 to -1, White-orange
Arlington, Va. 071 039 077	77 61 30 W 38 51 30 N		23 35 05	$17^h52^m.5^s$	+12°23'			+4 to +6, Orange
Schenectady, N. Y. 081 043 074	73 52.6 W 42 49.8 N	α1	23 50 53 (Not at station)	00 29	+13	NNW-SSE		-2
Rantoul, Ill. 092 040 088	88 09 04 W 40 17 51 N	α1	23 21 32.5	17 55	+40.3			+1 or +2
Peoria, Ill. 023 041 090	89 35 51 W 40 45 19 N	α1	23 22 28	270°A	63.5A	NW-SE	1°/s	+1 to +2, Blue-white
November 27								
Ft. Worth, Tex. 068 033 097	97 22 10 W 32 44 40 N	α1	00 49 17	22 40	+30°25'			
Spokane, Wash. 086 048 118	117 21 01 W 47 37 37 N	α1	00 49 43 00 50 13	270° 19 48.3	60-65°A +8°43'	NW-SE		0 to +2
Los Alamos, N. Mex. 043 036 106	106 19 20 W 35 52 30 N	α1	00 49 57 00 53 51	22 54 19 53	+37 -03	NW-SE	4°/s 2°/s	+4, White +1 to +6, White
Denver, Colo. 013 040 105	104 56 36 W 39 44 52 N	α1	00 52	258.5°A	20.5A	NNW-S		+3 to +6, Yellow-white
Manhattan, Kans. 027 039 096	96 28.85 W 39 09.75 N	α1	00 53 06	17 31	+01°57'			+3
Phoenix, Ariz. 022 033 112	112 04 W 33 27 N	α1	00 53 16	88°A	40.5°	NW-SE		+1, Reddish
Albuquerque, N. Mex. 041 035 107	106 38 36 W 35 05 03 N	α1 α2	00 55 37.5 01 23 49.5	22 28 270°A	-32.6 25A	N-S		+1
Lawton, Okla. 110 035 198	98 24 12 W 34 39 45 N	α1	00 55 02	237°09'A	+14°27'A	NW-SW	0.3°/s	+2
Yankton, S. Dak. 061 043 097	97 23 26 W 42 52 42 N	α1	01 03 27	02 25	+20	NW-SE		+3
Waco, Tex. 093 032 097	97 05.5 W 31 38.5 N	α1	00 51 42	00 42	+57.6	NW-SE		+1.8
Amarillo, Tex. 064 035 102	101 50 W 35 13 30 N	α2	00 51 11	270°A	62A	NW-SE		+3
Walnut Creek, Calif. 011 038 122	122 04 30 W 35 55 30 N	α1	02 22 43.5	16 56	+10.7			+3, Yellow

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 27 (continued)								
Sacramento,								
Calif.	121°16′59″W	α1	02h 25m 02s.2	19h 21m.2	-25°.88	WSW-SSW		+1
007 039 121	38 38.43 N		02 25 07.5	19 25.6	-27.49			
			02 25 11.7	19 27.9	-28.32			
Mizusawa,								
Japan	141 07 45 E	α1	08 23 31	267.2A	21.6A			
267 039 321	39 08 03 N	α1	08 25 26	202.1A	16.4A			
		α1	08 25 56	194.2A	13.0A			
		α1	08 26 11	190.6A	11.3A			
Takamatsu,								
Japan	134 02 13 E	α1	08 23 57	006.5A	45.8A			0
251 034 314	34 20 28 N							
Mitake,								
Japan	139 32 31 E	α1	08 23 52	17 05	+31			+2
229 036 320	35 40 20 N		08 24 05	17 37	+27			
			08 24 08	17 50	+26			
Hiroshima,								
Japan	132 28 10 E	α1	08 23 23	09 38	+83			0
211 034 312	34 22 08 N							
Manazuru,								
Japan	139 08 46 E	α1	08 24 30	18 47	+22			+3
228 035 319	35 09 23 N		08 24 54	19 45	+05			0
			08 26 11	22 05	-32			+5
Sendai,								
Japan	140 51 56 E	α1	08 24 00	254.7A	25.6A			+1
246 038 321	38 15 22 N		08 25 21	205.3A	20.0A			
Musashino,								
Japan	139 34 35 E	α1	08 24 17	270A	38.0A			+1
233 036 320	35 42 58 N		08 24 57.4	225.0A	41.0A			
Shizuoka,								
Japan	138 23 18 E	α1	08 24 29	270A	43.0A			+1
247 035 318	34 58 25 N							
Kanayamachi,								
Japan	135 15 10 E	α1	08 24 19	21 39	+63			0
220 034 315	34 03 46 N							
Kyoto,								
Japan	135 42 24 E	α1	08 24 26	21 52	+33			0
259 035 316	35 01 01 N							
Manazuru,								
Japan	139 08 46 E	α1	08 24 30	18 47	+22			+3
228 035 319	35 09 23 N		08 24 54	19 45	+05			0
			08 26 11	22 05	-32			+5
Himeji,								
Japan	134 41 24 E	α1	08 25 24	141.1A	36.1A			0
262 035 315	34 50 25 N							
Nagoya,								
Japan	136 59 11 E	α1	08 25 22	180.0°A	41.0A			+1
236 035 317	35 08 57 N							
Honjo,								
Japan	139 11 05 E	α1	08 25 50	196.5°	31.5A			+1
212 036 319	36 14 25 N							
Otsu,								
Japan	135 52 08 E	α1	08 25 00	162.0°	40.0A			+2
269 035 316	35 00 24 N							
Toyohashi,								
Japan	135 24 37 E	α1	08 25 26	22 15	-13			+1
255 035 317	34 45 09 N							

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 27 (continued)								
Suwa, Japan 238 036 318	138°07'43"E 36 00 13 N	α1	$08^h24^m14^s$	18^h55^m ^{s}	+24° ' "			
			08 25 50	22 17	-29.36			
Takada, Japan 250 037 318	138 15 22 E 37 06 38 N	α1	08 25 54	22 24	-36			0
Higashim, Japan 210 036 319	139 23 54 E 36 02 22 N	α1	08 25 06	20 17	-12			0
Kasukabe, Japan 263 036 320	139 44 34 E 35 58 36 N	α2	08 55 20	290.0°A	20.7A			+7
New Haven, Conn. 087 041 072	72 56 50 W 41 19 58 N	α1	21 52 10	305°A	50A	NW-SE		+2, White
		α1	21 52 30	295°A	60A			+2, "
		α1	21 52 45	280°A	75A			+2, "
		α1	21 54 30	187°A	60A			+2, "
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N		21 53 06.8	244°A	44A			
			21 53 10.6	239°A	44A			
			21 53 47.0	199°A	34A			
			21 53 49.8	203.5°A	36A			
			21 53 50.8	195.5°A	33A			
			21 54 04.0	181°A	29A			
			21 54 13.6	176.5°A	28A			
Red Bank, N. J. 040 040 074	74 05 W 40 17 40 N	α1	21 53 56	38.5°A	77A	NW-SE		
			22 14 51.5	38.5°A	63A	SW-NE		+1
Bryn Athyn, Pa. 055 040 075	75 04 W 40 08 N	α1	21 58 38	60°A	53A	NW-SE		+1
		α2	22 29 11	270°A	20A	NW-SE		+4 or +5
Cambridge, Mass. 099 042 071	71 07 46 W 42 22 48 N		22 46 14	244°A	14A			
			22 46 34	249°A	16A			
			22 48 10.8	249°A	32.5A			
			22 48 18	248°A	36.5A			
			22 48 34.2	238°A	48A			
			22 55 47.4	244°A	09A			
			22 55 53	250°A	06A			
Los Alamos, N. Mex. 043 036 106	106 19 20 W 35 52 30 N		22 56 12	19 04	-21.5	NW-SE	1.5°/s	+2.5 to 3, White
		α1	22 56 25	19 36	-30.5			
Greensboro, N. C. 049 036 080	79 52 02 W 36 04 39 N		22 58 10	0°A	63A	SSW-NNE		+6, White
Milwaukee, Wis. 074 043 088	88 08 54 W 42 58 08 N	α1	23 23 20	17 35	+12	N-S		+2
Dayton, Ohio 082 040 084	84 15 50 W 39 50 52 N	α1	23 24 15	Long. 285.3 E.	Lat. 20.5°	NW-SE		+2.5, Reddish
		α1	23 25 29.5	Long. 299.7 E.	Lat. 33.9°	NW-SE		+3.5, Pink
Cincinnati, Ohio 050 039 085	84 42 35 W 39 11 30 N	α1	23 23 [illegible]	270°A	25A	N-S		+4 to +1, Orange
Peoria, Ill. 023 041 090	89 35 51 W 40 45 19 N	α1	23 24 30	270°A	24A	NW-SE		+2, Yellow-white

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 27 (continued)								
Indianapolis, Ind. 024 040 086	86°09'22"W 39 40 40 N	α1	23h 26m s	10° below Venus		N-S		+3, Yellow white
Sylacauga, Ala. 011 033 086	86 15 13 W 33 09 45 N	α1	23 25 32 23 28 05	270°A 180°A	49°09'14" 17°01'54"A	NW-SE		+1 to +6
Terre Haute, Ind. 025 039 087	87 23 50 W 39 31 38 N	α1	23 23 36.2	270°A	24°00'A	NNW-SSE	1.08°/s	+3, White
November 28								
New Orleans, La. 030 030 090	90 01 26 W 29 57 30 N		00 18 02	270°A	61°A	NW-SE		+5, White
El Paso, Tex. 104 032 106	106 23 W 31 50 N	α1	00 41 15	360°A	48A	NW-SE	20°/min	Light pink
Sacramento, Calif. 007 039 121	121 16.59 W 38 38.43 N		00 53 38.1	00h 58m.22s	+24.4	N-S		Fairly bright
Tucson, Ariz. 003 032 111	110 56 09 W 32 13 59 N	α1	00 54 54 00 56 39	125°A 01°A	33A 33A	NW-SSE		0
Phoenix, Ariz. 022 033 112	112 04 W 33 27 N	α1	00 54 03 00 55 03	270°A 270°A	87°A 57°A	NW-SE		+1 to +2
San Angelo, Tex. 105 031 100	100 27 47 W 31 27 19 N	α1	00 56 47 00 59 00	17 48 206°56'30"A	+31°27'19" 06 13 45A	NW-SE	36°/min	+1.2
Las Cruces, N. Mex. 042 032 107	106 50 50 W 32 19 42 N	α1	00 56 50 00 58 31.5	1.5° directly 22 30	above Venus -47			+3 varying
Albuquerque, N. Mex. 041 035 107	106 38 36 W 35 05 03 N	α1	00 57	17 30	+12	NW-SE		+2, Pale yellow
		α1	00 57 39	19 30 00	+20.5			+2
Perth, Australia 601 122 296	115 51 10 E 32 00 07 S	α1	03 40 26.6 03 42 44.4 03 43 31.1 03 43 47.4 03 43 50.7 03 44 12.8	336°57'A 142A 148 54A 149 54A 149 52A 151 20A	26°88'A 56 51A 29 32A 24 09A 23 35A 09 29A			
Kusakabe, Japan 263 036 320	139 44 34 E 35 58 36 N	α1	08 23 26	235°A	31.5			+2
Musashino, Japan 233 036 320	139 34 35 E 35 42 58 N		08 23 42 08 25 05	270.0°A 225°A	17.5A 20A			
Shizuoka, Japan 247 035 318	138 23 18 E 34 58 25 N	α1	08 23 46	17 15	+12			+1
Kiryu, Japan 223 036 319	139 19 54 E 36 24 22 N	α1	08 23 54	270.0°A	23.0A			+2
Himeji, Japan 262 035 315	134 41 24 E 34 50 25 N	α1	08 23 54	18 10	+25			+1

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satel-lite 1957	Time observed	Right as-cension or azimuth	Declin-ation or altitude	Direc-tion	Angular velocity	Magnitude and color
November 28 (continued)								
Suwa, Japan 248 036 318	138°07'43"E 36 00 13 N	α1	$08^h23^m55^s$	17^h42^m ^{s}	+04° ' "			+3
Konko, Japan 224 035 314	133 37 40 E 34 32 31 N		08 23 56	270.0°A	55.0A			+1
Mizukaido, Japan 231 036 320	139 59 18 E 36 00 56 N	α1	08 23 58	270°A	20.5A			+3
Mitake, Japan 229 036 320	139 32 31 E 35 40 20 N	α1	08 24 11 08 24 2 08 25 38	253.5°A 18 09 19 55	25.7A -05 -32			+1
Kure, Japan 226 034 313	132 33 44 E 34 14 57 N	α1	08 24 15	180.0°A	90A			0
Manazuru, Japan 228 035 319	139 08 46 E 35 09 23 N	α1	08 24 13 08 25 01 08 25 10 08 25 24 08 25 30	17 +3 18 59 19 12 19 38 19 44	+03 -19 -21 -25 -27			
Kanayamachi, Japan 220 034 315	135 15 10 E 34 03 46 N	α1	08 25 40	21 40	-34			+2
Yokkaichi, Japan 258 035 317	136 39 00 E 35 00 15 N	α1	08 25 31	194.5°A	22A			0
Uwajima, Japan 256 033 313	132 33 32 E 33 12 49 N	α1	08 25 15	20 41	+47			+1
Higashim, Japan 210 036 319	139 23 54 E 36 02 22 N	α1	08 25 20	19 30	-28			+1
Adelaide, Australia 600 125 319	138 36 14 E 34 55 14 S	α1	10 13 09 10 15 00	60°15' 06 22	62A -52°40'			
Perth, Australia 601 122 296	115 51 10 E 32 00 07 S	α1	11 40 15.0 11 40 26.6 11 42 44.4 11 43 31.1 11 43 47.4 11 43 50.7 11 44 12.8	336°43'A 336 57 A 142 00 A 148 54 A 149 54 A 149 52 A 151 20 A	18°30'A 21 08 A 56 51 A 29 32 A 24 09 A 24 35 A 09 29 A			+0.5 to +1.5
November 29								
Tucson, Ariz. 003 032 111	110 56 09 W 32 13 59 N	α1	00 50 10 ("Going too fast to measure Azimuth accurately.")	About 290°A	20A	WNW-SSW		+1
Sacramento, Calif. 007 039 121	121 16.59 W 38 38.43 N	α2	00 41	90°	59.4A	NW-SE		
Perth, Australia 601 122 296	115 51 10 E 32 00 07 S	α1	11 34 57.1 11 35 04.2 11 35 43.6 11 37 35.4 11 38 09.6	185°32'A 181 51 A 168 21 A 164 26 A 159 47 A	45°22'A 40 04 A 24 11 A 17 41 A 08 50 A			-1 steady

Table 1.--Observations of Satellites 1957 α1 and α2 by Moonwatch teams through Dec. 1, 1957 (continued)

Date (U.T.) Station name Code number	Station coordinates	Satellite 1957	Time observed	Right ascension or azimuth	Declination or altitude	Direction	Angular velocity	Magnitude and color
November 29 (continued)								
Tulsa, Okla. 054 036 096	95°57' "W 36 03 N	α1	$23^h58^m31^s$	Same as Venus	+17A° ' " 2° down from Venus	NW-SE		+2
November 30								
Peoria, Ill. 023 041 090	89 35 51 W 40 45 19 N	α2	12 23 45	90°A	63A	NE-SW	0.6°/s	+5
December 1								
Walnut Creek, Calif. 011 038 122	122 04 30 W 37 55 30 N	α1?	00 06 To 00 08	90°A	15-20A			Faint
Los Altos, Calif. 005 037 122	122 07 26 W 37 23 56 N	α1	00 09±10 (In sight for two minutes.)	60°A	50°A	NW-SE		-6 varying, White

An Interim Model Atmosphere Fitted to Preliminary Densities Inferred from U. S. S. R. Satellites [1]

By T. E. STERNE, B. M. FOLKART,[2] and G. F. SCHILLING

The purpose of this paper is to construct an interim model atmosphere based on density values which have been inferred from satellite observations. The authors hope that this model will, despite its crudeness, contribute to the prediction of the lifetimes of new satellites and to an understanding of the rates at which the elements of satellite orbits change.

Preliminary values of atmospheric density at perigee heights of 220 to 233 km were inferred from early satellite observations (see p. 207). Those density values were higher than the values predicted by most existing model atmospheres at the same altitudes. Comparable results, derived from radio observations, have been published by British investigators (Mullard Radio Astronomy Observatory, 1957; Royal Aircraft Establishment, 1957). Although all these results are of an extremely tentative nature, the orbital behavior of the Soviet satellites appears to indicate that the upper-atmosphere densities are somewhat higher than many people had expected.

Grimminger (1948) alone has devised a model atmosphere whose density at a height of 220 km was as high as 24.5×10^{-10} kg/m^3. The Rocket Panel in 1952 recommended a value of 0.716×10^{-10} kg/m^3. Minzner and Ripley of the ARDC in 1956 predicted a value of 0.515×10^{-10}.

In the first report (p. 191) a probable lifetime of the order of some 10 weeks was predicted for Satellite 1957 $\alpha 1$, the last rocket stage of the first U. S. S. R. launching. It is now known that the actual lifetime was more nearly eight weeks.

It may appear almost absurd, at first glance, to construct an interim atmosphere on practically a single value of density at one altitude. Yet one can reflect that all model atmospheres are to some extent inherently speculative. Indeed, there are some which by necessity are based on pure extrapolation without the benefit of even a single observed value of the density at the higher altitudes.

We hope that this crude interim model will be replaced by a better one as soon as more extensive observational data are available. This report is considered indicative, merely, of scientific results that can be obtained from satellite research. Only a low degree of accuracy is claimed for our results.

The models

It has been inferred (see p. 209) from observations of the U. S. S. R. artificial earth satellites that the atmospheric density at an altitude of about 220,000 meters is approximately 4.5×10^{-10} kilograms per cubic meter, or about 8.7 times the density predicted at that height by the atmospheric model devised by Minzner and Ripley (1956) of the ARDC. The present authors have tried to change the Minzner-Ripley model to agree with the observed value 4.5×10^{-10} kg/m^3 at 220 km, with as few other changes as possible.

The Minzner-Ripley model adopts a relation between altitude and molecular scale temperature, inferring the pressure and density at all altitudes from their sea-level values, from the equation of hydrostatic equilibrium, and from the adopted temperature-altitude relation. The altitude employed by Minzner and Ripley is the so-called geopotential altitude, H; it is the fictitious altitude at which a potential corresponding to a constant value of gravity $g=g_0=9.80665$ meters per (second)^2 would

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equal the true potential at the geometric altitude Z, the true potential being derived, of course, from the correct variation of g with altitude. It follows from their gravity-variation formula that the relation of geopotential altitude, H, to geometric altitude Z is,

$$H=Z(1+Z/R)^{-1} \quad (1)$$

where R is 6,356,766 meters. The "molecular scale temperature" of Minzner and Ripley is the quantity $T_M=TM_0/M$, where T is the absolute temperature of the air, defined as in the kinetic theory of gases, M_0 is the molecular weight at sea level, taken to be 28.966 grams per mole, and M is the molecular weight at altitude Z. With these definitions the equation of hydrostatic equilibrium is

$$dP=-\rho g_0 dH, \quad (2)$$

where P is the pressure and ρ is the density. The equation of state becomes

$$P=R^*T_M\rho/M_0 \quad (3)$$

where R^* is the universal gas constant, taken to be 8.31439 joules/°K.

For the relation of T_M to H, Minzner and Ripley adopted a broken straight line, with slopes discontinuous at particular altitudes H_b and with constant derivatives, L_M, of T_M with respect to H between the discontinuities; T_M is continuous. Above H=53,000 meters their relation is given in the following table, in which H_b is the lower altitude in meters of each straight segment of the $H-T_M$ relation; L_M is the derivative dT_M/dH in degrees per meter over the segment; and $(T_M)_b$ is the value of T_M at the lowest altitude of the segment:

H_b	$(T_M)_b$	L_M
53, 000	282. 66	−. 0039
75, 000	196. 86	zero
90, 000	196. 86	+. 0035
126, 000	322. 86	+. 0100
175, 000	812. 86	+. 0058

Throughout any straight portion

$$T_M=(T_M)_b+L_M(H-H_b) \quad (4)$$

and the value +.0058 is retained for L_M up to H=500,000 meters. In any straight portion, equation (2) can be integrated to give

$$\log P=\log P_b-(g_0M_0/R^*L_M)\log[1+(L_M/T_M)_b(H-H_b)] \quad (5)$$

and

$$\log \rho=\log \rho_b-(1+g_0M_0/R^*L_M)\log[1+(L_M/(T_M)_b(H-H_b)] \quad (6)$$

where P_b and ρ_b are the pressure and density at the lower altitude of the straight portion.

The revision of the Minzner-Ripley-ARDC model to fit the value $\rho=4.5\times10^{-10}$ kg/m^3 at a geometrical altitude Z of 220,000 meters, inferred from satellite observations in an earlier report (p. 207), has been carried out by modifying the T_M-H relation. It was desired to retain the broken-line character of that relation; it was further desired to modify the relation of Minzner and Ripley merely by retaining their model unaltered up to some altitude H' or Z', and by adopting some new constant value of L_M at all greater altitudes. The authors realized that so simple a procedure has little theoretical validity, there being no *a priori* reason, for instance, why L_M should be constant above the altitude H'. Somewhat the same objection, however, could be brought against the Minzner-Ripley model itself, even though the present authors think that it is one of the best atmospheric models that have been devised. Their broken-straight-line assumption about the T_M-H relation is merely a convenient approximation that does no violence to the observations at the altitudes where they have been made, but that has no *a priori* or observational justification. The present authors could have adopted a broken line with two or more segments above the altitude H'; but they felt that then they would have had so much freedom, with two adjustable heights H' and H'' and two slopes, and therefore with three degrees of freedom after matching the density at 220,000 meters, that any solution of the resulting indeterminate problem would have been very highly arbitrary. The adopted procedure provided only one degree of freedom, because once H' is chosen, the value L_M at greater altitudes is then determined by the density at 220,000 meters.

It was found that if Z' were much higher than 100,000 meters, then L_M had to be so large as to lead to disturbingly high values of T_M at higher altitudes, particularily in the neighborhood of 300,000 meters. On the other hand, if Z' were much lower than 80,000 meters then the temperatures, densities, and pressures would disagree too much with observations at altitudes somewhat higher than Z'. Accordingly, three models were selected corresponding to values 80,000 meters, 90,000 meters and 100,000 meters of Z'. The corresponding values of L_M, applicable to all higher altitudes, were .00616, .009017, and .01282 degrees per meter, respectively.

Results

Figure 1 exhibits the temperature-altitude relation for the Minzner-Ripley-ARDC model, and for the three revised models. Figures 2 and 3 contain, respectively, the corresponding density-altitude and pressure-altitude relations. The spread introduced in figure 2 by the variations of Z' provides, the authors hope, some indication of the uncertainty inherent in the provisional density here presented. If the authors were forced at this time to select some one model for predicting the lifetimes of satellites, they would choose, aware of its great uncertainty, the central revision (curve 2, Z'=90,000 meters).

The curves do not extend above H=500,000 meters. If values of the density, ρ, in kilograms per cubic meter are needed at greater altitudes they may be calculated from the equations

$$T_m=0.0090167\,H-603.318 \qquad (7)$$

and

$$\log_{10}\rho=5.588-4.79\log_{10}T_M \qquad (8)$$

which holds, for the central curve (curve 2, figure 2) at all altitudes above Z=90,000 meters.

Remarks

The preceding model atmospheres provide the best estimates of the atmospheric density that the authors have been able to infer from

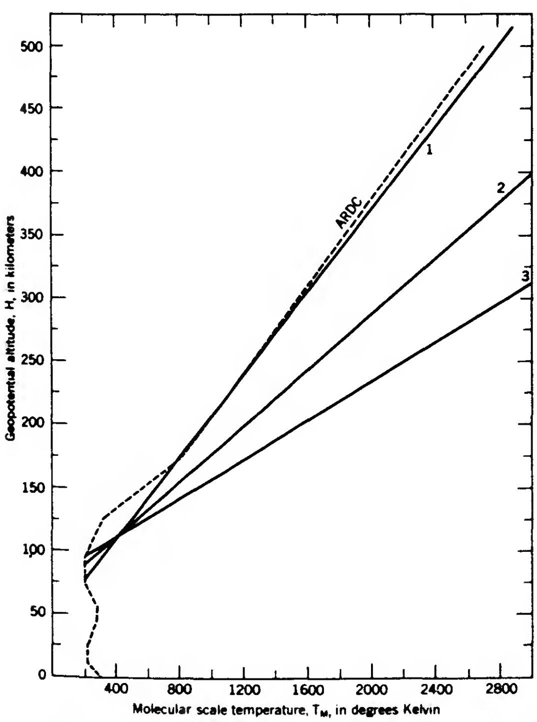

FIGURE 1.—Temperature-altitude relations for the model atmospheres.

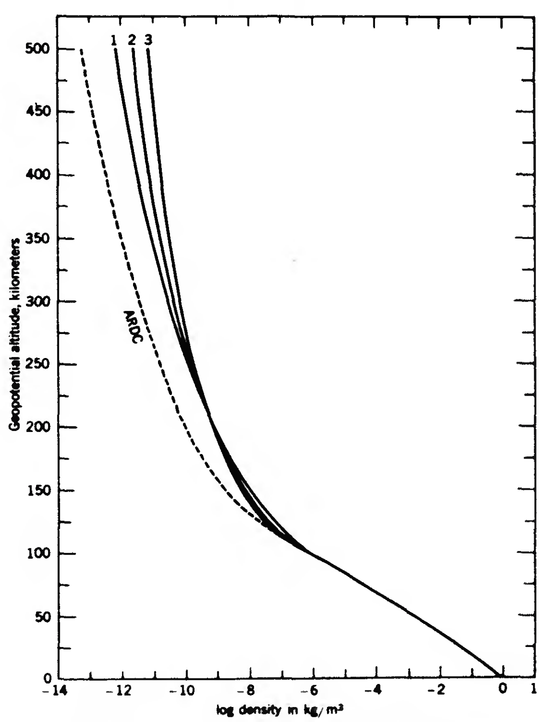

FIGURE 2.—Density-altitude relations for the model atmospheres.

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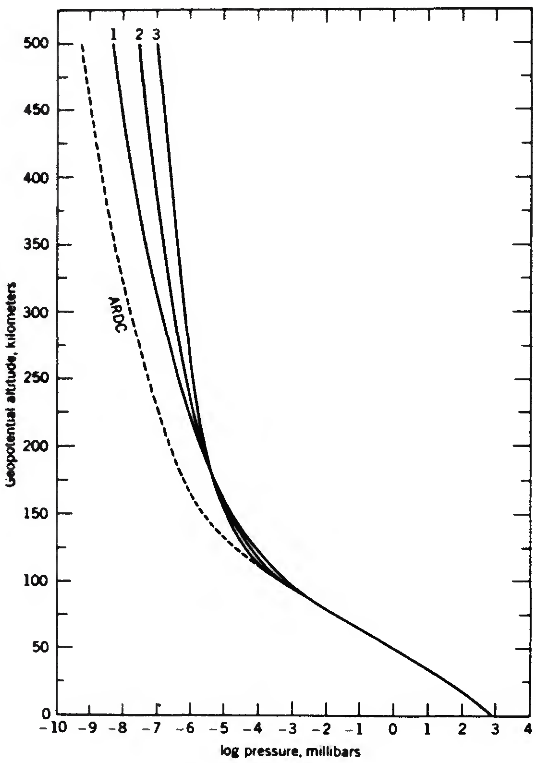

FIGURE 3.—Pressure-altitude relations for the model atmospheres.

the observational data, uncertain though the estimates are. On the other hand, the authors particularly wish to invite attention to the fact that the models are almost certainly incorrect. In particular, the temperatures for all three models may be too high in the region from 80,000 to 120,000 meters. A constant vertical gradient of temperature was assumed above an altitude H' on p. 276—even though this assumption was realized and pointed out probably to be false—because some assumption had to be made, because any assumption was likely to be false, and because the assumption actually made was one of the simplest. In part, at least, the high temperatures in all the models are a consequence of the adoption of the Minzner-Ripley temperatures below H' and of a constant gradient of temperature above H', and are not implied by the observed density at $Z=220{,}000$ meters alone.

The observed density at 220,000 meters does rigorously imply that *somewhere* in the region between sea-level and 220,000 meters the molecular scale temperature T_M is higher than the value adopted by Minzner and Ripley of the ARDC. It does not need to be higher in the particular regions, nor by the amounts, indicated in figure 1. In particular, by adopting somewhat higher temperatures than Minzner and Ripley at lower altitudes than H', one could avoid the necessity for adopting higher temperatures at higher altitudes to match the observed density at 220 kilometers. Alternatively, by adopting considerably greater temperatures than Minzner and Ripley in some region between 80 and 120 kilometers one could match densities without implying temperatures as high as those of our models at still greater altitudes.

The authors hope that future satellite data will provide observational values of the atmospheric densities at new heights, and make it possible to replace the present provisional atmospheric models by more realistic ones, less speculative and arbitrary. It is hoped that the atmospheric densities in this report may be of use in the meantime.

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1956. The ARDC model atmosphere, 1956. Air Force Surveys in Geophysics, No. 86, Geophysics Research Directorate, AFCRC, ARDC, December.

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Abstract

As earlier reported, preliminary values of the atmospheric density have been inferred from observations of artificial U. S. S. R. earth satellites. Those densities were greater than the densities predicted by most existing atmospheric models at corresponding altitudes. The present paper presents an interim and highly tentative atmospheric model adjusted to be the same as the ARDC model atmosphere, (devised by Minzner and Ripley) at altitudes below about 90 kilometers, and to agree with the densities inferred from the satellites at an altitude of 220 kilometers. Although this model is crude and only roughly approximate, it may be of use in predicting the lifetimes of new earth satellites.

Soviet Orbit Information for Satellites 1957 $\alpha 2$ and $\beta 1$ [1]

By G. F. SCHILLING

The present report continues the compilation of Soviet data from the point where the related report (p. 219) left off. It does not include Soviet predictions of satellite passages over or near world points; such information is still released daily by the U. S. S. R., but it is felt that this type of bulky data no longer falls within the specific scope of these reports.

It will be understood that the principal purpose of the report is to make available raw data which may be considered of lasting interest with respect to orbit evaluations. It should be emphasized, however, that this compilation of data must not be considered as complete.

Revolutions and path distances.—On Oct. 13, 1957, the U. S. S. R. began to release information about the number of revolutions and the distances traveled, and gave predictions of values about one day in advance for Satellite 1957 Alpha. The earlier report tabulated these data to Dec. 5, 1957. Tables 1 and 2 continue the tabulation of this information for Satellites 1957 $\alpha 2$ and 1957 $\beta 1$. In these tables, the available data are posted against the date and approximate time for which the statement was made, and not against the date when the information was released.

Periods and heights.—Since Oct. 20, 1957, the U. S. S. R. has occasionally released data on the periods and apogee heights of the various satellites. The three pertinent releases during the report period are summarized in table 3.

Final orbit decay.—On Dec. 7, 1957, the U. S. S. R. released statements relating to the final orbit decay of Satellite 1957 $\alpha 1$. In condensed form, the data based on this information are as follows:

Initial period	96.2 minutes.
Initial apogee	Over 900 kilometers.
Duration	58 days.
Distance traveled	39 million kilometers.
Start of descent	Nov. 30, 1957.
Rapid descent	Dec. 1, 1957, along path through area of Irkutsk, Chukotka Peninsula, Alaska, and along west coast of America.
Re-entry	Along path, started to burn and break up.

On Jan. 20, 1958, the U. S. S. R. released statements relating to the final orbit decay of Satellite 1957 $\alpha 2$. In condensed form, the data based on this information are as follows:

Initial period	96.2 minutes.
Initial apogee	950 kilometers.
Duration	92 days.
Distance traveled	60 million kilometers.
Number revolutions	About 1,400.
Final descent	Jan. 4, 1958. Penetrated denser layers of atmosphere and evaporated.
Observations	Was made of low melting metal. Overcast weather in the moderate latitudes of the Northern Hemisphere and lack of sufficient observation stations prevented observations of final descent. (Prof. Fedynsky on Jan. 21, 1958.)

The line entries that follow are official U. S. S. R. statements, released Dec. 13, 1957, and Jan. 1, 1958, regarding data which have been obtained by surface observations and

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 8, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Jan. 31, 1958.

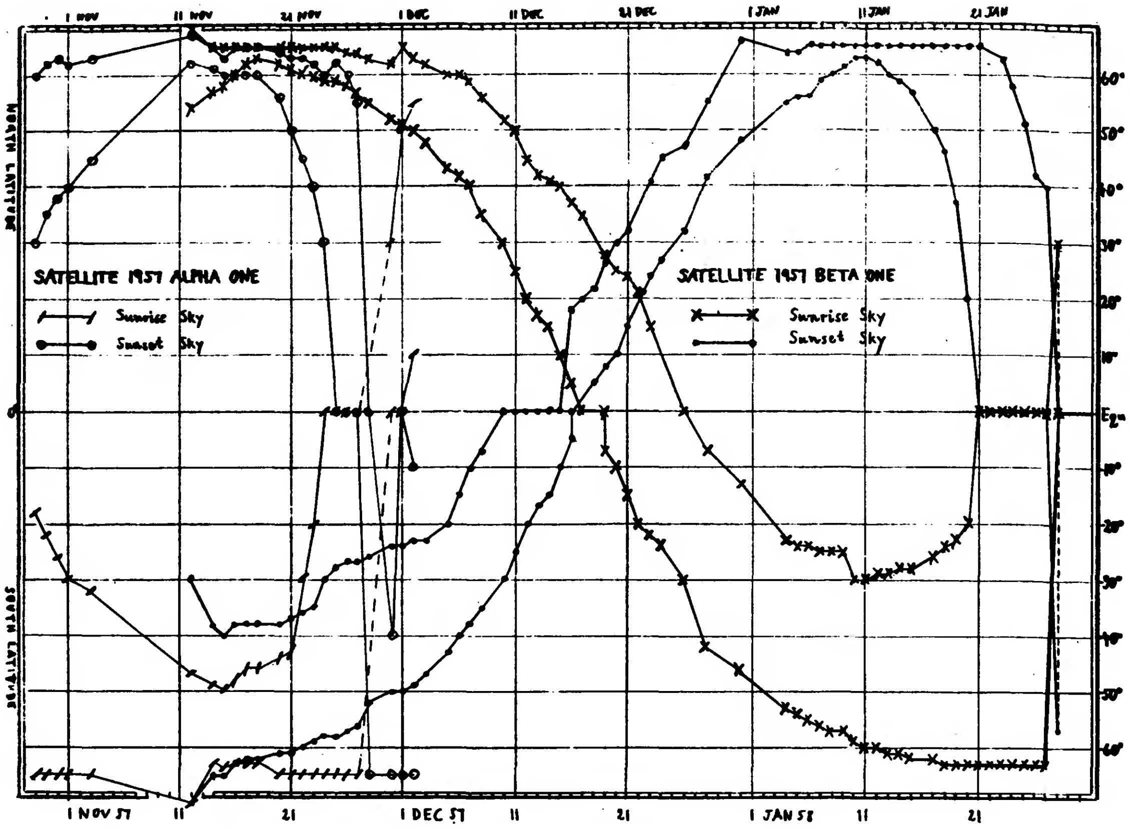

FIGURE 1.—Soviet predictions of zones of visibility.

by telemetry from the first Soviet satellite launching:

- Density of matter above height of 200 km.
- Distribution of matter within the earth.
- Quantity of meteoric matter in the transatmospheric expanse.
- Temperature within satellite.
- Pressure within satellite.
- Structure of ionosphere.
- Reception of radio signals up to 10,000 kms.
- Danger from meteorites much smaller than expected; remained unscathed for a long time.
- Preliminary report on the flight of the sputniks, prepared by Soviet International Geophysical Year Committee, is being circulated to the organizations participating in the International Geophysical Year.

[This official report did not contain scientific data or specific results; it only repeated general statements previously released by Radio Moscow and the Soviet press. No specific scientific data have been received by us, as yet.]

Zones of visibility.—Since Oct. 28, 1957, the U. S. S. R. has given a series of practically daily releases concerning the latitude zones of visibility for $\alpha 1$, and later also for $\beta 1$. These data were released in the form of predictions one to two days in advance. The collection of data in table 4 refers to the time periods after Dec. 6, 1957, and contains information for $\beta 1$ only.

Figure 1 is a plot analysis of the predicted visibility zones for both $\alpha 1$ and $\beta 1$. The geographic latitudes are plotted against the date of the prediction and are corrected only for obvious transmission errors and mistakes. While the values for $\beta 1$ evidence quite a characteristic behavior with respect to time sequence, the $\alpha 1$ predictions after about November 25 may appear somewhat confusing. It is interesting to compare these Soviet predictions with actual data on optical sightings.

Table 1.--Revolutions and path distances, Satellite 1957 α2

Date	Moscow time	Number of revolutions	Distance travelled (in km)	Remarks
Dec.				
6	0600	944		
7	0600	959		
8	0600	975		
9	2000	1,000	43.2 million	Will end existence in January 1958.
11	0600	1,022		
12	0600	1,037		
13	0600	1,053		
14	0600	1,068		
15	0600	1,084		
16	0600	1,099		
17	0600	1,115		
18	0600	1,130		
19	0600	1,146		
20	0600	1,162		
21	0600	1,177		
22	0600	1,193		
23	0600	1,209		
24	0600	1,225		
27	0600	1,272		
28	0600	1,288		
31	0600	1,336		
31	2400	1,348	57.6 million	Will cease to exist in the first days of January.

Table 2.--Revolutions and path distances, Satellite 1957 β1

Date	Moscow time	Number of revolutions	Distance travelled (in km)	Remarks
Dec.				
6	0600	460		
7	0600	474		
8	0600	489		
9	2000	511		
11	0600	531		
12	0600	545		
13	0600	559		
14	0600	573		
15	0600	387(?)		
16	0600	602		
17	0600	616		
18	0600	630		
19	0600	664		
20	0600	658		
21	0600	673		
22	0600	687		
23	0600	701		
24	0600	715		
27	0600	758		
28	0600	772		
31	0600	815		
31	2400	826	37.6 million	
Jan.				
4	0600	873		
5	0600	887		
6	0600	901		
7	0600	915		
8	0600	930		
9	0600	944		
10	0600	959		
11	0600	973		
12	0600	987		

Table 2.--Revolutions and path distances, Satellite 1957 β1 (continued)

Date	Moscow time	Number of revolutions	Distance travelled (in km)	Remarks
Jan.				
13	0200	1,000	45.4 million	2.2 million km more than distance covered by α2 in 1,000 revolutions.
14	0600	1,016		
15	0600	1,030		
17	0600	1,059		
18	0600	1,073		
19	0600	1,088		
20	0600	1,103		
21	0600	1,117		
22	0600	1,132		
23	0600	1,146		
24	0600	1,161		
25	0600	1,175		
26	0600	1,190		
27	0600	1,204		
28	0600	1,219		
29	0600	1,233		

Table 3.--Satellite periods and heights

Release date	Satellite	Apogee (in km)	Period (in minutes)
Dec. 9, 1957	α2	Over 600	About 92.7
Dec. 31, 1957	α2	320	90.0
Jan. 13, 1958	β1	1,300 Decrease of 370 km since launching	Daily decrease now about 4.5 seconds per period; after launching, it was a little over 2 seconds. Period decreased approximately 3.9 minutes since launching.

Table 4.--Soviet predictions of visibility zones for Satellite 1957 β1

Date	Northern Hemisphere: Degree Latitude	Northern Hemisphere: Time	Southern Hemisphere: Degrees Latitude	Southern Hemisphere: Time
Dec.				
6	42-60	Before sunrise	15-40	After sunset
7	40-59	" "	10-38	" "
8	35-56	" "	7-35	" "
10-11	30-52	" "	0-30	" "
11	25-50	" "	0-25	" "
12	20-45	" "	0-20	" "
13	17-42	" "	0-17	" "
14	15-41	" "	0-15	" "
15	10-40	" "	0-10	" "
16	5-37	" "	0- 5	" "
	0-18	After sunset		
17	0-35	Before sunrise	-	(Unfavorable)
	0-20	After sunset		
18	0-30	Before sunset(?)	-	"
	5-22	After sunset		
19	0-28	Before sunrise	0- 7	Before sunrise
	8-26	After sunset		
20	0-25	Before sunrise	0-10	" "
	10-30	After sunset		
21	0-24	Before sunrise	0-15	" "
	15-32	Before sunset		
22	0-21	Before sunset(?)	0-20	Before sunset(?)
	20-28	After sunset		
23	0-15	Before sunrise	0-22	Before sunrise
	24-41	After sunset		
24	27-45	" "	0-24	" "
26	32-47	" "	0-30	" "
28	42-55	" "	7-42	" "
31	48-66	" "	13-46	" "
Jan.				
4	55-64		23-53	
5	56-64	" "	24-54(?)	" "
6	56-65	" "	24-55	" "
7	59-65	" "	25-56	" "
8	60-65	" "	25-57	" "
9	61-65	" "	25-57	" "
10	63-65	" "	30-59	" "
11	63-65	" "	30-60	" "
12	62-65	" "	29-60	" "
13	60-65	" "	29-61	" "
14	59-65	" "	28-61	" "
15	57-65	" "	28-62	" "
17	50-65	" "	26-62	" "
18	46-65	" "	24-63	" "
19	37-65	" "	23-63	" "
20	20-65	" "	20-63	" "
21	0-65	" "	0-63	" "
22	0-64	" "	0-63	" "
23	0-63	" "	0-63	" "
24	0-58	" "	0-63	" "
25	0-51	" "	0-63	" "
26	0-42	" "	0-63	" "
27	0-40	" "	0-63	" "
28	0-30	Before sunrise	0-57	After sunset
29	-	(Unfavorable)	-	(Unfavorable)
30	-	"	-	"
31	-	"	-	"

Basic Orbital Data for Satellite 1957 β1 [1]

By L. G. Jacchia [2]

The data in table 1 summarize the results of an analysis of approximately 1100 optical and radio observations of Satellite 1957 β1 received at the Smithsonian Astrophysical Observatory. Sub-satellite points were computed for each observation by use of the following basic elements:

Epoch and osculation	1957 December 17.16575 UT
Semi-major axis	$a=1.1311$
Eccentricity	$e=0.0868$
Argument of perigee	$\omega=42°.8$
Inclination	$i=65°.3$

It was assumed that the precession in ω was 0.152 times the precession in α_Ω, the right ascension of the ascending node, i. e., the theoretical value corresponding to $i=65°.3$. For the epoch of the elements this gives

$$d\omega/dt=-0°.418/\text{day}$$

and

$$d^2\omega/dt^2=-0°.00054/\text{day}^2.$$

The instantaneous value of the major axis was computed from the sidereal period, which in turn was derived from the observed nodal period. The instantaneous value of the eccentricity was obtained by changing the perigee distance q in function of the apogee distance according to Sterne's (1958) equations, using the Smithsonian Interim Atmosphere (see p. 275). The resulting values are tabulated below (n=number of revolutions, a=semi-major axis in earth's equatorial radii, and q=perigee distance in earth's equatorial radii):

n	a	q
0	1. 1467	1. 0337
200	1. 1416	1. 0335
400	1. 1364	1. 0334
600	1. 1311	1. 0332
800	1. 1250	1. 0330
1000	1. 1179	1. 0328
1200	1. 1109	1. 0326
1400	1. 1037	1. 0323

The individual columns in table 1 give, respectively:

1. The number of revolutions (n) elapsed since the first ascending-node crossing given in the table (*not* the first crossing after the launching).
2. The time of the ascending-node crossing.
3. The instantaneous value of the nodal period P_Ω, obtained by numerical differentiation of column 2.
4. The rate of change of anomalistic period (P_π) in seconds per day.
5. The right ascension of the ascending node.
6. The nodal precession, in degrees per day.

An interesting feature of this table is the erratic fluctuation in the orbital acceleration. The data of column (4) are plotted in figure 1.

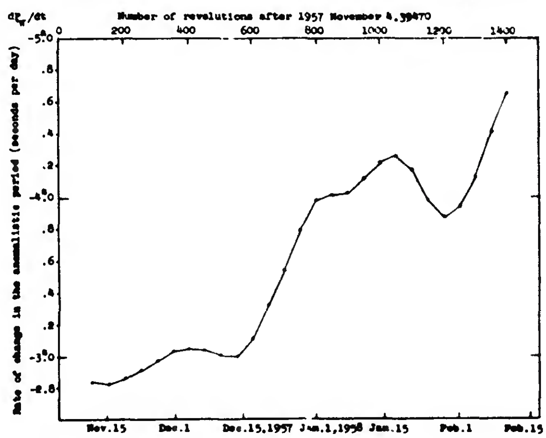

Figure 1.—Rate of change of the anomalistic period as a function of time.

A simple explanation of these changes may lie in a systematic variation of the effective presentation area of the satellite, although day-to-day variations in the density of the upper atmosphere cannot be discounted as a possible cause.

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 9, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Feb. 21, 1958.

[2] Physicist, Smithsonian Astrophysical Observatory; Research Associate, Harvard College Observatory.

A similar study of a spherical satellite could decide between the two hypotheses; unfortunately the observational material at hand for Satellite 1957 $\alpha 2$ is too scanty to yield any reliable results.

The present tabulation supersedes the one in Harvard Announcement Card 1391 (1958) which was obtained by using older orbital data.

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1958. Satellite 1957β. Harvard Announcement Cards 1391, 1392.

STERNE, T. E.
1958. An atmospheric model, and some remarks on the inference of density from the orbit of a close earth satellite. Astron. Journ., in press.

Table 1.--Analysis of optical and radio observations of Satellite 1957 $\beta 1$

(1) n	(2) T_Ω		(3) P_Ω	(4) dP_π/dt	(5) α_Ω	(6) $d\alpha_\Omega/dt$
0	1957 Nov.	4.39470	($0^d.072009$)		112°.4	
50		7.99208	.071887		102.9	
100		[11.58344]	[.071768]	[$-2^s.84$]	[93.4]	-2°.65
150		[15.16891]	[.071651]	[-2.83]	[83.9]	
200		[18.74854]	[.071534]	[-2.86]	[74.4]	-2.67
250		[22.32224]	[.071414]	[-2.91]	[64.9]	
300		25.88994	.071293	-2.97	55.3	-2.69
350		29.45149	.071169	-3.03	45.7	
400	1957 Dec.	3.00682	.071044	-3.05	36.1	-2.71
450		6.55585	.070918	-3.04	26.4	
500		10.09864	.070794	-3.01	16.8	-2.73
550		13.63525	.070672	-3.00	7.2	
600		17.16577	.070548	-3.11	357.5	-2.75
650		20.68995	.070417	-3.32	347.8	
700		24.20735	.070278	-3.54	338.1	-2.77
750		27.71756	.070129	-3.79	328.4	
800		31.22012	.069970	-3.98	318.6	-2.80
850	1958 Jan.	3.71447	.069807	-4.01	308.8	
900		7.20078	.069646	-4.02	298.9	-2.83
950		10.67902	.069483	-4.11	289.1	
1000		14.14898	.069316	-4.21	279.2	-2.86
1050		17.61052	.069145	-4.26	269.3	
1100		21.06346	.068974	-4.17	259.3	-2.89
1150		24.50809	.068813	-3.97	249.3	
1200		27.94485	.068659	-3.87	239.3	-2.91
1250		31.37399	.068505	-3.94	229.3	
1300	1958 Feb.	3.79531	.068347	-4.12	219.3	-2.94
1350		7.20853	.068179	-4.41	209.2	
1400		10.61301	.067999	-4.65	199.1	-2.98

When tabulated values are uncertain because of scarcity of observations, they are enclosed in brackets. A parenthesis denotes a quantity which is somewhat more uncertain than the average due to computational causes.

Processed Observational Data for U. S. S. R. Satellites 1957 Alpha and 1957 Beta [1]

By R. M. ADAMS,[2] N. MCCUMBER,[3] and M. BRINKMAN [4]

This report presents a collection of observational data, received and processed by the Smithsonian Astrophysical Observatory, for the Soviet artificial earth satellites launched on Oct. 4, 1957, and Nov. 3, 1957. The data cover the total lifetime of the components $\alpha 1$, $\alpha 2$, and probably $\alpha 3$ from the Satellite 1957 Alpha launching. For the second Soviet satellite, 1957 Beta, the data extend from the day of launching to the middle of February 1958. At the time of this report, 1957 Beta is still in orbit and is expected to stay in orbit until mid-April 1958.

Sources of data

Since the first Soviet satellites were launched before all precision optical tracking stations were activated, the task of providing the observations, necessary to compute ephemerides and predictions, has fallen to a large extent on the Moonwatch network and other observing agencies such as astronomical observatories, radar stations, and various other organizations and individuals.

Observations are received by the Smithsonian Astrophysical Observatory in a number of ways. Moonwatch observations made in the United States are normally telephoned in and then confirmed by letter. Observations made in foreign countries are sent by the IGY communications system (AGIWARN), if possible. When this is not possible, the observations are sent by air mail. Observations made by civilian, industrial, and military research institutions are received through teletype channels as well. A considerable number of observations are also furnished through Project Vanguard of the Naval Research Laboratory and Project Space Track of the Geophysics Research Directorate at the Air Force Cambridge Research Center, ARDC, as well as by interested amateurs and private individuals.

Processing the data

As observational data are received, they are sifted, processed, and put into form for use in IBM 704 programs. The limited staff makes it impossible to process all observations received. A major portion of the usable observations have been processed, however, and it is planned to process others as time permits.

As of this date approximately 4500 visual and photographic observations of the Russian earth satellites have been received at the Smithsonian Astrophysical Observatory. About 2980 of these have been processed for use in the IBM computer programs.

The unprocessed observations fall into two groups: (*a*) those that will be processed as soon as time permits; (*b*) those that are not accurate enough to be used. The unprocessed observations in group (*a*) are, in general, additional sightings on days for which a large number of observations have already been processed. To be usable, an observation must be accurate to at least one second of time and the position given must be exact to one degree of arc.

The following is a breakdown of all observations:

	1957 $\alpha 1$	1957 $\alpha 2$ and $\alpha 3$	1957 Beta
Processed	1320	*50	1610
Unprocessed:			
Usable	470	0	500
Not usable	300	......	250
Total	2090	50	2360

*14 of the observations were rejected after processing.

Twelve reports of falling objects seen between November 30 and December 11 and 26 reports

[1] Carried out in part under NSF Grant No. Y/30.10/167; Special Report No. 10, IGY Project No. 30.10, Smithsonian Astrophysical Observatory, Cambridge; first issued Mar. 1, 1958.

[2] Chief, Computations and Analysis Section, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory.

[3] Mathematician, Computations and Analysis Section, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory.

[4] Computer, Computations and Analysis Section, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory.

of similar objects seen between December 20 and January 8 have been received. These have been investigated as possible observations of burnouts of $\alpha 1$ and $\alpha 2$, but analysis makes it highly unlikely that any of these observations could have been of the demise of $\alpha 1$ or $\alpha 2$.

No attempt has been made to process radio and radar sightings unless they were made during a period when there were no visual sightings. In the tabular material that follows, all radar and radio observations are labeled as such.

The observations of 1957 $\alpha 2$ have been analyzed by Dr. Luigi Jacchia and published on Harvard Announcement Card 1402. The results of this analysis have been noted in the column preceding the observation number in table 2 of this report. Observations labeled $\alpha 2$ appear to be of the satellite itself. Those labeled $\alpha 3$ are observations that do not lie on the $\alpha 2$ curve but instead seem to form an orbit of their own. Possibly these "$\alpha 3$" observations are of the nose cone of the carrier rocket. In both cases, doubtful observations have been designated by a question mark.

The observations

All processed observations have been listed by date of observation. Tables 1, 2, and 3 contain the observations of 1957 $\alpha 1$, 1957 $\alpha 2$ and 1957 Beta respectively. The possible observations of $\alpha 3$ have been grouped with the $\alpha 2$ data.

A serial number is assigned to the observation at the time that it is processed. Observation numbers for 1957 $\alpha 1$ begin with 00100 and continue in numerical order, skipping the numbers from 00138 to 00199 and from 00261 to 00299. Observation numbers for 1957 $\alpha 2$ begin with 00100. For 1957 Beta the numbering of observations made in 1957 begins with 00001; for observations made in 1958, the numbering begins again with 00001. A few observations have been discarded as obviously incorrect; their numbers have not been reassigned.

Some observers have corrected their data for atmospheric refraction. These observations are indicated by an asterisk before the altitude. All Moonwatch observations are uncorrected.

All positions are given in the form used for the IBM computers. The headings of tables 1, 2, and 3 have the following meanings:

Symbol	*Term*	*Units*
α	Right ascension	Hours, minutes, seconds.
δ	Declination	Degrees, minutes, seconds.
Z	Azimuth	Degrees, minutes, seconds; measured clockwise from north.
h	Angular elevation	Degrees, minutes, seconds; measured upward from the horizon.
Mag	Apparent magnitude	Dimensionless.

Some stations report their data in degrees and fractions of a degree; in these instances conversions have been made. Three particular stations have provided a large fraction of the observations received. It should be noted, therefore, that Pic du Midi gives time to 1^s and positions to 0°1. White Sands records time to units and the error does not exceed one millisecond; positions are given to 0°001. Cape Canaveral also reports time to units and gives positions to 0°01.

Station coordinate list

Every station has been given a registration number of four digits (xxxx), which appears in table 4 with the observation and identifies its source. The coordinates of the stations are listed by station number in the tabular material.

The registration numbers have been assigned by a code designed to indicate the type of station, its geographical location, and the kind of observations made. However, classification has been difficult since pertinent facts are often missing and some stations make several different kinds of observations (e. g., visual and photographic).

The first of the four digits (0xxx) denotes the type of station:

0xxx:	Moonwatch (visual)
2xxx:	Astronomical observatories (visual and photographic)
3xxx, 5xxx, 6xxx, 7xxx:	Non-Moonwatch (visual and photographic)
4xxx:	Radio and radar
8xxx:	Alternate observation sites; the names of all Moonwatch stations in this category are followed by MW.
9xxx:	Precision Optical Tracking Stations

When ambiguities remain, the station name listed in tables 1, 2, and 3 is followed by symbols with the following meanings:

MW:	Moonwatch project
SS:	Super-Schmidt camera
BN:	Baker-Nunn satellite camera
PT:	Phototrack project

In the categories 0xxx, 2xxx, 3xxx, 4xxx, 5xxx, and 6xxx, the second of the four digits (x0xx) indicates the geographical location of the station, as follows:

x0xx and x1xx:	United States, including all territories and possessions except Alaska
x2xx and x3xx:	Japan
x4xx:	Africa, Alaska, Canada. In this category, the third of the 4 digits is also used to distinguish the location as follows: x40x to x44x: Africa; x45x to x49x: Canada and Alaska
x5xx:	Asia
x6xx:	United Kingdom, Eire, and Australia
x7xx:	Europe (except British Isles)
x8xx:	South America
x9xx:	World-wide

Acknowledgments

We wish to emphasize that the observational data stem from the efforts of thousands of persons who, in the true spirit of the International Geophysical Year, have given freely of their time and work. It is a privilege for us to acknowledge these contributions which have made possible the tracking of artificial earth satellites.

At the Smithsonian Astrophysical Observatory, the task of obtaining, screening, and processing the raw data has been the obligation of the Optical Satellite Tracking Program under Dr. J. Allen Hynek, associate director of the observatory, and K. H. Drummond, executive officer of the tracking program. It fell principally upon the staff of the Computations and Analysis Section of this program to cope with the large volume of data and to present the material in a useful form. For the manuscript preparation of the report, we wish to thank Thelma Bourne, Lillian Christmas, Janet Clarke, Connie Cowhig, Jane Henderson, Bringfriede Jensen, and Rinda Rogers.

Table 1.--Processed optical observations of Satellite 1957 α1

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			October 5, 1957					
00980	Terre Haute	0025	00:50:46			180	47	
00981	Terre Haute	0025	01:46:00			180	40	
			October 7, 1957					
00102	Boulder-Radio	8035	15:11:05			232	44	
00103	Mt. Stromlo	2600	09:39:27	23 40	-37			2.0
00112	Melbourne	0604	09:34			90	85	
00481	Mt. Stromlo	2600	09:38:21.5	00 00	-55			
00482	Mt. Stromlo	2600	09:38:49.2	23 40	-37			
00483	Mt. Stromlo	2600	09:38:53	23 40	-37			
			October 8, 1957					
00105	Sydney	0602	09:39:08	15 50 42	-62 48±0°3			
00106	Sydney	0602	09:40:43.4	20 15	-28 30±0°5			
00107	Mt. Stromlo	2600	09:36:34	12 38	-60			
00108	Mt. Stromlo	2600	09:38:28	15 25	-69			
00109	Mt. Stromlo	2600	09:38:52	16 45	-69			
00110	Mt. Stromlo	2600	09:39:43	20 10	-55			
00111	Mt. Stromlo	2600	09:40:14	21 40	-16 42			
00113	Melbourne	0604	09:38:15±1m			183	48	
00114	Melbourne	0604	09:39:15±1m			106	68	
00115	Melbourne	0604	09:40:15±1m			53 30	45	
00116	Melbourne	0604	09:41:15±1m			43	25	
00117	Melbourne	0604	09:45:15±1m			139	61	
00135	Fort Churchill	3450	10:15	13 45 52	49 31 30			
00136	Mt. Stromlo	2600	09:37:31	13 37	-65			
00137	Woomera	3601	11:15:25			226 17 52	25 30 56	2
00258	Sydney	0602	09:40:42.25	20 15	-28 30			
00484	Mt. Stromlo	2600	09:36:32	12 41	-58 10			
00485	Mt. Stromlo	2600	09:36:37	12 35	-61			
00569	Mt. Stromlo	2600	09:37:31	13 36 54	-64 53			
			October 9, 1957					
00120	Mt. Stromlo	2600	09:39:54	16 50	-41			
00121	Mt. Stromlo	2600	09:40:08	17 21	-38			
00122	Mt. Stromlo	2600	09:40:13	17 26	-36			
00123	Mt. Stromlo	2600	09:40:41	18 24	-24			
00124	Mt. Stromlo	2600	09:40:47	18 28	-22			
00125	Mt. Stromlo	2600	09:41:33	19 50	6			
00126	Mt. Stromlo	2600	09:41:38	19 57	5			
00127	Mt. Stromlo	2600	09:42:23	20 45	22			
00129	Sydney	0602	09:41:25.5	18 30 16	-10 40			
00130	Sydney	0602	09:41:30.5	18 35	- 9 00			
00132	Sydney	0602	09:41:18.52	18 11 13.4	-14 46 17			
00259	New Brook	5451	11:52:11	15 37	49 06			2
00260	Dominion Obs.	2450	10:21:51			82	3 50	
00486	Mt. Stromlo	2600	09:40:16	17 25	-36			
00487	Mt. Stromlo	2600	09:41:35	20 00	4			
00488	Mt. Stromlo	2600	09:41:44	19 54	5			
00489	Mt. Stromlo	2600	09:42:06	20 31	17 30			
00586	Perth	0601	11:17:14			101 20 00	*36 08 00	
00587	Perth	0601	11:18:15			66 56 00	*20 26 25	
01009	Edinburgh, Scot.	2653	05:30:28			91	*39	
			October 10, 1957					
00128	New Haven	0087	10:23			45	40	3
00204	Ft. Churchill	3450	11:53:21			258 50	44 00	
00205	Ft. Churchill	3450	11:53:40			234 20	48 00	
00206	Ft. Churchill	3450	11:54:01			214 00	50 00	
00207	Ft. Churchill	3450	11:54:23			201 00	50 00	
00208	Ft. Churchill	3450	11:54:31			185 00	42 40	
00209	Ft. Churchill	3450	11:54:56			171 00	35 00	
00588	Perth	0601	11:17:24.8			66 03 40	*44 00 20	
00589	Perth	0601	11:17:30.5			63 53 40	*43 49 19	
00590	Perth	0601	11:17:53.5			55 35 00	*35 20 00	
00591	Perth	0601	11:19:16			41 30 50	*15 59 00	
01120	Skalnate Pleso	2711	03:55:32			59 06	24 24	

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			October 11, 1957					
00202	Armagh	2651	05:28:31			9 48	49 18	0
00203	Armagh	2651	05:30:27			116 18	26 06	0
00211	Woomera	3601	09:40:27.93			25 12 28	10 16 52	
00220	Dominion Obs.	2450	10:17:34	16 25	61 30			
00221	Pic du Midi	2705	05:29:20			190	18	1 to 2
00222	Woomera	3601	09:39:03.37			24 19 00	33 11 04	
00223	Woomera	3601	09:39:35.01			24 45 20	23 34 36	
00224	Vienna	2700	03:52:00.5			356 36	12 36	2
00225	Vienna	2700	03:53:28.2			27 12	21 24	2
00226	Vienna	2700	03:55:59			86 00	16 00	2
00227	Woomera	3601	09:38:21.6			23 04 02	53 19 08	
00230	Woomera	3601	09:40:27.93			24 57 26	13 40 16	
00243	Perth	0601	11:16:30			19 33 00	*48 19 29	
00244	Perth	0601	11:16:45.8			21 15 00	*40 09 52	
00245	Perth	0601	11:16:55			21 29 40	*36 02 41	
00246	Perth	0601	11:16:59.5			21 52 00	*34 15 15	
00247	Perth	0601	11:17:16.8			22 13 00	*28 38 14	
00248	Adelaide	0600	09:39:12.5	20 18 39.15	-14 54 55.6	(1958.0 position)		
00326	Mt. Stromlo	2600	09:40:14	17 33	12 30			3
00327	Mt. Stromlo	2600	09:40:44	18 00	22			3
00328	Mt. Stromlo	2600	09:40:58	18 16	24 30			3
00490	Mt. Stromlo	2600	09:39:25.0	16 20	- 7			
00677	Salisbury	3602	09:38:54.9	19 48	-29 32			
00678	Salisbury	3602	09:39:11.7	20 17	-17 11			
00679	Salisbury	3602	09:39:11.7	20 05	-14 11			
00680	Salisbury	3602	09:39:03.8	29 05	-22 46			
00681	Salisbury	3602	09:39:09.4	20 14	-18 49			
00682	Salisbury	3602	09:39:11.1	20 16	-17 43			
01121	Skalnate Pleso	2711	03:54:13			41 36	33 42	
			October 12, 1957					
00200	Herstmonceux	2650	05:29:04	8 15	32			
00201	Cordoba	2800	00:04:17	16 55 38	9 26 26			2.5
00228	Utrecht	2707	03:50	14 30	52 00			2
00229	Armagh	2651	05:25:54.1	22 27 36.347	58 11 59.08			0
00234	Niigata	0238	19:53:39			65	17 30	2
00236	Perth	0601	11:11:50.5			231 35 00	*30 05 20	
00237	Perth	0601	11:12:39.5			240 52 00	*43 45 59	
00239	Perth	0601	11:16:12.7			7 36 10	*13 47 49	
00309	Cordoba	2800	00:04:17	16 55 38	9 26 26			2.5
00469	Pic du Midi	2705	05:28:55			7 54	24 30	
00470	Pic du Midi	2705	05:30:33			61 30	33 54	
00556	Bratislava	2701	03:52:19.2	13 21 34	55 13 48			
00582	Armagh	2651	05:26:11.8	22 48 30	65 47			
00592	Perth	0601	11:13:27.3			293 10 20	*52 54 16	
00593	Perth	0601	11:14:43.5			350 46 20	*33 10 31	
00594	Perth	0601	11:15:57			5 52 00	*16 23 25	
00683	Salisbury	3602	09:37:10.0	18 28	- 4 33			
00684	Salisbury	3602	09:37:12.5	18 33	-33 03			
00685	Salisbury	3602	09:37:15.0	18 36	- 1 55			
00687	Salisbury	3602	09:37:01.9	18 16	- 8 37			
00688	Salisbury	3602	09:37:03.6	18 19	-17 54			
00689	Salisbury	3602	09:37:05.1	18 21	- 7 10			
00690	Salisbury	3602	09:37:07.2	18 24	- 5 55			
00691	Salisbury	3602	09:37:09.5	18 28	- 4 44			
00692	Salisbury	3602	09:37:11.2	18 31	- 3 49			
00693	Salisbury	3602	09:38:27.1	20 05	26 48			
00694	Salisbury	3602	09:38:29.2	20 07	27 26			
00695	Salisbury	3602	09:38:30.2	20 07	27 26			
00696	Salisbury	3602	09:38:30.2	20 08	27 41			
00697	Salisbury	3602	09:38:32.4	20 10	28 16			
00698	Salisbury	3602	09:38:33.6	20 11	28 31			
00699	Salisbury	3602	09:38:36.5	20 14	29 17			
00726	Sydney	0602	15:26:13	17 10	-67			
01010	Edinburgh, Scot.	2653	05:29:22			146 30	* 24 08	
01122	Skalnate Pleso	2711	03:51:40			1 06	33 54	
01123	Skalnate Pleso	2711	03:52:05			16 42	40 36	
01124	Skalnate Pleso	2711	03:52:35			46 12	47 18	

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

October 13, 1957

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG
00210	Swarthmore	2038	10:15:50			74	25	
00233	Dominion Obs.	2450	10:13:51.0	11 41 36.5	58 39 00	(1950 position)		
00240	Woomera	3601	09:34:03.73			255 17 58	49 17 24	
00255	Naval Obs.	2011	10:17			90±1	17±1	
00304	Helsinki B	6701	02:10:42	8 32	42			
00305	Helsinki B	6701	02:11:47	8 38	15			
00312	Perth	0601	11:08:08.8			235 44 20	*19 18 16	
00313	Perth	0601	11:09:21.6			255 40 00	*28 25 53	
00314	Perth	0601	11:09:59.0			274 54 30	*30 39 22	
00315	Perth	0601	11:10:57.8			310 35 40	*31 41 46	
00316	Perth	0601	11:11:25.8			324 44 00	*27 44 10	
00329	Takada	0250	19:50:03.5	13 37	51 18			2
00330	Takada	0250	19:50:11.9	12 05	38 42			4
00331	Osaka Yomiuri	0241	19:47:28	18 19	68 09			3
00365	U. of Michigan	2020	10:15:28.5	12 14	24 18			
00366	U. of Michigan	2020	10:15:39.4	11 49	14 12			
00367	U. of Michigan	2020	10:16:32.5	11 35	4 54			
00557	Bratislava	2701	03:49:30.9	13 11 04	67 35 06			
00558	Bratislava	2701	03:52:40.5	10 28 07	- 3 39 00			
00598	Jockis	6700	03:48:18			41 00	24 42 36	

October 14, 1957

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG
00252	Princeton	2025	10:10:10.9	14 42	75 30	(Epoch 1950.0)		1
00253	Princeton	2025	10:11:05.9	11 34	55 00	(Epoch 1950.0)		1
00254	Princeton	2025	10:16:00.7	12 10	58	(Epoch 1950.0)		1
00300	Washington, D.C.	8032	10:10:55±1	15 48± 7	70±1			2
00301	Washington, D.C.	8032	10:11:09±1	13 00± 4	56±1			2
00302	Washington, D.C.	8032	10:11:39	11 18± 4	20±1			2
00306	Washington, D.C.	6001	10:09:00	17 10	65			2
00307	Agassiz	2052	10:07:58±3	22 44	65 54			3
00308	Agassiz	2052	10:11:46±3	9 30	- 7			3
00310	Woomera	3601	09:32:29			346 10 44	19 42 26	
00311	Woomera	3601	09:33:17			352 14 58	15 19 36	
00319	Perth	0601	11:07:03.47			307 44 00	*21 16 52	
00320	Perth	0601	11:07:46.2			323 33 00	*17 19 11	
00321	Perth	0601	11:08:01.3			328 03 40	*15 33 45	
00324	Naval Obs.	2011	10:11:25.6			56 36	29 27 24	2
00332	Musashino	0233	19:46:13			54 06	27 24	1.5
00334	Shizuoka	0247	19:45:49	13 12	54 10			2
00335	Nagoya	0236	19:47:49			90	16 42	3
00336	Otaru	0243	19:45:30			63 30	51 36	1.5
00337	Toyama	0254	19:45:36			50 18	21 30	2
00459	Takaoka	0270	19:46:04			54 30	22	2
00460	Akita	0200	19:44:18	14 58	74 11			2
00461	Akita	0200	19:45:14	11 40	56 16			
00471	Pic du Midi	2705	05:26:08			133 12	25 24	
00542	Bedford	3002	10:09:17.9	22 40 48	64 54			
00543	Bedford	3002	10:09:38.1	23 08 48	70 41			
00544	Bedford	3002	10:10:33.6	6 31 54	75 47			
00545	Bedford	3002	10:06:40.1	7 26 30	23 12			
00546	Bedford	3002	10:07:40.4	8 24 06	- 4 19			
00554	Ondrejov	2702	03:46:36	9 52 30	19 40			
00555	Ondrejov	2702	03:52:42	4 07 00	88 17			
00559	Bratislava	2701	03:45:07.4	15 42 30	85 15 48			
00560	Bratislava	2701	03:45:59.7	10 42 36	72 32 30			
00561	Bratislava	2701	03:47:15.2	9 55 02	21 10 42			
00570	Perth	0601	11:06:25.0			292 01	23 05	
00571	Perth	0601	11:06:29.5			293 09	23 06	
00575	Stockholm	2708	03:44:32	4 32 48	50 51			
00576	Stockholm	2708	03:44:40	4 47 06	4 08			
00577	Stockholm	2708	03:44:54	5 12 36	1 03			
00595	Perth	0601	11:06:29.5			293 08 40	*23 06 04	
00730	North Canton	0053	10:07:47			0	*11 12	
00731	State College	0060	10:10:25	12 52	56 15			
01106	Boston U.	2054	10:10:42.05	6 48 44	73 53 24			
01107	Boston U.	2054	10:10:43.27	6 56 13	73 12 04			
01108	Boston U.	2054	10:10:44.50	7 03 04	72 30 11			
01109	Boston U.	2054	10:10:46.88	7 15 08	71 05 17			
01110	Boston U.	2054	10:10:48.26	7 21 23	70 14 46			

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			October 15, 1957					
00317	Meanook	5450	11:38:00	8 34	32 36			
00322	Naval Obs.	2011	10:07:43±17^s			90 54	37 57 18	
00338	Washington, D.C.	8032	10:06:04±1^s	11 45±5	58±1/4°			1
00339	Washington, D.C.	8032	10:06.55±1	10 46±5	33±1/2°			1
00340	Washington, D.C.	8032	10:07:31±1	10 40±5	21±1/2°			1
00361	Lick Obs.	2005	13:19:04.3±0^{s}5	10 12 35.3	24 29 27	(1950.0)		
00362	Lick Obs.	2005	13:19:09.2±0^{s}5	10 11 56.6	22 08 19	(1950.0)		
00368	Athens Obs.	2706	03:44:31	10 02	43 30	(1950.0)		
00369	Athens Obs.	2706	03:45:24	9 58	22 30			
00370	Musashino	0233	19:40:53.5			53 54	36	2
00373	Takaoka	0270	19:39:43			125 30	23	
00374	Takada	0250	19:38:50	16 00	74 00			
00375	Takada	0250	19:39:59	12 15	57 14			
00376	Takada	0250	19:40:25	11 44	48 00			
00378	Kanazawa	0221	19:39:48	12 45	57 22			
00379	Kanazawa	0221	19:41:42	11 10	16 20			
00404	Colgate U.	2044	10:03:53			0	45 06	2
00406	Millbrook	0045	10:08:12	9 12	2 30			
00407	Cambridge	0099	10:06:47			159 00	63 24	
00408	Washington, D.C.	0014	10:06:09	11 46	53 28			
00409	Harrisonburg	0703	10:07:18	11 19 10	20 50			
00472	Pic du Midi	2705	05:16:35			328 06	17 18	
00473	Pic du Midi	2705	05:17:23			328 36	27 42	
00474	Pic du Midi	2705	05:17:50			328 48	38 36	
00475	Pic du Midi	2705	05:18:22			329 48	52 06	
00476	Pic du Midi	2705	05:18:24			329 54	53 48	
00527	State College	0060	10:04:10	18 27	72 15			
00528	State College	0060	10:05:41	11 27	54 30			
00529	Schenectady	0081	10:05:59	8 11	43 06			
00578	Stockholm	2708	03:39:37	3 51 24	4 03			
00579	Stockholm	2708	03:39:50	4 11 36	1 48			
00580	Stockholm	2708	03:40:05	4 07 00	- 1 03			
00581	Stockholm	2708	03:40:18	4 58 00	- 3 30			
00700	Bratislava	2701	03:41:16.3	6 47 06	78 05 12			
00701	Bratislava	2701	03:42:42.8	8 56 00	12 04 30			
00732	NYC B	8510	10:04:38	23 00	65 36			
00733	NYC B	8510	10:05:36	4 08	87 42			
00734	NYC B	8510	10:07:34	9 33	23 39			
00735	NYC B	8510	10:08:16	9 34	- 1 00			
00736	NYC B	8510	10:08:40	9 38	- 8 18			
00737	NYC B	8510	10:08:47	9 37	-10 00			
01008	Hastings	6011	10:06:10.5			32	36	
01125	Skalnate Pleso	2711	02:05:12.8	11 22 00	17 11			
01126	Skalnate Pleso	2711	03:41:06.4	2 58 36	53 45			
01127	Skalnate Pleso	2711	03:41:34.4	5 02 00	44 22			
01128	Skalnate Pleso	2711	03:42:44.5	7 37 18	5 30			
			October 16, 1957					
00341	Colgate U.	2044	10:58:40	1 59 48^{s}17	472 13 10"09			
00342	Princeton Obs.	2053	09:59:08.5	1 20	79 30			1
00343	Princeton Obs.	2053	09:00:46.3	8 28	31 18			1
00344	Princeton Obs.	2053	09:01:29.6	8 52	6 12			1
00347	Dominion Obs.	2450	09:58:59.5	5 55 41.4	42 37 57			
00364	Dover	0039	10:00:08.4	10 30	49 45 00			3 to 1
00371	Naval Obs.	2011	10:00:52±5^s			37	48	
00372	Fort Monmouth	3006	10:00:18			51±5	75 30±30'	
00380	Lincoln	0038	11:36:25.4	7 01	20 36			3 or 2
00381	Cambridge	0099	09:59:50.2			275	59 30	
00382	Cambridge	0099	10:00:23.4			227	64 30	
00383	Cambridge	0099	10:00:35.6			208	60 30	
00384	Cambridge	0099	10:00:37.6			205 30	58 30	
00385	Bedford	3002	09:57:44			312 21	32 45	
00386	Bedford	3002	09:58:55			267 50	60 38	
00387	Bedford	3002	10:01:32			173 40	39 57	
00388	Bedford	3002	10:03:23			161 10	17 47	
00389	Bedford	3002	10:05:00			158	8 22	

460132 O—58——8

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

October 16, 1957 (cont'd.)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
00390	Cambridge	0099	09:59:30	5 20	27 00+30	10		
00391	Milton	6003	09:59:07	2 28	48 54			
00392	Milton	6003	09:59:48	3 01	40 54			
00393	Milton	6003	10:00:05	4 51	33 06			
00394	Milton	6003	10:00:45	6 20	13 00			
00395	Milton	6003	10:01:29	7 21	- 5 00			
00396	Milton	6003	10:02:31	8 05	-20 00			
00397	Milton	6003	10:03:09	8 21	-25 00			
00399	Milbrook	0045	10:00:02	2 03	64 35			
00400	Milbrook	0045	10:00:45	7 22	28 50			
00401	Schenectady	8038	09:59:46	5 47	37 12			
00402	Sacramento	0007	13:13:02.9	8 42 30	6 42			
00403	Red Bank	0040	10:00:18			51	75 30	
00477	Lick	2005	13:12:46.7	9 01 54.0	25 32 52			
00478	Lick	2005	13:12:50.7	9 03 22.8	23 09 01			
00479	Lick	2005	13:12:52.7	9 03 59.3s	22 08 42			
00480	Lick	2005	13:12:56.7	9 05 20.4	19 52 35			
00494	Pic du Midi	2705	05:11:03			313 24	35 00	
00495	Pic du Midi	2705	05:12:27			303 30	53 36	
00496	Pic du Midi	2705	05:13:08			261 42	69 12	
00497	Pic du Midi	2705	05:13:17			242 06	71 24	
00498	Pic du Midi	2705	05:14:20			175 54	53 18	
00499	Pic du Midi	2705	05:15:13			160 54	35 18	
00500	Pic du Midi	2705	05:15:31			160 12	30 12	
00501	Pic du Midi	2705	05:15:59			158 24	26 36	
00502	Pic du Midi	2705	05:17:24			156 36	15 18	
00540	Mansfield	8034	09:59:19	2 39	56 36			
00541	Mansfield	8034	09:59:59	5 08	43 18			
00547	Bedford	3002	10:00:24.4	5 46 36	21 33			
00548	Bedford	3002	10:05:35.8	6 08 42	15 29			
00710	Athens Obs.	2706	03:40:58	9 19	-11 24			
01129	Skalnate Pleso	2711	03:35:06.6	2 01 36	41 22			
01130	Skalnate Pleso	2711	03:35:25.6	2 59 00	37 44			
01131	Skalnate Pleso	2711	03:36:28.1	5 50 36	12 42			
01132	Skalnate Pleso	2711	03:39:20.1	8 12 00	-23 57			

October 17, 1957

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
00351	Westover	3011	09:51:12			312 13	29 33	
00352	Westover	3011	09:51:18			311 49	31 15	
00353	Westover	3011	09:51:22			310 24	32 29	
00354	Westover	3011	09:51:30			308 13	35 40	
00355	Westover	3011	09:54:48			166 06	30 08	
00356	Westover	3011	09:54:49			165 32	29 18	
00357	Westover	3011	09:54:57			164 48	27 48	
00358	Westover	3011	09:55:11			163 43	25 00	
00363	Pasacal	8008	13:05:57.550	5 45 48	42 26			
00466	Las Cruces	0042	11:28:15			23	12	2.5
00467	Lincoln	0038	11:29:34.5	6 30 00	7 30			
00468	Lincoln	0038	11:29:46.2	6 42	2 00			
00503	Pic du Midi	2705	05:04:47			305 12	27 54	
00504	Pic du Midi	2705	05:05:08			299 42	33 54	
00505	Pic du Midi	2705	05:05:36			288 06	42 24	
00506	Pic du Midi	2705	05:05:51			278 54	47 24	
00507	Pic du Midi	2705	05:06:14			255 42	53 54	
00508	Pic du Midi	2705	05:06:35			233 12	54 24	
00509	Pic du Midi	2705	05:06:41			228 30	54 06	
00510	Pic du Midi	2705	05:06:57			210 42	50 54	
00511	Pic du Midi	2705	05:07:14			198 48	46 48	
00512	Pic du Midi	2705	05:07:24			192 12	43 24	
00513	Pic du Midi	2705	05:07:28			191 48	43 06	
00514	Pic du Midi	2705	05:07:50			181 48	36 06	
00515	Pic du Midi	2705	05:08:18			175 06	29 24	
00516	Pic du Midi	2705	05:08:47			170 30	24 18	
00517	Pic du Midi	2705	05:08:53			170 12	23 24	
00518	Pic du Midi	2705	05:08:56			170 00	23 24	
00519	Pic du Midi	2705	05:09:02			169 06	21 36	
00520	Pic du Midi	2705	05:09:08			168 18	20 24	
00521	Pic du Midi	2705	05:09:26			167 18	18 54	

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			October 17, 1957 (cont'd.)					
00522	Pic du Midi	2705	05:09:36			166 06	17 06	
00523	Pic du Midi	2705	05:09:56			164 18	14 42	
00524	Pic du Midi	2705	05:10:33			162 30	10 54	
00525	Pic du Midi	2705	05:11:02			161 18	8 54	
00526	Pic du Midi	2705	05:11:43			160 06	5 54	
00530	Manhattan	0027	11:29:34	5 56	21 40			
00531	Manhattan	0027	11:30:11	7 01	4 05			
00532	Manhattan	0027	11:30:20	7 15	00 40			
00533	Manabattan	0027	11:31:55	8 16	-23 20			
00534	Milton	6003	09:52:55	3 39	27 36			
00535	Milton	6003	09:55:11	6 57	-18 48			
00536	Schenectady	8511	09:53:02	5 35	21 00			
00537	Sacramento A	0007	13:05:05.0	6 43 30	27 06			
00538	Cambridge	0099	09:52:51.2			268	47	
00539	Bedford	3002	09:51:25.8			301 24	31 37	
00549	Bedford	3002	09:52:40.0	3 43 18	26 52			
00550	Bedford	3002	09:52:55.6	4 26 06	19 04			
00551	Bedford	3002	09:54:45	6 50 24	-16 38			
00563	Higashimatsuyama	0210	19:29:03	9 24 54	- 8 34			
00564	Osaka Yomiuri	0241	19:34:08	18 28	70			4
00565	Hofu	0213	19:29:15	12 47	15			3
00566	Kiryu	0223	19:25:15	6 32	88			2
00702	Bratislava	2701	03:28:36.1	3 10 04	47 50 54			
00703	Bratislava	2701	03:29:56.0	6 43 55	8 39 12			
00711	Athens Obs.	2706	03:30:22	00 50	68 30			
00712	Athens Obs.	2706	03:30:49	3 15	67 00			
00713	Athens Obs.	2706	03:31:55	5 28	48 36			
00714	Athens Obs.	2706	03:33:26	6 50	9 36			
00715	Athens Obs.	2706	03:33:54	7 54	-12 30			
01133	Skalnate Pleso	2711	03:28:39.6	2 47 06	27 41			
01134	Skalnate Pleso	2711	03:28:49.6	3 14 48	24 25			
01135	Skalnate Pleso	2711	03:29:09.6	3 59 06	19 21			
01136	Skalnate Pleso	2711	03:29:19.6	4 22 36	14 20			
01137	Skalnate Pleso	2711	03:29:29.6	4 43 54	10 38			
01138	Skalnate Pleso	2711	03:29:39.6	5 02 42	6 57			
01139	Skalnate Pleso	2711	03:29:49.6	5 21 00	3 15			
01140	Skalnate Pleso	2711	03:30:09.6	5 50 00	- 2 53			
01141	Skalnate Pleso	2711	03:31:29.6	7 08 12	-19 07			
01142	Skalnate Pleso	2711	03:31:49.6	7 20 54	-21 39			
			October 18, 1957					
00491	U. of Kansas	8037	11:21:16.5	4 26 11	19 05 18			
00492	Portland	0076	12:56:30	6 23	-17 42			
00552	Milwaukee	0074	09:45:46.5	9 47	- 3 20			
00573	Manhattan	0027	11:20:37	3 56	39 12			
00583	Manazuru	0228	19:18:15.7	9 20	53 18			
00584	Kanagawa	0219	19:21:00			215	45	
00615	Pic du Midi	2705	03:22:33			86 30	12 30	
00616	Pic du Midi	2705	03:22:55			89 30	11 30	
00617	Pic du Midi	2705	03:23:14			92 42	10 30	
00618	Pic du Midi	2705	03:23:28			95 00	9 30	
00619	Pic du Midi	2705	03:23:40			96 48	8 30	
00620	Pic du Midi	2705	03:23:50			97 30	8 06	
00621	Pic du Midi	2705	03:23:55			99 00	8 00	
00622	Pic du Midi	2705	03:24:05			100 24	7 00	
00623	Pic du Midi	2705	03:24:12			100 36	6 48	
00624	Pic du Midi	2705	03:24:20			102 12	6 30	
00625	Pic du Midi	2705	03:24:33			103 30	5 30	
00626	Pic du Midi	2705	03:24:50			104 30	5 00	
00627	Pic du Midi	2705	03:25:05			106 42	4 00	
00628	Pic du Midi	2705	03:25:26			108 30	3 18	
00629	Pic du Midi	2705	03:25:37			109 24	2 24	
00630	Pic du Midi	2705	03:25:55			110 42	1 30	
00631	Pic du Midi	2705	03:26:05			101 12	1 00	
00632	Pic du Midi	2705	03:26:15			112 30	00 30	
00633	Pic du Midi	2705	04:57:14			292 18	29 06	
00634	Pic du Midi	2705	04:57:36			283 06	34 24	
00635	Pic du Midi	2705	04:57:50			275 36	37 30	
00636	Pic du Midi	2705	04:57:54			275 06	38 00	
00637	Pic du Midi	2705	04:58:05			266 48	42 36	
00638	Pic du Midi	2705	04:58:07			265 48	40 54	
00639	Pic du Midi	2705	04:58:19			256 24	42 42	

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			October 18, 1957 (cont'd.)					
00640	Pic du Midi	2705	04:58:39			240 06	44 18	
00641	Pic du Midi	2705	04:58:48			234 42	40 24	
00642	Pic du Midi	2705	04:58:57			226 12	43 24	
00643	Pic du Midi	2705	04:59:09			216 42	41 48	
00644	Pic du Midi	2705	04:59:19			211 18	40 42	
00645	Pic du Midi	2705	04:59:33			204 48	37 54	
00646	Pic du Midi	2705	04:59:35			202 42	37 06	
00647	Pic du Midi	2705	04:59:59			193 18	32 54	
00648	Pic du Midi	2705	05:00:22			186 48	28 24	
00649	Pic du Midi	2705	05:00:22			187 00	28 36	
00650	Pic du Midi	2705	05:00:33			184 30	26 42	
00651	Pic du Midi	2705	05:00:37			184 06	25 24	
00652	Pic du Midi	2705	05:00:42			182 30	25 06	
00653	Pic du Midi	2705	05:00:55			178 12	21 54	
00654	Pic du Midi	2705	05:00:59			179 24	22 24	
00655	Pic du Midi	2705	05:01:11			177 42	20 42	
00656	Pic du Midi	2705	05:01:21			176 18	19 36	
00657	Pic du Midi	2705	05:01:23			175 24	18 54	
00658	Pic du Midi	2705	05:01:31			175 00	18 00	
00659	Pic du Midi	2705	05:01:36			173 54	17 24	
00660	Pic du Midi	2705	05:01:45			173 42	16 36	
00661	Pic du Midi	2705	05:01:55			173 24	15 24	
00662	Pic du Midi	2705	05:01:57			171 54	15 06	
00663	Pic du Midi	2705	05:02:07			171 30	14 24	
00664	Pic du Midi	2705	05:02:13			170 36	13 24	
00665	Pic du Midi	2705	05:02:20			170 36	13 00	
00666	Pic du Midi	2705	05:02:33			169 06	11 48	
00667	Pic du Midi	2705	05:02:38			168 42	11 24	
00668	Pic du Midi	2705	05:02:46			168 12	11 00	
00669	Pic du Midi	2705	05:02:52			167 48	8 06	
00670	Pic du Midi	2705	05:03:11			167 18	8 12	
00671	Pic du Midi	2705	05:03:16			166 54	8 24	
00672	Pic du Midi	2705	05:03:27			166 18	7 30	
00673	Pic du Midi	2705	05:03:41			165 42	6 24	
00674	Pic du Midi	2705	05:04:26			163 54	3 54	
00675	Pic du Midi	2705	05:05:02			163 00	1 54	
00676	Pic du Midi	2705	05:05:18			162 54	0 54	
00707	Fort Worth	0069	11:22:45	7 47	33 30			
00982	White Sands B	5011	11:21:46			243 03 04	*60 23 06	
00983	White Sands B	5011	11:22:02			250 35 13	*60 48 40	
00984	White Sands B	5011	11:22:18			257 32 53	*61 40 44	
00985	White Sands B	5011	11:22:28			261 38 42	*62 22 12	
00986	White Sands B	5011	11:22:40			266 13 26	*63 25 34	
00987	White Sands B	5011	11:22:54			271 13 08	*64 45 11	
00988	White Sands B	5011	11:23:12			276 43 37	*66 31 30	
00989	White Sands B	5011	11:23:32			281 56 24	*68 38 38	
00990	White Sands B	5011	11:23:34			282 24 54	*68 51 07	
00991	White Sands B	5011	11:23:46			285 11 31	*69 59 38	
00992	White Sands B	5011	11:23:58			287 40 30	*71 11 28	
00993	White Sands B	5011	11:24:10			289 58 01	*72 23 35	
00994	White Sands B	5011	11:24:22			292 05 28	*73 31 05	
00995	White Sands B	5011	11:24:36			294 17 10	*74 49 05	
00996	White Sands B	5011	04:24:48			295 55 16	*75 53 42	
00997	White Sands B	5011	11:25:16			299 23 02	*78 10 37	
			October 19, 1957					
00427	Lick	2005	12:48:01.99	5 34 34.88	10 40 25.8			
00428	Lick	2005	12:48:05.41	5 39 50 66	8 57 52.9			
00429	Lick	2005	12:48:08.14	5 43 44 88	7 38 18.4			
00430	Lick	2005	12:48:16.16	5 55 06 55	3 52 29.1			
00431	Lick	2005	12:48:19.75	5 59 22 94	2 14 57.6			

NOTE: Estimated uncertainties in above Lick Observations are $0^{s}.1$ in time and 10" of arc in each coordinate.

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
00462	Bryan	0065	11:13:20	5 49	42 08			
00463	Bryan	0065	11:14:10	7 03	18 09			
00464	Bryan	0065	11:15:10	7 40	- 0 48			
00465	Bryan	0065	11:16:30	8 25	-22 09			
00533	Kansas City	0036	11:12:43	4 34	- 2 30			

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h	α m	α s	δ °	δ '	δ "	Z °	Z '	Z "	h °	h '	h "	MAG.
October 19, 1957 (cont'd.)																
00567	Yokkaichi	0258	19:07:38							39	48		57	24		
00574	Lincoln	0038	11:12:53	5	42		-14	48								
00704	Bratislava	2701	03:15:19.8	7	04	48	-23	49	00							
00705	Bratislava	2701	03:15:20.9	7	05	38	-24	00	00							
00706	Bratislava	2701	03:15:50.4	7	18	42	-26	44	12							
00708	Fort Worth	0069	11:12:27	6	25		30	30								
00716	Athens Obs.	2706	03:14:02	1	28		46	00								
00717	Athens Obs.	2706	03:14:43	3	00		35	54								
00718	Athens Obs.	2706	03:15:16	3	47		27	42								
00719	Athens Obs.	2706	03:15:45	5	21		5	42								
00720	Athens Obs.	2706	03:16:58	6	32		-15	12								
01003	C. Canaveral D	8017	09:37:54.170							48	38	24	29	52	29	
01004	C. Canaveral D	8017	09:38:00.690							51	38	55	30	13	31	
01005	C. Canaveral D	8017	09:38:58.180							79	52	27	29	30	29	
01006	C. Canaveral D	8017	09:39:08.175							83	54	44	28	47	34	
01007	C. Canaveral D	8017	09:39:14.180							86	16	05	28	17	59	
October 20, 1957																
00562	Conally AFB	0093	11:02:30							180			28	31	30	
00568	Tulsa	0054	11:04:35							180			28	30		
00709	Fort Worth	0069	11:03:03	5	08		28	45								
October 21, 1957																
00437	Musashino	0233	08:43:58							137	42		12	42		2
00439	Nagano	0234	08:48:29							155			9			1
00440	Honjo	0212	08:48:34							144			14			
00445	Philadelphia	0058	23:22:00							0			40			1.5
00572	Weston	6004	23:27:30±1^m	22	55		-29	45								
00721	Athens Obs.	2706	16:45:04	20	40		-32									
October 22, 1957																
00414	Musashino	0233	08:36:38.7							135			21	24		1
00415	Musashino	0233	08:36:50							120	30		22	30		1
00417	Toyahashi	0255	08:31:08							90			16			1
00418	Suwa	0248	08:37:38	1	34		10	30								1
00420	Toyama	0254	08:36:15							90	00		12	30		3
00421	Manazuru	0228	08:36:40							123	30		21			
00422	Manazuru	0228	08:36:52.4							108	30		21	40		
00423	Manazuru	0228	08:37:53.1							75			15			
00424	Takada	0250	08:37:23	23	15		-25	00								1
00425	Higashimatsuyama	0210	08:36:29	22	33		-24									0
00426	Sapporo	0245	08:37:52	22	38		-27	54								3.5
00441	Millbrook	0045	22:54:05	23	03		-17	20								2
00442	Millbrook	0045	22:54:34	0	02		- 7	50								
00443	Dover	0039	22:53:52	00	07		-10									0
00444	Manhattan	0027	00:43:04	22	48	30	-14	14								1
00722	Athens Obs.	2706	16:33:00	21	42		-13	48								
00723	Athens Obs.	2706	16:33:34	23	39		14	42								
00724	Athens Obs.	2706	16:33:44	00	08		21									
00725	Athens Obs.	2706	16:34:09	1	30		27	00								
October 23, 1957																
00448	Kurume Machi	0227	09:24:25							315			17			4
00449	Mitaka	0229	08:23:26							105			22			1
00450	Nagano	0234	08:23:15							112			23			2
00456	Sendai	0246	08:24:49	1	36		22									1
00729	Kurume Machi	0227	08:23:34							98	06		23	54		1

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			October 24, 1957					
00410	Whittier	0012	01:49:02	15 33	77 30			1
00441	Whittier	0012	01:49:07	15 03	77 45			
00412	Whittier	0012	01:49:08	14 55	78 30			
00413	St. Louis	0080	00:13:59	16 34 30	-10 24			
00432	Pasacal	8008	01:48:13.343	16 45 12	7 18			
00433	Pasacal	8008	01:48:23.352	16 44 12	19 00			
00434	Pasacal	8008	01:49:23.392	7 20	85 07			
00435	Pasacal	8008	01:49:27.395	6 33	82 50			
00436	Pasacal	8008	01:49:31.396	6 08	80 36			
00453	San Antonio	0089	00:12:12	18 45	28 34			2
00458	Hofu	0213	09:44:43			314 30	9 12	4
			October 25, 1957					
00452	Whittier	0012	01:30:36	15 46	21 30			
01143	Skalnate Pleso	2711	17:25:46			272	19	
			October 26, 1957					
01144	Skalnate Pleso	2711	17:09:26	11 01 06	62 00			
			October 27, 1957					
01145	Skalnate Pleso	2711	16:49:49	13 45 48	49 48			
			October 28, 1957					
00597	Woomera	3601	18:46:26			118 59 34	33 11 40	
00740	Armagh B	8036	18:04:48.2			111 36	47 06	
00741	Armagh B	8036	18:04:43.6			118 30	48 00	
01111	Skalnate Pleso	2711	16:29:24.4	13 54 12	50 40			
01012	Edinburgh, Scot.	2653	18:05:40			90 45	*44 20	
01011	Edinburgh, Scot.	2653	18:04:58			171 55	*49 20	
00861	Perth	0601	19:57:05			46 15	*51 17	
00862	Perth	0601	19:58:11			91 05	*51 01	
00863	Perth	0601	19:59:25			120 04	*36 57	
01112	Skalnate Pleso	2711	16:09:35	5 32	46			
			October 31, 1957					
00614	Boyden Obs.	2400	01:54:42	12 30 00	-67 48			
00742	Armagh	8036	18:30:37.8			279 19	11 15	
00743	Armagh	8036	18:31:57.6			340 24	19 18	
00864	Perth	0601	19:09:09			63 58	*37 24	
00865	Perth	0601	19:09:40			77 51	*37 50	
00866	Perth	0601	19:10:18.5			93 36	*34 43	
00867	Perth	0601	19:15:51			140 13	* 2 48	
01063	Mt. Stomolo	2600	17:36:21	6 43	-16 36			
01064	Mt. Stromlo	2600	17:37:18	8 02	-39 54			
01065	Mt. Stromlo	2600	17:39:47	12 36	-58 06			
			November 1, 1957					
00599	Jodrell, Radar	4650	18:06:35			180	12 18	
00601	Woomera	3601	18:43:16.6			279 01 00	29 51 29	
00602	Woomera	3601	18:44:52.3			242 57 28	38 07 12	
00727	Dunsink	2652	18:04:47			310 12	17 54	
00728	Dunsink	2652	18:05:47			349 30	17 06	
00744	Armagh, B	8036	18:05:46.7			350 12	21 30	
00745	Armagh, B	8036	18:06:28.4			11 06	16 18	
01066	Mt. Stromlo	2600	17:09:55	6 59	- 5 18			
01067	Mt. Stromlo	2600	17:10:41	7 55	-22 42			
01068	Mt. Stromlo	2600	17:11:42	9 29	-40 12			
			November 2, 1957					
01069	Mt. Stromlo	2600	16:43:15	8 27	-18 00			
01070	Mt. Stromlo	2600	16:45:15	10 13	-41 54			
01071	Mt. Stromlo	2600	18:20:04	0 24	-42 36			

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			November 3, 1957					
00600	Jodrell, Radar	4650	18:45:55			164	8	
01013	Edinburgh, Scot.	2653	17:10:27			30 56	*14 56	
			November 4, 1958					
01014	Edinburgh, Scot.	2653	18:14:58			348 51	*13 56	
			November 6, 1958					
01015	Edinburgh, Scot.	2653	17:07:58			335 35	*17 57	
			November 7, 1957					
01072	Mt. Stromlo	2600	17:15:18	21 54	-55 12			
			November 9, 1957					
01073	Mt. Stromlo	2600	15:58:16	20 45	-75 18			
01074	Mt. Stromlo	2600	16:00:27	15 41	-64 42			
			November 18, 1957					
00755	Jodrell, Radar	4650	19:04:17			00	90	
01113	Skalnate Pleso	2711	15:53:00	6 11 42	42 42	(1855 position)		
			November 19, 1957					
00756	Jodrell, Radar	4650	11:44:59			00	90	
00778	Armagh	2651	17:56:44.1			346 06	19 54	
00779	Armagh	2651	17:56:58.4			351 30	22 36	
01114	Skalnate Pleso	2711	16:26:32	7 59 18	56 37	(1855 position)		
			November 21, 1957					
00780	Armagh	2651	18:55:03.5			283 24	17 28	
00781	Armagh	2651	18:55:48.1			264 54	23 42	
00782	Armagh	2651	18:56:35.3			234 36	28 54	
01115	Skalnate Pleso	2711	15:51:10	8 17 00	54 48			
01116	Skalnate Pleso	2711	15:22:17	5 10 00	46 36			
			November 22, 1957					
00809	Armagh	2651	17:45:58.0			320 48	27 18	
00810	Armagh	2651	17:46:25.1			323 42	40 12	
01096	Dunsink B	2654	17:46:38.5	13 44	67 30			
01097	Dunsink B	2654	17:46:45.5	14 00	72 15			
01098	Dunsink B	2654	17:48:00	0 24 30	30 36			
01099	Dunsink B	2654	17:48:17	0 30	18 42			
01100	Dunsink	2652	17:48:45	0 42	1 36			
01101	Dunsink	2652	19:20:50	18 57	- 5 18			
01117	Skalnate Pleso	2711	16:16:15	11 32 36	69 36			
01118	Skalnate Pleso	2711	16:18:17	1 28 42	15 48			
			November 23, 1957					
00785	Sydney	0602	11:00:19	8 30	-62 30			
01017	Pic du Midi	2705	18:08:51			323 00	11 45	
01018	Pic du Midi	2705	18:09:47			319 45	21 33	
01019	Pic du Midi	2705	18:10:29			314 59	35 15	
01020	Pic du Midi	2705	18:11:12			291 35	62 27	
01021	Pic du Midi	2705	18:12:16			167 29	45 15	
01022	Pic du Midi	2705	18:12:36			162 00	36 09	
01093	Bratislava-Koliba	2701	16:39:39.8	23 39 48	- 1 46 42			
01102	Dunsink	2652	18:07:34	16 25	29 24			
01103	Dunsink	2652	18:08:29	19 07	16 36			
01104	Dunsink	2652	18:09:19	21 16	- 3 06			
01105	Dunsink	2652	18:11:59	23 38	-26 54			
01119	Skalnate Pleso	2711	16:39:16	21 23 18	1 00			

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
	November 24, 1957							
00746	Columbus	0051	00:16:40	17 54	19			+3
00747	Columbus	0051	00:16:43	18 05	19			
00748	Columbus	0051	00:16:48	18 08	16			
00749	Portland	0076	01:46:13	1 22 30	60			
00750	Boise	0018	01:46:25			270	90	
00751	Phoenix	0002	01:48:27	13 15	68			
00752	Phoenix	0002	01:48:57	17 00	85			
00753	Phoenix	0002	01:49:12	0 15	61			
00754	Oakland	0006	01:48:56	3 16	25 30			
00760	Arlington	0071	23:02:16	20 35 30	36 25			
00761	Arlington	0071	23:02:39	23 53 18	14 45			
00762	Bryn Athyn	0055	23:01:36	19 35	44			
00763	Bryn Athyn	0055	23:02:39	22 24	- 1			
00764	Springfield, Va.	8509	23:02:21	23 40	28 30			
00766	Silver Spring	0032	23:02:43.5	00 36	30 42			
00773	Sacramento B	8500	01:45:23.6	10 12 18	65 14 24			
00774	Sacramento B	8500	01:47:19.1	3 42 06	47 27 36			
00775	Sacramento B	8500	01:47:19.9	3 39 54	47 33 36			
00776	North Canton	0053	23:01:31	1 12	35 30			
00786	Portland	0076	01:45:53	1 23 03	60 01 04	(1958.0 position)		
00787	Perth	0601	14:18:37			246 43 00	7 20 00	
00788	Perth	0601	14:19:00			241 16 00	8 20 00	
00789	Washington	6001	23:02:48	23 20	28 00			
00790	Washington	6001	23:03:47	0 50	17 00			
00791	Utrecht B	8002	16:54:23	19 11	42 12			
00792	Utrecht B	8002	16:56:40	20 53	30 36			
00793	Utrecht A	2707	16:54:30	20 09	37 30			
00827	Cambridge	0099	23:03:13			197	23	
00828	Cambridge	0099	23:04:23.4			176	12	
00829	Cambridge	0099	23:04:32.8			174 30	11	
00960	Mitaka	0229	09:24:22	18 35	21 30			
00961	Yokkaichi	0258	09:24:52	20 37	15 00			
00962	Hiroshima	0211	09:23:33	22 26	77 00			
00963	Kanayamachi	0220	09:24:41	20 55	47 00			
00964	Takada	0250	09:25:06	20 41	- 10 00			
00965	Sendai	0246	09:25:04	20 10	- 14 00			
00966	Miyazaki	0230	09:24:56	2 24	50 00			
00971	Musashino	0233	09:24:32.7			270 00	32 00	
00972	Niigata	0238	09:24:52			240 00	30 00	
00973	Hofu	0213	09:23:25			0	34 00	
00974	Sendai	0246	09:25:19			208 48	23 18	
00978	Columbus	0051	23:01:49	2 12	22			
01023	Pic du Midi	2705	18:26:54			298 47	10 15	
01024	Pic du Midi	2705	18:27:35			288 53	14 39	
01025	Pic du Midi	2705	18:28:13			275 23	18 57	
01026	Pic du Midi	2705	18:28:54			254 52	22 33	
01027	Pic du Midi	2705	18:29:43			228 35	21 39	
01028	Pic du Midi	2705	18:30:12			215 16	19 39	
01029	Pic du Midi	2705	18:30:43			204 17	16 27	
01030	Pic du Midi	2705	18:31:12			196 49	13 27	
01031	Pic du Midi	2705	18:31:43			190 26	10 45	
01032	Pic du Midi	2705	18:32:15			185 29	8 15	
01033	Pic du Midi	2705	18:32:40			182 41	6 33	
01034	Pic du Midi	2705	18:32:53			181 26	5 45	
01094	Bratislava-Koliba	2701	16:57:48.6	21 14 12	-20 42 12			
	November 25, 1957							
00757	Sacramento A	0007	02:03:50	20 40 36	50 10 12			
00758	Sacramento A	0007	02:04:36.3	22 51 42	8 53			
00759	Sacramento A	0007	02:05:19.2	23 40 48	-14 48			
00765	Milwaukee B	0198	00:36:28	19 30	-18			
00767	Lemont	0022	00:34:09	19 44	-17 30			
00768	Oakland	0006	02:03:15	22 19	58 05			
00769	Oakland	0006	02:03:54.4	22 10 07	62			
00770	Oakland	0006	02:04:27.8	23 35	28 25			
00771	Whittier	0012	02:05:54	22 48	8 18			
00772	Walnut Creek	0011	02:04:17	22 32	38			
00777	Tucson	0003	00:44:42			314	36	
00783	North Canton	0053	00:35:24	19 32	-21 48			
00784	North Canton	0053	00:21:17	19 27	-22 24			

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			November 25, 1957 (cont'd)					
00794	College	6450	01:57:20			180	22	
00798	Sunnyvale B	8508	02:04:15	0 30	62			
00802	Bristol	0097	23:15:23			270	87	
00806	Greensboro A	0049	23:15:10			180	46	
00812	Danville	0021	23:14:10			90	49	
00820	Springfield, Va.	8509	23:15:12	19 15	-1			
00824	St. Louis	0080	23:13:41	2 56	49 18			
00825	Rantoul	0092	23:14:06.5	2 05	44 48			
00826	Terre Haute	0025	23:14:26			90	43 28	
00831	Sydney	0602	09:59:22	4 03	-13			
00832	Washington, D. C.	6001	23:15:10	17 13	25 06			
00833	Washington, D. C.	6001	23:16:35	20 15	-13 00			
00834	C. Canaveral F	8020	23:17:51			101 44 49	*39 48 04	
00835	C. Canaveral F	8020	23:17:55			105 46 12	*38 28 41	
00836	C. Canaveral F	8020	23:18:02			110 11 56	*36 09 14	
00837	C. Canaveral F	8020	23:18:07			113 01 34	*34 31 34	
00838	C. Canaveral F	8020	23:18:10			114 34 26	*33 34 05	
00923	Woomera	3601	11:30:32.8			192 46 44	37 48 52	
00967	Mitaka	0229	08:07:47	3 10	28 00			
00958	Asahigawa	0201	08:05:34	20 52	48 00			
00969	Sendai	0246	08:09:06	1 34	-13 00			
00970	Takada	0250	09:39:03	17 38	14 00			
00975	Kurumemachi	0227	08:06:59			45 00	24 00	
00977	Akron-Canton	0053	00:35:24	19 32	-21 48			
01035	Pic du Midi	2705	17:09:29			14 27	35 38	
01036	Pic du Midi	2705	17:10:03			47 45	43 32	
01037	Pic du Midi	2705	17:10:28			77 43	41 26	
01038	Pic du Midi	2705	17:11:03			104 27	31 32	
01039	Pic du Midi	2705	17:11:29			115 15	24 14	
01040	Pic du Midi	2705	17:11:55			121 33	19 08	
01041	Pic du Midi	2705	17:12:28			126 30	14 08	
01042	Pic du Midi	2705	17:12:54			129 28	10 38	
01043	Pic du Midi	2705	17:13:25			131 54	7 56	
01044	Pic du Midi	2705	17:13:48			133 15	5 44	
01045	Pic du Midi	2705	17:14:17			134 41	3 38	
01075	Canberra	7000	09:59:59.7	5 26	-20 48			
01076	Canberra	7000	10:00:50	6 18	-30 00			
			November 26, 1957					
00795	Walnut Creek	0011	02:17:25.5	20 22	-17 30			
00796	College	6450	02:10:12			180	12	
00797	Sunnyvale	0078	02:11:30	22 22 27	37 22 48			
00799	Waco	0093	00:47:44	21 05	9 18			
00800	Los Alamos	0043	00:46:16	0 30	20			
00801	Los Angeles	0100	02:18:59	19 04	- 5			
00803	Fort Worth	0069	00:47:54	20 12	-17			
00804	Big Spring	0083	00:32:43			59	70	
00805	Yankton	0061	00:44:29	17 48	6			
00807	Whittier	0012	02:17:24	18 19 00	10 18			
00808	Santa Barbara	0009	02:20:18			180	14	
00811	Kansas City	0036	00:45:07	17 25	10			
00813	Bryan	0065	00:49:42	21 42 00	-33 32			
00814	Bryan	0065	00:47:59.5	19 34 00	7 24			
00815	Oakland	0006	02:16:53	19 18 00	- 1 15			
00816	Oakland	0006	02:17:22.5	20 22 00	-17 30			
00817	San Angelo	0105	00:42:29	20 40 00	31 27 19			
00818	San Angelo	0105	00:48:50	0 05 00	-29 30			
00819	Tulsa	0054	00:46:14	18 06	9 30			
00821	Sacramento A	0007	02:15:46.2	17 32 34	16 32 24			
00822	Sacramento A	0007	02:17:11.7	20 35 10	-25 09 36			
00823	Manhattan	0027	00:46:13	18 57 32	- 8 02			
00830	Organ Pass	9001	00:46:27	2 06 00	42 18			
00839	Peoria	0023	23:22:28			270	63 30	
00840	Redbank	0040	21:50:16			43	33 30	
00844	Sylacauga B	8506	23:24:31			90	81 33 54	
00845	Rantoul	0092	23:21:32.5	17 55	40 18			
00848	Arlington	0071	23:35:05	17 52 30	12 23			
00849	St. Louis	0080	23:22:03	22 13	37 24			

Table 1.--Processed optical observations of Satellite 1957 α1 (concluded)

November 26, 1957 (cont'd)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
00850	Terre Haute	0025	23:22:55			180	42 28	
00852	Wilmore	0029	23:23:25			214 06	34 53	
00853	Harrisonburg	0072	23:15:52			270	51	
00854	Roanoke	0073	23:22:07	19 28	24			
00855	Evansville	0094	23:22:16			270	62	
00856	Cleveland	0052	23:05:20			270	22	
00859	Organ Pass	9001	00:46:36:277	1 51 48	41 30	Epoch 1855		
00860	San Antonio	0089	00:47:55	20 12	25 30			
00881	Sydney	0602	10:10:01	20 15	-48			
00883	Adelaide	0600	11:42:57	6 20	-66 30			
00887	Amarillo AFB	0064	00:46:07.8			270	61 30	
00888	C. Canaveral G	8039	23:29:44			213 29 28	*47 49 37	
00889	C. Canaveral G	8039	23:29:49			208 17 28	*45 56 38	
00890	C. Canaveral G	8039	23:29:56			201 46 12	*42 59 17	
00891	C. Canaveral G	8039	23:30:04			195 44 49	*39 34 08	
00892	C. Canaveral G	8039	23:30:19			187 30 40	*33 35 24	
00924	Big Spring	0083	00:47:07			270	85	
00925	Kumamoto	0225	09:52:05	19 34	-24			
00926	Kagoshima	0218	09:52:18	19 35	-23			
00956	Near Adelaide	8507	11:43:18			191 06 40	14 32 20	
00976	Asahikawa	0201	08:17:57	20 14	-16 00			
00979	U. of Ill.	2014	23:23:18.0			169 46	24 29	
01001	Albuquerque	0041	00:45:46	0 43 21	57 33 30 (1950.0 position)			
01046	Pic du Midi	2705	17:18:11			315 42	24 18	
01047	Pic du Midi	2705	17:18:49			308 52	36 48	
01048	Pic du Midi	2705	17:19:44			217 20	64 48	
01049	Pic du Midi	2705	17:20:20			171 53	41 48	
01050	Pic du Midi	2705	17:20:49			163 20	28 48	
01051	Pic du Midi	2705	17:21:12			159 44	22 18	
01052	Pic du Midi	2705	17:21:41			157 07	16 18	
01053	Pic du Midi	2705	17:22:10			155 41	12 18	
01054	Pic du Midi	2705	17:22:36			155 03	9 18	
01055	Pic du Midi	2705	17:23:13			154 09	6 00	
01062	College, Alaska	6450	02:10:10	20 15 43	-12 40 36			
01077	Mt. Stromlo	2600	10:09:19	3 13	- 9 00			
01078	Mt. Stromlo	2600	10:09:29	3 45	-23 24			
01079	Mt. Stromlo	2600	10:09:37	4 16	-33 54			
01095	Bratislava	2701	15:47:14.2	18 57 40	50 43			

November 27, 1957

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
00596	Mt. Stromlo	2600	17:29:38.2	10 10 30	15			
00841	Sacramento A	0007	02:25:02.2	19 21 12	-25 52 48			
00842	Waco	0093	00:51:42	00 42	57 36			
00843	Lawton	0110	00:55:02			237 09 00	14 27 00	
00846	Manhattan	0027	00:53:06	17 31	1 57			
00851	Walnut Creek	0011	02:22:43.5	16 56	10 42			
00857	Los Alamos	0043	00:53:51	19 53	- 3			
00858	Phoenix	0002	00:53:16			88	40 30	
00868	Organ Pass	9001	00:53:56.043	18 55	37 50			
00869	Organ Pass	9001	00:54:20.041	20 13	19 24			
00872	Univ. of Illinois	2014	23:23:43.2			256 16	*24 04	
00873	Univ. of Illinois	2014	23:25:25.0			198 27	*16 29	
00874	Cambridge	0099	21:53:06.8			244	44	
00875	Cambridge	0099	21:53:49.8			203 30	36	
00876	Cambridge	0099	21:54:13.6			176 30	28	
00877	Los Alamos	0043	22:56:12	19 04	-21 30			
00878	Sylacauga	0001	23:25:32			270 00 00	49 09 14	
00884	Woomera	3601	10:11:50.4			26 21 46	25 34 02	
00885	Woomera	3601	10:13:55.3			105 38 59	26 17 01	
00886	Woomera	3601	10:14:33.7			119 38 56	19 32 54	
00899	Terre Haute	0025	23:23:36.2			270 00	24 00	
00900	Jodrell, Radar	4650	14:15:22	Slant Range:	1150 km	17	9	
00902	Milwaukee	0074	23:23:20	17 35	12			
00903	Peoria	0023	23:24:30			270	24	
00904	Greensboro A	0049	22:58:10			0	63	
00905	Red Bank	0040	21:53:56			38 30	77	
00906	New Haven	0087	21:52:10			305	50	
00907	Bryn Athyn	0055	21:58:38			60	53	
00908	New Haven	0087	21:52:45			280	75	

Table 1.--Processed optical observations of Satellite 1957 α1 (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			November 27, 1957 (cont'd)					
00927	Mitaka	0229	08:23:52	17 05	31			
00928	Mitaka	0229	08:24:05	17 37	27			
00929	Mitaka	0229	08:24:08	17 50	26			
00930	Toyohashi	0255	08:25:26	22 15	-13			
00931	Hiroshima	0211	08:23:23	9 38	83			
00932	Kanayamachi	0220	08:24:19	21 39	63			
00933	Takada	0250	08:25:54	22 24	-36			
00934	Kyoto	0259	08:24:26	21 52	33			
00935	Higashimatsuyama	0210	08:25:06	20 17	-12			
00936	Manazuru	0228	08:24:30	18 47	22			
00937	Manazuru	0228	08:24:54	19 45	5			
00938	Manazuru	0228	08:26:11	22 05	-32			
00939	Sendai	0246	08:24:00			254 42	25 36	
00940	Sendai	0246	08:25:21			205 18	20	
00941	Musashino	0233	08:24:17			270	38	
00942	Musashino	0233	08:24:57.4			225	41	
00943	Nagoya	0236	08:25:22			180	41	
00944	Takamatsu	0251	08:23:57			6 30	45 48	
00945	Shizuoka	0247	08:24:29			270	43	
00946	Honjo	0212	08:25:50			196 30	31 30	
00947	Otsu	0269	08:25:00			162	40	
00948	Himeji	0262	08:25:24			141 06	36 06	
00949	Mizusawa	0267	08:23:31			267 12	21 36	
00950	Mizusawa	0267	08:25:26			202 06	16 24	
00951	Mizusawa	0267	08:25:56			194 12	13	
00952	Mizusawa	0267	08:26:11			190 36	11 18	
00957	Adelaide	8507	10:12:07			10 26 00	17 45 40	
00959	Adelaide	8507	10:14:50			99 13 00	27 29 50	
01080	Pic du Midi	2705	17:22:53			261 26	25 18	
01081	Pic du Midi	2705	17:24:18			202 56	20 48	
01082	Pic du Midi	2705	17:24:30			196 11	18 18	
01083	Pic du Midi	2705	17:25:52			177 44	8 18	
			November 28, 1957					
00870	Adelaide	0600	10:13:09			60 15	62	
00871	Adelaide	0600	10:15:00	6 22	-52 40			
00879	Sacramento A	0007	00:53:38.1	00 58 13	24 24			
00880	San Angelo	0105	00:59:00			205 56 30	6 13 45	
00894	Albuquerque	0041	00:57:39	19 30 00	20 30			
00895	Phoenix	0002	00:55:03			270	57	
00896	Tucson	0003	00:56:39			1	33	
00897	New Orleans	0030	00:18:02			270	61	
00898	El Paso	0104	00:41:15			0	48	
00909	Mitaka	0229	08:25:38	19 55	-32			
00910	Suwa	0248	08:23:55	17 42	4			
00911	Shizuoka	0247	08:23:46	17 15	12			
00912	Manazuru	0228	08:25:01	18 59	-19			
00913	Manazuru	0228	08:25:10	19 12	-21			
00914	Manazuru	0228	08:25:24	19 38	-25			
00915	Manazuru	0228	08:25:30	19 44	-27			
00916	Higashimatsuyama	0210	08:25:20	19 30	-28			
00917	Himeji	0262	08:23:54	19 10	25			
00918	Musashino	0233	08:23:42			270 00	17 30	
00919	Musashino	0233	08:25:05			225	20	
00920	Konko	0224	08:23:56			270	55	
00921	Kiryu	0223	08:23:54			270	23	
00922	Mizukaido	0231	08:23:58			270 00	20 30	
00954	Organ Pass	9001	00:56:41.946	19 22 48	-21 26	(Epoch 1875)		
00955	Organ Pass	9001	00:55:57 969	18 12 18	- 0 49	(Epoch 1855)		
01084	Pic du Midi	2705	17:18:55			289 16	9 00	
01085	Pic du Midi	2705	17:19:08			284 51	10 00	
01086	Pic du Midi	2705	17:19:20			281 15	11 12	
01087	Pic du Midi	2705	17:19:34			276 13	12 18	
01088	Pic du Midi	2705	17:20:50			239 35	16 00	
01089	Pic du Midi	2705	17:21:07			231 29	15 30	
01090	Pic du Midi	2705	17:21:26			222 34	14 42	
01091	Pic du Midi	2705	17:22:44			296 01	8 12	
01092	Pic du Midi	2705	17:23:02			193 19	2 00	

Table 1.--Processed optical observations of Satellite 1957 α1 (concluded)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
				November 29, 1957				
00901	Jodrell, Radar	4650	12:35:30	Slant Range:	1300 km	4	3	
00953	Adelaide	0600	10:06:55			155 30	30 30	
01060	Pic du Midi	2705	17:12:24			211 46	7 48	
01061	Mt. Stromlo	2600	10:07:20	18 31	-35 54			
				November 30, 1957				
00998	Jodrell, Radar	4650	09:11:26	Slant Range:	540 km ± 30	321	19	
00999	Macclesfield, Radar	4650	13:46:57	Slant Range:	900 km ± 50	29	9	
01000	Macclesfield, Radar	4650	15:17:36	Slant Range:	240 km	180	40	

Table 2.--Processed optical observations of Satellites 1957 α2 and α3

	OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ')	h (° ' ")	MAG.
				October 9, 1957					
α2	00149	Sydney MW	0602	09:39:31	15 18	-44 48			Faint
				October 14, 1957					
α2?	00119	Sendai	0246	19:56:43	13 11	55			4
α2	00127	State College	0060	10:18:12	12 17	57			
				October 15, 1957					
α2?	00103	U.S. Naval Obs.	2011	10:20:40			111	41	
α3?	00105	Takada	0250	19:43:45	10 10	-16			
				October 16, 1957					
	00101	Sacramento A	0007	13:27:27	7 25 30	0 54 36			6
				October 17, 1957					
α3	00104	Westover	3011	09:55:18			308 13	35 40	
α2	00114	Sacramento A	0007	13:24:48	7 07 48	-21 18			6
				October 18, 1957					
α2	00112	Sacramento A	0007	13:21:33.6	6 40 30	-31			6.5
α2	00116	Milwaukee A	0074	10:04:53.5	9 47	54			5
α3	00124	Kurume Machi	0227	19:28:41.9			270	81 30	
α2	00125	Hiroshima	0211	19:40:23	6 18	81			
				October 19, 1957					
α2?	00117	Greensboro	0049	09:58:00	8 40	79			6
				October 20, 1957					
α3	00118	Waco (Conally AFB)	0093	11:24:27			180	28 31 30	6
				October 22, 1957					
α2?	00106	Musashino	0233	09:23:51.7			315	22 30	7
α2?	00107	Kurume Machi	0227	09:24:21.8	14 07	55 54			6
α2	00120	Las Cruces	0042	01:20:56			122	70	
α3	00121	Bryn Athyn	0055	23:29:48	18 30	45			
α3	00122	Bryn Athyn	0055	23:30:09			0	71	
α3	00123	Bryn Athyn	0055	23:30:53	1 30	58			
				October 23, 1957					
α2	00109	Kurume Machi	0227	09:13:15			315	21	5
				October 24, 1957					
α3	00102	San Antonio	0089	00:57:00	16 45	10 50			
α2	00111	Ashigawa	0201	09:07:02			275	26	4
α2	00130	Cambridge	0099	22:48:07.2			399	85 30	
α2	00131	Cambridge	0099	22:48:11			312	88	
				October 25, 1957					
α2	00144	Skalnate Pleso	2711	16:57:03			0	90	
				October 26, 1957					
α2	00145	Skalnate Pleso	2711	16:47:33.6	17 37 18	55 17			
α2	00146	Skalnate Pleso	2711	16:47:53.4			0	52 42	

Table 2.--Processed optical observations of Satellites 1957 α2 and α3 (concluded)

	OBS. NO.	STATION	STA. NO.	U.T.	α h	α m	α s	δ °	δ '	δ "	Z °	Z '	Z "	h °	h '	h "	MAG.
November 26, 1957																	
α2	00129	Los Alamos	0043	01:25:01	21	14		10	48								
α2?	00132	Sacramento A	0007	03:05:05.6	21	15	28	-32	25	12							
November 27, 1957																	
α2?	00143	Amarillo AFB	3010	00:53:06.6							265			65			4
November 29, 1957																	
α2	00138	Sac Peak	2043	01:14:59	19	09		-17	36								
α2	00139	Organ Pass	9001	01:14:13	18	25	36	15									
α2	00140	Organ Pass	9001	01:14:53	19	24	48	- 6	48								
α2	00147	Skalnate Pleso	2711	16:16:18	10	23	00	66	20								
α2	00148	Skalnate Pleso	2711	16:17:38	6	04	18	49	08								

Table 3.--Processed optical observations of Satellite 1957 Beta

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			November 4, 1957					
00002	Quito, B	5801	09:29	10 50	12			2
00011	Mitaka	0229	20:00:11	13 12	11 30			2
00012	Kiryu	0223	19:58:15			160	19 06	2
00178	Perth	0601	19:44:01			25 37	25 02	
00179	Perth	0601	19:44:31			25 38	20 55	
00497	Canberra	7000	17:56:48.5	3 56	-13 36			
00498	Canberra	7000	17:56:55.5	4 47	+ 6 54			
00499	Canberra	7000	17:59:03.5	5 35	21 06			
			November 5, 1957					
00001	Navy	8010	05:04:38			200	25	
00003	Vienna	2700	04:41:09.6			121 30	16 42	
00004	Vienna	2700	04:42:05.8			96 06	12 54	
00005	Mt. Vaca	8011	13:16:59+1^s	12 39	- 1 00			1
00010	Los Altos	0005	13:15:58	11 20	-20			1 to 5
00013	Navy	8012	09:48			170	45	Bright
00014	Quito, B	5801	09:42:57	11 32	71			
00017	Mitaka	0229	20:10:44	07 55	- 4			1
00018	Kurume Machi	0227	20:09:47			90 00	70	4
00019	Kurume Machi	0227	20:11:15.9			90 00	74 18	-1
00020	Suwa	0248	20:11:04.5	10 32 00	11 00			0
00021	Kanaya Machi	0220	20:10:40	11 55	13			2
00022	Ichinomiya	0215	20:10:35	11 30	17			1
00023	Yokkaichi	0258	20:10:48	11 32	16			2
00024	Shizuoka	0247	20:10:49			45 00	66 00	0
00025	Nagoya	0236	20:11:04			135 00	46 00	1
00026	Nagoya	0236	20:10:42	10 04	3			1
00027	Sendai	0246	20:10:19	10 03	22			4
00028	Sendai	0246	20:11:23			189 30	45 42	1
00029	Sendai	0246	20:12:37			42 48	31 12	2
00030	Sendai	0246	21:13:05			38 00	19 24	3
00031	Sendai	0246	20:13:51			34 36	9 30	4
00032	Fukuoka I	0205	20:10:30			90 00	19 30	1
00033	Manazuru	0228	20:11:39	13 10	58			2
00034	Manazuru	0228	20:11:02	9 10	37			0
00035	Tohoku	0252	20:13:37	13 40	53			1
00037	Hofu	0213	20:11:16			87 18	23 30	2
00038	Kiryu	0223	20:10:41	08 24	- 5			1
00039	Chunichi	0204	20:10:48	11 35	8			0
00040	Kumamoto	0225	20:11:00	13 42	20			3
00041	Mitaka	0229	20:10:22.4	07 17	-18 30			
00042	Mitaka	0229	20:10:29.0	07 27	-13 48			
00043	Mitaka	0229	20:10:35	08 15	16 30			
00044	Mitaka	0229	20:11:09.9	09 12	27 30			
00045	Mitaka	0229	20:11:19.4	10 02	41 12			
00061	Sendai	0246	20:11:32	08 28	0			2
00102	Perth	0601	19:50:13			237 40	*37 29	
00103	Perth	0601	19:50:30			239 01	*39 57	
00104	Perth	0601	19:51:49			270 32	*51 54	
00105	Perth	0601	19:53:30			330 19	*46 28	
00106	Perth	0601	19:54:33.5			347 45	*33 17	
00107	Perth	0601	19:55:02.6			352 48	*27 39	
00161	Perth	0601	19:57:36			06 56	*07 26	
00169	Bratislava	2701	04:41:56.8	14 01 07	11 00 30			
00500	Mt. Stromlo	2600	16:22:20.6	09 06	-43 12			
00501	Mt. Stromlo	2600	16:23:21.6	09 08	-25 30			
00502	Mt. Stromlo	2600	16:24:19.6	09 21	- 9 18			
00503	Mt. Stromlo	2600	18:07:59.5	03 13	- 9 00			
00504	Mt. Stromlo	2600	18:09:46.5	03 56	12 36			
00505	Mt. Stromlo	2600	18:10:17.5	04 07	18 30			
00506	Mt. Stromlo	2600	18:10:30.3	04 18	21 42			
			November 6, 1957					
00057	China Lake	8013	13:27:18.05			270 10	34 35	1.1
00116	Perth	0601	20:04:11			303 23	*29 08	
00114	Perth	0601	20:02:16			267 12	*29 57	
00117	Perth	0601	20:05:16			321 40	*23 48	
00115	Perth	0601	20:02:28			269 13	*30 15	
00006	Lemont, Ill.	0022	11:46:18			0	32	-2 0
00008	Bryn Athyn, Pa.	0055	10:01:45	14 10	19			
00009	St. Paul, Minn.	0035	11:45:59	12 02	16 30			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			November 6, 1957 (cont'd.)					
00015	Yerkes	2042	11:46:19.0	06 12	11			
00046	Kagoshima	0218	20:21:36	12 40	60			0
00047	Kumamoto	0225	20:21:37	12 34	50 18			1
00048	Kochi	0264	20:22:28	16 44	63 00			0
00049	Kanaya Machi	0220	20:33:27			355 00	8 00	0
00051	Chunichi	0204	20:33:52			356 36	8 00	2
00054	Yerkes	2042	11:46:19.0	06 13 27	10 44			
00055	Ondrejov	2702	04:53:44.7			302 36	25 42	
00056	Princeton	2025	10:01:50	14 15	19			0 to invisible
00058	Sydney Obs.	2601	16:37:53.4	08 26	24 12			
00059	Sydney	0602	16:34:36.5	07 07	-30 12			
00060	Sydney	0602	16:36:25	08 30	-09 30			
00062	Musashino	0233	20:22:04.7			294 48	26 54	0
00063	Musashino	0233	20:22:25.4			314 54	27 00	0
00064	Kurume Machi	0227	20:21:37.9			270 00	22 42	0
00065	Niigata	0238	20:22:16			270 00	35 42	0
00066	Niigata	0238	20:22:40			300 00	39 42	0
00067	Kanaya Machi	0220	20:21:26	05 14	46			0
00068	Kanaya Machi	0220	20:22:07	20 30	86			1
00069	Inchinomiya	0215	20:21:31	04 13	23			
00070	Hashimoto	0209	20:22:17	20 32	85			0
00071	Hashimoto	0209	20:21:24	04 48	45			0
00072	Yokkaichi	0258	20:23:39	23 27	79			0
00073	Kashiwabara	0222	20:22:28			00	21	1
00074	Asahigawa	0201	20:24:17	05 00	44			1
00075	Shizuoka	0247	20:21:33	04 02	25			1
00076	Isahaya	0217	20:20:52	11 10	22			1
00077	Nagoya	0236	20:22:47			00	20 00	0
00078	Sendai	0246	20:22:37	03 48	29			0
00079	Nagasaki I	0235	20:22:36	13 50	47			0
00080	Manazuru	0228	20:22:36			333 00	22 48	0
00081	Manazuru	0228	20:22:44			337 00	21 18	1
00082	Tokushima	0253	20:21:52			00 00	19	1
00083	Mizukaido	0231	20:22:16			316	24 30	2
00084	Fuchu	0214	20:22:06	11 10	65			0
00085	Oita	0239	20:21:24			43 00	31 48	
00086	Oita	0239	20:22:03			40 36	24 00	
00087	Kure	0226	20:21:36	11 10	56			
00088	Saga	0244	20:16:46	13 50	48			0
00089	Osaka-Yomiuri	0240	20:20:44	20 42	88			1
00090	Kiryu	0223	20:23:30	20 38	78			0
00091	Kanagawa	0219	20:21:58			270 00	45 00	1
00092	Akita	0200	20:23:06	04 14	50			0
00093	Honjo	0212	20:21:50	04 18	14			1
00094	Otaru	0243	20:22:45	06 07	-20			1
00095	Kyoto	0259	20:22:18	22 22	88			0
00096	Osaka	0240	20:23:16			180	32 12	0
00097	Sapporo	0245	20:24:49	06 03	44			0
00098	Sapporo	0245	20:22:48	05 53	-05			0
00100	Sacramento A	0007	13:28:21.8	12 36 39	41 08			
00108	Perth	0601	18:17:47.3			109 02	*32 59	
00109	Perth	0601	18:18:02			103 27	*31 12	
00110	Perth	0601	18:18:25.5			96 45	*29 37	
00111	Perth	0601	18:20:34.6			71 53	*15 54	
00112	Perth	0601	18:20:52			69 29	*14 21	
00113	Perth	0601	20:01:16			253 20	*25 50	
00125	St. Louis	0080	11:44:38	4 52	32 42			-2
00126	Whittier	0012	13:26:54	4 17	20 12			0
00127	Whittier	0012	13:27:26	3 22	48 48			
00128	Whittier	0012	13:28:13	23 05	74 18			
00129	Santa Barbara	0009	13:28:13			0	31 30	1
00130	Los Altos	0005	13:27:33	10 05	15 20			
00131	Los Altos	0005	13:28:20	13 44	47 20			0 to 5
00132	Milwaukee A	0074	11:46:58.5	5 43	62 30			
00133	Milwaukee A	0074	11:47:24	5 57	54 20			
00134	Milwaukee A	0074	11:48:09	18 04	47 40			
00135	Milwaukee A	0074	11:49:25	18 06	44 55			
00150	Lick	2005	13:28:02.23	12 13 15.70	46 58 46.6			
00151	Lick	2005	13:28:04.55	12 27 17.15	48 08 42.5			
00152	Lick	2005	13:28:06.71	12 39 54.88	48 42 04.3			
00153	Lick	2005	13:28:09.98	12 58 09.44	50 02 55.6			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			November 6, 1957 (cont'd.)					
00154	Lick	2005	13:28:13.10	13 15 38.43	51 01 43.0			
00162	Armagh	2651	06:37:07.2			164 54	16 24	
00165	Armagh	2651	06:38:20.4	14 32	19 30			
00167	Dunsink	2652	06:37:37			297 30	29 42	
00170	Bratislava	2701	04:51:54.8	8 37 49	-12 19 18			
			November 7, 1957					
00016	Dahlgren	6008	10:11:53.2			51 14 42	15 20 00	
00101	New Haven A	0087	10:11:31.4	10 09 33	21 25 40			
00118	Perth	0601	18:25:08			176 29	*37 22	
00119	Perth	0601	18:26:46.8			145 21	*50 39	
00120	Perth	0601	18:28:04			99 38	*38 33	
00121	Perth	0601	18:29:26.5			70 34	*36 27	
00122	Perth	0601	20:10:48.5			253 03	*15 11	
00123	Perth	0601	20:11:20.5			258 03	*16 20	
00124	Naval Obs.	2011	10:11:26			71 48	19 52	
00155	Salisbury	3602	16:43:33.1	8 36	-32 30			
00156	Salisbury	3602	16:43:49.1	8 38	-27 30			
00157	Salisbury	3602	16:44:11.05	8 40	-21			
00163	Armagh	2651	06:47:50.7			189 18	39 06	
00166	Armagh	2651	06:48:08.9	10 08	19 42			
00181	State College	0060	10:11:20			90	22	1 to 4
00182	N.Y.C.	0046	10:14:43	11 21	28			
00183	Baltimore	0088	10:11:11			90	34	1
00184	Bryn Athyn	0055	10:08:16	8 30	-44			4 to 0
00185	Harrisburg	0057	10:11:12.5			90	25	1 to 3
00186	Milton	6003	10:13:31	14 31	57			
00187	Millbrook	0045	10:12:11	12 27	29 20			
00507	Mt. Stromlo	2600	16:42:55.5	4 26	-53 48			
00508	Mt. Stromlo	2600	16:43:54.5	4 46	-32 48			
00509	Mt. Stromlo	2600	16:46:50.0	7 19	22 06			
			November 8, 1957					
00136	Woomera	3601	15:03:04.9			180 56 14	33 19 20	
00137	Woomera	3601	16:51:32.8			165 49 06	41 17 08	
00138	Woomera	3601	16:51:54.2			163 56 18	44 25 24	
00139	Woomera	3601	16:53:07.4			131 34 16	52 21 20	
00140	Woomera	3601	16:53:39.6			112 35 34	52 05 48	
00141	Woomera	3601	16:54:25.3			06 33 12	46 33 36	
00142	Woomera	3601	18:35:04.4			241 18 22	10 48 08	
00143	Woomera	3601	18:36:14.8			249 47 38	13 34 48	
00144	Woomera	3601	18:36:54.8			255 55 34	15 42 04	
00145	Woomera	3601	18:37:32.6			262 22 56	17 06 37	
00146	Woomera	3601	18:37:46.6			264 57 34	16 25 24	
00147	Sydney	0602	16:54:49	01 10	-49			
00148	Sydney	0602	16:55:16	1 20	-43 30			
00173	Perth	0601	16:51:32			117 45	13 00	5 to 3
00174	Perth	0601	18:33:23			203 03	27 58	
00175	Perth	0601	18:34:12.8			201 39	34 57	
00176	Perth	0601	18:34:18.8			201 26	35 26	
00177	Perth	0601	18:34:40			200 49	38 11	
			November 9, 1957					
00149	Sydney Obs.	2601	16:59:12.6	0 09	-35 30			
00158	Salisbury	3602	17:01:37.08	4 15	-31 42			
00159	Sydney	0602	15:18:27	8 42	19 48			
00160	Sydney	0602	17:02:08	1 58 18	-13 38			
00164	Armagh	2651	07:07:14.3			304 06	27 36	-1
			November 13, 1957					
00168	Harestua	2709	05:54:51	21 28 08	70 22 34			
			November 23, 1957					
00510	National Univ. Canberra	7001	10:53:18.6	6 48	-32 24			

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Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
				November 24, 1957				
00171	Perth	0601	14:21:35.2			155 32	45 26	1.5
				November 26, 1957				
00172	College, Alaska	6450	16:34:50			180	67	
00491	College, Alaska	6450	16:35:59	14 05 31	19 05 57			
				November 28, 1957				
00180	College, Alaska	6450	16:27:30			180	58	
00511	Mt. Stromlo	2600	10:45:21.1	5 34	- 9 12			
00512	Mt. Stromlo	2600	10:43:47.5	5 44	-34 54			
00513	Mt. Stromlo	2600	12:27:44.0	22 31	-11 24			
				November 29, 1957				
00188	College, Alaska	6450	16:22:34			180	52	
00492	College, Alaska	6450	16:22:10	9 21	33 18			
00493	College, Alaska	6450	16:28:46	13 05	11 42			
00514	Mt. Stromlo	2600	10:39:10.0	5 09	-35 18			
00515	Mt. Stromlo	2600	10:39:47.0	5 07	-22 12			
				November 30, 1957				
00189	Woomera	3601	12:15:38.9			220 53 48	31 31 04	
00190	Woomera	3601	12:17:06			237 36 00	51 30 24	
				December 3, 1957				
00191	College, Alaska	6450	15:56:30			180	38	
00283	Utrecht, B	8002	05:44:49	15 48	25 30			
00284	Hilversum	8003	05:44:14	21 20	64 30			
00285	Hilversum	8003	05:44:54	17 52	52 36			
				December 4, 1957				
00286	Hilversum	8003	05:34:03	0 04	57 36			
00287	Hilversum	8003	05:35:23	19 20	66 30			
00288	Steenwijk	8004	05:37:59	15 44	26 18			
				December 5, 1957				
00564	Johannesburg	2401	18:28:39	21 48	-38 00			
				December 6, 1957				
00192	Suwa	0248	20:41:05	17 18	37			
00193	Mizukaido	0231	20:37:44			8	9	
				December 7, 1957				
00194	Takada	0250	20:29:40	17 40	40			
00195	Suwa	0248	20:29:11	18 12	52			
00196	Yamagata	0257	20:29:17	17 42	52			
00204	Whittier	0012	13:43:03	17 12	33			
00205	Whittier	0012	13:44:19	16 37	20 30			
00524	Pezinok	7002	05:07:58.0	03 46 07	70 55 30			
00525	Bratislava	2701	05:08:45.1	9 31 12	81 35 30			
00526	Bratislava	2701	05:09:50.8	13 26 26	50 54 42			
				December 8, 1957				
00197	Mitaka	0229	20:17:39	18 35	58			
00198	Toyohashi	0255	20:17:55	17 50	33			
00199	Shizuoka	0247	20:18:05	17 55	51			
00200	Mizukaido	0231	20:18:12	17 23	52			
00201	Mitaka	0229	20:17:41			31 54	18	
00202	Mitaka	0229	20:19:36			61 54	21	
00203	Mizukaido	0231	20:16:15			10	11	
00206	Whittier	0012	13:31:29	17 08	37 18			
00207	Whittier	0012	13:32:02	16 48	31 24			
00208	Whittier	0012	13:32:34	16 23	21 48			
00565	Johannesburg	2401	17:57:52			299 18	37 30	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
				December 9, 1957				
00209	Whittier	0012	13:18:21	17 49	51 48			
00210	Whittier	0012	13:19:20	16 58	39 12			
00211	Whittier	0012	13:21:12	16 09	17 18			
00212	Sacramento	0007	13:19:22.4	16 10 25.8	23 30			
00213	Sacramento	0007	13:21:14.1	15 43 12	6 13 48			
00215	Mitaka	0229	20:09:00	15 53	16			
00216	Suwa	0248	20:05:27	18 03	55			
00217	Shizuoka	0247	20:05:56	17 30	50			
00218	Mizukaido	0231	20:07:31	16 40	35			
00219	Mitaka	0229	20:06:15			43 03	20 50	
00220	Mizukaido	0231	20:06:25			45	19 30	
00221	Musashino	0233	20:06:20.2			45	22	
00527	Bratislava	2701	04:45:06.7	3 47 30	65 22 30			
00528	Bratislava	2701	04:45:51.4	6 54 30	75 02 48			
00529	Bratislava	2701	04:49:22.8	13 33 35	- 0 19 00			
00530	Bratislava	2701	04:50:53.8	13 49 19	-12 45 00			
00566	Johannesburg	2401	17:47:56.5	23 36	45 18			
00567	Johannesburg	2401	17:48:17			348 36	13 42	
				December 10, 1957				
00222	Los Angeles	0100	13:09:48	15 40	6 30			
00223	Oakland	0006	13:06:44.6	19 48	44 20			
00224	Tucson	0003	13:06:00			20	25	
00225	Los Alamos	0042	13:07:57	14 20	38 30			
00226	Albuquerque	0041	13:06:47	15 00	72			
00227	Whittier	0012	13:06:45	16 38	39 18			
00228	Whittier	0012	13:08:15	15 57	22 42			
00229	Portland	0076	15:47:15			270	34	
00241	Suwa	0248	19:56:13	15 42	13			
00242	Sapporo	0245	19:52:17.3	15 32	55 18			
00243	Mitaka	0229	19:54:12			57	22 42	
00244	Sendai	0246	19:53:26			51	29 06	
00245	Kiryu	0223	19:54:45			70	23 30	
00246	Mizukaido	0231	19:53:32			45	22 30	
00249	Sacramento	0007	13:05:46.2	16 21 42	33 40 48			
00517	Pic du Midi	2705	04:34:00			69 45	29 15	
00518	Pic du Midi	2705	06:20:29			181 13	43 03	
00531	Pezinok	7002	04:35:36.2	12 44 20	19 21 24			
				December 11, 1957				
00230	Idaho Falls	0019	12:52:23			90	48	
00231	Denver	0013	12:57:00			149	36	
00232	Albuquerque	0041	12:55:38	14 38	28			
00233	Tucson	0003	12:53:39			38 30	29	
00234	Tucson	0003	12:55:13			70 30	31	
00235	St. Paul	0035	12:52:07	7 39 30	16			
00236	Milwaukee	0074	11:14:47	14 16	-14 25			
00237	Cambridge	0099	11:09:48.4			297	32	
00238	Cambridge	0099	11:11:49.6			228	51 30	
00239	Cambridge	0099	11:13:59.4			188	34 30	
00240	Cambridge	0099	11:15:23.8			178	24 30	
00247	Whittier	0012	12:52:11	17 27	52 30			
00248	Los Alamos	0042	12:54:01	14 05	53 30			
00258	Mitaka	0229	19:41:34	15 30	28			
00259	Mizukaido	0231	19:39:54			45	24 30	
00267	Sapporo	0245	19:39:02.4	15 04 48	48 02			
00268	Manazuru	0228	19:40:38	16 14	40			
00269	Higashimatsuyama	0210	19:41:31.4	15 42 30	25 42			
				December 12, 1957				
00250	Harrisonburg	0072	10:58:12			90	74	
00251	Idaho Falls	0019	12:38:27			90	64	
00252	Albuquerque	0041	12:38:42.5	15 10	80			
00253	Albuquerque	0041	12:40:08.5	14 10	36			
00254	Albuquerque	0041	12:43:33	14 10	-10			
00255	Los Alamos	0042	12:40:03	13 50	49 12			
00256	Yerkes	2042	10:56:18	14 30	38 30			
00257	Univ. of Ill.	2014	10:59:27.7			111 28	23 30	
00260	Tucson	0003	12:40:49			61 30	32	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
	December 12, 1957 (cont'd.)							
00261	Whittier	0012	12:39:23	16 10	37 54			
00262	Milwaukee	0074	10:56:08.3	14 23	47			
00263	Milwaukee	0074	10:59:14.1	14 02	-05 10			
00264	Milwaukee	0074	11:01:53.9	14 06	-20 55			
00265	Milwaukee	0074	12:38:53	07 50	26			
00266	Los Angeles	0100	12:45:49	15 44	26 24			
00270	Blossom Point	8014	10:57:26.25	10 31	57 30			
00271	Sacramento	0007	12:37:43.9	16 16 06	40 02 24			
00272	Sacramento	0007	14:22:07.6	9 15 42	26 40 48			
00281	Washington	6001	10:55:53	4 49	66 48			
00282	Washington	6001	10:59:57	12 46	- 0 30			
00336	Wright-Patterson AFB	3009	10:56:54			60 18	54 24	
00337	Kagoshima	0218	21:11:04	12 40	40			
00338	Konko	0224	21:10:18			270	79	
	December 13, 1957							
00273	Akron-Canton	0053	10:41:25	11 10	73			
00274	Tucson	0003	12:26:26			72 30	32	
00275	St. Paul	0035	12:23:41	7 39 45	14			
00276	State College	0060	10:42:39	10 59	37 30			
00277	Bryn Athyn	0055	10:42:20	9 15	50			
00278	Schenectady	0081	10:43:07	10 06	13 06			
00279	Idaho Falls	0019	12:22:49	13 24	55			
00280	Denver	0013	12:27:00			153	36	
00289	Albuquerque	0041	12:24:43	14 03 13	64 35			
00290	Amarillo	0064	12:26:15			90	76	
00291	Wichita	0028	12:25:28.9	9 26 18	33 45			
00292	Cambridge	0099	10:41:42.8			282	39	
00293	Cambridge	0099	10:43:19.0			227	47	
00294	Cambridge	0099	10:44:48			193	37	
00303	Organ Pass (SS)	5001	12:25:46.8	14 32	50 42			
00304	Organ Pass (SS)	5001	12:26:01.2	14 27	46 12			
00305	Organ Pass (SS)	5001	12:26:29.4	14 22 30	38 30			
00308	Tulsa	0054	12:29:50	12 12	-22 20			
00339	Mitaka	0229	19:12:00	15 23	37 30			
00340	Suwa	0248	20:56:02	9 47	8 00			
00341	Yokkaichi	0258	20:55:59	10 08	14			
00342	Kanaymachi	0220	20:58:25	12 09	-18 00			
00343	Kochi	0264	20:56:18.4	11 34	15 12			
00344	Higashimatsuyama	0210	20:54:15.0	7 31 24	32 00			
00345	Mitaka	0229	20:53:52			293 54	34	
00346	Mitaka	0229	20:55:39			249 36	48 18	
00347	Mitaka	0229	20:58:38			188 54	30 36	
00348	Mizukaido	0231	20:56:24			225	45	
00519	Pic du Midi	2705	05:38:05			169 50	54 45	
00520	Pic du Midi	2705	05:40:07			157 30	28 30	
00521	Pic du Midi	2705	05:40:39			157 15	24 30	
00522	Pic du Midi	2705	05:41:04			155 26	21 30	
00523	Pic du Midi	2705	05:41:31			153 38	18 45	
	December 14, 1957							
00299	Organ Pass (BN)	9001	12:09:35.74	14 44 30	64 50			
00300	Organ Pass (BN)	9001	12:10:35.73	14 14 0	44 03			
00301	Organ Pass (SS)	5001	12:10:49.2	14 15	39 12			
00302	Organ Pass (SS)	5001	12:11:00.6	14 14	35 54			
00306	Warner and Swasey	2031	10:26:23	11 32	54 48			
00307	Warner and Swasey	2031	10:27:38	12 26	21 18			
00311	Lawton	0110	12:13:31			157	40 48	
00312	Albuquerque	0041	12:09:48.5	13 50	50			
00313	Idaho Falls	0019	12:11:02	13 25	-10			
00314	St. Paul	0035	12:08:21.5	7 37	13 57			
00315	Amarillo	0064	12:10:41			90	76	
00316	Milwaukee	0074	12:12:38.5	9 57	-21 50			
00317	Harrisonburg	0072	10:27:57			90	72	
00318	Pittsburgh	0059	10:26:58	11 50	48			
00319	Washington	0014	10:29:42			145	44 30	
00320	W. Palm Beach	0016	10:27:41			12	22	
00321	Dayton	0082	10:27:33			90	50	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h	α m	α s	δ °	δ '	δ "	Z °	Z '	Z "	h °	h '	h "	MAG.
December 14, 1957 (cont'd.)																
00322	Lemont	0022	10:26:54	14	02		25	30								
00324	Tulsa	0054	12:10:54	9	45		24									
00333	Univ. of Ill. "B"	2014	12:09:30.9							275	53		*25	05		
00334	Washington, D.C.	6001	10:26:46	8	58		67	24								
00335	Washington, D.C.	6001	10:28:36	11	42		15	12								
00349	Toyohashi	0255	20:40:04	10	00		9									
00350	Suwa	0248	20:36:44	5	19		46									
00351	Yokkaichi	0258	20:40:19	10	04		13									
00352	Kanaya Machi	0220	20:43:05	12	08		-21									
00353	Chunichi	0204	20:40:20	10	01		11									
00354	Manazuru	0228	20:39:48	8	50		19									
00355	Kochi	0264	20:42:46	12	27		-16									
00356	Konko	0224	20:39:28							270			81	30		
December 15, 1957																
00295	Organ Pass (BN)	9001	11:53:05.32	15	01	30	69	40								
00296	Organ Pass (BN)	9001	11:54:45.32	14	03	54	36	50								
00297	Sac Peak (SS)	2043	11:53:05.4	14	47		71	30								
00298	Organ Pass (SS)	5001	11:53:05.4	14	56		69	42								
00325	Bryn Athyn	0055	10:12:02	10	40		21									
00326	Fort Belvoir	0077	10:11:08							0			76			
00327	W. Palm Beach	0016	10:16:14							94	30		30			
00328	Lawton	0110	11:56:23							157	00		53			
00329	Amarillo	0064	11:54:51.5							95			69			
00330	Dayton	0082	10:11:29							90			46			
00331	Cambridge	0099	10:12:13.8							206			47	30		
00332	Cambridge	0099	10:12:54.2							192	30		42	30		
00357	Mitaka	0229	18:42:34.9	14	40		10	30								
00358	Yokkaichi	0258	20:23:56	10	08		13									
00359	Kashiwabara	0222	20:23:18	9	51		27									
00360	Kanayamachi	0220	20:23:50	10	26		20									
00361	Manazuru	0228	20:24:04	9	27		8									
00362	Kochi	0264	20:27:11	12	36		-24									
00363	Mizukaido	0231	20:22:21	7	12		28									
00364	Mitaka	0229	20:24:17.5							221	18		48	54		
00365	Musashino	0233	20:22:47.7							270			47			
00366	Himeji	0262	20:27:24							161	48		25	42		
00367	Suwa	0248	20:21:01	5	57		45									
00368	Suwa	0248	20:22:43	8	22		28									
00369	Suwa	0248	20:27:39	11	37		-36									
00370	Miyazaki	0230	20:25:34	12	56		- 3									
00379	Blossom Point	8001	10:12:27.8	11	46	36	24	57								
00430	Welcome	6010	10:10:34.5	9	05		67									
00431	Welcome	6010	10:11:33	11	05		45									
00554	Mitaka	0229	20:23:37.9	9	00	36	12	33								
00555	Mitaka	0229	20:24:01.0	9	21	48	6	28								
00556	Mitaka	0229	20:25:29.4	10	28	12	-13	37								
00557	Mitaka	0229	20:25:54.4	10	40	12	-17	26								
December 16, 1957																
00371	Fort Worth	0069	11:38:31	10	47		34	30								
00372	St. Paul	0035	11:39:33	9	22		-10									
00373	Tucson	0003	13:19:58							278			31			
00374	Milwaukee	0074	11:36:55.8	7	56		2									
00375	Milwaukee	0074	11:41:49.0	11	40		-33	27								
00376	Sacramento	0007	13:20:38.8	10	48	33	- 8	36	36							
00377	Organ Pass	9001	11:42:37.46	13	46	48	-12	45								
00378	Sac Peak	2043	11:36:52.8	13	56		56	42								
00388	Suwa	0248	20:05:16	8	05		31									
00389	Suwa	0248	20:07:15	10	04		- 0	30								
00390	Suwa	0248	20:08:37	10	57		-18									
00391	Kochi	0264	20:07:48	11	25		11									
00392	Mitaka	0229	18:23:21.8	14	42		21									
00393	Yokkaichi	0258	20:06:51	10	08		13									
00394	Kashiwabara	0222	20:06:20	9	52		27									
00395	Takada	0250	20:10:10	10	48		-18									
00396	Kanagawa	0219	20:06:33	9	58		9									
00397	Manazuru	0228	20:05:51	8	14		28									
00398	Manazuru	0228	20:08:21	10	34		-11									
00399	Mizukaido	0231	20:06:26	7	41		28									

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			December 16, 1957 (cont'd.)					
00400	Higashimatsuyama	0210	20:06:12	8 39	16			
00401	Yamagata	0257	20:08:20	10 23	-20			
00402	Mitaka	0229	18:23:49			81 30	18 42	
00432	Welcome	6010	09:54:42.25	11 10	45			
00433	Welcome	6010	09:56:50.5	12 19	- 0 18			
			December 17, 1957					
00380	Biloxi	0090	11:21:47			270	55	
00381	New Orleans	0031	11:21:58			270	56	
00382	New Orleans	0030	11:21:52			270	61 30	
00383	Edinburgh, Tex.	0066	11:22:00			45	61 30	
00384	Fort Worth	0069	11:20:48	10 59	36 30			
00385	Fort Worth	0069	11:20:58	11 05	32 00			
00386	Fort Worth	0069	11:21:10	11 08	29			
00387	Milwaukee	0074	11:20:36	8 29	-11			
00403	Cambridge	0099	09:37:58.4			201 30	48	
00404	Cambridge	0099	09:38:36.8			184	41	
00413	Washington	6001	09:39:10	12 13	- 0 18			
00414	Washington	6001	09:43:25	12 52	-28 48			
00415	Washington	6001	11:20:25	7 16	6 00			
00416	Washington	6001	11:25:20	9 40	-35			
00558	Kochi	0264	19:52:25	12 31	-23			
00559	Miyazaki	0230	19:50:42	12 45	-01			
00405	Biloxi	0090	11:03:30			270	58	
00406	W. Palm Beach	0016	09:23:19			90	26	
00407	W. Palm Beach	0016	11:04:48			270	34	
00408	Cambridge	0099	09:20:52			176	37	
00409	Cambridge	0099	09:21:27.0			174	31	
00410	Cambridge	0099	09:22:30.0			169	21 30	
00411	Cambridge	0099	09:23:03.6			167	19 30	
00412	Honolulu	0114	16:11:07	8 07	14 06			
00420	Yokkaichi	0258	19:31:14	10 35	9			
00421	Mitaka	0229	19:31:25			190 42	47 18	
00422	Mitaka	0229	19:32:37			177 30	34 24	
00423	Mitaka	0229	19:34:29			169	21	
00424	Suwa	0248	19:31:08	10 23	- 4			
			December 19, 1957					
00417	W. Palm Beach	0016	09:04:19			90	27	
00418	Edinburg, Tex.	0066	10:45:53.5			90	48 30	
00419	Edinburg, Tex.	0066	12:27:48			270	19 45	
			December 20, 1957					
00425	Organ Pass	5001	12:07:48	8 17	-07 48			
00426	Organ Pass	5001	12:08:22	8 44	-15 48			
00427	Organ Pass	5001	12:09:08	9 08	-24 12			
00428	Organ Pass	5001	12:10:00	9 39	-29 42			
00429	W. Plam Beach	0016	10:33:38			180	14	
00440	Greensboro	0049	23:26:30			270	85	
00441	W Palm Beach	0016	22:26:18			270	80	
			December 21, 1957					
00442	Miyazaki	0230	09:35:46	20 40	15			
			December 22, 1957					
00437	Greensboro	0049	22:46:03	4 35	06			
00438	Cambridge	0099	22:45:31.2			190	11 30	
00439	Cambridge	0099	22:46:18.2			179	18 30	
00443	Ichinomiya	0215	09:16:35	19 30	16			
00444	Hiroshima	0211	09:16:39	00 09	59			
00445	Fuchu	0214	09:15:27	21 20	41			
00452	Washington, D.C.	6001	22:46:15	3 30	- 5			
00560	Tadotsu	0249	09:15:46	20 52	48			
00561	Miyazaki	0230	09:13:53	21 30	-17			
00562	Miyazaki	0230	09:14:26	22 01	21			
00563	Kagoshima	0218	09:14:20	22 30	12			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
				December 23, 1957				
00434	Lawton	0110	00:26:29			201 12	54 54	
00435	Oakland	0006	02:08:57.5	03 10	42			
00436	Sacramento	8500	02:08:06.3	22 05 09	-24 55 12			
00448	Fort Worth	8503	00:27:05	17 30	86 30			
00449	Bryn Athyn	0055	22:24:15			90	16	
00450	Cambridge	0099	22:24:09.9			142	23 30	
00451	Cambridge	0099	22:24:21.4			132	25 30	
00453	Suwa	0248	08:53:50	19 36	45			
00454	Shizuoka	0247	08:53:07	19 47	12			
00455	Manazuru	0228	08:53:42	19 59	37			
00456	Osaka-Yomiuri	0241	08:53:49	23 59	87			
00457	Kochi	0264	08:54:06	00 53	60			
00458	Mitaka	0229	08:52:59			253 36	17 30	
00459	Musashino	0233	08:53:24			270	22 30	
00460	Kiryu	0223	08:53:45			300	28	
00461	Mizukaido	0231	08:53:30			270	22	
00462	Himeji	0262	08:53:40			11 48	47 30	
00463	Cambridge	0099	22:24:24.8			130	25 30	
00516	Walnut Creek	0011	02:08:40	23 40	-01 24			
				December 24, 1957				
00446	Lawton	0110	00:04:33			64 06		
00447	Milwaukee	0074	00:05:29	21 15	-11 30			
00464	Univ. of Ill., B	2046	23:42:23.9	20 52 06	39 22			
00465	Sacramento	8501	01:46:41.8	4 21 07.2	33 38 24			
00495	Milwaukee	0074	23:42:26	23 45	-08 40			
00496	Milwaukee	0074	23:43:01	23 35	32 30			
00532	Mitaka	0229	08:29:20.0			229 06	13 30	
00533	Mitaka	0229	08:30:44.3			294 06	41 12	
00534	Mitaka	0229	08:31:14.7			342 12	33 06	
00535	Mitaka	0229	08:31:37.6			0	23 36	
00536	Musashino	0233	08:30:56			315	41 18	
00537	Nagoya	0236	08:30:39			0	60	
00538	Suwa	0248	08:30:20	21 22	73			
00539	Suwa	0248	08:31:26	7 28	78			
00540	Yokkaichi	0258	08:30:36	00 04	59			
00541	Kashiwabara	0222	08:30:59	6 10	59			
00542	Kiryu	0223	08:31:37	11 40	85			
00543	Nagano	0234	08:30:59			0	42 30	
00544	Manazuru	0228	08:30:45	19 30	52			
00545	Tokushima	0253	08:30:51			59	51 48	
00546	Kochi	0264	08:31:40	5 13	50			
00547	Mizukaido	0231	08:30:38			270	36 30	
00548	Higashimatsuyama	0210	08:31:35.6	12 09	81			
00549	Himeji	0262	08:30:28			64 48	48 36	
				December 25, 1957				
00466	Mitaka	0229	08:06:35.6	21 53	14			
00467	Suwa	0248	08:06:47	00 45	24			
00468	Sapporo	0245	08:08:52	3 45	27			
00477	Sacramento	8501	01:22:52.3	3 46 54	11 09			
00478	Sacramento	8501	01:23:07.3	4 25 48	19 31 12			
00550	Asahikawa	0201	08:07:34	22 45	-32			
00551	Shizuoka	0247	08:06:35	23 34	35			
00552	Mizukaido	0231	08:07:00			315	79	
00553	Higashimatsuyama	0210	08:06:17	21 39	-13			
				December 26, 1957				
00469	Sapporo	0245	07:44:21	4 28	18			
00470	Sapporo	0245	07:44:32	5 06	22			
00471	Asahigawa	0201	07:44:32			80	30	
00474	Greensboro, B	0197	22:51:59	18 10	36 30			
00475	Chattanooga	0062	22:56:00±1			90	60±5	
00476	Milwaukee, B	0198	22:54:00	4 43	23 00			
00568	Johannesburg	2401	01:41:37	13 03	14 12			
00569	Johannesburg	2401	01:43:49.2			87 48	30 09 36	
00570	Johannesburg	2401	01:44:05	13 55	- 8 30			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
				December 27, 1957				
00472	Denver	0013	00:34:00			313 45	23	
00473	Manhattan, Kan.	0027	00:35:19	17 00	35 24			
00479	Paterson	0108	22:28:10	16 43	42 54			
00480	Bryn Athyn	0055	22:29:48	11 00	62			
00482	Cambridge	0099	22:29:30.4			346 15	15 45	
00483	Cambridge	0099	22:29:44.8			351 45	16 45	
00484	Cambridge	0099	22;29:46.0			349	15 15	
00485	Cambridge	0099	22:29:54.2			353 30	15	
00571	Johannesburg	2401	01:19:22.5	14 05	-10 18			
00572	Pretoria	0404	01:22:33.4	15 18	-30 30			
				December 28, 1957				
00481	Manhattan, Kan.	0027	00:08:55	16 52	33			
00486	Cambridge	0099	22:01:41.8			326	25	
00487	Cambridge	0099	22:01:50.5			332	22	
00488	Cambridge	0099	22:01:50.5			327	23 30	
00576	Santiago Obs.	2801	07:39:15	13 58	- 9 18			
				December 29, 1957				
00489	Sapporo	0245	08:07:16	17 25	24			
00490	Sapporo	0245	08:07:33	17 14	33			
				December 30, 1957				
00494	Otaru	0243	07:39:43			330	23	
00573	Johannesburg	2401	01:39:26	11 05	-18			
00574	Johannesburg	2401	01:23:20	14 03	-57 12			
00577	Santiago Obs.	2801	08:25:15	11 16 52.3	-21 05 39			
00578	Santiago Obs.	2801	08:28:07.5	13 43 58.7	-52 01 10			
				December 31, 1957				
00575	Johannesburg	2401	01:11:14	12 00	-22 30			
00579	Santiago Obs.	2801	07:57:40	12 53 54	-34 34 12			
				January 1, 1958				
00001	Armagh	2651	18:28:55.1			309 24	19 12	
00019	Johannesburg	2401	02:25:37.4	6 37	-53 30			
00032	Santiago Obs.	2801	07:29:17	14 19 36	-39 31			
00033	Santiago Obs.	2801	07:30:10	14 55 25	-42 56			
				January 2, 1958				
00020	Johannesburg	2401	01:52:59.4	7 15	-37 00			
00034	Santiago Obs.	2801	06:56:29	13 16 36	-22 51			
00035	Santiago Obs.	2801	08:33:39	7 18 17.0	6 19 57			
				January 3, 1958				
00002	Armagh	2651	17:24:10.6			287 12	29 36	
00003	Armagh	2651	17:24:51.1			325 54	35 18	
00004	Armagh	2651	17:25:37.6			6 26	27 53	
00022	Johannesburg	2401	01:21:38	8 10 30	-47 11			
00021	Johannesburg	2401	01:21:07.4	8 00 36	-59 48			
00023	Johannesburg	2401	01:24:36	10 25	-80 30			
00024	Johannesburg	2401	01:26:27	17 00	-80			
				January 4, 1958				
00014	Johannesburg	2401	00:47:38	8 47	-28 30			
				January 5, 1958				
00015	Johannesburg	2401	02:00:42	4 12	-62 30			
00036	Santiago Obs.	2801	07:00:08	12 06 18	-50 22			
00037	Santiago Obs.	2801	08:44:07	4 23	-63 30			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U. T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			January 6, 1958					
00038	Santiago Obs.	2801	08:06:15	5 50 20	-41 07 00			
			January 7, 1958					
00039	Santiago Obs.	2801	05:48:34.8	12 08 29.1	23 19 26			
00040	Santiago Obs.	2801	07:29:11.8	6 21 12	-29 54			
			January 8, 1958					
00016	Johannesburg	2401	00:10:36	8 48	-50 12			
00017	Johannesburg	2401	23:34:51	10 25	-67			
00041	Santiago Obs.	2801	06:54:32.8	7 56 34.5	-63 09 41			
			January 9, 1958					
00018	Johannesburg	2401	01:15:10.5	4 29	-34 18			
			January 12, 1958					
00005	College, Alaska	6450	01:57:36			180	75	
00006	College, Alaska	6450	03:40:12			0	85	
			January 13, 1958					
00007	College, Alaska	6450	01:15:35			180	60	
00008	College, Alaska	6450	02:58:20			0	80	
00009	College, Alaska	6450	04:40:25			0	90	
			January 14, 1958					
00010	College, Alaska	6450	02:15:32			0	87	
00011	College, Alaska	6450	03:58:21			180	86	
00012	College, Alaska	6450	01:31:42			180	84	
			January 16, 1958					
00013	College, Alaska	6450	04:13:02			180	70	
			January 17, 1958					
00071	Armagh	2651	18:24:43.6			39 06	29 57	
			January 18, 1958					
00042	Sacramento D	8005	02:43:31.2	8 36	37			
00055	College, Alaska	6450	02:39:04			0	90	
00056	College, Alaska	6450	04:22:00			180	50	
			January 19, 1958					
00025	Cambridge	0099	23:28:38			347	09	
00026	Cambridge	0099	23:29:30.2			5	17 30	
00027	Cambridge	0099	23:30:49			12 30	23 30	
00028	Cambridge	0099	23:30:44			12	21 30	
00029	Cambridge	0099	23:31:06			17 30	25	
00030	Washington, D.C.	6001	23:31:04	11 00	52 00			
00031	Washington, D.C.	6001	23:31:22	10 20	53 08			
00043	Sacramento B	8500	03:37:50.2	16 55 53.4	65 07 48			
00044	Sacramento B	8500	03:37:56.1	16 52 12	66			
00046	Sacramento B	8500	01:57:56.6	10 13 06	44 12			
00516	Pic du Midi	2705	18:31:43			9 36	17 48	
00517	Pic du Midi	2705	18:32:40			26 06	21 06	
00518	Pic du Midi	2705	18:32:53			29 00	21 48	
00519	Pic du Midi	2705	18:33:10			33 24	22 18	
			January 20, 1958					
00045	Sacramento B	8500	02:50:50.2	11 23	60 42			
00049	Cambridge	0099	22:42:49			45	20	
00057	College, Alaska	6450	02:44:17			180	82	
00058	College, Alaska	6450	04:27:33			180	31	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			January 21, 1958					
00047	Ft. Belvoir	0077	00:23:04			0	29	
00048	Washington, D.C.	8009	00:23:35			6 36	33 30	
00050	Cambridge	0099	00:21:12			328 30	15 30	
00051	Cambridge	0099	00:23:02.5			332 30	35	
00052	Cambridge	0099	00:23:36			331 30	44	
00053	Cambridge	0099	00:23:47			329 30	52	
00054	Cambridge	0099	00:23:58			331	55	
00059	Washington, D.C.	8006	00:23:13			0	31	
00060	Milton	6003	00:23:33	22 57	66 30			
00061	Sacramento B	8500	02:01:25.2	9 55 24	48 30			
00062	Sacramento B	8500	02:02:34.0	9 01 56.4	38 49 48			
00063	Sacramento B	8500	02:03:30.5	8 33 12	30 01 48			
00064	Sacramento B	8500	03:41:14.5	19 26 12	62 26 24			
00065	Sacramento B	8500	03:41:52.0	20 02 42.6	67 43 12			
00066	Sacramento B	8500	03:43:09.6	00 11 27	75 45			
00067	Sacramento B	8500	03:43:19.8	1 05 01.2	74 52 12			
00068	Washington, D.C.	6001	00:21:43	16 40	65 36			
00069	Washington, D.C	6001	00:23:13	15 00	80 00			
00070	Washington, D.C.	6001	00:23:33	9 30	81 09			
00096	College, Alaska	6450	03:36:57			180	46	
00520	Pic du Midi	2705	18:31:14			341 36	8 18	
00521	Pic du Midi	2705	18:31:37			342 54	10 00	
00522	Pic du Midi	2705	18:31:48			344 06	11 30	
00523	Pic du Midi	2705	18:32:00			345 36	12 54	
00524	Pic du Midi	2705	18:32:14			347 06	14 18	
00525	Pic du Midi	2705	18:32:24			348 24	15 24	
00526	Pic du Midi	2705	18:32:34			349 48	16 48	
00527	Pic du Midi	2705	18:32:49			352 06	18 30	
00528	Pic du Midi	2705	18:32:58			353 24	19 36	
00529	Pic du Midi	2705	18:33:09			355 30	21 06	
00530	Pic du Midi	2705	18:33:22			357 48	22 30	
00531	Pic du Midi	2705	18:33:34			00 54	24 18	
00532	Pic du Midi	2705	18:33:53			5 06	27 24	
00533	Pic du Midi	2705	18:34:07			8 42	29 12	
00534	Pic du Midi	2705	18:34:20			12 48	31 06	
00535	Pic du Midi	2705	18:34:30			16 36	32 54	
00536	Pic du Midi	2705	18:34:44			21 18	34 18	
00537	Pic du Midi	2705	18:34:55			25 24	35 48	
00538	Pic du Midi	2705	18:35:11			32 36	37 36	
00539	Pic du Midi	2705	18:35:22			36 54	38 18	
00540	Pic du Midi	2705	18:35:31			41 06	38 42	
00541	Pic du Midi	2705	18:35:42			46 42	39 12	
99542	Pic du Midi	2705	18:35:59			54 36	39 24	
00543	Pic du Midi	2705	18:36:21			64 06	38 36	
00544	Pic du Midi	2705	18:36:34			70 06	37 54	
00545	Pic du Midi	2705	18:36:46			74 42	36 54	
00546	Pic du Midi	2705	18:36:56			78 18	36 06	
00547	Pic du Midi	2705	18:37:11			83 24	34 36	
00548	Pic du Midi	2705	18:37:24			87 18	33 06	
00549	Pic du Midi	2705	18:37;33			89 42	32 18	
00589	Pic du Midi	2705	18:37:47			93 18	30 42	
00754	Dunsink Obs.	2652	18:30:21.9±.5	17 35 00	53 42	(1950 position)		
00755	Dunsink Obs.	2652	18:30:26.9±.1	17 36 00	54 54	(1950 position)		
00756	Dunsink Obs.	2652	18:30:31.9±.1	17 37 00	56 18	(1950 position)		
00757	Dunsink Obs.	2652	18:31:26.9±.1	17 50 00	74 00	(1950 position)		
00758	Dunsink Obs.	2652	18:31:31.9±.1	17 52 30	76 06	(1950 position)		
00759	Dunsink Obs.	2652	18:31:36.9±.1	17 57 00	78 18	(1950 position)		
00760	Dunsink Obs.	2652	18:31:41.9±.1	18 02 30	80 24	(1950 position)		
00761	Dunsink Obs.	2652	18:31:46.9±.1	18 12 30	82 42	(1950 position)		
00762	Dunsink Obs.	2652	18:32:01.9±.1	00 00 00	88 42	(1950 position)		
00763	Dunsink Obs.	2652	18:32:06.9±.1	3 50 00	87 00	(1950 position)		
00764	Dunsink Obs.	2652	18:32:11.9±.1	4 40 00	84 36	(1950 position)		
00765	Dunsink Obs.	2652	18:32:16.9±.1	4 57 30	81 54	(1950 position)		
00766	Dunsink Obs.	2652	18:32:21.9±.1	5 10 00	79 12	(1950 position)		
00767	Dunsink Obs.	2652	18:32:41.9±.1	5 23 30	68 18	(1950 position)		
00768	Dunsink Obs.	2652	18:32:46.9±.1	5 24 30	65 30	(1950 position)		
00769	Dunsink Obs.	2652	18:32:51.9	5 26 00	62 42			
00770	Dunsink Obs.	2652	18:32:56.9	5 27 00	60 00			
00771	Dunsink Obs.	2652	18:33:01.9	5 28 00	57 18			
00772	Dunsink Obs.	2652	18:33:16.9	5 32 00	49 42			
00773	Dunsink Obs.	2652	18:33:21.9	5 32 30	47 18			
00774	Dunsink Obs.	2652	18:33:26.9	5 33 00	44 42			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ')	Z (° ')	h (° ')	MAG.
			January 21, 1958 (cont'd.)					
00775	Dunsink Obs.	2652	18:33:31.9	5 33 30	42 30			
00776	Dunsink Obs.	2652	18:33:36.9	5 34 00	40 12			
00777	Dunsink Obs.	2652	18:33:56.9	5 37 00	32 12			
00778	Dunsink Obs.	2652	18:34:01.9	5 37 30	30 30			
00779	Dunsink Obs.	2652	18:34:06.9	5 37 30	28 48			
00780	Dunsink Obs.	2652	18:34:11.9	5 38 00	26 54			
00781	Dunsink Obs.	2652	18:34:16.9	5 38 30	25 24			
00782	Dunsink Obs.	2652	18:34:31.9	5 39 30	21 06			
00783	Dunsink Obs.	2652	18:34:36.9	5 40 00	19 42			
00784	Dunsink Obs.	2652	18:34:41.9	5 40 30	18 18			
00785	Dunsink Obs.	2652	18:34:46.9	5 41 00	17 12			
00786	Dunsink Obs.	2652	18:34:51.9	5 41 30	15 54			
00787	Dunsink Obs.	2652	18:35:06.9	5 42 30	12 42			
00788	Dunsink Obs.	2652	18:35:26.9	5 43 30	8 48			
00789	Dunsink Obs.	2652	18:35:36.9	5 44 30	7 00			
00790	Dunsink Obs.	2652	18:35:56.9	5 46 00	3 54			
00791	Dunsink Obs.	2652	20:13:59.9	23 47 00	15 30			
00792	Dunsink Obs.	2652	20:14:04.9	23 53 00	14 42			
00793	Dunsink Obs.	2652	20:14:09.9	23 58 30	14 12			
			January 22, 1958					
00072	St. Paul	0035	01:13:42	4 50	41			
00073	Lawton	0110	01:12:25			13 18	17 24	
00074	Lawton	0110	01:13:39			28 30	23 06	
00075	Lawton	0110	01:14:27			42 30	25 42	
00076	Lawton	0110	01:15:17			57	27	
00077	Los Alàmos	0043	02:54:27	00 05	59 24			
00078	Los Alamos	0043	02:54:44	00 43	57			
00079	Oakland	0006	02:54:37	7 35	33			
00080	San Angelo	0105	01:36:15			90	25	
00081	Mitaka	0229	09:30:37	8 28	61			
00082	Mitaka	0229	11:11:01	23 05	29			
00083	Mizukaido	0231	11:10:23	22 40	31			
00084	Suwa	0248	09:32:22	7 32	31			
00085	Mitaka	0229	09:28:43.6			5 24	21	
00086	Mizukaido	0231	09:31:22			45	38	
00087	C. Canaveral B	8007	01:14:45			339 14	19 01	
00088	C. Canaveral B	8007	01:14:50			339 21	19 43	
00089	C. Canaveral B	8007	01:14:55			339 31	20 20	
00090	C. Canaveral B	8007	01:15:00			339 40	21 04	
00091	C. Canaveral B	8007	01:15:05			339 49	21 47	
00092	C. Canaveral B	8007	01:15:10			339 58	22 31	
00093	C. Canaveral B	8007	01:15:15			340 08	23 16	
00094	C. Canaveral B	8007	01:15:20			340 17	24 05	
00095	C. Canaveral B	8007	01:15:25			340 32	24 37	
00097	College, Alaska	6450	02:45:42			180	62	
00098	College, Alaska	6450	04:29:27			180	23	
00125	Sacramento C	8501	02:51:10.7	13 34 43.8	74 27			
00126	Sacramento C	8501	02:53:02.7	8 14 12	59 40 48			
00127	Sacramento C	8501	04:33:29.9	23 13 30	27 58 12			
00128	Sacramento C	8501	04:34:47.0	00 21 18	17 20 24			
00138	Sendai	0246	09:29:09	11 38	82			
00139	Sendai	0246	09:31:40			72 30	45 36	
00195	Musashino	0233	09:29:48			20	31	
00794	Dunsink Obs.	2652	19:23:15.0	1 01 30	23 42			
00795	Dunsink Obs.	2652	19:23:20.0	1 09 30	22 24			
00796	Dunsink Obs.	2652	19:23:25.0	1 17 30	21 12			
00797	Dunsink Obs.	2652	19:23:30.0	1 25 30	19 48			
			January 23, 1958					
00099	Sac Peak	2043	02:06:01.2	6 35	16			
00100	Ft. Belvoir	0077	00:24:20			0	76	
00101	Washington, D.C.	0014	00:21:27			333 30	23 30	
00102	Chicago	0085	00:22:53.5	6 46 36	48 48			
00103	Chicago	0085	00:23:05.0	6 57	45 06			
00104	Amarillo	0064	02:05:21			90	68	
00105	St. Louis	0080	00:21:28	10 21	65 54			
00106	St. Louis	0080	00:22:36.5	8 12	52 30			
00107	St. Louis	0080	02:04:24	1 02	14 18			
00108	Alamagordo	0102	02:05:01	6 41	41 42			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ')	h (° ')	MAG.
			January 23, 1958 (cont'd.)					
00109	Wichita	0028	02:06:53			165 30	36	
00110	Los Alamos	0043	02:04:19	6 22	43 30			
00111	Los Alamos	0043	02:05:19	6 16	22 30			
00112	Los Alamos	0043	02:06:12	6 13	8 30			
00113	Milwaukee	0074	00:18:52	16 50	61			
00114	Milwaukee	0074	00:22:09.1	6 50	60			
00115	Milwaukee	0074	02:06:55.8	2 31	-19 20			
00116	Milwaukee	0074	02:04:37.8	1 00	1 50			
00117	Albuquerque	0041	02:03:36	6 30	80			
00118	Tucson	0003	02:31:00			90	27	
00119	Tucson	0003	04:08:00			290	36	
00120	Tucson	0003	04:14:00			240	36	
00121	Tucson	0003	04:13:00			270	36	
00122	Albuquerque	0041	02:02:57	14 45	75			
00123	Albuquerque	0041	02:04:29	6 40	45			
00124	Albuquerque	0041	02:05:53	6 31	18 30			
00129	Sacramento C	8501	02:00:15.3	9 56 34.2	57 04 48			
00130	Sacramento C	8501	02:00:59.9	9 02 21.6	49 52 12			
00131	Sacramento C	8501	02:01:51.3	7 51 58.2	28 31 48			
00132	Sacramento C	8501	02:04:04.2	7 30 36	15 54			
00133	Sacramento C	8501	02:05:39.7	7 16 22.2	2 58 12			
00134	Sacramento C	8501	03:41:07.4	21 47 24	52 39 36			
00135	Sacramento C	8501	03:42:44.1	00 34 07.2	44 15			
00136	Sacramento C	8501	03:42:57.6	1 00 18.6	41 04 48			
00137	Sacramento C	8501	03:46:53.6	4 24 21	-18 35 24			
00140	Washington, D.C.	6001	00:22:47	22 10	72 02			
00141	Washington, D.C.	6001	00:23:42	1 54	63 07			
00142	Washington, D.C.	6001	00:24:22	3 19	48 08			
00143	Washington, D.C.	6001	00:25:12	4 06	27 02			
00144	Washington, D.C.	6001	00:25:57	4 35	13 08			
00145	Washington, D.C.	6001	00:26:32	4 54	5 02			
00146	Washington, D.C.	6001	00:27:22	5 11	- 8 06			
00147	Washington, D.C.	6001	00:27:50	5 14	-13 02			
00148	Higashimatsuyama	0210	08:40:38	7 49	25			
00149	Higashimatsuyama	0210	10:23:03	3 50	- 9			
00150	Fuchu	0214	10:20:45	4 37	48			
00151	Fuchu	0214	10:23:17	5 33	- 1			
00152	Kanaya Machi	0220	10:21:02	3 53	46			
00153	Manazuru	0228	08:37:15	10 34	58			
00154	Mitaka	0229	10:23:49	4 10	-14 30			
00155	Mitaka	0229	12:01:13	23 52	3			
00156	Mitaka	0229	12:03:09.8	00 40	- 8 12			
00157	Osaka-Yomiuri	0241	10:19:59	2 00	64			
00158	Osaka-Yomiuri	0241	10:22:09	4 33	16			
00159	Yokkaichi	0258	10:22:41	4 34	7			
00160	Mitaka	0229	08:37:21.5			26 48	15 30	
00161	Mitaka	0229	10:18:52.4			316 54	33 30	
00162	Mitaka	0229	10:20:21.6			297 24	56 24	
00163	Musashino	0233	10:21:02.4			270	65 30	
00164	Sendai	0246	08:37:36.6			31 54	24 48	
00165	Sendai	0246	08:39:13.6			59 00	24 24	
00166	Sendai	0246	08:40:19.8			75 24	22 24	
00167	Sendai	0246	08:42:22.2			96 12	15 12	
00168	Shizuoka	0247	08:43:05			94 30	11 00	
00177	Ikoma	0216	10:22:09	4 28	16			
00178	Konko	0224	10:21:22	4 55	35			
00179	Konko	0224	10:22:41	5 20	6			
00180	Manazuru	0228	10:22:02	3 14	16			
00181	Manazuru	0228	10:22:23	3 26	10			
00182	Manazuru	0228	10:22:28	3 31	7			
00183	Miyazaki	0230	10:21:23	6 13	45			
00184	Miyazaki	0230	10:21:44	6 12	23			
00185	Suwa	0248	08:37:47	9 28	53			
00186	Suwa	0248	10:20:24	1 37	44			
00187	Suwa	0248	10:20:37	1 55	41			
00188	Suwa	0248	10:22:19	3 44	6			
00189	Suwa	0248	10:22:35	3 58	-00 10			
00190	Suwa	0248	10:23:44	4 28	-14			
00191	Konko	0224	10:21:22			90	72	
00192	Mitaka	0229	10:18:47			317 06	30 24	
00193	Mitaka	0229	10:20:30.9			293 12	57 24	
00194	Mitaka	0229	10:22:12.7			201 12	61 06	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° '	h ° '	MAG.
			January 23, 1958 (cont'd.)					
00196	Arlington	0071	23:33:21			90	37 30	
00197	Cleveland B	8505	23:32:21+4	6 28	18+2.5			1 to 9
00198	North Canton	0053	23:32:59	6 42	14 30			
00209	Pittsburgh	0059	23:31:33	7 16	37 30			
00210	Pittsburgh	0059	23:35:45			135	25	
00211	Dover	0039	20:31:29			45	60	
00212	Dover	0039	23:32:24			90	56	
00213	State College	0060	23:32:30			89	41	
00214	State College	0060	23:32:45	6 27	19 30			
00215	State College	0060	23:37:06	6 20	-18			
00216	Bryn Athyn	0055	23:29:34	16 06	80			
00217	Bryn Athyn	0055	23:29:52			0	35	
00218	Bryn Athyn	0055	23:31:33			45	53	
00219	Bryn Athyn	0055	23:35:18	6 00	- 8			
00220	Bryn Athyn	0055	23:37:00	6 00	-19			
00221	Millbrook	0045	23:31:56	5 04	41 10			
00222	Millbrook	0045	23:33:41	5 35	- 4 00			
00223	Paterson, N.J.	0108	23:33:13	5 43	8 30			
00224	Washington, D.C.	0014	23:35:12.5			112 42	24	
00230	Milwaukee B	0198	23:30:58	7 18	29 00			
00238	New Haven	0087	23:25:02	5 23 00	6 19			
00239	Washington, D.C.	6001	23:29:05	14 50	74 05			
00240	Washington, D.C.	6001	23:31:05	8 00	69 08			
00241	Washington, D.C.	6001	23:32:05	6 40	43 04			
00242	Washington, D.C.	6001	23:33:05	6 35	24 02			
00243	Washington, D.C.	6001	23:33:35	6 32	16 05			
00244	Washington, D.C.	6001	23:34:55	6 28	1 05			
00245	Washington, D.C.	6001	23:35:50	6 26	- 7 04			
00246	Washington, D.C.	6001	23:37:10	6 21	17 06			
00423	Cambridge	0099	23:30:38			338	58	
00424	Cambridge	0099	23:30:42			342	62	
00425	Cambridge	0099	23:30:55			354 30	67 30	
00426	Cambridge	0099	23:31:07			348 30	68	
00427	Cambridge	0099	23:31:15			355	72 30	
00428	Cambridge	0099	23:31:22			1 30	75	
00429	Cambridge	0099	23:31:28			12	76 30	
00430	Cambridge	0099	23:31:32			10 30	79 30	
00431	Cambridge	0099	23:31:38			17	81	
00432	Cambridge	0099	23:31:40			38 30	81 30	
00433	Cambridge	0099	23:31:44			56 30	82 30	
00434	Cambridge	0099	23:32:13			131 30	74	
00435	Cambridge	0099	23:32:33			121 30	69	
00436	Cambridge	0099	23:33:09			130	53	
00437	Cambridge	0099	23:33:28			131	49	
00438	Cambridge	0099	23:33:37			132	45	
00439	Cambridge	0099	23:33:43			133	44	
00440	Cambridge	0099	23:33:36			146	46	
00441	Cambridge	0099	23:33:55			147 30	40	
00442	Cambridge	0099	23:35:02			144	31 30	
00443	Cambridge	0099	23:35:39			147	25 30	
00575	College, Alaska	6450	03:36:24			180	37	
00672	Pic du Midi	2705	18:28:22			332 12	6 42	
00673	Pic du Midi	2705	18:28:45			333 00	8 42	
00674	Pic du Midi	2705	18:28:58			333 24	10 00	
00675	Pic du Midi	2705	18:29:13			334 12	11 30	
00676	Pic du Midi	2705	18:29:25			334 36	13 00	
00677	Pic du Midi	2705	18:29:41			335 30	14 42	
00678	Pic du Midi	2705	18:29:50			336 00	15 48	
00679	Pic du Midi	2705	18:30:00			336 36	17 12	
00680	Pic du Midi	2705	18:30:09			337 00	18 36	
00681	Pic du Midi	2705	18:30:19			337 48	20 00	
00682	Pic du Midi	2705	18:30:25			338 48	22 12	
00683	Pic du Midi	2705	18:30:42			339 30	23 48	
00684	Pic du Midi	2705	18:31:09			342 24	28 48	
00685	Pic du Midi	2705	18:31:19			343 30	30 42	
00686	Pic du Midi	2705	18:31:27			344 36	32 42	
00687	Pic du Midi	2705	18:31:37			346 00	34 48	
00688	Pic du Midi	2705	18:31:52			348 30	38 24	
00689	Pic du Midi	2705	18:32:03			351 00	41 18	
00690	Pic du Midi	2705	18:32:13			353 36	44 12	
00691	Pic du Midi	2705	18:32:23			356 24	47 00	
00692	Pic du Midi	2705	18:32:36			1 06	51 00	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ')	h (° ')	MAG.
			January 23, 1958 (cont'd.)					
00693	Pic du Midi	2705	18:32:48			5 48	54 24	
00694	Pic du Midi	2705	18:33:00			12 48	57 36	
00695	Pic du Midi	2705	18:33:12			21 00	60 30	
00696	Pic du Midi	2705	18:33:30			35 12	63 36	
00697	Pic du Midi	2705	18:33:44			51 12	64 42	
00698	Pic du Midi	2705	18:33:59			69 06	63 36	
			January 24, 1958					
00169	Pasacal	8008	02:50:37.091	2 07 48	80 46 (1950 position)			
00170	Pasacal	8008	02:50:45.092	2 47 00	78 59 (1950 position)			
00171	Pasacal	8008	02:50:53.092	3 15 54	76 56 (1950 position)			
00172	Organ Pass-BN	9001	02:54:03.95	1 39 12	17 25			
00173	Organ Pass-BN	9001	02:54:39.95	2 12 54	7 00			
00174	Organ Pass-SS	5001	02:52:25.8	23 53	40 27			
00175	Sac Peak-SS	2043	01:10:38.4	9 12	57 30			
00176	Sac Peak-SS	2043	02:52:25.2	23 45	37 30			
00199	North Canton	0053	01:13:47.5	1 44	- 2 48			
00200	Lawton	0110	01:08:57			355 00	18 42	
00201	Lawton	0110	01:11:00	19 18	36 24			
00202	Lawton	0110	01:12:54			68 30	44 18	
00203	China Lake	0098	02:51:02			0	57 30	
00204	Whittier	0012	02:54:47	5 43	- 1 12			
00205	Whittier	0012	02:55:06	5 50	- 5 48			
00206	Whittier	0012	02:55:59	5 52	-14 18			
00207	Wichita	0028	01:09:32.6	2 52 01.6	89 50			
00208	Wichita	0028	01:14:25.8	5 52	7 48			
00225	Washington, D.C.	0014	01:15:23.5			221 36	29	
00226	Columbus	0051	01:11:27	23 20	19			
00227	Tulsa	0054	01:11:54	5 42	45 30			
00228	Tulsa	0054	01:13:48	7 55	7 50			
00229	Tulsa	0054	01:15:58	6 00	-20 50			
00231	Milwaukee	0074	01:11:14	0 55	27 30			
00232	Milwaukee	0074	01:13:28.6	3 03	5 30			
00233	Milwaukee	0074	01:18:00.0	4 37	-30 50			
00234	Los Alamos	0043	01:12:01	7 35	31 00			
00235	Los Alamos	0043	02:52:04	0 10	29 00			
00236	Tucson	0003	02:54:38			180	69	
00237	Tucson	0003	02:56:31			164	39	
00247	Washington, D.C.	6001	01:11:05	22 52	27 04			
00248	Washington, D.C.	6001	01:12:50	0 13	11 08			
00249	Suwa	0248	09:30:27	5 58	- 2			
00250	Sendai	0246	09:25:14			338 42	33 18	
00251	Sendai	0246	09:25:59.8			343 36	45 24	
00252	Sendai	0246	09:26:41.7			353 18	59 12	
00358	Quebec	8021	22:37:19	5 32	45 30			
00359	Quebec	8021	22:39:26	5 32	6 40			
00360	Quebec	8021	22:39:38	5 32	- 0 45			
00444	Cambridge	0099	01:11:15			276	14 30	
00445	Cambridge	0099	01:12:54			252	18	
00446	Cambridge	0099	01:16:32			229	12	
00699	Pic du Midi	2705	17:39:59			35 12	32 42	
00700	Pic du Midi	2705	17:39:44			39 42	33 18	
00701	Pic du Midi	2705	17:39:52			43 24	33 42	
00702	Pic du Midi	2705	17:40:05			49 06	34 00	
00703	Pic du Midi	2705	17:40:21			54 24	34 00	
00704	Pic du Midi	2705	17:40:35			60 24	33 36	
00705	Pic du Midi	2705	17:40:45			64 18	35 18	
00706	Pic du Midi	2705	17:40:56			68 24	32 36	
00707	Pic du Midi	2705	17:41:09			72 30	31 54	
00708	Pic du Midi	2705	17:41:19			75 48	31 06	
00709	Pic du Midi	2705	17:44:31			79 24	30 12	
00710	Pic du Midi	2705	17:41:43			82 48	29 12	
00711	Pic du Midi	2705	17:41:53			85 24	28 24	
00712	Pic du Midi	2705	17:42:09			89 06	26 54	
00713	Pic du Midi	2705	17:42:19			91 18	26 00	
00714	Pic du Midi	2705	17:42:30			93 36	24 54	
00715	Pic du Midi	2705	17:42:43			95 54	23 54	
00716	Pic du Midi	2705	17:42:55			97 54	22 54	
00717	Pic du Midi	2705	17:43:04			99 24	22 00	
00719	Pic du Midi	2705	17:43:26			102 36	20 06	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
January 24, 1958 (cont'd.)								
00720	Pic du Midi	2705	17:43:35			103 54	19 18	
00721	Pic du Midi	2705	17:43:49			105 42	18 00	
00722	Pic du Midi	2705	17:44:04			107 06	17 00	
00723	Pic du Midi	2705	17:44:20			108 54	15 54	
00724	Pic du Midi	2705	17:44:30			110 00	15 06	
00725	Pic du Midi	2705	17:44:39			110 42	14 30	
00726	Pic du Midi	2705	17:44:47			111 30	13 54	
00727	Pic du Midi	2705	17:45:01			112 30	13 00	
00728	Pic du Midi	2705	19:19:54			292 18	28 18	
00729	Pic du Midi	2705	19:20:02			290 24	29 42	
00730	Pic du Midi	2705	19:20:10			287 48	30 54	
00731	Pic du Midi	2705	19:20:24			284 42	32 54	
00732	Pic du Midi	2705	19:20:39			280 24	35 06	
00733	Pic du Midi	2705	19:21:07			269 48	38 54	
00734	Pic du Midi	2705	19:21:20			265 12	40 06	
00735	Pic du Midi	2705	19:21:28			261 18	41 00	
00736	Pic du Midi	2705	19:21:38			256 54	41 42	
00737	Pic du Midi	2705	19:21:46			253 00	42 18	
00738	Pic du Midi	2705	19:21:59			247 48	42 48	
00739	Pic du Midi	2705	19:22:12			241 36	42 54	
00740	Pic du Midi	2705	19:22:18			238 18	42 48	
00741	Pic du Midi	2705	19:22:51			223 12	41 18	
00742	Pic du Midi	2705	19:23:00			220 18	40 30	
00743	Pic du Midi	2705	19:23:09			216 12	39 30	
00744	Pic du Midi	2705	19:23:18			213 42	38 36	
00745	Pic du Midi	2705	19:23:29			210 00	37 24	
00746	Pic du Midi	2705	19:23:[illegible]2			206 48	36 06	
00747	Pic du Midi	2705	19:23:50			204 06	35 12	
00748	Pic du Midi	2705	19:24:00			202 00	33 48	
00749	Pic du Midi	2705	19:24:09			200 06	33 18	
00750	Pic du Midi	2705	19:24:44			193 06	28 48	
00751	Pic du Midi	2705	19:24:53			191 30	27 42	
00752	Pic du Midi	2705	19:25:02			190 12	26 48	
00753	Pic du Midi	2705	19:25:21			187 36	24 54	
January 25, 1958								
00253	Woomera	3601	12:14:29.1			318 36 00	45 25 10	
00254	Woomera	3601	12:19:43			167 57 46	47 12 24	
00255	Woomera	3601	12:20:00.7			165 59 26	42 50 24	
00256	Woomera	3601	12:20:30.7			164 04 06	38 12 44	
00257	Woomera	3601	12:20:54.4			162 36 24	33 47 20	
00258	Woomera	3601	12:21:27.4			161 19 40	29 30 32	
00259	Woomera	3601	12:22:07			159 55 10	24 34 00	
00261	Woomera	3601	12:22:55			158 39 00	19 35 00	
00262	Organ Pass BN	9001	01:00:46.08	4 46 33.8	30 59	(1950 position)		
00263	Organ Pass BN	9001	01:01:50.08	5 07 31.50	9 55	(1950 position)		
00264	Organ Pass BN	9001	01:03:42.13	5 33 16.5	-15 26	(1950 position)		
00265	New Orleans	0030	00:22:21	7 01	20 39			
00266	New Orleans	0030	00:21:32			16	32 30	
00267	W. Palm Beach	0016	00:23:40			61	90	
00268	St.Petersburg	0121	00:23:58	6 12	12			
00269	Denver	0013	01:57:00			310 45	45 30	
00270	Denver	0013	02:01:00			168 18	36 36	
00271	Spokane B	8502	01:56:51	4 37	16			2
00272	Spokane B	8502	01:58:55	5 55	7 30			3
00273	Amarillo	0064	01:59:51			270	71 30	
00274	Alamagordo	0102	01:58:16	22 50	72 00			
00275	Alamagordo	0102	01:59:03	1 53	70 18			
00276	Alamagordo	0102	02:03:05	5 12	8 16			
00277	Sacramento C	8501	01:58:14.7	6 55 37.8	26 07 12			
00278	Sacramento C	8501	03:38:10.9	0 10 38.4	19 38 24			
00279	Sacramento C	8501	03:38:28.2	0 29 00	15 43 12			
00280	Lawton	0110	02:01:05			232 06	57 06	
00281	Lawton	0110	02:03:18			184 54	36 30	
00282	Lawton	0110	02:04:51			175 48	23 54	
00283	Los Alamos	0043	01:59:22	3 30	42			
00284	Los Alamos	0043	02:00:14	4 00	22 00			
00285	Los Alamos	0043	02:01:34	4 42	- 3 06			
00286	Edinburg, Tex.	0066	02:00:37			315 30	39 30	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			January 25, 1958 (cont'd)					
00287	Edinburg, Tex.	0066	02:02:49			266 30	73 30	
00288	Edinburg, Tex.	0066	02:03:53			183 30	68	
00289	Edinburg, Tex.	0066	02:05:03			168	49	
00290	Edinburg, Tex.	0066	02:07:33			162	24 30	
00291	Higashimatsuyama	0210	08:33:51.8	7 35	41			
00292	Higashimatsuyama	0210	10:20:57	3 47	-38			
00293	Fuchu	0214	10:16:46	3 18	3			
00294	Kagoshima	0218	10:19:10	5 09	- 9			
00295	Kanaya Machi	0220	10:16:55	2 44	3			
00296	Miyazaki	0230	10:17:39.6	4 26	1			
00297	Miyazaki	0230	10:17:57.6	5 33	- 3			
00298	Miyazaki	0230	10:19:39.9	5 04	-22			
00299	Shizuoka	0247	10:16:38	1 24	5			
00300	Sendai	0246	08:32:28.4			27 48	34	
00301	Sendai	0246	08:33:43.2			62	37 42	
00302	Sendai	0246	10:15:04			253 18	34 30	
00303	Sendai	0246	10:16:11.8			230 36	34	
00304	Mizusawa	0267	10:15:48			234 42	32 54	
00305	Mizusawa	0267	10:16:33			222 12	30 30	
00306	Mizusawa	0267	10:17:33			208 36	26 18	
00310	Cary	0112	23:27:34	6 10	44 30			
00311	Cary	0112	23:27:41	5 52	7 12			
00312	Cary	0112	23:28:03	5 48	- 3 30			
00361	C. Canaveral B	8007	23:28:38			74 35	29 07	
00362	C. Canaveral B	8007	23:28:48			77 13	28 45	
00363	C. Canaveral B	8007	23:28:58			79 47	28 20	
00364	C. Canaveral B	8007	23:29:08			82 13	27 51	
00365	C. Canaveral B	8007	23:29:18			84 36	27 20	
00366	C. Canaveral B	8007	23:29:28			86 54	26 47	
00370	C. Canaveral B	8007	23:29:38			89 07	26 11	
00371	C. Canaveral B	8007	23:29:42			90 00	25 54	
00372	C. Canaveral B	8007	23:29:48			91 08	25 34	
00373	C. Canaveral B	8007	23:30:00			93 32	24 48	
00374	C. Canaveral B	8007	23:30:30			98 53	22 46	
00375	C. Canaveral B	8007	23:31:00			103 37	20 41	
00376	C. Canaveral B	8007	23:31:30			107 40	18 37	
00377	C. Canaveral B	8007	23:32:00			111 12	16 36	
00378	C. Canaveral B	8007	23:33:00			116 56	12 47	
00379	C. Canaveral B	8007	23:34:00			121 24	9 16	
00380	C. Canaveral B	8007	23:35:00			124 56	6 04	
00381	C. Canaveral B	8007	23:36:00			127 49	3 07	
00390	C. Canaveral B	8007	01:09:30			251 23	38 38	
00576	College, Alaska	6450	03:32:00			180	25	
00647	C. Canaveral E	8018	00:22:16.88			51 05	53 46	
00648	C. Canaveral E	8018	00:22:28.88			61 36	54 22	
00649	C. Canaveral E	8018	00:22:44.88			75 39	63 56	
00650	C. Canaveral E	8018	00:23:08.88			93 49	61 04	
00651	C. Canaveral E	8018	00:23:44.88			112 05	54 08	
00657	Johannesburg	2401	18:49:57	5 36	- 6			
00658	Johannesburg	2401	20:34:04	1 00 24	- 46 42			
00663	Bonn Observatory	2712	16:45:31	5 26	43			2
00664	Bonn Observatory	2712	16:46:21	5 29	27 24			2
00665	Bonn Observatory	2712	18:23:59	21 11	28			3.0
00666	Bonn Observatory	2712	18:25:23	22 41	22 18			3.0
00667	Bonn Observatory	2712	18:25:53	23 26	19 18			3.0
00668	Bonn Observatory	2712	18:27:39	1 04	- 5 30			3.0
00669	Bonn Observatory	2712	18:29.25	1 42	- 16 06			3.0
00670	Bonn Observatory	2712	18:28:00	0 30	4			3.5
			January 26, 1958					
00307	Higashimatsuyama	0210	09:19:43	0 48	59			
00308	Mizukaido	0231	09:20:59			225	88	
00309	Organ Pass SS	5001	02:45:00	23 39 30	20 24			
00313	Denver	0013	01:02:24			358 30	35	
00314	Tulsa	0054	01:06:58	3 52	11 45			
00315	Tulsa	0054	01:08:52.5	4 38	-14 30			
00316	Tulsa	0054	01:10:26	5 01	-26 20			
00317	San Antonio	0096	01:08:03.2	5 45	25			
00318	Lawton	0110	01:07:25			123 24	53	
00319	Lawton	0110	01:07:49			128 54	46 54	
00320	Lawton	0110	01:08:06			131 30	43 30	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			January 26, 1958 (cont'd)					
00321	Denver	0013	02:45:30			256	20	
00322	Amarillo	0064	01:06:35	5 38	21 12			
00323	Amarillo	0064	01:07:24	5 40 00	7			
00324	Amarillo	0064	01:08:12	5 43	- 2 48			
00325	Edinburg	0066	01:07:40			45	47	
00326	Edinburg	0066	01:07:35			45	45 30	
00327	Edinburg	0066	01:07:23			45	46	
00328	Edinburg	0066	01:07:40			45	46	
00329	Alamagordo	0102	01:05:50	6 50	40 54			
00330	Alamagordo	0102	01:10:10	6 40	-16 00			
00331	Tucson	0003	02:44:07			308	27 30	
00332	Tucson	0003	02:51:24			180	22	
00382	C. Canaveral B	8007	01:08:00			280 13	32 46	
00383	C. Canaveral B	8007	01:08:10			277 28	33 50	
00384	C. Canaveral B	8007	01:08:20			274 35	34 44	
00385	C. Canaveral B	8007	01:08:30			271 34	35 37	
00386	C. Canaveral B	8007	01:08:35.2			270 00	36 01	
00387	C. Canaveral B	8007	01:08:40			268 25	36 20	
00388	C. Canaveral B	8007	01:08:50			265 11	37 02	
00389	C. Canaveral B	8007	01:09:00			261 49	37 37	
00391	C. Canaveral B	8007	01:09:40			247 50	38 43	
00392	C. Canaveral B	8007	01:09:50			244 23	38 41	
00393	C. Canaveral B	8007	01:10:00			240 55	38 31	
00394	C. Canaveral B	8007	01:11:00			222 17	35 28	
00395	C. Canaveral B	8007	01:12:00			208 26	30 23	
00396	C. Canaveral B	8007	01:13:00			198 38	24 54	
00397	C. Canaveral B	8007	01:14:00			191 47	19 47	
00398	C. Canaveral B	8007	01:15:00			186 48	15 16	
00399	C. Canaveral B	8007	01:16:00			183 05	11 11	
00400	C. Canaveral B	8007	01:17:00			180 11	7 37	
00401	C. Canaveral B	8007	01:17:04			179 59	7 22	
00402	C. Canaveral B	8007	01:18:00			177 46	4 20	
00577	College, Alaska	6450	02:36:20			180	45	
00659	Johannesburg	2401	17:53:04.6	6 25 12	23 12			
00660	Johannesburg	2401	19:34:45	2 05	-16 42			
00847	Pic du Midi	2705	19:12:10			276 42	23 54	
00848	Pic du Midi	2705	19:12:22			274 12	25 00	
00849	Pic du Midi	2705	19:12:34			271 00	25 36	
00850	Pic du Midi	2705	19:12:43			268 18	26 18	
00851	Pic du Midi	2705	19:12:55			265 00	27 06	
00852	Pic du Midi	2705	19:13:05			262 18	27 42	
00853	Pic du Midi	2705	19:13:14			259 36	28 06	
00854	Pic du Midi	2705	19:13:23			256 54	28 30	
00855	Pic du Midi	2705	19:13:30			254 42	28 42	
00856	Pic du Midi	2705	19:13:37			252 48	28 54	
00857	Pic du Midi	2705	19:13:46			250 18	29 06	
00858	Pic du Midi	2705	19:13:54			247 30	29 12	
00859	Pic du Midi	2705	19:14:08			243 24	29 12	
00860	Pic du Midi	2705	19:14:10			240 36	29 06	
00861	Pic du Midi	2705	19:14:28			237 30	29 00	
00862	Pic du Midi	2705	19:14:39			234 18	28 42	
00863	Pic du Midi	2705	19:14:48			232 00	28 24	
00864	Pic du Midi	2705	19:14:58			229 06	28 00	
00865	Pic du Midi	2705	19:15:05			227 12	27 42	
00866	Pic du Midi	2705	19:15:13			225 24	27 24	
00867	Pic du Midi	2705	19:15:21			223 06	26 54	
00868	Pic du Midi	2705	19:15:29			221 24	26 30	
00869	Pic du Midi	2705	19:15:38			219 18	26 00	
00870	Pic du Midi	2705	19:15:48			217 06	25 24	
00871	Pic du Midi	2705	19:15:55			215 36	24 54	
00872	Pic du Midi	2705	19:16:07			213 06	24 12	
00873	Pic du Midi	2705	19:16:17			211 12	23 24	
00874	Pic du Midi	2705	19:16:26			209 36	22 48	
00875	Pic du Midi	2705	19:16:33			208 12	22 12	
00876	Pic du Midi	2705	19:16:45			206 24	21 24	
00877	Pic du Midi	2705	19:16:54			205 00	20 48	
00878	Pic du Midi	2705	19:17:05			203 18	20 00	
00879	Pic du Midi	2705	19:17:18			201 30	19 12	
00880	Pic du Midi	2705	19:17:26			200 24	18 30	

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Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ′ ″	Z ° ′ ″	h ° ′ ″	MAG.
			January 26, 1958 (cont'd)					
00881	Pic du Midi	2705	19:17:35			199 18	17 54	
00882	Pic du Midi	2705	19:17:47			197 48	17 12	
00883	Pic du Midi	2705	19:17:54			197 00	16 36	
00884	Pic du Midi	2705	19:18:02			196 06	16 00	
00885	Pic du Midi	2705	19:18:23			193 54	14 42	
00886	Pic du Midi	2705	19:18:35			193 00	13 54	
00887	Pic du Midi	2705	19:18:50			191 24	12 54	
00888	Pic du Midi	2705	19:19:01			190 36	12 18	
00889	Pic du Midi	2705	19:19:10			190 00	11 42	
00890	Pic du Midi	2705	19:19:22			189 00	11 00	
00891	Pic du Midi	2705	19:19:31			188 18	10 24	
00892	Pic du Midi	2705	19:19:42			187 36	9 54	
00893	Pic du Midi	2705	19:19:51			186 54	9 18	
00894	Pic du Midi	2705	19:20:53			183 18	5 54	
00895	Pic du Midi	2705	19:21:09			182 24	5 06	
00896	Pic du Midi	2705	19:21:18			182 00	4 36	
00897	Pic du Midi	2705	19:21:32			181 24	3 54	
			January 27, 1958					
00333	Biloxi	0090	00:13:22			90	60	
00334	New Orleans	0031	00:13:41			90	48	
00335	New Orleans	0030	00:12:28			60	48 30	
00336	W.Palm Beach	0016	00:14:33			270	86	
00337	Arlington	0071	00:09:51	22 41	30 00			
00338	Arlington	0071	00:10:44			270	36	
00339	St. Petersburg	0121	00:12:25	2 00	65			
00340	St. Petersburg	0121	00:14:25	3 55	22 30			
00341	St. Petersburg	0121	00:19:58	5 25	-35 30			
00342	Silver Spring	0032	00:10:08	23 00	26	0	32 30	
00343	China Lake	0098	01:47:19					
00344	Amarillo	0064	01:47:57	21 25	45	295	38	
00345	Edinburg, Tex.	0066	01:52:26			270 30	48 30	
00346	Edinburg, Tex.	0066	01:53:36			189 30	31 30	
00347	Edinburg, Tex.	0066	01:57:30					
00348	Manhattan	0027	01:50:00	23 02	14 56			
00349	Lawton	0110	01:50:20	23 05	26 06	199 30	25 06	
00350	Lawton	0110	01:55:08					
00351	San Antonio	0096	01:52:39.3	23 33	17	270	44 30	
00352	San Antonio	0089	01:52:36					
00353	Phoenix	0002	01:50:50	3 58	39 35			
00354	Phoenix	0002	01:52:00	4 22	15 30			
00355	Phoenix	0002	01:55:04	5 11	-21 45			
00356	Alamagordo	0102	01:49:43	22 40	52 00			
00357	Alamagordo	0102	01:51:48	2 04	23 12			
00367	Washington,D.C.	6001	23:12:00	20 20	51 06			
00368	Washington,D.C.	6001	23:15:00	1 50	37 05			
00369	Washington,D.C.	6001	23:18:10	4 15	- 7			
00403	Higashimatsuyama	0210	10:08:47.9	1 29 12	-20 36			
00404	Fuchu	0214	10:05:24	23 51	19			
00405	Kagoshima	0218	10:06:08	00 56	34			
00406	Kanaya Machi	0220	10:05:04	23 08	28			
00407	Konko	0224	10:05:05	23 30	28			
00408	Mizukaido	0231	08:27:02	5 38	9			
00409	Yokkaichi	0258	10:06:43	00 33	4	106 36	33	
00410	Mitaka	0229	08:27:20.2			275 54	24 24	
00411	Mitaka	0229	10:04:54.4					
00412	Mitaka	0229	10:05:44.2			263 36	27 30	
00413	Mitaka	0229	10:06:54.3			244 12	29 00	
00414	Mitaka	0229	10:08:26.9			221 24	25 48	
00415	Mitaka	0229	10:10:16.1			203 18	18	
00416	Sendai	0246	08:24:59			77 42	54	
00417	Sendai	0246	08:25:16			87 24	1 54	
00418	Sendai	0246	08:26:43			115 42	36 42	
00419	Yamagata	0257	08:25:18			90	49 42	
00420	Yatsushiro	0272	10:03:06			315	40	
00421	Washington,D.C.	6019	00:09:49	22 39	29 30			
00422	Albuquerque	0103	01:56:08	4 25	-34			3 - 4
00447	C. Canaveral B	8007	00:08:30			332 16	10 55	
00448	C. Canaveral B	8007	00:09:00			332 05	13 58	
00449	C. Canaveral B	8007	00:09:30			331 52	17 26	
00450	C. Canaveral B	8007	00:10:00			331 33	21 21	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			January 27, 1958 (cont'd)					
00451	C.Canaveral B	8007	00:10:30			331 07	25 58	
00452	C.Canaveral B	8007	00:11:00			330 30	31 16	
00453	C.Canaveral B	8007	00:11:30			329 38	37 34	
00454	C.Canaveral B	8007	00:12:00			328 22	45 04	
00455	C.Canaveral B	8007	00:12:30			326 15	53 57	
00456	C.Canaveral B	8007	00:13:00			321 58	64 14	
00457	C.Canaveral B	8007	00:13:30			310 43	75 21	
00458	C.Canaveral B	8007	00:14:00			251 49	83 49	
00459	C.Canaveral B	8007	00:14:30			183 58	77 22	
00460	C.Canaveral B	8007	00:15:00			170 13	67 00	
00461	C.Canaveral B	8007	00:15:30			165 22	57 37	
00462	C.Canaveral B	8007	00:16:00			162 59	49 35	
00463	C.Canaveral B	8007	00:16:30			161 35	42 44	
00464	C.Canaveral B	8007	00:17:00			160 40	37 04	
00465	C.Canaveral B	8007	00:17:30			160 04	32 08	
00466	C.Canaveral B	8007	00:18:00			159 35	27 56	
00467	C.Canaveral B	8007	00:18:30			159 13	24 20	
00468	C.Canaveral B	8007	00:19:00			158 56	21 06	
00469	C.Canaveral B	8007	00:19:30			158 43	18 13	
00470	C.Canaveral B	8007	00:13:55.7			270 00	83 18	
00471	Ft.Belvoir	0077	23:16:19			180	86	
00472	Philadelphia	0058	23:16:23			180	54	
00473	Washington,D.C.	0014	23:14:02			323 42	59	
00474	Silver Spring	0032	23:14:11	0 40	49			
00491	W.Palm Beach	0016	23:19:14			90	43	
00492	C.Canaveral B	8007	00:14:35.1			180 00	75 37	
00495	Washington,D.C.	6001	00:08:15	21 20	39			
00496	Washington,D.C.	6001	00:09:30	22 34	30 07			
00497	Washington,D.C	6001	00:09:40	22 41	29 06			
00498	Washington,D.C.	6001	00:10:00	23 04	28 08			
00499	Washington,D.C.	6001	00:11:10	0 07	13 05			
00500	Washington,D.C.	6001	00:11:30	0 25	9 05			
00501	Washington,D.C.	6001	00:13:10	1 48	-11 06			
00502	Washington,D.C.	6001	00:15:50	3 02	-25 07			
00503	Washington,D.C.	6001	00:17:30	3 45	-37 00			
00569	Swarthmore	2038	23:14:50	1 18 58.8	32 21 12.9	(1958 Position)		
00570	Swarthmore	2038	23:14:53	1 20 29.8	32 17 16.4	(1958 Position)		
00571	U.of Penna. B	8015	23:14:53	1 18 57.2	32 19 15	(1958 Position)		
00578	College, Alaska	6450	03:24:25			180	16	
00652	C.Canaveral D	8017	00:15:07.31			166 58	67 07	
00653	C.Canaveral D	8017	00:15:11.31			166 16	65 46	
00654	C.Canaveral D	8017	00:15:15.31			165 39	64 28	
00655	C.Canaveral D	8017	00:15:19.31			165 00	63 09	
00656	C.Canaveral D	8017	00:15:29.31			163 59	59 55	
00661	Johannesburg	2401	18:38:21.4	3 22 06	9 06			
			January 28, 1958					
00475	Biloxi	0090	00:56:52			270	44 30	
00476	Denver	0013	00:54:22			125	59	
00477	Edinburg,Tex.	0066	00:55:37			352	42	
00478	Edinburg,Tex.	0066	00:57:03			18	65 30	
00479	Edinburg,Tex.	0066	00:57:51			71 30	73	
00480	Amarillo	0064	00:55:10			90	81 30	
00481	Amarillo	0064	00:55:26			96	79	
00482	Amarillo	0064	00:55:35	3 43 00	24 30			
00483	Sylacauga	0001	00:55:14	22 47 55	24 22 27			
00484	Sylacauga	0001	00:59:24			225	32 13 10	
00485	San Antonio	0089	00:57:04			90	81	
00486	Manhattan	0027	00:51:39	20 40	45 06			
00487	Manhattan	0027	00:53:58	23 29	37 21			
00488	Manhattan	0027	00:54:27	0 10 30	29 40			
00489	San Antonio	0096	00:57:02.8	3 34	28 30			
00490	Whittier	0012	02:34:30			268	61	
00493	Tucson	0003	02:38:04			219 30	30 45	
00494	Tucson	0003	02:39:57			199 45	21	
00507	Honolulu	0114	05:56:40	0 11 30	11			
00508	Honolulu	0114	06:01:23	0 48	-51			
00509	Kanazawa	0221	09:08:54	1 15	37			
00510	Kanazawa	0221	09:09:33	1 55	22			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			January 28, 1958 (cont'd)					
00511	Takada	0250	09:08:51	0 40	30			
00512	Sendai	0246	09:09:00			252 18	49 36	
00513	Sendai	0246	09:11:00			197 48	37 06	
00514	Sendai	0246	09:12:34			182 30	27 12	
00515	Yamagata	0257	09:11:02			192 30	40 18	
00550	Bryn Athyn	0055	23:57:22			270	21	
00553	St.Petersburg	0121	23:51:00	5 42	7			
00586	Suwa	0248	09:08:00	23 05	49			
00587	Suwa	0248	09:08:40	0 12	41			
00606	C.Canaveral C	8016	23:56:00			324 18	9 41	
00607	C.Canaveral C	8016	23:57:00			321 44	15 42	
00608	C.Canaveral C	8016	23:58:00			317 40	23 03	
00609	C.Canaveral C	8016	23:59:00			311 07	32 32	
00618	C.Canaveral B	8007	00:53:30			308 10	5 59	
00619	C.Canaveral B	8007	00:54:00			304 25	8 49	
00620	C.Canaveral B	8007	00:54:30			301 20	10 56	
00621	C.Canaveral B	8007	00:55:00			297 47	13 05	
00622	C.Canaveral B	8007	00:55:30			293 46	15 18	
00623	C.Canaveral B	8007	00:56:00			289 17	17 22	
00624	C.Canaveral B	8007	00:56:30			284 12	19 36	
00625	C.Canaveral B	8007	00:57:00			278 29	21 34	
00626	C.Canaveral B	8007	00:57:30			272 24	23 13	
00627	C.Canaveral B	8007	00:57:41.0			270 00	23 50	
00628	C.Canaveral B	8007	00:58:00			265 43	24 44	
00629	C.Canaveral B	8007	00:58:30			258 41	25 40	
00630	C.Canaveral B	8007	00:59:00			251 30	26 10	
00631	C.Canaveral B	8007	00:59:30			244 23	26 07	
00632	C.Canaveral B	8007	01:00:00			237 29	25 36	
00633	C.Canaveral B	8007	01:00:30			231 01	24 40	
00634	C.Canaveral B	8007	01:01:00			225 05	23 24	
00635	C.Canaveral B	8007	01:01:30			219 44	21 54	
00636	C.Canaveral B	8007	01:02:00			214 56	20 17	
00637	C.Canaveral B	8007	01:02:30			210 41	18 33	
00638	C.Canaveral B	8007	01:03:00			206 53	16 47	
00639	C.Canaveral B	8007	01:03:30			203 32	15 01	
00640	C.Canaveral B	8007	01:04:00			200 33	13 16	
00641	C.Canaveral B	8007	01:04:30			197 56	11 34	
00642	C.Canaveral B	8007	01:05:00			195 32	9 55	
00643	C.Canaveral D	8017	00:59:37.86			260 31	25 53	
00644	C.Canaveral D	8017	00:59:41.86			259 34	26 00	
00645	C.Canaveral D	8017	01:01:13.86			236 18	25 50	
00646	C.Canaveral D	8017	01:01:17.86			235 28	25 44	
00662	Washington,D.C.	6001	23:57:00	22 42	30 02			
00671	Bonn Obs.	2712	17:19:42	0 10	14 30			
			January 29, 1958					
00551	Bryn Athyn	0055	00:00:47			225	23	
00552	Decatur	0132	00:00:00	1 17	32 30			
00554	St.Petersburg	0121	00:01:42	0 58	35 18			
00555	St.Petersburg	0121	00:03:00	2 05	17			
00556	Spokane A	0086	01:32:00			320	20	
00557	Spokane A	0086	01:33:30			270	60	
00558	Spokane A	0086	01:36:45			180	35	
00559	Manhattan	0027	01:38:00	23 18	1 40			
00560	Manhattan	0027	01:41:08	0 54	-24 15			
00561	Whittier	0012	01:37:31			60	68	
00562	Alamagordo	0102	01:37:39	23 03	32 48			
00563	Alamagordo	0102	01:39:33	1 06	21 48			
00564	Amarillo	3010	01:35:53			270	30 30	
00565	Edinburg, Tex.	0066	01:38:45			296	22	
00566	Edinburg, Tex.	0066	01:39:46			284 30	28	
00567	Edinburg, Tex.	0066	01:40:42			270	32 30	
00568	Edinburg, Tex.	0066	01:43:13			225	32 30	
00572	Organ Pass-SS	5001	01:36:43.2	21 21 00	47 06			
00573	Organ Pass-SS	5001	01:39:44.4	0 14	6 12			
00574	Organ Pass-SS	5001	01:40:55.8	2 04 30	-11 18			
00588	McDonald	2309	01:45:56	3 13	-41			
00590	Bryn Athyn	0055	22:59:50			270	48	
00610	C. Canaveral C	8016	00:00:00			299 05	44 12	
00611	C. Canaveral C	8016	00:01:00			274 46	55 47	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
			January 29, 1958 (cont'd.)					
00612	C. Canaveral C	8016	00:01:07.9			270 00	56 56	
00613	C. Canaveral C	8016	00:02:00			234 44	58 50	
00614	C. Canaveral C	8016	00:03:00			203 49	50 44	
00615	C. Canaveral C	8016	00:04:00			188 22	40 13	
00616	C. Canaveral C	8016	00:05:00			180 19	31 08	
00617	C. Canaveral C	8016	00:05:01.8			180 00	30 52	
00822	Nagasaki I	0235	09:53:32	22 40	28			
00834	Johannesburg	0403	18:28:46	3 21	-62 54			
			January 30, 1958					
00591	Lawton	0110	00:39:45			294 12	46 24	
00592	Lawton	0110	00:41:30			232 48	59	
00593	Lawton	0110	00:44:36			176 36	28 54	
00594	San Angelo	0105	00:41:38			270	80	
00595	San Antonio	0096	00:42:19.5	1 38	27 30			
00596	Edinburg, Tex.	0066	00:43:37			225	81 15	
00597	Edinburg, Tex.	0066	00:44:46			170 30	61 30	
00598	Edinburg, Tex.	0066	00:46:34			162 30	36 15	
00599	Sylacauga	0001	00:44:44			225	12 03 14	
00600	Wichita	0028	00:44:48.2	2 50 49.2	-32 42			
00601	Fort Worth	0069	00:41:07	1 52	29 50			
00602	Fort Worth	0069	00:41:09	1 48	30 20			
00603	Fort Worth	0069	00:41:09	1 56	27 40			
00604	Fort Worth	0069	00:41:30	1 26	24 15			
00605	Spokane A	0086	02:15:45			280	20	
00798	Laredo	4009	00:44:05	3 05	4			
00799	Laredo	4009	00:46:47	4 35	-24			
00800	Greensboro A	0049	23:46:00			209	26	3
00801	W.Palm Beach	0016	23:52:07			180	15	1
00807	C.Canaveral B	8007	23:44:06			280 07	38 11	
00808	C.Canaveral B	8007	23:45:06			258 08	43 25	
00809	C.Canaveral B	8007	23:46:06			233 32	43 10	
00810	C.Canaveral B	8007	23:47:06			213 41	38 12	
00811	C.Canaveral B	8007	18:48:06			200 22	31 34	
00812	C.Canaveral B	8007	23:49:06			191 40	25 13	
00813	C.Canaveral B	8007	23:50:06			185 45	19 40	
00814	C.Canaveral B	8007	23:51:06			181 35	14 55	
00815	C.Canaveral B	8007	23:52:06			178 29	10 44	
00816	C.Canaveral B	8007	23:53:06			176 04	7 04	
00817	C.Canaveral B	8007	23:54:06			174 09	3 49	
00818	C.Canaveral B	8007	23:44:35.7			270 00	41 19	
00819	C.Canaveral B	8007	23:51:34.5			180 00	12 52	
00820	Kanazawa	0221	08:54:17	0 25	17			
00821	Yokkaichi	0258	08:54:12	0 03	27			
00823	Mizukaido	0231	08:55:34			225	42	
00824	Otsu	0269	08:54:28			258	65	
00825	Washington,D.C.	6001	23:42:15	22 37	9 24			
00826	Washington,D.C.	6001	23:43:25	23 22	- 1 48			
00827	Washington,D.C.	6001	23:44:40	0 34	19 48			
00828	Washington,D.C	6001	23:46:20	1 01	-26			
00835	Johannesburg	0403	17:27:26.4	5 08	- 8 36			
00836	Edwards AFB	3013	02:20:30			245 24	38 43	
			January 31, 1958					
00802	Denver	0013	01:19:36.6			274 30	22	1
00803	Denver	0013	01:20:48.6			256 30	25	
00804	San Antonio	0089	01:23:18	22 52	09 30			6
00805	Albuquerque	0041	01:21:27.5	24 15	15			1 - 7
00806	Albuquerque	0041	01:27:27.5			264	35 54	
00829	Cambridge	0099	22:43:12			236	27	
00830	Cambridge	0099	22:43:35			229 30	28	
00831	Cambridge	0099	22:44:52			212 30	24	
00832	Cambridge	0099	22:45:07			211 30	23	
00833	Cambridge	0099	22:45:21.2			207 30	19 30	
00838	Johannesburg	0403	18:10:47.6	1 35-12	-57 30			

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α h m s	δ ° ' "	Z ° ' "	h ° ' "	MAG.
				February 1, 1958				
00839	Johannesburg	0403	02:53:53	20 16	-57 12			
00840	C. Canaveral B	8007	00:28:00			238 23	13 23	
00841	C. Canaveral B	8007	00:28:30			234 00	12 48	
00842	C. Canaveral B	8007	00:29:00			229 52	12 06	
00843	C. Canaveral B	8007	00:29:30			226 02	11 07	
00844	C. Canaveral B	8007	00:30:00			222 20	10 11	
00845	C. Canaveral B	8007	00:30:30			219 17	9 05	
00846	C. Canaveral B	8007	00:31:00			216 09	8 06	
				February 2, 1958				
00837	Stanford, Radar	4008	15:21	Slant Range: 340 km±10		120±1	41±1	
				February 3, 1958				
00898	C. Canaveral F	8020	00:01:00			282 58	6 54	
00899	C. Canaveral F	8020	00:02:00			274 59	8 58	
00900	C. Canaveral F	8020	00:03:00			266 19	10 21	
00901	C. Canaveral F	8020	00:04:00			257 21	11 11	
00902	C. Canaveral F	8020	00:05:00			248 23	11 17	
00903	C. Canaveral F	8020	00:06:00			239 47	10 41	
00904	C. Canaveral F	8020	00:08:00			224 50	7 56	
00905	C. Canaveral F	8020	00:02:34.8			270 00	9 49	
01007	Pic du Midi	2705	18:04:24			238 24	10 12	
				February 4, 1958				
00906	C. Canaveral C	8016	11:36:15			118 04	29 05	
00907	C. Canaveral C	8016	11:36:30			99 49	28 34	
00908	C. Canaveral C	8016	11:36:45			83 40	25 47	
00909	C. Canaveral C	8016	11:37:00			71 28	22 11	
00910	C. Canaveral C	8016	11:37:15			62 46	18 40	
00911	C. Canaveral C	8016	11:37:30			56 21	15 37	
00912	C. Canaveral C	8016	11:37:45			51 40	12 59	
00913	C. Canaveral C	8016	11:38:00			48 04	10 49	
00914	C. Canaveral C	8016	11:38:15			45 16	8 56	
00915	C. Canaveral C	8016	11:38:30			43 02	7 19	
00916	C. Canaveral C	8016	11:38:45			41 13	5 54	
00917	C. Canaveral C	8016	11:39:00			39 42	4 38	
00918	C. Canaveral C	8016	11:39:15			38 26	3 31	
00919	C. Canaveral C	8016	11:39:30			37 22	2 30	
00920	C. Canaveral C	8016	11:39:45			36 27	1 33	
00921	Grand Bahama, Radar	4900	11:36:10	Slant Range: 728,487'		86 01 52	70 22 01	
00922	Grand Bahama, Radar	4900	11:36:20	Slant Range: 811,158'		54 34 48	57 43 19	
00923	Grand Bahama, Radar	4900	11:36:30	Slant Range: 955,998'		43 36 36	45 36 25	
00924	Grand Bahama, Radar	4900	11:36:40	Slant Range: 1,139,496'		38 27 07	36 29 17	
00925	Grand Bahama, Radar	4900	11:36:50	Slant Range: 1,345,876'		35 29 38	29 49 19	
00926	Grand Bahama, Radar	4900	11:37:00	Slant Range: 1,564,774'		33 35 17	24 50 53	
00927	Grand Bahama, Radar	4900	11:36:09.2	Slant Range: 725,289'		90 23 53	71 03 04	
00928	Grand Bahama, Radar	4900	11:36:09.3	Slant Range: 725,664'		89 52 26	70 59 06	
				February 6, 1958				
00929	Bloemfontein	0401	02:39:50	8 02 06	-39 53 02			
00930	Milton	6003	11:10:42	16 34	- 7 12			0
00931	Milton	6003	11:11:22	19 11	27 18			
00932	Milton	6003	11:11:56	20 12	40 18			
00933	Milton	6003	11:12:47	22 52	42 42			2
00934	W. Palm Beach	0016	11:06:03			180	25	
00935	W. Palm Beach	0016	11:07:39			49	28	
00936	St. Petersburg	0121	11:06:32	17 40	-21			
00937	St. Petersburg	0121	11:07:21	19 32	10 36			
00938	St. Petersburg	0121	11:08:30	21 18	35			1 to
00939	St. Paul B	0199	12:50:28	18 52	31			2 to
00940	San Angelo	0105	12:46:27			180	77 45	-2
00941	San Angelo	0105	12:46:42			90	84	

Table 3.--Processed optical observations of Satellite 1957 Beta (continued)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			February 6, 1958 (cont'd.)					
00942	Cambridge	0099	11:11:04.8			122	47	
00943	Cambridge	0099	11:11:09.6			114 06	47 06	
00944	Cambridge	0099	11:11:27.4			85	42 30	
00945	Cambridge	0099	11:11:27.6			82	42 12	
00946	Cambridge	0099	11:11:32.2			81	41 30	
00947	Cambridge	0099	11:11:34.4			77 06	40 30	
00948	Cambridge	0099	11:11:34.8			76	40 06	
00949	Cambridge	0099	11:11:43.8			71 30	34 30	
00950	Cambridge	0099	11:13:00.8			48 30	15 12	
00951	Cambridge	0099	11:13:23.0			45 48	12 00	
00952	Cambridge	0099	11:13:15.8			42 30	12 36	
00953	Amarillo	0064	12:47:31	19 07	13 18			1
00954	Quebec	8021	11:10:50.4	16 29	-26 50			
00955	Quebec	8021	11:12:22.2	19 47	7 10			
00966	Montevideo	0808	07:35:34.2±0.5			27 18±1°	57 42±30'	0 to ·
00967	Maui	5010	03:00:45	19 03 43	56 19			
00977	Athens	2706	04:36:07	16 30	-27 06			5
			February 7, 1958					
00956	Organ Pass	5001	13:19:51.6	10 20	21			
00957	U. of Illinois	2014	11:43:44.4±.1	20 02 12±6	16 57±1.5	(1958 position)		
00958	U. of Illinois	2014	11:42:49.7±.1			131 40±1.5	*23 16±1.5	
00959	U. of Illinois	2014	11:43:55.3±.1			68 51±1.5	*19 38±1.5	
00960	Albuquerque	0041	13:19:50			225	25	-3
00961	Albuquerque	0041	13:20:22	11 12	15 30			
00962	Albuquerque	0041	13:20:27	11 08	21			
00963	Albuquerque	0041	13:21:08	9 40	65			
00964	Milwaukee B	0198	11:46:00±3	19 50	8			2
00965	Alamagordo	0102	13:22:00	14 54	69 08			0.5
00968	Albuquerque	0103	13:21:52			0	21	
			February 8, 1958					
00969	Mitaka	0229	20:26:44.2	23 36	56			
00970	Kurume Machi	0227	20:24:38.6			315	79 18	
00971	Sendai	0246	20:25:53			27 12	41 42	
00972	Mitaka	0229	20:26:03.3			25 06	17 48	
00973	Mitaka	0229	20:27:05.7			26 54	8 18	
00974	Mitaka	0229	20:25:50			24 18	21 24	
00975	Mitaka	0229	20:27:07			26 48	8 06	
00976	U. of Illinois A	2014	12:16:00.4	10 04 54	42 18	(1958 position)		
			Note:	Angles to 10'	Time to $0^s.5$			
00978	Athens	2706	04:03:16	16 23	-25 12			2.5
00979	Athens	2706	04:03:34	17 08	-15 42			3.5
00980	Athens	2706	04:03:57	18 09	- 0 24			-
00981	Athens	2706	04:04:16	19 05	13 18			3.0
00982	Athens	2706	04:04:54	20 26	27 30			5.0
00984	Chicago	0020	12:15:55			270	45	-3
00985	Evansville	0094	12:15:00			270	10	
00986	Lemont	0022	12:17:26			0	35±5	
00987	Terre Haute	0025	12:15:15			270	28	-1.5
00988	Terre Haute	0025	12:17:08			0	35	3
00989	Los Altos	0005	13:52:14	16 10	12			0
00990	Milwaukee A	0074	12:15:30	12 00	- 6 30			1
00991	Milwaukee A	0074	12:16:22.9	11 42	33 30			1
00992	Milwaukee A	0074	12:18:59	1 00	52 30			4
00993	Chicago	0085	12:15:44.0	11 15 30	10 07			-1
00994	Chicago	0085	12:15:51.9	11 10 18	15 23			
00999	Washington, D.C.	6001	10:36:40	19 26	7 48	(1950 position)		
01008	Yerkes	2042	12:16:01	12 40	- 1			
01015	Edwards AFB	3013	13:54:29			9 47 49	10 41 42	
			February 9, 1958					
00983	U. of Illinois	2014	11:08:41.9	20 36 42	23 58	(1958 position)		
			Note:	Angles to 5'	Time to $0^s.5$			
00995	Harrisonburg	0072	11:10:11	0 47	57 42			0
00996	Dayton	0082	11:08:29.8±0.3	20 16±1	39 54±0.1			1.5
00997	Dayton	0082	11:08:45.8±0.3	20 56±1	40 42±0.2			
00998	St. Paul B	0199	12:56:52			270	24	
01000	Dunlap Obs.	2451	11:11:04	23 07 10	44 41	(1958 position)		
01001	Washington, D.C.	6001	11:08:18	10 39	25 12	(1950 position)		

Table 3.--Processed optical observations of Satellite 1957 Beta (concluded)

OBS. NO.	STATION	STA. NO.	U.T.	α (h m s)	δ (° ' ")	Z (° ' ")	h (° ' ")	MAG.
			February 9, 1958 (cont'd.)					
01002	Washington, D.C.	600.	11:08:51	9 28	51 04 12			1
01003	Washington, D.C.	6001	11:09:00	8 50	61 00			0
01004	Washington, D.C.	6001	11:09:33	3 30	71 24			1
01005	Washington, D.C.	6001	11:10:01	1 54	63 30			2
01006	Washington, D.C.	6001	11:10:18	1 36	59 24			3
01012	Athens	2706	04:36:21	8 49	47 42			0
			February 10, 1958					
01009	Dayton	0082	11:40:23.8±0.5			0±0°3	9 45±18	0
01010	Stanford, Radar	4008	13:14:35			120	48	
				Slant Range: 360 km				
01011	St. Paul B	0199	11:39:44.5	20 45	33 30			-1
			February 11, 1958					
01024	College, Alaska	6450	17:07:00			180	35	
			February 12, 1958					
01013	Stanford, Radar	4008	12:31:44			120	25	
				Slant Range: 535 km				
01016	Landstraat	8031	06:07:39.8	2 05	63 36			
			February 13, 1958					
01014	Stanford, Radar	4008	12:58:28	Slant Range: 430 km		300	32	
01017	Landstraat	8031	04:54:37.8	20 31	29 12			3.5
01018	Blaricum	8023	04:54:03.7	19 01 36	32 18			0.3
01019	Netherlands, 812	8029	04:54:02.7	19 12	31 06			1.5
01020	Utrecht A	2707	04:54:03.0	19 25 18	28 36			1.5
01021	Utrecht A	2707	04:54:20.0	20 21 48	32 00			
			February 14, 1958					
01022	Steenwijk	8004	05:19:36.8	11 11 36	62			-3.0
01023	Steenwijk	8004	05:20:35.0	10 35 24	79			
01025	College, Alaska	6450	16:46:30			180	55	
			February 16, 1958					
01033	College, Alaska	6450	15:54:15.2			180	41	
			February 17, 1958					
01026	Steenwijk	8004	04:52:17.4	1 54	63 18			
01027	Emmen	8025	04:52:37.6	1 30	57 12			1
01028	Sneek	8028	04:52:30.8	1 08 36	60 12			1
01029	Sneek	8028	04:52:52.6	1 39 42	56 54			
			February 18, 1958					
01030	Emmen	8025	05:14:29.2	03 10	31 00			1
01031	Sneek	8028	05:13:56.7	3 46 54	55 18			1
01032	Steenwijk	8004	05:13:36.9	4 53 30	63 18			1
01034	College, Alaska	6450	16:37:33.2			180	88 30	
			February 19, 1958					
01035	Laredo, Radar	4009	10:16:43.2	Slant Range: 800 N Miles		311 21	2 36	
01036	Laredo, Radar	4009	10:16:57.8	Slant Range: 805 N Miles		316 21	4 54	

Table 4.--Code numbers and geographical coordinates of observing stations

Station No.	Station	Longitude East ° ' "	Latitude ° ' "	Height Meters
0001	Sylacauga, Ala.	273 44 47.4	33 09 44.6	181
0002	Phoenix, Ariz.	247 56	33 27	335
0003	Tucson, Arizona	249 03 51	32 13 59	227
0004	Altaville, Calif.	239 20	38 10 07	366
0005	Los Altos, Calif.	237 52 34	37 23 56	29
0006	Oakland, Calif.	237 48	37 47 00	30
0007	Sacramento A, Calif.	238 43 25	38 38 25.8	180
0008	San Francisco, Calif.	237 32 07	37 46 10	76
0009	Santa Barbara, Calif.	240 18 30	34 24 30	12
0010	Stockton, Calif.	238 47 36	37 54 17	11
0011	Walnut Creek, Calif.	237 55 30	37 55 30	10
0012	Whittier, Calif.	241 58 25	33 58 40	149
0013	Denver, Colo.	255 03 24	39 44 52	1625
0014	Washington, D.C.	282 47 29.5	38 45 37.3	69
0015	Lakeland, Fla.	278 03	28 02	61
0016	West Palm Beach, Fla.	279 55 20	26 39 30	5
0017	Hapeville, Ga.	275 42	33 47 27	323
0018	Boise, Idaho	243 32 30	43 36 30	1006
0019	Idaho Falls, Idaho	247 49 58	43 26 17	1423
0020	Chicago, Ill.	272 21	41 59	218
0021	Danville, Ill.	272 22 26	40 08 57	189
0022	Lemont, Illinois	272 00 19	41 41 48	229
0023	Peoria, Ill.	270 24 09	40 54 19	238
0024	Indianapolis, Ind.	273 50 38	39 40 40	223
0025	Terre Haute, Ind.	272 36 10	39 31 38	155
0027	Manhattan, Kans.	263 31 09	39 09 45	311
0028	Wichita, Kansas	262 45 19	37 41 44	413
0029	Wilmore, Ky.	275 20 06.1	37 51 36	282
0030	New Orleans, La.	269 59	29 57	2
0031	New Orleans, La.	269 53	29 56	2
0032	Silver Spring, Md.	282 59 37	39 05 50	140
0033	Detroit, Mich.	276 47 35	42 28 57	183
0034	Lansing, Mich.	275 31	42 44	261
0035	St. Paul Minneapolis A, Minn.	266 50 01.1	44 55 03.6	306
0036	Kansas City, Mo.	265 25 08	39 02 02	259
0038	Lincoln, Nebr.	263 20 48	40 50 18	355
0039	Dover, N. J.	285 28 15	40 57 30	267
0040	Red Bank, N. J.	285 55	40 17 40	0
0041	Albuquerque , New Mex.	253 21 24	35 05 03	1520
0042	Las Cruces, New Mex.	253 09 10	32 19 42	1186
0043	Los Alamos, New Mex.	253 40 40	35 52 30	2256
0044	Buffalo, N. Y.	281 24	42 58	229
0045	Millbrook, N. Y.	286 22 33	41 51 30	243
0046	New York City, N. Y.	286 01 15	40 54 30	259
0047	Rochester, N. Y.	282 26 11	43 06 27	154
0048	Charlotte, N. C.	279 12 30	35 13 00	195
0049	Greensboro A, N. C.	280 07 57.58	36 04 38.53	265
0050	Cincinnati, Ohio	275 17 24.757	39 11 29.881	270
0051	Columbus, Ohio	276 58 45	39 58 45	229
0052	Cleveland A, Ohio	278 12 16	41 29 46	220
0053	North Canton, Ohio	278 32 40.6	40 55 54.9	366
0054	Tulsa, Okla.	264 03	36 03	204
0055	Bryn Athyn, Pa.	284 56	40 08	85
0056	Chambersburg, Pa.	282 22 10	39 55 41	201
0057	Harrisburg, Pa.	283 05 20	40 15 42	128
0058	Philadelphia, Pa.	284 59 18	39 57 28	32
0059	Pittsburgh, Pa.	280 00	40 29	381
0060	State College, Pa.	282 06 36	40 44 00	393
0061	Yankton, S. Dak.	262 36 34	42 52 42	379
0062	Chattanooga, Tenn.	274 44 23	35 01 02.41	229
0064	Amarillo, Tex.	258 03 28	35 11 30	1125
0065	Bryan, Tex.	263 39 58.630	39 38 14.708	92
0066	Edinburgh, Tex.	261 49 39	26 18 20.4	28
0068	Fort Worth, Tex.	262 37 50	32 44 40	186
0069	Forth Worth, Texas	262 38 14.57	32 42 27.25	182
0070	Waco, Tex.	262 47	31 37	
0071	Arlington, Va.	282 53 30	38 51 30	59
0072	Harrisonburgh, Va.	281 08	38 28 20	463
0073	Roanoke, Va.	280 04	37 19	343
0074	Milwaukee A, Wisc.	271 51 05.62	42 58 07.53	294
0075	Struthers, Ohio	279 30	41 07 30	305
0076	Porthland, Oreg.	237 22 27	45 29 19	9
0077	Fort Belvoir, Va.	282 48 42	38 45 30	85
0078	Sunnyvale, Calif.	237 30	37 22 27	17
0079	Athens, Ga.	276 40 35	33 57 06	245
0080	St. Louis, Mo.	269 48 09.5	38 37 59.1	152
0081	Schenectady, N. Y.	285 58 57	42 53 32.4	235
0082	Dayton, Ohio	275 44 10	39 50 52	229
0083	Big Spring, Tex.	258 33 27	32 15 11	754
0084	Dodson, Tex.	259 43 30	34 42	549
0085	Chicago, Ill.	272 23 35.9	41 51 58.4	194
0086	Spokane A, Wash.	242 38 59	47 37 37	706
0087	New Haven A, Conn.	287 03 10	41 19 58	12
0088	Baltimore, Md.	283 24 35	39 24 28	144
0089	San Antonio, Tex.	261 30 48.9	29 27 24.9	256
0090	Biloxi, Miss.	271 08 28	30 23 27	7
0091	Panama City, Fla.	274 25	30 06	5
0092	Rantoul, Ill.	271 50 56.2	40 17 50.7	237
0093	Waco (Connally AFB), Tex.	262 55 30	31 38 30	149
0094	Evansville, Ind.	272 28 08.80	37 58 14.86	129
0096	San Antonio (Randloph AFB), Tex.	261 42 33	29 32 06	232
0097	Bristol, Tenn.	277 50 31	36 35 03	527
0098	China Lake, Calif.	242 20 13.2	35 39 25.2	701
0099	Cambridge, Mass.	288 52 14.25	42 22 47.6	24
0100	Los Angeles, Calif.	241 45 43	33 59 41	61
0101	Dayton (Wright-Patterson AFB), Ohio	274 55	39 47	
0102	Alamogordo, New Mex.	254 02 58.045	32 52 24.273	1335
0103	Alburquerque (Kirtland AFB), N. Mex.	253 23 30.837	35 03 18.25	1618
0104	El Paso (Biggs AFB), Tex.	253 37	31 50	
0105	San Angelo (Goodfellow AFB), Tex.	259 32 13	31 27 19	581

Table 4.--Code numbers and geographical coordinates of observing stations (continued)

Station No.	Station	Longitude East ° ′ ″	Latitude ° ′ ″	Height Meters
0106	Phoenix (Williams AFB), Ariz.	248 19	33 17	
0107	Yuma, Ariz.	245 24 53	32 39 09	65
0108	Patterson, N. J.	285 51	40 54	30
0109	Santa Monica, Calif.	241 20	34 04 30	2800
0110	Lawton, Okla.	261 35 48	34 39 45	1175
0111	Clinton, Miss.	269 40 03.787	32 20 20.78	353
0112	Cary, N. C.	281 14 17	35 47 41	152
0113	Van Nuys, Calif.	241 24 45	34 14 22	276
0114	Honolulu, Pacific	202 20 45	21 18 13	94
0115	Truk, Pacific	151 51	7 28	2
0116	Wake, Pacific	166 39	19 16 30	4
0117	Yap, Pacific	138 08	9 31	16
0118	Pago Pago, Pacific	189 19 10	-14 16 50	3
0119	Culver City, Calif.	241 24 06	34 09 01.8	
0120	Norwalk, Conn.	286 34 35	41 09 21	30
0121	St. Petersburg, Fla.	277 16	27 46 40	15
0122	Madison, Wisc.	270 33 39	43 03 57	317
0123	Memphis, Tenn.	270 08 46.6	35 09 26	85
0124	New Britian, Conn.	284 13 45	41 41 25	61
0125	San Antonio (Lackland AFB), Tex.	261 23 09.1	29 22 46.7	213
0126	Bartlesville, Okla.	264 04	36 42	213
0127	Reno, Nev.	240 12	39 33	1372
0128	Salem, Ill.	271 02 00	38 38 45	174
0129	Dallas, Tex.	263 14 29	32 51 10	172
0130	Tempe, Ariz.	248 06	33 25	347
0131	Hapeville, Ga.	275 38 24	33 39 11	270
0132	Decatur, Ga.	275 42 57	33 47 27	323
0133	San Diego, Calif.	242 45 13.7	32 42 25.9	125
0134	San Jose, Calif.	238 11 13	37 23 01	122
0135	Oklahoma City, Okla.	262 29 20	35 33 50	360
0136	Wichita Falls, Tex.	261 26	33 49	303
0194	New Haven B, Conn.	287 05 55	41 19 41	
0197	Greensboro B, N. C.	280 11	36 04	
0198	Milwaukee B, Wisc.	272 01 15.1	42 59 25.5	
0199	St. Paul B, Minn.	266 45 59.4	44 58 30.7	
0200	Akita, Japan	140 07 02	39 41 42	6
0201	Asahikawa	142 21 50	43 46 27	113
0202	Ashiya	135 18 55	34 43 42	14
0204	Chunichi	136 54 14	35 10 23	25
0205	Fukuoka I	130 25 40	33 37 25	16
0206	Fukuoka II	130 21 33	33 34 50	14
0207	Fukuoka III	130 24 59	33 33 10	23
0208	Gifu	136 47 04	35 25 49	339
0209	Hashimoto	135 37 03	34 19 02	125
0210	Higashimatsuyama	139 23 54	36 02 22	31
0211	Hiroshima	132 28 10	34 22 08	3
0212	Honjo	139 11 05	36 14 25	56
0213	Hofu	131 33 56	34 03 13	10
0214	Fuchu	133 14 25	34 34 25	30
0215	Ichinomiya	136 48 42	35 17 32	8
0216	Ikoma	135 40 23	34 40 34	634
0217	Isahaya	130 03 08	32 51 41	70
0218	Kagoshima	130 31 47	31 31 34	13

Station No.	Station	Longitude East ° ′ ″	Latitude ° ′ ″	Height Meters
0219	Kanagawa	139 21 16	35 26 34	51
0220	Kanaya Machi, Japan	135 15 10	34 03 46	40
0221	Kanazawa	136 41 01	36 32 45	80
0222	Kashiwabara	135 48 15	34 30 24	66
0223	Kiryu	139 19 54	36 24 22	110
0224	Konko	133 37 40	34 32 31	4
0225	Kumamoto	130 44 34	32 46 57	17
0226	Kure	132 33 44	34 14 57	5
0227	Kurume Machi	139 31 48	35 45 18	52
0228	Manazuru	139 08 46	35 09 23	25
0229	Mitaka	139 32 30	35 40 20	50
0230	Miyazaki	131 25 24	31 55 23	8
0231	Mizukaido	139 59 18	36 00 56	12
0232	Mount Fuji I	138 48 50.3	35 31 20.8	815
0233	Musashino	139 34 35	35 42 58	75
0234	Nagano	137 50 44	35 30 50	500
0235	Nagasaki I	129 51 56	32 46 53	15
0236	Nagoya	136 59 11	35 08 57	50
0237	Nakatsu	131 11 53	33 36 10	5
0238	Niigata	139 02 21	37 55 05	24
0239	Oita, Japan	131 11 57	33 36 06	4
0240	Osaka	135 31 01	34 38 36	24
0241	Osaka Yomiuri	135 30 30	34 41 51	30
0243	Otaru	141 00 23	43 11 27	10
0244	Saga	130 17 59	33 14 35	5
0245	Sapporo	141 22 13	43 04 49	20
0246	Sendai	140 51 56	38 15 22	45
0247	Shizuoka	138 23 18	34 58 25	20
0248	Suwa	138 07 43	36 00 13	762
0249	Tadotsu	133 45 16	34 16 20	5
0250	Takada	138 15 22	37 06 38	23
0251	Takamatsu	134 02 13	34 20 28	5
0252	Tohoku Univ.	140 52 38	38 16 28	47
0253	Tokushima	134 35 32	34 07 34	1
0254	Toyama	137 11 07	36 42 13	65
0255	Toyohashi	137 24 37	34 45 09	16
0256	Uwajima	132 33 32	33 12 49	2
0257	Yamagata	140 20 59	38 15 16	151
0258	Yokkaichi, Japan	136 39 00	35 00 15	3
0259	Kyoto	135 42 24	35 01 01	55
0260	Atsuta	136 54 17	35 08 05	10
0261	Chiba	139 58 14	35 51 29	10
0262	Himeji	134 41 24	34 50 25	25
0263	Kasukabe	139 44 34	35 58 36	5
0264	Kochi	133 30 35	33 33 25	30
0265	Kyushu Univ.	130 30 41	33 19 55	8
0266	Mie	136 37 19	34 58 10	3
0267	Mizusawa	141 07 51	30 08 04	62
0268	Nagasaki II	129 52 20	32 47 05	25
0269	Otsu	135 52 08	35 00 24	90
0270	Takaoka	137 01 39	36 44 23	8
0271	Utsunomiya	139 51 45	36 33 56	130
0272	Yatsushiro	130 36 15	32 30 21	3
0273	Mt. Fuji II	138 48 57.5	35 25 50.6	1040

Table 4.--Code numbers and geographical coordinates of observing stations (continued)

Station No.	Station	Longitude East ° ′ ″	Latitude ° ′ ″	Height Meters
0400	Lwiro, Belgian Congo	28 45	- 2 16	1707
0401	Bloemfontein, Union of S. Africa	26 13 35.50	-29 06 19.56	1494
0402	Cape Town, Union of S. Africa	18 28 37.984	-33 56 00.440	7
0403	Johannesburg, Union of S. Africa	28 04 30	-26 10 55.3	1806
0404	Pretoria, Union of S. Africa	28 13 43.5	-25 47 18	1542
0600	Adelaide, Australia	138 36 14	-34 55 14	55
0601	Perth	115 51 10	-32 00 07	5
0602	Sydney	151 05 41	-33 54 43	15
0603	Woomera	136 46 59	-31 06 13	155
0604	Melbourne	144 58 24	-37 49 54	29
0800	Buenos Aires	301 33 55.96	-34 36 19.26	23
0801	Buenos Aires	301 33 39	-34 37 10	103
0802	Merlo Pcia, Bs. As.	301 15 03	-34 40 56	25
0803	Cordoba	295 48 12	-31 25 16	439
0804	Antofagasta, Chile	289 34 03	-23 39 11	10
0805	Santiago (Romero)	289 18 48	-33 33 42	573
0806	Santiago (Heilmaier)	289 21 46	-33 25 21	864
0807	Arequipa, Peru	288 27 55	-16 23 05	2377
0808	Montevideo, Uruguay	303 50 00	-34 55 10	38
0809	Quito, Ecuador	281 32 15	- 0 10 47	
0900	Puebla, Pue, Mex.	261 49	19 03	2200
0901	Curacao, Emmastad, Netherlands, Antilles	291 03 28	12 09 04	6
2001	Univ. of Alabama Obs.	272 27 27	33 12 33	87
2002	Lowell Obs.	248 18 51	35 12 30.5	2210
2003	Univ. of Arizona Obs.	249 03 05	32 13 59.4	757
2004	Leuschner Obs.	237 44 16	37 52 23.5	94
2005	Lick Observatory	238 21 16	37 20 25.3	1283
2006	Mt. Palomar Obs.	243 08 10	33 21 22.4	1706
2007	Mt. Wilson Obs.	241 56 25	34 12 59.5	1742
2008	Wesleyan Univ. Obs.	287 20 27	41 33 18	65
2009	Yale Univ. Obs.	287 04 51	41 19 22.3	40
2010	Georgetown College Obs.	282 55 26	38 54 26	62
2011	U. S. Naval Obs.	282 56 03	38 55 14.0	86
2012	Agnes Scott College Obs	275 42 21	33 55 54.5	315
2013	Northwestern Univ. Obs.	272 19 32	42 03 27.2	175
2014	Univ. of Illinois Obs., A	271 46 31.5	40 06 20.2	236
2015	Univ. of Indiana, Obs.	273 28 45	39 09 56	238
2016	Univ. of Iowa, Obs.	268 28 00	41 39 44	221
2017	Maria Mitchell Obs.	289 53 43	41 16 50	20
2018	Mt. Holyoke College Obs.	287 25 15	42 15 18.2	76
2019	Wellesley College Obs.	288 41 40	42 17 37.1	61
2020	Univ. of Michigan Obs.	276 16 11	42 16 48.7	282
2021	McMath-Hulbert Obs.	276 44 10	42 39 47.7	296
2022	Univ. of Minnesota, Obs.	266 45 44	44 58 40	260
2023	Univ. of Mississippi, Obs.	270 28 12	34 22 12.6	161
2024	Washington Univ. Obs.	269 41 40	38 38 57.0	178
2025	Princeton Univ. Obs.	285 21 06	40 20 47.7	43
2026	Dudley Obs.	286 13 13	42 39 12.8	70
2027	Cornell Univ. Obs.	283 31 26	42 27 10.4	270
2028	Columbia Univ. Obs.	286 02 30	40 48 34.6	25
2029	Syracuse Univ. Obs.	283 51 40	43 02 13.1	160
2030	Cincinnati Obs.	275 34 39	39 08 19.8	247
2031	Warner and Swasey Obs., A	278 25 55	41 32 13.1	247
2032	Ohio State Univ. Obs.	276 59 21	39 59 50.4	233
2033	Ohio Wesleyan Univ.Obs.	276 56 40	40 15 04	270
2034	Univ. of Pittsburgh, Obs.	279 58 40	40 28 58.1	370
2035	Haverford College Obs.	284 41 49	40 00 40.1	116
2036	Univ. of Pennsylvania Obs., A	284 43 17	39 58 02.1	74
2037	Lehigh Univ. Obs.	284 37 01	40 36 23.2	110
2038	Swarthmore College Obs.	284 38 36	39 54 16.2	63
2039	McDonald Obs.	255 58 40	30 40 17.0	2081
2040	Univ. of Virginia Obs.	281 28 40	38 02 01.2	259
2041	Univ. of Wisconsin Obs.	270 35 32	43 04 36.8	292
2042	Yerkes Obs.	271 26 41	42 34 12.6	334
2043	Sacramento Peak Obs.	254 10 47.261	32 47 14.870	2823
2044	Colgate Univ. Obs.	284 28	42 49	
2045	Rensselaer Polytechnic Obs.	286 19 14.893	42 43 44.2	
2046	Univ. of Illinois Obs., B	271 46 36.7	40 06 16.2	
2047	Univ. of Illinois Obs. C	271 46 24.0	40 05 54.3	
2048	Univ. of Illinois Obs. D	271 40 22.8	40 01 04.6	
2049	Univ. of Illinois Obs. E	271 49 55	40 08 28	
2050	Warner and Swasey (Nassau Sta.), B	278 55 36	40 35	
2052	Agassiz Station, Har.	288 26 27	42 25 18	183
2053	Princeton Obs. of Instruction	285 20 35.8	40 20 57.8	65
2054	Boston Univ. Obs.	288 53 37.5	42 21 00.6	36
2400	Boyden Station, Bloemfontein	26 24 21	-29 02 18	1387
2401	Union Obs. Johannesburg	28 04 30	-26 10 55.3	1806
2450	Dominion Obs., Ottawa	284 17 00.8	45 23 38.1	87
2451	David Dunlap Obs., Univ. of Toronto	280 34 40.5	43 51 46	244
2600	Mt. Stromlo Obs.	149 00 20	-35 19 16	768
2601	Sydney Obs.	151 12 14.6	-33 51 41.1	44
2650	Royal Greenwhich Obs., Herstmonceux	0 20 16	50 52 01.3	32
2651	Armagh Obs., A	353 21 08	54 21 11.1	64
2652	Dunsink Obs., A	353 39 43.5	53 23 13.1	86
2653	Royal Obs. Edinburgh	356 48 59	55 55 30	146
2654	Dunsink (santry), B	353 45	53 24	
2700	Vienna Univ. Obs.	16 20 20	48 13 55.1	240
2701	Bratislava-Koliba Obs.	17 06 37	48 10 18	260
2702	Ondrejov Obs.	14 47 01	49 54 38.1	533
2703	Copenhagen Univ. Obs.	12 34 40	55 41 12.6	14
2704	Helsinki Univ. Obs.	24 57 16.5	60 09 42.3	33
2705	Pic du Midi Obs.	0 08 32	42 56 12.0	2862

Table 4.--Code numbers and geographical coordinates of observing stations (continued)

Station No.	Station	Longitude East ° ′ ″	Latitude ° ′ ″	Height Meters
2706	National Obs., Athens	23 43 01	37 58 19.7	110
2707	Sonnenborgh Obs., Utrecht A	5 07 45	52 05 10	14
2708	Stockholm Obs.	18 18 30	59 16 18	55
2709	Harestua Obs.	10 45 00	60 12 30	
2710	Observatoire de Saint Michel	5 04 48	43 55 47.2	580
2711	Skalnaté Pleso (Haute Tatra) Obs.	20 14 00	49 11 42	1783
2712	Univ. Obs., Bonn	.7 05 47.7	50 43 45.0	62
2800	National Obs., Cordoba	295 48 12.6	-31 25 16.4	434
2801	National Obs., Santiago	289 18 43.6	-33 33 44.2	580
2900	Manila Obs., Phillippines	120 34 45	16 24 46	
3001	Perkin Elmer, Norwalk, Conn.	286 35	41 09	
3002	Hanscom AFB, Mass.	288 44 42	42 27 18	
3003	Cape Canaveral, A, Fla.	279 25 39	28 26 02.36	
3004	Perkin Elmer, Fla.	279 27 04.32	28 02 58.48	30
3005	Patuxent N.A.S., Md.	283 36	38 17	
3006	Fort Monmouth, N. J.	285 54 39	40 17 46	
3007	Holloman AFB, White Sands, New Mex.	253 40	32 25 30	
3008	Whittenburg College, Ohio	276 11 02.9	39 56 08.1	
3009	Wright-Patterson, AFB, Ohio	275 55 11	39 47 22	
3010	Amarillo AFB, Tex.	258 03 28	35 11 30	
3011	Westover AFB, Mass.	286 19 15	42 43 44	
3012	Eglin AFB, Fla.	273 30	30 30	
3013	Edwards AFB, Calif.	242 04 58.43	34 56 43.19	
3450	Fort Churchill, Manitoba	265 55 01	58 45	
3601	Woomera Range, Edinburg, Australia	136 46 46	-31 06 06	
3602	Salisbury, Australia	138 38 45	-34 44 13	
3900	Wilkes, Antarctica	110 27	-66 28	
4001	Stanford Res. Inst. Palo Alto, Calif.	237 47	37 25	
4002	Lincoln Labs., Lexington, Mass.	288 30 31	42 37 02	
4003	Evans Labs, N. J.	285 56 20.4	40 11 02	
4004	Diana Radar, N. J.	285 05 42	40 12	
4007	Cornell Aero. Lab., B, N. Y.	281 16 36	42 55 56	
4008	Stanford Res. Inst., Calif.	237 49 29	37 24 11	152
4009	Laredo Radar, Tex.	260 29 21	27 31 07	
4650	Jodrell Bank , Macclesfield, Eng.	357 41 38	53 30 11	
4900	Grand Bahama, B.W.I.	281 39 06.8	26 36 34.9	
5001	Organ Pass, New Mex, SS	253 26 51.741	32 25 24.550	1651

Station No.	Station	Longitude East ° ′ ″	Latitude ° ′ ″	Height Meters
5002	El Segundo, Calif. PT	241 50	33 50	
5003	Eastman, Rochester, N. Y. PT	282 33 58	43 03 38	
5004	Good Hope, Ill. PT	269 20	40 38	
5005	Cleveland, Ohio, PT	278 20	41 30	
5006	Ansco, Binghampton, N. Y. PT	284 10	42 07	
5007	Albuquerque, New Mex.PT	253 20	35 00	
5008	Petersburg, Alaska, PT	227 00	56 45	
5009	Menlo Park, Calif., PT	237 50	37 25	
5010	Maui Hawaii, SS	203 44 23.4	20 42 36	3058
5011	Holloman AFB, White Sands, New Mex., B	253 50 26.949	33 07 56.183	
5450	Meanook, Alberta	246 39 15.4	54 36 58.6	68
5451	Newbrook, Alberta	247 02 43.7	54 19 28.3	67
5800	Quito Station, New Mex. College Of A and M	281 39	- 0 05 30	
5801	Quito Station, B	281 31	- 0 12	
6001	Washington, D. C., R. H. Wilson	282 59 24	38 50	
6002	Washington, D. C., Smithsonian Inst.	282 58 24	38 53 17.3	
6003	Milton, Mass., H. Stubbs	288 53	42 13	
6004	Weston, Mass., A. Campbell	288 43 25	42 23 09	175
6005	Dover, New Hampshire	289 07 26	43 23 10	
6006	Cornell Aero. Lab., A	281 19 30	42 57 05	213
6007	Charleston, S. C., G. L. Luke	280 01	32 55	
6008	Dahlgren, Va., NPG	282 57 59.07	38 17 03.19	
6010	Welcome, Md., L.T. Johnson	282 53 26	38 24 29	
6011	Hampton, Va., Hastings-Raydist, Inc.	238 39 03.409	37 00 56.210	
6019	Washington, D. C., H Fitzpatrick	282 56 24	38 56 06	
6450	College Geophysical Station, Alaska	212 10 12	64 51 18	
6700	Jockis Meteorlogical Obs., Finland	23 19	60 49	
6701	Helsinki Obs., B	25 02 30	60 12 54	
6900	Cape Hallett, Antarctica	170 18	-72 18	
6901	Air Force. Arctic	251 30	81 24	
7000	Canberra, Australia, Lawley House	149 08	-35 19	570
7001	Canberra, Australia, National Univ.	149 06 30	-35 16	560
7002	Pezinok, Czechoslovakia	17 16 21	48 17 47	170
7003	Decatur, Georgia	275 42 57	33 47 27	323
8001	Blossom Pt. Md., R. H. Wilson	282 54 48.2	38 25 49.6	

Table 4.--Code numbers and geographical coordinates of observing stations (concluded)

Station No.	Station	Longitude East ° ′ ″	Latitude ° ′ ″	Height Meters
8002	Utrecht B, Netherlands - 802	5 05 20	52 05 31	
8003	Hilversum, Netherlands - 805	5 10 00	52 12 20	
8004	Steenwijk, Netherlands - 807	6 07 01	52 46 59	
8005	Sacramento MW, D	239 08 36	38 38 06	
8006	Washington D. C., L. Holloway	283 03	38 52	
8007	Cape Canaveral B, Fla.	279 26 21.5	28 31 29.3	11
8008	Pasadena, Calif., (Pasacal)	241 50 38	34 06 56	
8009	Washington, D.C., MW, C	282 47 30	38 45 30	69
8010	Navy	14 52	35 51	
8011	Mt. Vaca, Calif., (Sacramento MW)	237 53 24	38 24 30	
8012	Navy	291 34 42	36 01 12	
8013	China Lake, Calif.	242 22 30	35 41 38	
8014	Blossom Pt., Md. L.T. Johnson	282 55	38 25	
8015	Univ. of Penn., B	284 31 24	39 59 57	74
8016	Cape Canaveral, C, Fla.	279 25 05.5	28 25 16.3	6
8017	Cape Canaveral, D, Fla.	279 25 40.4	28 06 33.8	6
8018	Cape Canaveral, E, Fla.	279 26 11.0	28 30 02.2	9
8020	Cape Canaveral, F, Fla.	279 24 38	28 27 58.3	
8021	Quebec, Canada	288 31 06	46 53 03	
8022	Weesp, Netherlands - 803	5 02 21	52 18 12	
8023	Blaricum, Netherlands - 804	5 14 53	52 16 15	
8024	Amsterdam, Netherlands - 806	4 42 00	52 18 25	
8025	Emmen, Netherlands - 808	6 54 15	52 46 40	
8026	Beverwijk, Netherlands - 809	4 38 56	52 28 58	
8027	Bussum, Netherlands - 810	5 09 18	52 16 52	
8028	Sneek, Netherlands - 811	5 39 52	53 02 25	
8029	Netherlands - 812	6 08 28	52 19 51	
8030	Netherlands - 813	5 03 14	52 39 50	
8031	Landstraat, Netherlands 814	4 44 59	52 37 39	
8032	Washington, D. C., Bald Eagle Hill	282 59 31	38 49 13	
8034	Mansfield, Conn.	287 48 40	41 49 20	
8035	Boulder, Radio	254 42	40 05	
8036	Armagh Obs., B	353 21 12	54 21 12	
8037	Univ. of Kansas	264 45	38 37 31	
8039	Cape Canaveral, Fla. G	279 24 38	28 16 18	11
8500	Sacramento, Calif., MW. B	238 59 38.4	38 41 19.8	411
8501	Sacramento, Calif., MW, C	238 14 58.8	38 33 05.4	
8502	Spokane, Wash., MW, B	242 42 30	47 45 00	
8503	Fort Worth, Tex. MW, B	262 37 51	32 42 42	
8505	Cleveland, Ohio, MW, B	278 10 18	40 25 30	
8506	Sylacauga, Ala., MW, B	273 44 39.8	33 10 20.3	
8507	Near Adelaide, Australia	138 35 48	-34 55 39	
8508	Sunnyvale, Calif., MW, B	238 01 48	37 12	
8509	Springfield, Va. (Washington D. C. MW), B	282 56 48	38 54 12	
8510	New York City, MW, B.	286 04 10	40 44 23	
8511	Schenectady, N.Y., B	286 03 30	42 54 36	123
9001	Organ Pass, N. Mex., BN	253 26 51.741	32 25 24.550	1651
9002	Olifantsfontein, S. Africa, BN	28 08 25.5	-26 11 42	1707
9003	Woomera, Australia, BN	136 48	-31 08	
9005	Tokyo, Japan, BN	139 32 30	35 40 21.4	59
9004	Cadiz, Spain, BN	353 47 42	36 27 42.0	30

Successive Revisions of Orbital Elements for Satellite 1957 Beta

By L. G. Jacchia

Since the launching of the second Soviet earth satellite, the computation and analysis center of the Optical Satellite Tracking Program at the Smithsonian Astrophysical Observatory has issued orbital elements, ephemerides, predictions of latitude crossings, as well as station predictions on a continuous basis. The frequency with which these parameters are issued depends on operational needs; the orbital elements are revised at intervals of about one week.

A selected listing of orbital elements for Satellite 1957 β1, determined at various intervals, is presented in table 1. It should be emphasized that two basic effects determine the degree of revision necessary for successive determinations of the elements.

During the initial stages of orbit calculations, a process takes place which has its closest analogy in the mathematical process of successive approximations. As more and better data are received, the exact values of orbital elements can be determined with increasing accuracy.

On the other hand, the orbit configurations of a satellite close to a planetary body undergo considerable changes with time. The changes in the values of the orbital elements evidence the effects of such factors as the oblateness of the earth and atmospheric drag, and, in turn, lend themselves to a determination of these factors.

It should be made clear that the orbital elements in table 1 are *prediction* elements, in the form suited for the machine computation of ephemerides. In view of the erratic acceleration of the satellite in its orbit, no simple equation can represent its orbital position over any extensive period of time. Therefore these prediction elements should not be used to compute satellite positions except for epochs very close to the date at which they were released.

Preliminary orbital elements

On Nov. 5, 1957, only hours after the launching, Drs. C. A. Whitney, L. G. Jacchia, and G. Veis derived the following preliminary orbital elements for Satellite 1957 Beta from U. S. S. R. announcements and three optical sightings:

Epoch and time of osculation (at ascending node).	Nov. 4.3952 UT
Inclination	$i = 63\overset{\circ}{.}8 \pm 1°$
Period	$P = 103.6 \pm 0.05$ min
Right ascension of node	$\alpha_{\Omega} = 111\overset{\circ}{.}0 \pm 0\overset{\circ}{.}1$
Eccentricity	$e = 0.105$
Semi-major axis (in equatorial radii).	$a = 1.1463$
Argument of perigee	$\omega = 44° + 0\overset{\circ}{.}6$/day

The successive revisions of the prediction elements are given in table 1. Table 2 gives the orbital elements derived from the prediction elements.

Table 1.--Successive revisions of prediction elements for Satellite 1957 Beta (t in year days)

Date of revision	Time of ascending node crossing	Right ascension of ascending node	Argument of perigee	Perigee distance	Inclination
1957 Dec. 27	$358.136965 + 0.070279655n$ $-1.42032 \times 10^{-6}n^2$ $-4.252 \times 10^{-10}n^3$	338°3-289 (t-358)	40°0-0.2 (t-358)		65°0
1958 Jan. 9	$358.136965 + 0.070279655n$ $-1.42032 \times 10^{-6}n^2$ $-4.252 \times 10^{-10}n^3$	338°1-2.799 (t-358) $-0°0019\ (t-358)^2$	40°0-0.2 (t-358)		65°0
Jan. 16	$358.20725 + 0.07028728n$ $-1.586 \times 10^{-6}n^2$ $-6.0 \times 10^{-11}n^3$ $(n > 0)$ $358.20725 + 0.07028728n$ $-1.290 \times 10^{-6}n^2$ $-6.0 \times 10^{-11}n^3$ $(n < 0)$		40°-0.2 (t-358)	1.034	65°
Jan. 22	$386.06345 + 0.06897305n$ $-1.714 \times 10^{-6}n^2$ $-1.138 \times 10^{-10}n^3$	259°65-2°877 (t-386) $-0°0018\ (t-386)^2$	34°-0°3 (t-386)		65°4
Jan. 28	$386.06347 + 0.068980n$ $-1.636 \times 10^{-6} \times n^2$	259°8-2°87 (t-386) $-0°0017\ (t-386)^2$	34°-0°3 (t-386)		65°4
[1]Feb. 4	$399.79521 + 0.068349n$ $-1.55 \times 10^{-6}n^2$ $-1.0 \times 10^{-10}n^3$	259°3-2°876 (t-386) $-0°0017\ (t-386)^2$	27°3-0°461 (t-386) $-0°00027\ (t-386)^2$	1.031	65°4
[1]Feb. 11	Feb. $10.61309 + 0^{d}068000n$ $-1.86 \times 10^{-6}n^2$ $-3.0 \times 10^{-10}n^3$	201°0-2°944 (t-Feb. 10.0) $-0°0017$ (t-Feb. $10.0)^2$	19°4-0°44 (t-Feb. 10.0) $-0°00025$ (t-Feb. $10.0)^2$	1.031	65°3
[1]Feb. 19	Feb. $17.39430 + 0^{d}067620n$ $-1^{d}90 \times 10^{-6}n^2$ $-3^{d}0 \times 10^{-10}n^3$	171°0-3°00 (t-Feb. 20.0) $-0°0018$ (t-Feb. $20.0)^2$	15°0-0°445 (t-Feb. 20.0) $-0°00025$ (t-Feb. $20.0)^2$	1.030	65°3
[1]Feb. 25	Feb. $24.13890 + 0^{d}067260n$ $-1^{d}94 \times 10^{-6}n^2$ $-3.0 \times 10^{-10}n^3$	159°1-3°008 (t-Feb. 24.0) $-0°0018$ (t-Feb. $24.0)^2$	13°2-0°447 (t-Feb. 24.0) $-0°00025$ (t-Feb. $24.0)^2$	1.032	65°3

[1]The acceleration of the satellite in its orbit is experiencing marked fluctuations, presumably due to systematic variations in its effective cross-section.

Table 1.--Successive revisions of prediction elements for Satellite 1957 Beta (continued)
(t in year days)

Date of revision	Time of ascending node crossing	Right ascension of ascending node	Argument of perigee	Perigee distance	Inclin-ation
1958 [2]Mar. 4	Mar. 2.84610 + $0\overset{d}{.}066881n$ $-1\overset{d}{.}91 \times 10^{-6}n^2$ $-3\overset{d}{.}0 \times 10^{-10}n^3$	137°.9-3°.033 (t-Mar. 3.0) -0°.0018 $(t\text{-Mar. }3.0)^2$	9°.2-0°.458 (t-Mar. 3.0) $-0°.00027\ (t\text{-Mar. }3.0)^2$	1.031	65°.29
[3]Mar. 10	Mar. 9.51273 + $0\overset{d}{.}066436n$ $-2.44 \times 10^{-6}n^2$ $-6.0 \times 10^{-10}n^3$	115°.2-3°.142 (t-Mar. 10.0) -0°.0028 $(t\text{-Mar. }10.0)^2$	6°.0-0°.474 (t-Mar. 10.0) $-0°.0004\ (t\text{-Mar. }10.0)^2$	1.0307	65°.29
[4]Mar. 17	Mar. 16.13077 + $0\overset{d}{.}0659098n$ $-2.833 \times 10^{-6}n^2$ $-1.33 \times 10^{-9}n^3$	96°.1-3°.188 (t-E) $-0°.0033\ (t\text{-}E)^2$ $-6° \times 10^{-6}\ (t\text{-}E)^3$	2°.9-0°.481 (t-E) $-5°.0 \times 10^{-4}\ (t\text{-}E)^2$ $-9° \times 10^{-7}\ (t\text{-}E)^3$	1.0307 -6×10^{-5} (t-E) $-9 \times 10^{-7}\ (t\text{-}440)^2$	65°.29

[2]At the present rate of acceleration the satellite should perform its last revolutions around April 17.

[3]Starting about March 3, the orbital acceleration of the satellite has undergone a very rapid increase. At the present rate of acceleration its fall is expected around April 14. Under these circumstances predictions are becoming very difficult and can be expected to be in error by many minutes after only a few days.

[4]At the present rate of acceleration the satellite is expected to fall about April 12.

Table 2.--Successive revisions of orbital data for Satellite 1957 Beta

Date and time	Eccen-tricity	Semimajor axis	Nodal period
1957 Dec. 27	0.08342	1.12810	
1958 Jan. 9	0.08342	1.12810	
1958 Jan. 22	0.0727	1.1140	
1958 Jan. 28	0.07296	1.1143	
1958 Feb. 3.795	0.0688	1.1072	
1958 Feb. 10.613	0.0659	1.1037	
1958 Feb. 20.0	0.0632	1.0995	97.358
1958 Feb. 24.0	0.0582	1.0958	96.866
1958 Mar. 3.0	0.0554	1.0915	96.297
1958 Mar. 10.0	0.0510	1.0864	95.62
1958 Mar. 16.0	0.0461	1.0805	94.89

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A Chart for Finding a Satellite's Distance and Elevation [1]

By J. W. Slowey [2]

Satellite observers often want to know the conditions of visibility for an object, yet do not have all the desired information. For example, an observer in Chicago may know that at a particular time a Russian artificial satellite is to pass directly over Pittsburgh, say, at a height of 500 miles. He wants to know how many degrees up the sky the satellite will appear from Chicago, how many miles away it will be at the time, and how bright it will look.

The graph on the following page provides an easy way to obtain approximate answers to questions of this kind. On it are represented the four principal quantities involved in the geometry of satellite observations:

Height (in miles) of the satellite above the earth's surface.

Distance (in degrees) along the surface from the observer to the place where the satellite passes overhead (sub-satellite point).

Range or line-of-sight distance from the observer to the satellite.

Altitude or angular elevation of the satellite above the observer's horizon.

Given any two of these quantities, the remaining two can be found from the graph Perhaps the two most frequently known prior to making an observation are height and distance. They are represented on the graph by two families of heavy curved lines. The first, giving lines of equal distance to the sub-satellite point, runs from lower left to upper right; the second, giving lines of equal satellite height, runs from lower right to upper left.

Therefore, in our Chicago-Pittsburgh example, the observer knows the height, 500 miles, and the approximate distance between the cities, 400 miles. The distance must be converted to degrees, 1 degree on the earth's surface being about 69 miles; therefore 400 miles is nearly 5.8 degrees. Read up the scale of heights on the right-hand edge of the graph to the line for 500-mile height; then follow this line to the left until its intersection with the other curved line representing 6 degrees of distance on the earth's surface (this is the 12th line from the right in that family). It is easy to interpolate for the value 5.8 between the curves for 5.5 and 6 degrees. This point on the 500-mile height curve completely determines the situation geometrically.

Read vertically downward from this point to the scale at the bottom of the graph, where we see that the altitude of the satellite at Chicago will be about 47 degrees. Next read horizontally to the scale at the far left, where the range of the satellite is found to be about 660 miles. It should be possible to interpolate with similar accuracy at all points on the graph.

The chart also provides a means of estimating the apparent magnitude of a spherical satellite from its range and the altitude. At the observer's zenith, the apparent magnitude of a satellite illuminated by the sun when the latter is below the horizon depends principally on the height of the sphere, its diameter, and the reflectivity of its surface. Therefore, on the right side of the graph there is a scale showing the *photovisual magnitude* of a satellite at the zenith. This is evaluated for a 21-inch sphere of 80 percent reflectivity, about that of polished aluminum.

The observer will rarely see a satellite exactly in his zenith, however, so the magnitude scale must be corrected for the *extinction* or dimming by the atmosphere, which depends upon the altitude above the observer's horizon. This correction to the photovisual magnitude scale is shown at the top of the graph—for altitudes above 45 degrees it amounts to 0.1 magnitude or less and may be ignored for most purposes. For altitudes of less than 15 degrees, extinction

[1] First issued March 1958 in Bulletin for Visual Observers of Satellites, No. 8, Smithsonian Astrophysical Observatory.

[2] Physicist, Optical Satellite Tracking Program, Smithsonian Astrophysical Observatory.

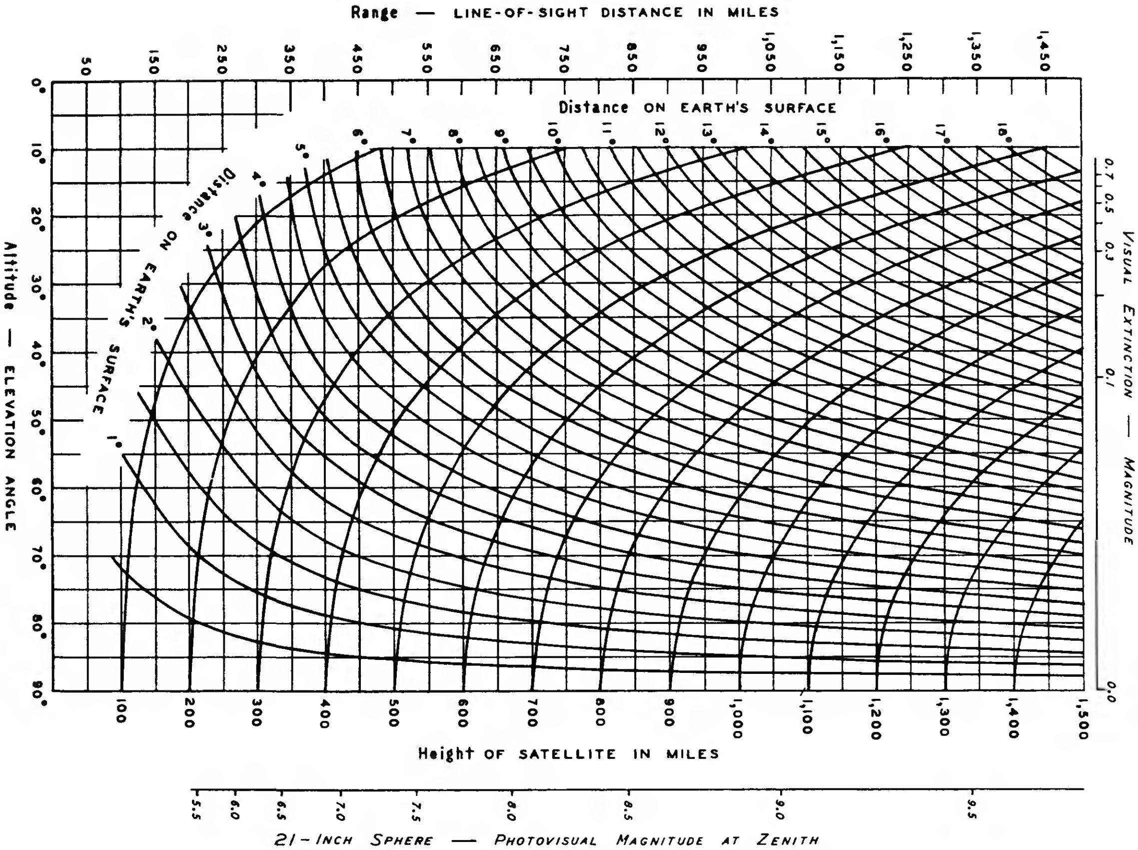

FIGURE 1.—Diagram for finding a satellite's distance and elevation.

increases rapidly and depends so much upon the condition of the atmosphere (haze, smoke, and the like) that magnitude predictions cannot be made with any reliability.

For spheres of sizes other than 21 inches, the correction to be added to the value given by the magnitude scale is given by the expression:

$$Correction = -5 \log (diameter/21),$$

where the diameter of the sphere is in inches. Here are some representative values:

Diameter in inches	6	30	60	120
Correction	+2.72	−0.77	−2.28	−3.78

A second correction, to be added for a reflectivity different from 0.8, is

$$Correction = -2.5 \log (reflectivity/0.8).$$

Some typical values are:

Reflectivity	0.75	0.70	0.60	0.50
Correction	+0.07	+0.15	+0.31	+0.51

Recent Orbital Information

In accord with agreements made for the International Geophysical Year, the Harvard College Observatory has generously cooperated by printing and distributing important orbital data on the Harvard Announcement Cards, a rapid method of communicating information. Information announced in this way since Jan. 31, 1958, is summarized below.

Special reference should be made to Announcement Cards 1389, 1391, and 1392 (fig. 1).

HARVARD COLLEGE OBSERVATORY

ANNOUNCEMENT CARD 1389

Satellite 1957α1.—According to Dr. L. G. Jacchia of the Astrophysical Observatory of the Smithsonian Institution, the following ephemeris represents with a fair degree of accuracy the equatorial crossings from the time of the launching to 1957 December 1.0, U.T., time of the last reliable observation:

$$T\Omega = 1957 \text{ Oct. } 0.83058 \text{ (U.T.)} + 0^d.0666[illegible]n - 1^d.47721\exp(0.00134n) - 1^d.784 \times 10^{-[illegible]}\exp(0.0102n) - 1^d.96 \times 10^{-[illegible]}\exp(0.0[illegible]n)$$

$$\alpha\Omega = 334°.3 - 3°.068\,(t - \text{Oct. } 7.0) - 0°.0041\,(t - \text{Oct. } 7.0)^2 \text{ (t in days, U.T.)}$$

These equations were obtained from an analysis of approximately 300 sub-satellite points derived from visual and radio observations. The following elements were used in the computation of the sub-satellite points and nodes:

$\omega = 46° - 0°.4\,(t - \text{Oct. } 7.0)$; q = const. = 1.035 earth's equatorial radii; i = 65.3

The plane of reference is the plane of the earth's equator.

n represents the number of revolutions elapsed since Oct. 8.34335 (n = 0)

January 31, 1958 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY

ANNOUNCEMENT CARD 1391

Satellite 1957β.—From an analysis of approximately 1000 Moonwatch and radio observations Dr. L. G. Jacchia of the Astrophysical Observatory of the Smithsonian Institution has derived the following equatorial elements:

Epoch and osculation: 1957 December 17.16575 U.T.

$a = 1.1311$
$e = 0.0676$
$i = 65°.4$
$\alpha\Omega = 357°.5$
$\omega = 43°.0$
$\nu = -\omega.$

Following is a list of normal values of the position and time of crossing of the ascending node, as well as instantaneous values of the nodal period and of the precession of the node as derived from observations, at intervals of 100 revolutions:

n	tΩ	αΩ	PΩ	dαΩ/dt
0	1957 Nov. 4.39573	112°.5	0^d.071990	−2°.86
100	11.58346	93.3	.071765	−2.86
200	(18.74857)	(74.1)	(.071534)	(−2.67)
300	25.88997	55.0	.071292	−2.68
400	Dec. 3.00674	35.8	.071043	−2.69
500	10.09865	16.7	.070796	−2.71
600	17.16575	357.5	.070547	−2.73
700	24.20737	338.2	.070277	−2.76
800	31.22018	318.6	.069971	−2.79
900	1958 Jan. 7.20102	298.9	.069645	−2.83
1000	14.14905	279.1	.069312	−2.86
1100	21.06338	259.2	.068977	−2.88
1200	27.94480	239.4	.068659	−2.90

(To be continued on H.A.C. 1392)

February 5, 1958 FRED L. WHIPPLE

HARVARD COLLEGE OBSERVATORY

ANNOUNCEMENT CARD 1392

(Continued from H.A.C. 1391)

The acceleration of the orbital motion during this time interval underwent marked fluctuations, presumably due to systematic variations in the effective cross-sectional area of the satellite. The precession of the ascending node in the time interval from 1957 Nov. 6.0 to 1958 Jan. 25.0 amounted to −220°.4 as compared with the theoretical first-order value of −221°.5, computed using the above elements and J = .0163847. Since a difference of 0°.1 in i alone would cause a difference of 0°.8 in the total precession, the discrepancy can easily be accounted for by the uncertainty in the present elements. The ratio dω/dαΩ was assumed throughout to be 0.1604, the theoretical value for i = 65°.4.

February 5, 1958 FRED L. WHIPPLE

FIGURE 1.—Harvard Announcement Cards giving recent orbital information for Satellites 1957 α1 and 1957 Beta.

The ephemeris derived by Dr. L. G. Jacchia and published on Card 1389 depicts with a fair degree of accuracy the life history of Satellite 1957 $\alpha 1$. Approximate determinations of any instantaneous location of the carrier rocket of Satellite 1957 Alpha can be made with the information given.

Satellite 1957 Beta is still in orbit at the time of this writing, but the information on Cards 1391 and 1392 fulfills a similar objective within the limitations specified.

The results of Dr. Jacchia's preliminary calculations with regard to Satellite 1957 $\alpha 2$ are shown on Harvard Announcement Card 1402 (fig. 2).

HARVARD COLLEGE OBSERVATORY

ANNOUNCEMENT CARD 1402

Satellite 1957α2. — Dr. Luigi G. Jacchia of the Astrophysical Observatory of the Smithsonian Institution has made an analysis of the optical observations received at the Observatory and reports as follows:

Out of 45 observations of faint moving objects, only 21 can be safely attributed to 1957α2, and these refer to 17 separate sightings — 14 in the interval October 2–29, and 3 in the interval November 24–29. Subsatellite points were computed using the same values of ω and q as for 1957α1 (see H.A.C. 1389), and from these, under the assumption of $i = 65^\circ.3$, equatorial crossings were derived, which can be fairly well represented by

$$T_\Omega = 1957 \text{ Oct. } 4.87159 \text{ (U.T.)} + 0^d.0667951\, n - 7^d.466 \times 10^{-7} n^2 - 2^d.83 \times 10^{-10} n^3$$

$$\omega_\Omega = 334^\circ.3 - 3^\circ.06\,(t - \text{Oct. } 7.0) - 0^\circ.0022\,(t - \text{Oct. } 7.0)^2$$

(n represents the number of revolutions elapsed since 1957 Oct. 4.87159).

Seven observations (five separate sightings) between October 7 and October 24 yield values of ω_Ω in essential agreement with the expression given above, but the times of the equatorial crossings are off by 8 to 13 minutes and can be represented quite well by the equation.

$$T_\Omega = 1957 \text{ Oct. } 4.87159 \text{ (U.T.)} + 0^d.0667068\, n - 5^d.945 \times 10^{-7} n^2$$

Since a chance alignment of wrong sightings seems to be highly improbable, the object (nose cone?) has been tentatively labelled 1957α3.

March 10, 1958 FRED L. WHIPPLE

FIGURE 2.—Harvard Announcement Card giving recent orbital information for Satellite 1957 $\alpha 2$.

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