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DETERMINATION OF THE OBSERVATION CONDITIONS OF CELESTIAL BODIES WITH THE AID OF THE DISPO SYSTEM

R.K. Kazakov and A.V. Krivov

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16. Abstract

The interactive system for determining the observation conditions of celestial bodies is described in the present work. A system of programs has been created containing a part of the DISPO (Display Interactive System of Orbit Planning) of the IPM (Institute of Applied Mathematics) of the AN (Academy of Sciences) of the USSR.

The system was used for calculating the observation characteristics of Halley's comet during its approach to Earth in 1985-86.

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A N N O T A T I O N

The interactive system for determining the observation conditions of celestial bodies is described in the present work. A system of programs has been created containing a part of the DISPO (Display Interactive System of Orbit Planning) of the IPM (Institute of Applied Mathematics) of the AN (Academy of Sciences) of the USSR.

The system is designed for computation in the man-machine dialog mode of the position and movement of celestial bodies relative to the NIPs (Observation Measuring Points) located on the surface or close to the Earth's surface. The program facilities of the system make it possible to effect the output of resulting quantities in both tabular and graphic form on a display screen with the use of the facilities of interactive machine graphics. Capability is provided to automate operations for the creation of film-illustrative material based on the graphic facilities of the system.

The system was used for calculating the observation characteristics of Halley's comet during its approach to Earth in 1985-86.

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DETERMINATION OF THE OBSERVATION CONDITIONS OF CELESTIAL BODIES WITH THE AID OF THE DISPO SYSTEM

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INTRODUCTION /3*

The determination of the visibility conditions of celestial bodies from a ground, air or orbital observation point is a necessary link in the problems of planning and organizing astronomical observations and space experiments. Here we are concerned, in particular, with problems in the creation of ephemeris support of the programs of observation of natural bodies in the solar system. These problems arouse special interest in connection with the creation and functioning of artificial bodies, space vehicles of different types, AES (Artificial Earth Satellites) and their systems.

In many cases of this type (the formulation of retrieval ephemerides), ephemeris information of high precision is frequently not required. Therefore for small intervals in the prognosis of observation conditions, it is possible to confine oneself to approximations of the real motion by some simple model frequently even a Keplerian (unperturbed) orbit is sufficient, and the use of "spacing" of Keplerian curves or an Eulerian orbit [1] provides the necessary precision in the overwhelming majority of cases. In this work Keplerian or Eulerian elements (if necessary, periodically corrected) will be the input information about the object of observation.

* Numbers in margin indicate foreign pagination

The use of simple models of the movement of the Earth and the observed celestial bodies makes it possible to create a program system which would provide the calculation of ephemerides by fast-operating algorithms, would present to the user important conveniences for the input and correction of data and would have a developed set of capabilities for the presentation of resulting information in digital and graphical form, with recording on various media, etc.

An attempt to satisfy all these requirements was the "visibility" program system, created in the IPM (Institute of Applied Mathematics) of the AN, USSR based on the SDS-910 computer and comprising a part of the DISPO system [2,3,4] which has already been successfully used for many years. The given system, just like the other DISPO programs is interactive, i.e., it operates in the man-machine dialog mode. The selection of the computer for system implementation is dictated by the presence in the SDS-910 of a developed set of hardware and software facilities of interactive communication. Among the hardware dialog facilities one must include the "Graphic display - light pen" system; among the software - the set of subprograms supporting the interactive process by means of the set of "light buttons" and the LINK device [5]. The components of the system of programs and subprograms are written in the Fortran-II language for the SDS-910 computer [6]. /4

The system being examined makes it possible, in interactive form to enter and correct the input data, carry out for a sequence of time moments the calculation of series of topcentric characteristics of the observability of the object--the horizontal and equatorial coordinates, range, range rate, as well as a series of auxiliary quantities, and to achieve the output of results in digital form or graphic form, with a distribution of information to an a wide ATsPU (printing device), a DS (display screen), graph-plotter, and MT (magnetic tape). Special modes of operation of the system for obtaining film-illustrative material are based on the calculated ephemerides.

Despite the fact that a specific program to implement the system is accomplished within the framework of the DISPO system of the IPM AN, USSR, the general design principles of the system of programs for the calculation of ephemeris information, developed in the present work, can be recommended to a wide circle of persons interested in the building of similar systems based on different hardware and software support.

The authors take this opportunity to express their deep gratitude to K.L. Volkova, L.T. Gromova and L.A. Myryshkina for the great help in creating the "Visibility" system, installing and surveying film-illustrative material on observations of Halley's comet.

§I. The Algorithm for Calculating the Visibility Conditions of Celestial Bodies

I.I. The selection of a model of motion and reducing calculations

The algorithm for calculating ephemeris information about an object is broken down into two stages. In the first stage the position vectors and the velocity of the object relative to the center of mass of the central body are calculated. The second stage consists of the conversion of these quantities to a coordinate system: geocentric (if the central body is not the Earth) and topocentric. Then the desired topocentric quantities, comprising the ephemeris, are calculated. The following are adjusted to the point of the NIPs (observation-measuring points) by these quantities:

Elevation	γ	Declination	δ	Range	D
Azimuth	A_0	Right ascension	d	Range rate	$\dot{D}$

This set of quantities is, evidently, sufficiently complete, since /5
it responds to the interests of a wide circle of users of ephemeris information. The azimuth coordinates directly reflect the

accessibility of the object to observations and can be used as a rough guide to users applying a device on an azimuth installation; the equatorial coordinates are of interest in the organization of observations by means of classical astronomical instruments; the range is important in the observations of small bodies of the solar system and, in addition, can be useful in the case of laser or radar range finder measurements; the value of range rate is necessary in the use of narrow-band receivers for the calculation of the Doppler frequency shift.

At the same time the elevation of the Sun is calculated with these values. This makes it possible to determine whether the current instant of time is related to the dark or to the light time of the day.

To effect a specific implementation of the two stages of the algorithm described for the calculation of low precision ephemerides (of the research type, at the planning stage of a flight to celestial bodies) it is necessary to assume a model of the motion, which can be rather crude, but must be fast-operating and economic in the computation sense. For this, it is necessary to discard the method of approximation of the actual complex motion of the celestial body occurring under the action of all possible perturbing factors; to select those factors whose calculation is necessary for the attainment of the required precision, and neglect the rest. We shall consider both stages of the algorithm from this point of view.

The set of parameters specifying the orbit of the body and the current instant of time are the input quantities for the first stage. Whether or not parameters are in fact included in this set depends on the method of approximating a perturbing motion. Different versions having different precision and difficulty are possible. We shall point out the main ones:

1. The maximum possible calculation of perturbations. For example, the totality of the values of the osculating elements at the current instant of time is taken (for this a preliminary integration of the equations of perturbed motion is of course required) as a set of parameters. In this case with the passage from one instant to another, the values of all the parameters are changed. This leads to a large volume of input information. /6

2. A partial calculation of the perturbation by means of an approximation of the actual motion of a "spliced" Keplerian orbit. For example, the Keplerian elements, which are periodically adjusted, are taken as the parameters in this case. Thus, in the passage from one instant to another, the parameters are not changed each time.

3. The approximation of an Eulerian orbit. Eulerian elements are taken as the parameters.

4. The approximation of the perturbed motion of an unperturbed orbit. In this case the set of parameters is an aggregate of six Keplerian elements. It remains constant in the scanning of the current instants.

The class of celestial bodies for which it is possible to abandon the complete calculation of the perturbations (Method I) is defined by the required precision and time interval in which this precision has to be guaranteed. For the investigation of comets, the requirements for precision are not great. Such a class of objects will be sufficiently extensive. More than this, in most cases not even the use of a "splicing" of Keplerian orbits or a Eulerian orbit (Methods 2 and 3) is required, but it is sufficient to use the rather rough, but economical in the computation plan, Method 4 the approximation of the motion of an unperturbed orbit. The exceptions comprise only the remaining situations: close approaches of comets to large planets, the initial and final portions of the trajectory of a space device and a few others.

In Table I are shown δ - declination and D - the range of Halley's comet for the Ashkhabad NIP, calculated by two methods based on the complete calculation of the perturbations and by means of an approximation of the unperturbed orbit, i.e., corresponding to Methods 1 and 4. The data according to the use of Method 1, taken from [7] are obtained on the basis of the numerical integration of the equations of motion with regard for the perturbations of 8 large planets. In the calculation by Method 4, the set of values of the osculating elements at the instant the comet will pass perihelion on 9 February 1986 is taken as the fixed Keplerian elements.

It is seen that errors in an angular quantity (declination) do not exceed 22' in the neighborhood of the pericenter, and decrease rapidly at a distance from it (for several months before it and during several months after it, the deviation is already less than 1'). The range error for every interval considered does not exceed 2 million kilometers, i.e., it comes to about 0.4%. These values for ephemerides of the research type are fully acceptable.

TABLE I /7

Date	δ - Declination		D - Range, millions of km	
	Method I	Method 4	Method I	Method 4
05.0I.I985	I2°5!4	I2°5!9	646.I	645.2
06.03.	I3 46.9	I3 47.4	686.7	685.7
05.05.	I6 I8.6	I6 I9.3	732.3	73I.8
02.09.	I9 2I.6	I9 23.5	44I.3	439.8
0I.II.	2I 46.7	2I 52.0	I6I.I	I69.4
3I.I2.I985	- 2 I4.I	- 2 28.0	I70.4	170.9
0I.03.I986	-I6 I2.4	-I6 34.0	I89.8	I88.8
30.04.	-I9 I6.9	-I9 07.0	II5.2	II7.0
29.06.1986	- 4 59.7	- 4 59.8	400.9	402.3

The second stage of the algorithm is the transformation of the vectors of position and velocity to the desired ephemeris information. In this stage it is possible to neglect certain reduction calculations included in the classical astronomical system. We know it is possible not to consider those factors whose neglect leads to errors amounting to several minutes of arc for angular quantities. Thus, corrections for nutation and aberration are not introduced. Refraction is also not considered since in the zone of accessibility of astronomical and navigational devices (Elevation 8) it does not introduce errors greater than 3'. The calculation of precession is also not made, since, as a rule, the orbit elements of a celestial body,which are entered as input data can be supplied at a time close to the observation instants, so that precession will essentially already be accounted for in the orbit elements. However, for example, the flattening of the Earth should be taken into account since the reduction, subjected to it, of the astronomical latitude of the point to the geodesic, and consequently of the correction to the angular ephemeris quantities, can reach an unacceptably large value in 12'. We would also risk an error of the order of 10' if we were to neglect the altitude of the NIP about sea level.

I.2. A specific implementation of the algorithm in the "Visibility" system. /8

We shall consider in more detail a specific implementation in the "Visibility" system of the two algorithm stages described.

The first phase is program-effected in such a manner that the most convenient for the user are the Keplerian and piecewise-Keplerian approximation of motion, i.e., Methods 2 and 4. The use of Method 1 is also possible, however, as was noted above. This is connected with a sharp increase in difficulty, since the user must enter long series of values of the osculating elements. (For each instant these values will be his own). Method 3 has not been implemented in an operating version of the system. However, in case of need it is possible to modify in an appropriate fashion a number of the system modules so that this method could also be used. (For this it is necessary to introduce insignificant changes into certain program modules). The Eulerian model will not be considered further.

No matter which of the described models the user selects, in each current instant the 6 Keplerian elements and the adjusted mass of the central body, as well as the value of this instant, serve as the initial parameters defining the instantaneous orbit of the body. For brevity, we shall designate the set of these quantities by $\{\vec{\mathfrak{Z}}, t\}$. Then the first stage should be considered as the transformation of the vector $\{\vec{\mathfrak{Z}}, t\}$ into the vector $\{\vec{z}, \vec{v}, t\}$, i.e., into Cartesian coordinates and velocity components. This transformation is one of the main operations of DISPO, and is accomplished by access to the standard subprogram ЭДК [2,3,4].

In this case, if the object was designated by heliocentric ecliptical elements, and, consequently, the calculated coordinates and velocity components are referred to the heliocentric ecliptical system, the latter will then be transformed after the calculation of the Earth's heliocentric radius-vector (according to the elements of the Earth orbit available in the system) into geocentric ecliptical, and, finally by a rotation of the coordinate system about an angle $\varepsilon = 23°27'$ into geocentric equatorial coordinates. If, however, the object is designated by geocentric equatorial elements, then after the use of the operation ЭДК no additional transformations are required.

The second stage of the algorithm is the transformation of the vector $\{\vec{z}, \vec{v}, t\}$ into the set of ephemeris quantities listed in Para I.I. It is implemented in the form of a special subprogram. We shall consider this stage in more detail; /9

We shall assume the following quantities are known:

$x, y, z, \dot{x}, \dot{y}, \dot{z}$ - The coordinates and velocity components of the object in the absolute geocentric coordinate system;

t - The current instant of Greenwich mean time;

φ, λ, h - Astronomical latitude, longitude (considered positive eastward from Greenwich) and height of the NIP above sea level.

It is necessary to calculate the above-listed quantities $\gamma, A_0, \delta, \alpha, D, \dot{D}$.
We shall convert from astronomical latitude and NIP elevation to two equivalent quantities - the distance from the center of the Earth to the NIP Point R and the geocentric latitude ϕ [8].

$$R = R_3 (1 - \alpha_0 \sin^2 \varphi) + h$$
$$\Phi = \varphi - \alpha_0 (1 - h/R) \sin 2\varphi,$$

where R_3 - is the equatorial radius of the Earth (6378160 M);

α_0 - is the flattening of the terrestrial ellipsoid (0.0033529).

We now make a transformation to the Greenwich coordinate system (a geocentric cartesian system whose abscissa axis passes through the point $\varphi = 0, \lambda = 0$, Z-axis - through the North Pole, and ordinate axis expands the triad to the right):

$$x_1 = x \cos \psi + y \sin \psi$$
$$y_1 = -x \sin \psi + y \cos \psi$$
$$z_1 = z$$

here ψ is the sidereal time at the Greenwich meridian, corresponding to the instant t of Greenwich mean time. In the given algorithm, it is assumed

$$\psi = \psi_0 + \Omega (t - t_0),$$

where $\psi_0 = 6^h 42^m 07^s$; $t_0 = 1977$, January 1, $0^h\ 00^m\ 00^s$,

and the number of sidereal periods in some mean periods $\Omega = 1.0027379$.
It is natural that for a certain class of objects (low AES) the precision of the last formula may be insufficient, and at least a periodic adjustment of the null-point (ψ_0, t_0) will be required. But for the

overwhelming majority of cases, this formula may be used without reservations. /10

In the same system, Greenwich, the NIP coordinates will be:

$$\begin{cases} A = R\cos\varphi\cos\lambda \\ B = R\cos\varphi\sin\lambda \\ C = R\sin\varphi \end{cases}$$

We get the relative coordinates of the object (i.e., Greenwich topocentric coordinates):

$$\begin{cases} a = x_1 - A \\ b = y_1 - B \\ c = z_1 - C \end{cases}$$

and the range is $D = \sqrt{a^2 + b^2 + c^2}$

Now the declination and right ascension of the object are determined from the formulas:

$$\sin\delta = c/D\ , \qquad \delta \in [-90^\circ, 90]$$

$$\begin{cases} \cos\alpha = (a\cos\psi - b\sin\psi)/\sqrt{a^2+b^2} \\ \sin\alpha = (a\sin\psi + b\cos\psi)/\sqrt{a^2+b^2}, \end{cases} \quad \alpha \in [0, 360^\circ]$$

Next we shall calculate the horizontal topocentric coordinates of the object. For this we shall form the matrix of transition from the Greenwich topocentric to the horizontal topocentric coordinate system:

$$\| \delta_{ij} \| = \begin{pmatrix} -\cos\lambda\sin\varphi & -\sin\varphi\sin\lambda & \cos\varphi \\ \cos\varphi\cos\lambda & \cos\varphi\sin\lambda & \sin\varphi \\ -\sin\lambda & \cos\lambda & 0 \end{pmatrix}$$

The cosine of the Zenith distance, i.e., the sine of the elevation, is equal to the scalar product of the topocentric radius-vector $\{a, b, c\}$, normalized to unity, and the directional unit vector to the Zenith at the point of the NIP (second row of the matrix:

$$\sin\gamma = (a\delta_{21} + b\delta_{22} + c\delta_{23})/D$$

Then calculating the scalar products of the same radius-vector by the remaining rows of the matrix /11

$$\xi = a\delta_{11} + b\delta_{12} + c\delta_{13}\ , \quad \eta = a\delta_{31} + b\delta_{32} + c\delta_{33}\ ,$$

we find the azimuth from the formulas

$$\sin A_0 = \eta/\sqrt{\xi^2+\eta^2}\ ,\quad \cos A_0 = \xi/\sqrt{\xi^2+\eta^2}$$

Finally, we shall determine the radial velocity of the object. The velocity components on the Greenwich geocentric axes will be

$$\begin{cases} \ell = \dot{x}\cos\psi + \dot{y}\sin\psi + \Omega_0 \cdot B \\ m = -\dot{x}\sin\psi + \dot{y}\cos\psi - \Omega_0 \cdot A \\ n = \dot{z} \end{cases}$$

Here the last addends of the first two formulas reflect the rotation of the Earth with a velocity of $\Omega_0 = 1/13713.44$ radians/second.

The desired radial velocity equals

$$\dot{D} = (a\ell + bm + cn)/D.$$

§ 2. The Structure of the System and its communication with other program facilities of DISPO

The visibility system consists of two relatively independent program units where the coordination of the operation and the information interchange between them is effected by means of the LINK device available in the DISPO system. These parts, called henceforth the first and second LINK-blocks, or simply "Links" are individually written onto MT (magnetic tape). The need for such segmentation is caused by the large volume of memory which is required for the arrangement of the compiled operating programs of the system (about 45,000 cells of the SDS-910), which exceeds the volume of the machine's operating memory. However, the volume of each of the LINK-blocks does not surpass the capacity of an OZU (operating storage unit) of the SDS-910, and they are called up from the MT to the OZU alternately, according to need.

From the point of view of Fortran, each of the LINK-blocks represents an aggregate of a basic (control) program, a set of subprograms which is a property of "visibility", as well as those subprograms which play in DISPO a role of standard, but are necessary to the system during its functioning. /12

The decomposition of the system into two LINK-blocks, in addition to the requirements of the machine implementation (limited by volume), is carried but also with regard for logical considerations. The first LINK-block centralizes in itself the facilities which in the interactive mode permit the introduction of the input information necessary for the operation of the system; the second LINK-block has two main functions - it performs directly the computational algorithm considered in §I, and accomplishes the output of results in the necessary form. Naturally, each of the links performs other functions also -- communication with other units of DISPO, the transfer of control to another link, the control of the sequence of execution constituting the given link of the module, access to the file of the constant of an information field, documentation, etc.

The operation of the system is initiated by an instruction to the "Visibility" light button situated on the upper button level of DISPO and is started in the first link; subsequently the transfer of control from one LINK-block to another is carried out by the program facilities of the LINK-block themselves, i.e., automatically and the information interchange between them is effected by means of the designated COMMON-cells of the information field, accessible by both links of the system and by other program units of DISPO which makes it possible in case of need to transmit the latest information generated in the operation of the system.

A more detailed program implementation of "visibility" is performed in accordance with the conception of modular programming. The main programs of both LINK-blocks are built of relatively independent parts - modules. They are not program separated units (independent programs or subprograms of FORTRAN), but distinctly separated in the logical sense (each of them has a rigidly defined function - for example, the input of some data group), and in the structural (any module is bipolar, with one input point and one output point). From the point of view of FORTRAN, each module is represented by a group of 30 - 250 operators. Such a distribution by magnitude was the price which had to be paid for the clear observance of the reason for the logical and structural separability (especially the latter).

The structure described (LINK-block and modular) provides the logical simplicity of the system, facilitates familiarization and operation with it. In addition, it significantly simplifies the insertion of changes and modifications, which enables us to consider "Visibility" an open system. /13

The diagram of system interconnection with other program facilities of DISPO, reflecting both information interchange and links for the transfer of control, is depicted in Figure 1.

§3. The Interactive Operation with Respect to the Input of Initial Data

The structure and operating principles of the first LINK-block of the system will be described in this paragraph.

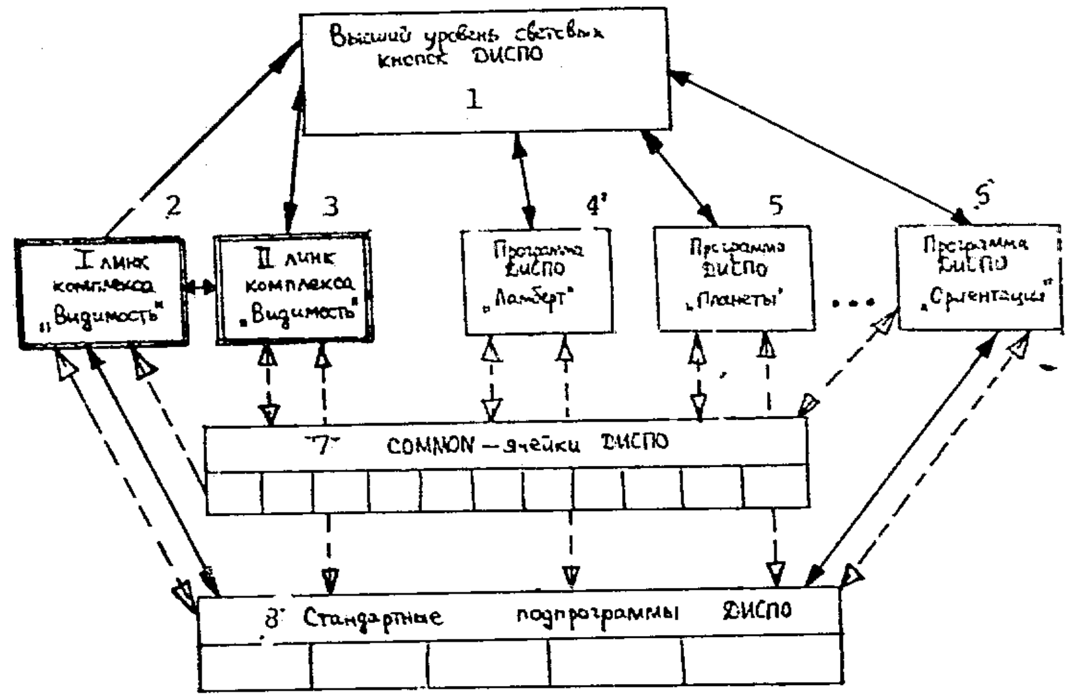
As was noted in Paragraph 2, the main function of this link is the bringing in of the necessary input information to the appropriate COMMON-cells of the DISPO information field. After completion of the input, operations control will be transferred to the second LINK-block, which retrieves this data, carries out its required transformation into the required ephemeris information and accomplishes its output in some form.

The link makes available to the user two main capabilities of data input. First, information can be entered from without, from various devices of the machine - from PC (punched cards), TT (teletype) and also from the DS by means of the light pen. Second, the link has its own small information field which besides an array of constants, contains data on a limited quantity of observation points (their coordinates), on certain more interesting objects of observation (the initial version contains orbital elements of Halley's comet), as well as a series of values of time parameters (their meaning will be explained below), adopted as standard. Thus the user working with the first LINK-block can initiate a transfer of data from this internal list to the common information field of DISPO by a simple instruction to a button by means of the light pen which, of course, shortens the time needed for the input of initial data. Since the data which the user wishes to enter rarely coincides completely with the standard, one most often successfully uses combined input when part of the information is entered from without, and part -- by the "rapid" method, from the internal list.

The operation of the link is constructed on the basis of the questionnaire method of data entry. It is implemented on 9 pushbutton levels (Figures 2,3). Each of them has several functions. A series of light buttons (lists of standard objects, points, etc.) services the above-described method of entering data from the internal list. Other buttons are used for "external" input: They make it /17 possible to select the desired set of quantities for the designation of any characteristic (for example, the object may be designated by both heliocentric ecliptic, and geocentric equatorial elements); to determine the external device from which data will be entered; to inform the system of the ending of the entry of the next data group, etc. Finally, there are special buttons which make it possible to control the sequence of data entry and artificially pass either to the second LINK-block or "upward" to the upper pushbutton level of DISPO.

As a whole, the interactive operation for information entry can be presented in the following manner. Operating with the light buttons with the aid of the light pen, the user enters in any sequence, by any of the methods described, in the most convenient and natural form, all the needed quantities. It is possible to use an incomplete entry, i.e., performing the processing of some variant of the initial data, to change quantities only partially and restart the machine for calculation. This makes it possible to "scan"

/14



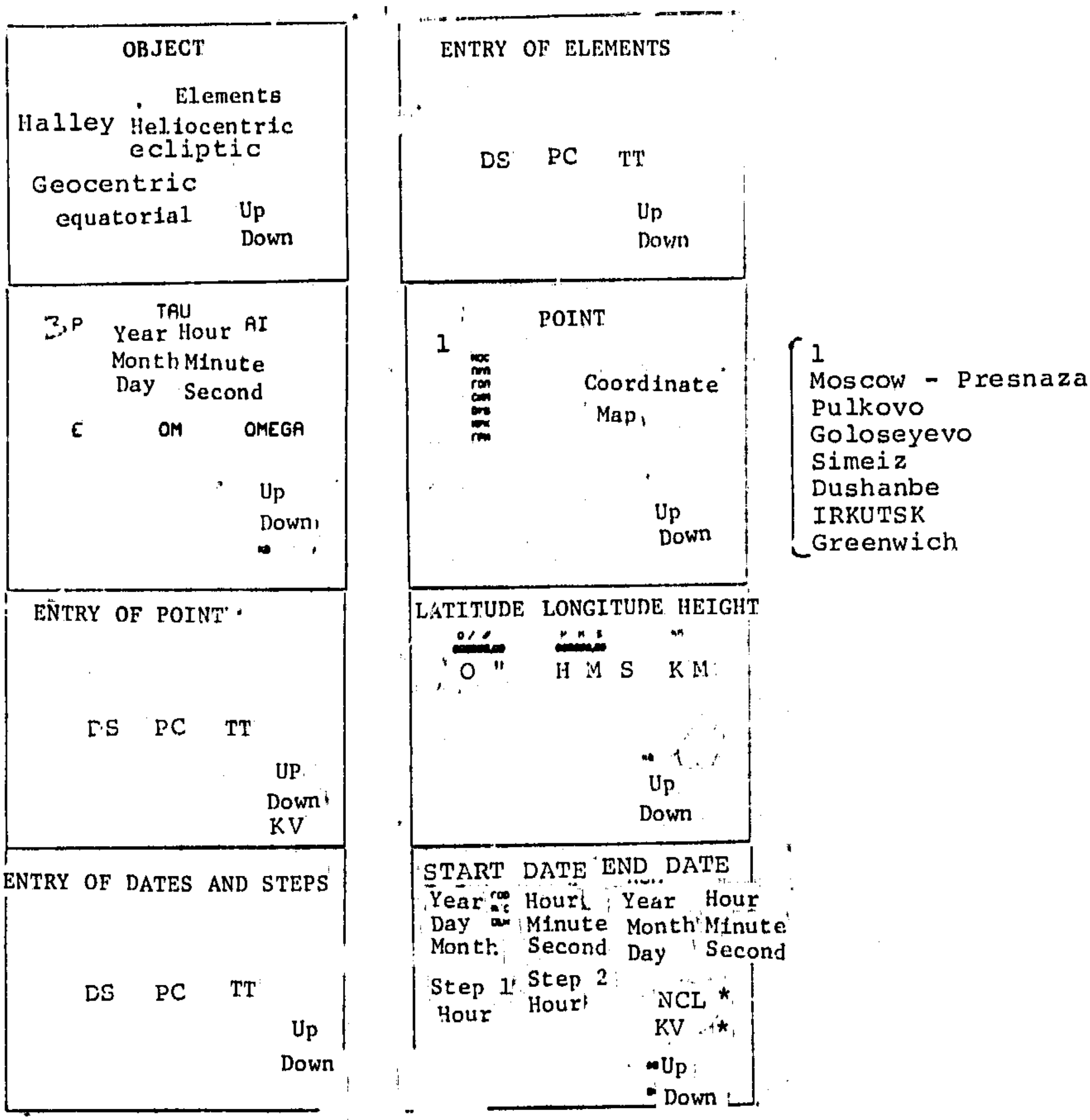
---▷ передача информации
——▶ передача управления 9

Рис. 1 Взаимосвязь комплекса с другими программными средствами ДИСПО

Figure 1. The interconnection of the system with other program facilities of DISPO.

Key: 1--Higher level of DISPO light buttons; 2--I LINK of the "Visibility" system; 3-- II LINK of the "Visibility" system; 4-- DISPO Program "LAMBERT"; 5--DISPO Program "PLANET"; 6--DISPO Program "ORIENTATION"; 7-- DISPO Common-cells; 8--DISPO Standard subprograms; 9-- - - → Transfer of information; ——→ Transfer of control.

/15


OBJECT
Elements
Halley
Heliocentric
ecliptic
Geocentric
equatorial
Up
Down
ENTRY OF ELEMENTS
DS
PC
TT
Up
Down
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AI
Month
Minute
Day
Second
OM
OMEGA
Up
Down
POINT
1
Coordinate
Map
Up
Down
1
Moscow - Presnaza
Pulkovo
Goloseyevo
Simeiz
Dushanbe
IRKUTSK
Greenwich
ENTRY OF POINT
DS
PC
TT
UP
Down
KV
LATITUDE
LONGITUDE
HEIGHT
H M S
K M
Up
Down
ENTRY OF DATES AND STEPS
DS
PC
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END DATE
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Up
Down

Figure 2.

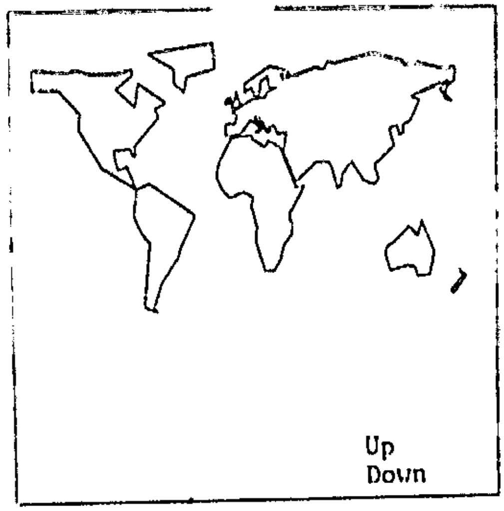


Figure 3. Representation of the world map for the entry of geographic coordinates.

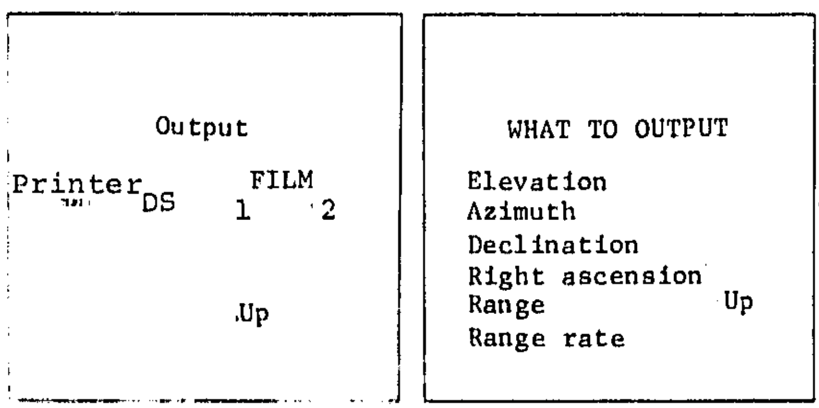


Figure 4. The levels of light buttons for information output.

1. Fullmotion Film
2. Continuous Motion Film

quickly the different variants - to vary the objects of observation, NIP's, time characteristics, etc.

We shall now consider the construction of the first LINK-block and its capabilities in more detail, at the module level. For the calculation of ephemeris information, three groups of numerical data are necessary: data on the object of observation, on the observation point and a number of parameters defining the sequence of instants at which the calculation of ephemeris data is carried out. According to this, the link is built up from three modules, each of which enters its own group of parameters.

The "object entry" module: During "internal" entry by means of the "Halley" button it is possible to transmit the elements of Halley's comet to the information field. During of "external" entry, there is the ability to enter orbital elements -- from PC, TT or ED. If the given celestial body revolves about the Sun, it is given ecliptic elements; if, however, the orbit is geocentric, then it is necessary to use equatorial elements.

The "point entry" module: There are the following capabilities of NIP designations: the "internal entry of the coordinates of one of seven points: Moscow- Presnya, Pulkavo, Calosevo, Simeiz, Dushanbe, Irkutsk, Greenwich; - the "External" entry - explicit entry of latitude, longitude and height from PC, TT or ED; -- calling to the ED of the /18 world map representation and the indication by the pen on any location of it, as a result of which the automatic calculation of geographic coordinates corresponding to the indicated point and the transmission of them to the information field take place.

The "dates and steps" entry module: The parameters "start date", "end date", "Step I" and "Step 2" make it possible to prescribe an aggregate of time instants for which the calculation of the characteristics of object visibility will be carried out. This set of instants in the system considered has a rigidly prescribed structure of the following form. It consists of a set of sequences of instants, up to 49 instants in each sequence, where the origins of the sequences are uniformly distributed along the time axis from "start date" to "end date" with a step equal to "Step I". Moreover, each sequence covers a time interval equal to "Step 2".

The structure described is flexible enough and especially convenient for making film-illustrative materials, since it permits to a known degree the automation of the process of creating film sections.

The indicated time parameters, like the preceding two groups of data, can be entered by both the "internal" and "external" methods. Additional facilities are provided for the use of "incomplete entry".

All of the entered data is documented by each of the opening modules for TT and printer. At the conclusion of input and documentation, the modules carry out a transformation of the data to a form necessary for the computing process, and in this form place them in the DISPO information field.

§4. Forms of Presentation of Output Ephemeris Information

The work of the second LINK-block is begun in the module "indications of the output quantity and output form". By means of the two push-button levels, the user is queried as to which of the ephemeris quantities are of interest to him in which form to output them (tabular or graphic) and which require action (for example, writing the graphs obtained) on [illegible]). The code number of the operation mode selected by the user for output and information on the quantities subject to output are transmitted to special cells whence they will then be retrieved and used by the next module of the second link - the module "calculations and output" (the push-button levels are depicted in Figure 4). /19

The quantities listed above -- elevation, azimuth, declination, right ascension, range, range rate of the object and the elevation of the Sun, constituting the principal ephemeris information -- are calculated in turn for each of the sequences of instants described in §3, and are packed into arrays, localized in the given link. This information will be transformed and output in numerical or graphic form. However, as follows from §I, during calculation other information is also generated. Certain of these intermediate quantities, for example, heliocentric and geocentric cartesian coordinates and velocity components of the object and the Earth, are available to other DISPO programs, since they are transmitted to the COMMON-cells of the information field. In addition this auxiliary information may also be necessary to the user; he can take out such quantities for printing, by operating the binary keys on the machine console.

We shall consider in more detail the system's operating modes with respect to the output of the main ephemeris information. There are three modes, conventionally called "DS", "Full Motion Picture" "Continuous Motion Picture". In all cases, the ephemerides are represented on the DS in the form of graphs giving a time function of one of the quantities γ, A_0, δ, α, D. . As only one of these modes is ordered, the buttons light up quickly, indicating on which one it is possible to select the relevant output quantity. Each graph corresponds to one of the sequences of instants.

In addition, to the points of the curve giving the time function of the selected quantity, "shade" is inscribed on the graph. The fact is that the elevation of the Sun $\gamma_{\odot}$ is determined simultaneously with the calculation of the visibility of the comet. In this case, the elements of the Sun (with regard for sign) will be the input into the visibility calculation block. The elevation of the Sun is required for a more descriptive representation of comet visibility on the graphs. If $\gamma_{\odot} \lesseqgtr 0$, , than a vertical band is traced on the graph, "shade" appears, corresponding to the dark time of the day. If $\gamma_{\odot} > 0$, , then the vertical band is not inscribed. Consequently this instant is related to the daylight hours.

Under the time axis from the left and right, the dates are illuminated (day, month, year, hours, minutes, seconds). The marking of the ordinate axis for elevation and azimuth is fixed: "-90", "90", "0", "360" (degrees). For the quantities δ, α, D, $\dot{D}$, the program finds the lowest and highest values of a quantity in a given interval and automatically selects the scale along the ordinate axis (Figure 5,6). In this case the appropriate documentation is available by printing on teletype. /20

Simultaneously with the graph, a set of light buttons is illuminated on the DS to support the interactive mode of operation in the calculation and the graphic output of the ephemerides. The buttons give to the user the ability to intervene at the right time in the computation process and in the image visualization process, to exit promptly from the given module for the purpose of data correction, to change the computation sequence, to perform an output of the image at any stage of its construction to the graph plotter, recording it on MT, etc. The button "ATsPU" makes it possible to output all the ephemeris information in digital form (Table 2-10).

Everything said above pertained in equal measure to all three modes. We shall consider the differences among them. In the ED mode, the graph is constructed on the ED and at the completion of construction is illuminated as long as the user does not indicate otherwise on the light button. In particular, for the program to pass to the construction of the next graph (for the next sequence of instants), an indication on a special button is required. In the "full motion picture" at the completion of construction of the next graph, the image is automatically written on to MT, and a transfer to the new calculations is immediately affected and then to the construction of a new graph and so on. The operation of the system also proceeds in a similar manner in the "continuous motion picture" mode, but in this case the writing on MT of not only each graph, but all stages of construction of each graph, takes place (in the construction of a graph on the DS, the axes, the numbering of the axes, the legend explaining for which of the quantities the graph is being constructed appear sequentially; then the points of the curve - one, two, ...49 appear in turn on this background).

From what has been said, it is clear that the modes "Full Motion Picture" and Continuous Motion Picture are oriented toward the creation of film-illustrative materials, which reflect the dynamics of change in the ephemeris quantities in graphic form. For practical operation in taking the appropriate film sections, there are in DISPO special program facilities. The sequence of images recorded by the "visibility" system is visualized on the DS by means of a special monitor program, is edited and photographed on a movie film by a movie camera synchronized with the DS [9]. Immediately after connection to DISPO, the "visibility" system was used for operations of this nature in the planning of film sections dedicated to the impending appearance of Halley's comet in 1985-1986. The results of the calculations carried out in this case, obtained by means of the visibility system, are covered in the following paragraph. /23

§5. The Results of the Calculations of Visibility Conditions for Halley's Comet in 1985-86.

The visibility conditions for Halley's comet in 1985-86 were calculated by means of the system described. The calculations are carried out for a number of NIP's located both in the northern and southern hemispheres. Moreover, the input parameters, especially "dates" and "steps" described in §3 were widely varied.

The resulting information was output in graphical and digital form. In the case of graphic output, the sequences of images, illuminated on the DS, were written onto PC which made it

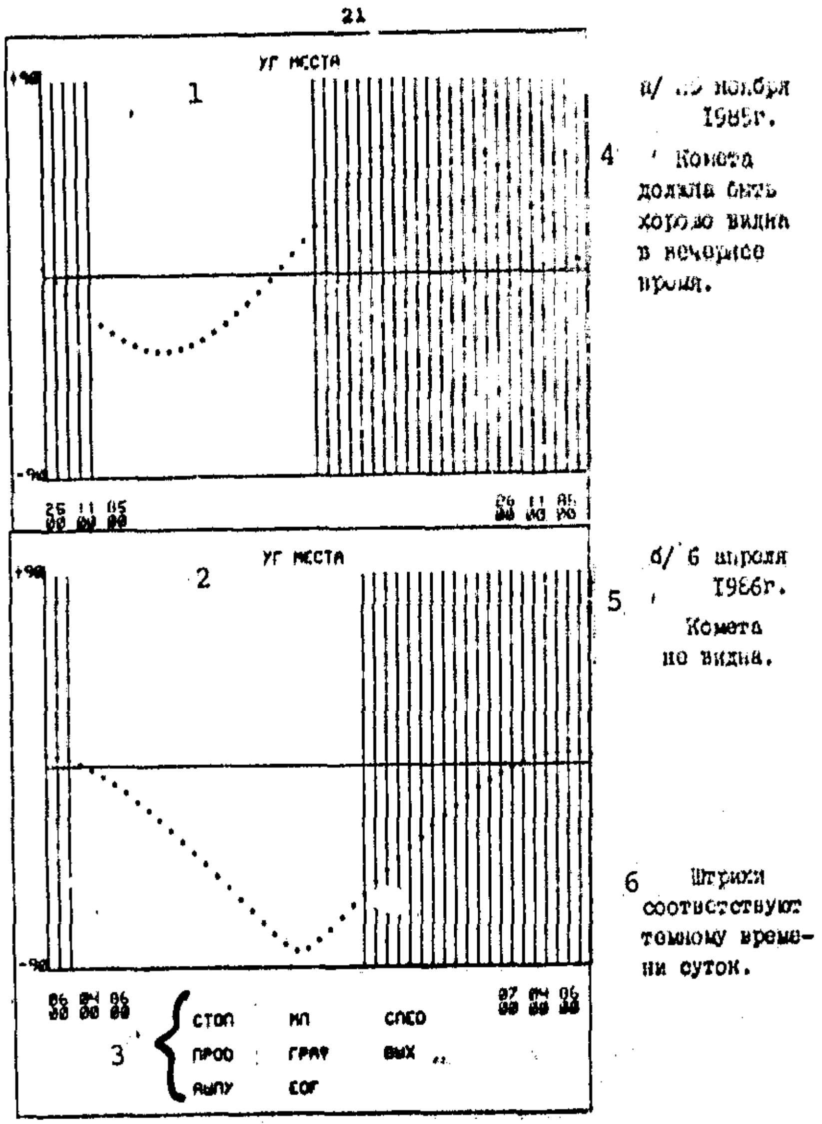
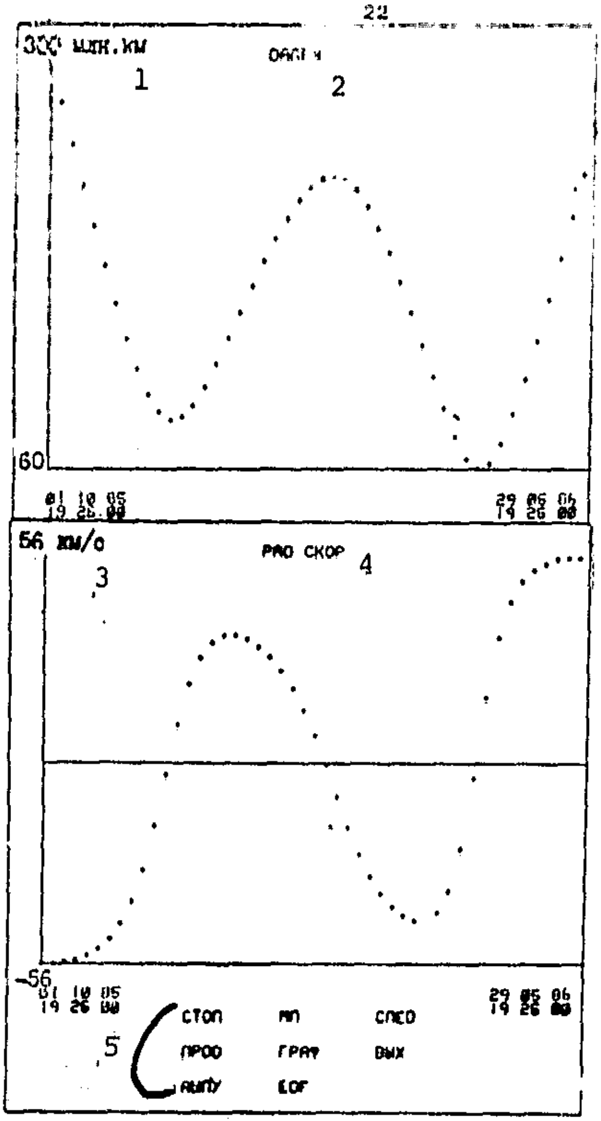


Figure 5. Dushanbe Observation Point.

Key: 1--Elevation; 2-- Elevation; 3-- Stop MT SLED (next) PROD GRAPH Output PrinterEOF
4-- 25 November 1985 Comet must be easily seen during evening hours; 5--6 April 1986. Comet not visible; 6--Strokes correspond to dark time of day.



(a) Range. 1st minimum 11/27/85. Second minimum, 4/10/86.

(b) Range rate

Figure 6. Dushanbe Observation Point.

The change in range and range rate in the period from 1 October 1985 up to 29 May 1986.

Key: 1-- Millions of kilometers; 2--range; 3--kilometers/second; 4-- Range rate; 5--As in Fig. 5

possible to obtain FILM sections demonstrating the dynamics of the observability characteristics of Halley's comet in 1985-86. In the present work, several graphs are depicted illustrating the daily variation of the comet's elevation (Figure 5a,b): During the 24 hours of 25 November 1985 (about the first closest approach to Earth) and during the 24 hours of 6 April 1986 (for 4 days up to the second closest approach to the Earth) under observation from the Dushanbe NIP; as well as graphs showing the dynamics of change in range and range rate in the period from October 1985 to May 1986 (see Figure 6a,b). The distinctive features of the impending appearance of the comet are seen on the graphs. The points of the closest approaches to Earth (27 November 1985, 93 million kilometers and 10 April 1986, 62 million kilometers) are singled out. It is evident that observation conditions in the northern hemisphere will be much worse than for southern NIP's and, in particular, that after passage of perihelion the comet will execute a steep "dive" downward, when its declination will reach -47°, as a result of which in the period of morning visibility it will be completely unavailable to observations from the northern NIP's.

As a result of the issuing of information in digital form, tables are obtained which give the elevation, azimuth, declination, right ascension, range, range rate of the comet for a number of domestic and foreign observatories and stations (Tables 2-10).

Since it is obvious that equatorial coordinates, range and range rate change little from point to point (within the limits of the computing precision provided by the system), it is possible for these characteristics not to make a distinction between geo- /24
centric and topocentric quantities. However, as for elevation and azimuth, it is necessary to calculate them for each point individually. But it is clear also that in the calculation of elevation and azimuth of a comet (in contrast to an AES, for example) for a general characteristic of the observability conditions, it is sufficient to take several points covering a large arc of latitude as the longitude may not be varied (the results of calculations performed for NIP's with identical latitude and different longitudes will

be almost identical with a precision before the shift along the time axis at a magnitude equal to the difference in longitudes since the equatorial coordinates of a comet change slowly). Starting from these considerations we cite data for only three points with widely varying latitudes: Pulkpvo ($\varphi = +59^{\circ}46'18''.5$, $h = 75$ м, $\lambda = +2^{h}01^{m}18^{s}.57$), Dushanbe ($\varphi = +38^{\circ}33'39''.9$, $\lambda = 4^{h}35^{m}07^{s}.47$, $h = 820$ м) and Perth (Australia) ($\varphi = -31^{\circ}57'10''$, $\lambda = 7^{h}42^{m}14^{s}.4$, $h = 0$).

Tables 2-4 cover the period from October 1985 to May 1986 with a step of 5 days. The times indicated in the first column of a table is with respect to Greenwich and correspond to the local mean midnight of the observation points. In the last column are shown the symbolic designations: 0 - light, 1 - dark part of the day. Tables 5 and 6 give more detailed information with 30 minute steps about comet visibility from Dushanbe during one 24-hour period on two dates: 25.11.85 and 6.4.86. The time is reckoned from Greenwich midnight.

The analysis of the results obtained makes it possible, in particular, to give the general nature of the comet's visibility conditions from any NIP. We shall consider Dushanbe as an example. At the beginning of October 1985 Halley's comet, already quite bright (about stellar magnitude 8) will be accessible to observations mornings, culminating high above the horizon (elevation 71°) approximately an hour before sunrise. At the end of October the visibility conditions are improved: The comet becomes visible almost all night, culminating at the height of 72° 3-4 hours before it sets. In the second half of November, the comet is accessible all night - at the time of sunset its angular height is 20-22°, culmination occurs around midnight (elevation 69°). The period of visibility is gradually displaced to the first half of the night; in mid-December the comet will culminate immediately after sunset at a height of 52°. By the middle of January, the observation conditions will worsen significantly. The comet will be visible evenings for a short time (not more than 2 hours) low above the horizon (not higher than 20°).

Then the comet will disappear in the Sun's rays, but after /25 passage of perihelion the second period of visibility will approach. During the second half of February and in March 1986, the comet will be visible mornings shortly before sunrise not high above the horizon (10-15°, but at the beginning of April - not higher than 8°). The total stellar magnitude will reach 4m. In May, the visibility conditions will improve again. However, the comet will quickly lose brightness and become less accessible for observations.

The cited tables also show how unfavorable conditions build up for northern points. Thus, for the Pulkovo NIP the comet will be accessible only to the end of December 1985, at the same time its elevation above the horizon will be 20-30°. However, at this time the comet will still be far from perihelion and its total stellar magnitude will not exceed 7-8m.

NIP's of the southern hemisphere will turn out to be in favorable conditions. In the case of Perth, it is evident that, for example, on 26 March 1986 the comet will culminate close to the zenith. It can be assumed that the geographic distribution of southern hemisphere points will not impose any limitations on the observability of Halley's comet. For such points only, the brilliance of the comet and the penetrating strength of the instruments being used determine the limits of the comet's accessibility period. The asymmetry described between northern and southern NIP's becomes still more acute if we consider that the southern observatories and stations are found usually in much better astroclimatic conditions.

In Tables 7-10 are shown the observation characteristics of Halley's comet from the Dushanbe (a southern point in the Northern Hemisphere) and Perth (Australia, Southern Hemisphere) NIP's with a step per 1 24-hour period) in a protracted interval of time in the region of the first and second approach of the comet to Earth.

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Table 2

Pulkovo

October 1985
May 1986

Local midnight

Step = 5 days

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASCENSION	RANGE	RANGE RATE	D-DAY	L-NIGHT
1985.10. 1.21.54.41.	211106.13	461243.59	200491.00	61106.05	.2998030598E 09	-.5409416476E 02		1
1985.10. 6.21.54.41.	240453.29	905242.00	201408.40	60833.49	.2756561468E 09	-.5508009860E 02		1
1985.10.11.21.54.41.	271723.73	955467.57	203005.69	60433.28	.2515801113E 09	-.5575442953E 02		1
1985.10.16.21.54.41.	304924.39	1013519.33	204644.67	55439.43	.2277284550E 09	-.5501070230E 02		1
1985.10.21.21.54.41.	342633.13	1040216.49	210617.33	55015.72	.2042940986E 09	-.5376879090E 02		1
1985.10.26.21.54.41.	382594.88	1154140.13	212826.88	53871.09	.1815310386E 09	-.5183538090E 02		1
1985.10.31.21.55.41.	429044.34	1251215.40	215137.55	52213.45	.1597874148E 09	-.4849746830E 02		1
1985.11. 5.21.55.41.	465752.33	1373748.15	221130.23	45943.84	.1395548815E 09	-.4468096532E 02		1
1985.11.10.21.55.41.	503650.05	1543065.83	221753.62	42868.39	.1213607380E 09	-.3942136810E 02		1
1985.11.15.21.55.41.	523257.00	1745955.58	215052.91	34501.45	.1068097549E 09	-.2943389000E 02		1
1985.11.20.21.55.41.	495101.16	2024450.49	207135.20	25647.36	.9648859580E 08	-.1793231250E 02		1
1985.11.25.21.55.41.	446531.47	2261835.47	172985.89	19915.32	.9211189618E 08	-.3018951120E 01		1
1985.11.30.21.55.41.	292284.69	2442423.14	133457.06	10311.76	.9382105500E 08	.1098876170E 02		1
1985.12. 5.21.56.41.	174345.10	2538214.11	92814.74	1512.70	.1009787690E 09	.2198658050E 02		1
1985.12.10.21.56.41.	72516.96	2648400.30	65119.63	233723.19	.1120757690E 09	.2928098270E 02		1
1985.12.15.21.56.41.	-11941.19	2775505.04	25722.57	230832.40	.1256186228E 09	.3341682080E 02		1
1985.12.20.21.56.41.	-81617.45	2855453.17	4218.96	224631.77	.1409194010E 09	.3522897760E 02		1
1985.12.25.21.56.41.	-101050.32	2932026.73	-10251.33	222923.88	.1556323108E 09	.3539259400E 02		1
1985.12.30.21.57.41.	-191104.57	3002930.45	-27642.24	221538.13	.1706469418E 09	.3433276000E 02		1
1986. 1. 4.21.57.41.	-237921.54	3073434.48	-33406.57	220408.38	.1849916660E 09	.3227996600E 02		1
1986. 1. 9.21.57.41.	-271417.76	3144508.08	-47624.14	215405.86	.1982628130E 09	.2932540060E 02		1
1986. 1.14.21.58.41.	-301118.41	3220450.82	-53147.71	214454.15	.2100711630E 09	.2545741650E 02		1
1986. 1.19.21.58.41.	-332326.77	3295201.26	-62544.75	213605.70	.2200074728E 09	.2058890060E 02		1
1986. 1.24.21.58.41.	-355157.74	3376929.26	-72110.45	212720.31	.2274137170E 09	.1459890800E 02		1
1986. 1.29.21.58.41.	-375426.75	3463348.11	-82029.12	211825.47	.2323876310E 09	.7422678150E 01		1
1986. 2. 3.21.58.41.	-393933.41	3553355.81	-92524.75	210917.49	.2338362450E 09	-.7925671660E 00		1
1986. 2. 8.21.58.41.	-405537.76	45512.18	-103049.09	210002.94	.2316117228E 09	-.9545632940E 01		1
1986. 2.13.21.58.41.	-412644.46	142557.78	-115447.59	205053.08	.2256398190E 09	-.180525[illegible]E 02		1
1986. 2.18.21.58.41.	-413925.79	235618.98	-131917.22	204158.12	.2161948480E 09	-.2558507418E 02		1
1986. 2.23.21.58.41.	-412516.56	372111.10	-145100.53	203314.53	.2037928100E 09	-.3176802490E 02		1
1986. 2.28.21.58.41.	-404279.51	423[illegible]4.79	-163211.17	202441.69	.1890312930E 09	-.3657387600E 02		1
1986. 3. 5.21.58.41.	-395555.97	515457.41	-182700.69	201540.10	.1727726798E 09	-.4013150790E 02		1
1986. 3.10.21.58.41.	-385332.55	612220.58	-204216.86	200529.29	.1546456858E 09	-.4255139810E 02		1
1986. 3.15.21.58.41.	-372937.89	712212.25	-232821.07	195256.55	.1360210850E 09	-.4381296550E 02		1
1986. 3.20.21.59.41.	-355824.12	822314.95	-270037.03	193553.49	.1171986830E 09	-.4365539700E 02		1
1986. 3.25.21.58.41.	-340654.37	953332.64	-313959.13	191533.99	.9875821000E 08	-.4138047410E 02		1
1986. 3.30.21.59.41.	-312915.31	1115625.47	-374248.47	182542.71	.8204909200E 08	-.3547341190E 02		1
1986. 4. 4.21.59.41.	-270721.19	1325416.47	-442132.25	171446.02	.6916014820E 08	-.2336118080E 02		1
1986. 4. 9.21.59.41.	-203123.64	1575529.14	-471417.21	151704.00	.6315994260E 08	-.3544737630E 01		1
1986. 4.14.21.59.41.	-113448.95	1983210.62	-414616.70	131606.10	.6653257630E 08	.1867513070E 02		1
1986. 4.19.21.59.41.	-30217.33	2083518.07	-323633.34	120705.03	.7842627530E 08	.3523650090E 02		1
1986. 4.24.21.58.41.	-12124.88	2173213.48	-244851.75	112148.98	.9591804850E 08	.45034705[illegible]E 02		1
1986. 4.29.21.58.41.	[illegible]456.65	2270413.39	-191142.90	105803.25	.1166126980E 09	.50[illegible]625[illegible] 02		1
1986. 5. 4.21.58.41.	1256.72	2350526.24	-151422.13	104358.19	.1391174930E 09	.5371667690E 02		1
1986. 5. 9.21.58.41.	-2617.67	2453244.57	-122456.47	103457.72	.1625641290E 09	.5554125020E 02		1
1986. 5.14.21.58.41.	-11518.17	2515710.49	-102141.03	102928.48	.1868365600E 09	.5655890730E 02		1
1986. 5.19.21.58.41.	-30324.74	2573412.02	-85031.80	102612.10	.2112537830E 09	.5706233680E 02		1
1986. 5.24.21.58.41.	-44450.11	2424448.21	-74219.47	102427.64	.2358324430E 09	.5714427340E 02		1
1986. 5.29.21.58.41.	-61256.70	2573710.62	-65110.16	102319.60	.2603686070E 09	.5605210290E 02		1

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASCENSION	RANGE	RANGE RATE	O-DAY 1-NIGHT
1985,10, 1,19,25, 0,	181418.84	743117.48	200418.50	4 [illegible]4.59	.300318576E 09	-.562115449E 02	1
1985,10, 6,19,25, 0,	223941.47	813213.95	201553.52	4 [illegible].67	.274171479E 09	-.562017164E 02	1
1985,10,11,19,25, 0,	272313.76	844535.75	202747.55	6 [illegible].58	.252092250E 09	-.559847830E 02	1
1985,10,16,19,25, 0,	323139.39	891820.95	204622.99	5 [illegible]8.50	.228232794E 09	-.551451471E 02	1
1985,10,21,19,25, 0,	381112.03	922209.48	210552.31	54028.47	.204782978E 09	-.532054294E 02	1
1985,10,26,19,25, 0,	442955.69	971030.05	212758.42	53848.79	.182007201E 09	-.519769926E 02	1
1985,10,31,19,25, 0,	513644.13	1035154.17	215111.03	52237.91	.160837115E 09	-.490998077E 02	1
1985,11, 5,19,25, 0,	593542.37	1135043.55	221113.14	50017.45	.139968943E 09	-.444502446E 02	1
1985,11,10,19,25, 0,	674676.45	1322726.70	221904.39	42943.91	.121914175E 09	-.386168670E 02	1
1985,11,15,19,25, 0,	731119.17	1723231.91	215204.10	34900.69	.107081046E 09	-.296672660E 02	1
1985,11,20,19,25, 0,	473109.57	2203103.43	202424.39	25756.26	.967495629E 08	-.175083415E 02	1
1985,11,25,19,25, 0,	531524.01	2450107.12	173428.74	20029.70	.921913958E 08	-.326074054E 01	1
1985,11,30,19,25, 0,	364242.67	2572642.26	134020.87	10419.24	.937225358E 08	.107568084E 02	1
1985,12, 5,19,25, 0,	210347.65	2652621.65	93121.08	1607.51	.100772744E 09	.214911450E 02	1
1985,12,10,19,25, 0,	73304.49	2713435.92	51533.66	231807.36	.111180440E 09	[illegible]	1
1985,12,15,19,25, 0,	-31542.97	2765[illegible]30.61	3[illegible]41.70	23[illegible]934.41	.125313168E 09	.3[illegible]481[illegible]317E 02	1
1985,12,20,19,25, 0,	-131615.93	[illegible]	-4[illegible]3.40	[illegible]90.6437	.140097214E 09	.359[illegible]70E 02	1
1985,12,25,19,25, 0,	-212456.27	2864034.98	-[illegible]2049.60	22[illegible]43.23	.155308577E 09	.395[illegible]E 02	1
1985,12,30,19,25, 0,	-243255.97	2915127.23	-27903.31	221554.02	.170331900E 09	.344718698E 02	1
1986, 1, 4,19,25, 0,	-345507.16	2971957.90	-31442.60	220401.24	.184676451E 09	.324276061E 02	1
1986, 1, 9,19,25, 0,	-404104.03	3032356.65	-43709.39	215418.60	.197994279E 09	.294797143E 02	1
1986, 1,14,19,25, 0,	-455546.92	3101436.25	-53036.70	214505.54	.209874509E 09	.256185947E 02	1
1986, 1,19,19,25, 0,	-503954.12	3152234.12	-62433.70	213616.80	.219819424E 09	.207585024E 02	1
1986, 1,24,19,25, 0,	-544914.87	3275727.91	-71905.90	212731.56	.227480605E 09	.147785943E 02	1
1986, 1,29,19,25, 0,	-581506.79	3392322.35	-81908.35	211837.00	.232320343E 09	.761160307E 01	1
1986, 2, 3,19,25, 0,	-603333.05	3524604.87	-92356.03	210929.48	.233846343E 09	-.601769426E 00	1
1986, 2, 8,19,25, 0,	-615006.60	73745.19	-103511.85	210014.78	.231702213E 09	-.936673035E 01	1
1986, 2,13,19,25, 0,	-613758.21	225123.55	-115301.75	205104.70	.225806477E 09	-.179032416E 02	1
1986, 2,18,19,25, 0,	-600605.03	371113.57	-131722.96	204209.39	.216430722E 09	-.254770664E 02	1
1986, 2,23,19,25, 0,	-522236.42	495417.43	-144856.18	203329.58	.204085464E 09	-.317042134E 02	1
1986, 2,28,19,25, 0,	-541352.56	605411.47	-162352.12	202452.83	.189368013E 09	-.365513478E 02	1
1986, 3, 5,19,25, 0,	-502224.43	704920.40	-182420.29	201552.28	.172847719E 09	-.401459937E 02	1
1986, 3,10,19,25, 0,	-469415.35	794692.03	-207904.22	200543.56	.155036825E 09	-.426002400E 02	1
1986, 3,15,19,25, 0,	-411854.68	883615.51	-232423.59	195314.99	.136423693E 09	-.438970529E 02	1
1986, 3,20,19,25, 0,	-355311.72	975219.28	-265525.80	193622.98	.117549559E 09	-.437817157E 02	1
1986, 3,25,19,25, 0,	-294330.24	1042330.91	-313307.09	191114.72	.991379458E 08	-.415671850E 02	1
1986, 3,30,19,25, 0,	-215858.60	1211618.93	-373413.12	182952.56	.823943657E 08	-.357574984E 02	1
1986, 4, 4,19,25, 0,	-120518.12	1375201.37	-441355.15	171649.42	.693741474E 08	-.237890072E 02	1
1986, 4, 9,19,25, 0,	-2440.75	1555113.35	-471544.43	151951.74	.631919317E 08	-.407368251E 01	1
1986, 4,14,19,25, 0,	92648.26	1420335.68	-415713.55	132012.61	.663601083E 08	.182469371E 02	1
1986, 4,19,19,25, 0,	142757.15	2025453.24	-324756.11	120415.56	.781012627E 08	.350123068E 02	1
1986, 4,24,19,25, 0,	151683.70	2190039.43	-245722.59	112222.20	.955028576E 08	.449703500E 02	1
1986, 4,29,19,25, 0,	134809.87	2305235.92	-191742.41	105826.31	.116146973E 09	.505725593E 02	1
1986, 5, 4,19,25, 0,	111606.38	2394730.02	-151835.93	104402.31	.138623009E 09	.537756966E 02	1
1986, 5, 9,19,25, 0,	81440.25	2464602.15	-122801.10	103506.48	.162153112E 09	.556300562E 02	1
1986, 5,14,19,25, 0,	45728.91	2522744.97	-102354.59	102933.81	.186286418E 09	.566646420E 02	1
1986, 5,19,19,25, 0,	13751.59	2571734.69	-85211.23	102615.11	.210729361E 09	.571627718E 02	1
1986, 5,24,19,25, 0,	-14631.77	2613146.64	-74333.78	102429.00	.235307276E 09	.572734900E 02	1
1986, 5,29,19,25, 0,	-51148.26	2452101.22	-65205.61	102349.78	.259865260E 09	.572874078E 02	1

Table 3

Dushanbe

October 1985

May 1986

Local midnight

Step = 5 days

Table 4

Perth

October 1985 – May 1986

Local midnight

Step = 5 days

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASSENSION	RANGE	RANGE RATE	Q DAY 1=NIGHT
1985,10, 1,16,17,46,	-82136.20	890062.40	200406.77	41111.55	.300948718E 09	-.56236381E 08	1
1985,10, 6,16,17,46,	-626.48	655904.56	201538.92	40452.62	.276401555E 09	-.562399124E 08	1
1985,10,11,16,17,46,	+1636.50	423518.68	202929.52	40497.09	.262718797E 09	-.379107264E 08	1
1985,10,16,16,17,46,	84926.21	594113.01	204601.13	55459.36	.223852378E 09	-.551912042E 08	1
1985,10,21,16,17,46,	133314.76	540456.85	210526.66	55043.77	.205392941E 09	-.839847372E 08	1
1985,10,26,16,17,46,	142820.97	402933.10	212730.26	53910.04	.142590960E 09	-.580695660E 08	1
1985,10,31,16,17,46,	233214.77	412421.25	215044.43	92307.38	.140789149E 09	-.492045505E 08	1
1985,11, 5,16,17,46,	243449.51	320352.36	221058.40	50054.01	.140474065E 09	-.449974355E 08	1
1985,11,10,16,17,46,	330733.61	194508.53	221823.73	43038.93	.122350343E 09	-.388192157E 08	1
1985,11,15,16,17,46,	340517.33	31111.70	215336.95	35012.46	.107417984E 09	-.299375736E 08	1
1985,11,20,16,17,46,	354105.16	3424804.87	202786.93	25724.46	.969522827E 08	-.179318454E 08	1
1985,11,25,16,17,46,	303907.60	3213700.01	174009.30	20200.54	.921842300E 08	-.362744257E 01	1
1985,11,30,16,17,46,	313424.35	3071518.27	134704.07	10541.97	.916082078E 08	.104435025E 08	1
1985,12, 5,16,17,46,	111490.62	2845959.76	93946.27	1714.97	.100532279E 09	.216767054E 08	1
1985,12,10,16,17,46,	11818.50	2775503.14	60084.40	233857.28	.111484897E 09	.271713821E 08	1
1985,12,15,16,17,46,	-72944.46	2685734.58	30454.92	230943.84	.124941852E 09	.334379452E 08	1
1985,12,20,16,17,46,	-150855.81	2611617.65	4810.86	224726.67	.139704482E 09	.353372349E 08	1
1985,12,25,16,17,46,	-214953.78	2541514.97	-5813.28	223007.15	.154913151E 09	.355578613E 08	1
1985,12,30,16,17,46,	-274716.42	2472828.05	-22855.66	221613.57	.169948639E 09	.345373501E 08	1
1986, 1, 4,16,17,46,	-225613.15	2403539.98	-33253.96	220438.62	.184334569E 09	.325147315E 08	1
1986, 1, 9,16,17,46,	-373149.52	2331935.98	-43331.92	215432.90	.197664914E 09	.295871883E 08	1
1986, 1,14,16,17,46,	-412926.67	2252510.55	-52804.95	214519.49	.209551845E 09	.25[illegible]475013E 08	1
1986, 1,19,16,17,46,	-443304.34	2164031.03	-62302.28	213430.47	.219586726E 09	.209119438E 08	1
1986, 1,24,16,17,46,	-470503.76	2070029.86	-71820.53	212745.30	.227314734E 09	.149785613E 08	1
1986, 1,29,16,17,46,	-482417.27	1963224.08	-81728.60	211601.07	.232233822E 09	.781822843E 01	1
1986, 2, 3,16,17,46,	-463111.62	1854007.11	-92203.71	210943.85	.233451335E 09	-.375980323E 00	1
1986, 2, 8,16,17,46,	-472203.27	1750326.41	-103309.17	210029.20	.231602979E 09	-.914005111E 01	1
1986, 2,13,16,17,46,	-456135.93	1650935.82	-115049.01	205118.86	.226[illegible]554E 09	-.176966647E 08	1
1986, 2,18,16,17,46,	-414050.76	1562940.96	-131459.36	204223.10	.216713399E 09	-.252[illegible] 08	1
1986, 2,23,16,17,46,	-373140.05	1490535.32	-144619.77	203342.32	.204437642E 09	-.315[illegible] 08	1
1986, 2,28,16,17,46,	-324209.23	1425102.64	-162657.98	202506.43	.185774187E 09	-.364578[illegible] 08	1
1986, 3, 5,16,17,46,	-271427.79	1373655.56	-182100.05	201606.98	.173293805E 09	-.400861607E 08	1
1986, 3,10,16,17,46,	-210365.16	1331047.90	-203504.81	200600.80	.155510073E 09	-.425721707E 08	1
1986, 3,15,16,17,46,	-135734.65	1292300.70	-231922.36	195337.13	.137910962E 09	-.433033482E 08	1
1986, 3,20,16,17,46,	-53041.95	1262759.81	-264900.23	193654.27	.118035107E 09	-.432327403 08	1
1986, 3,25,16,17,46,	50002.81	1241141.21	-312439.18	191203.49	.995983092E 08	-.416803116E 08	1
1986, 3,30,16,17,46,	184553.83	1225723.30	-372336.56	183110.14	.827826119E 08	-.359959[illegible] 08	1
1986, 4, 4,16,17,46,	371768.85	1234426.68	-440417.85	171917.49	.696359[illegible] 08	-.242276[illegible] 08	1
1986, 4, 9,16,17,46,	603355.55	1310236.65	-471654.67	152316.73	.532338[illegible] 08	-.467183534E 01	1
1986, 4,14,16,17,46,	794010.01	1875850.39	-421009.51	132240.64	.661570292E 08	.177164076E 08	1
1986, 4,19,16,17,46,	675932.24	2600315.67	-330135.17	120542.90	.777070653E 08	.346845[illegible] 08	1
1986, 4,24,16,17,46,	525331.62	2694546.01	-250738.70	112310.80	.949227800E 08	.449726[illegible] 08	1
1986, 4,29,16,17,46,	412242.13	2713404.36	-192454.31	105854.91	.115579847E 09	.5[illegible] 08	1
1986, 5, 4,16,17,46,	321557.21	2712146.31	-152339.46	104413.86	.138020560E 09	.537337[illegible] 08	1
1986, 5, 9,16,17,46,	244633.46	2702145.46	-123135.32	103517.42	.161530[illegible] 09	.556282[illegible] 08	1
1986, 5,14,16,17,46,	182137.50	2685753.41	-102633.09	102940.51	.185682[illegible] 09	.566770941E 08	1
1986, 5,19,16,17,46,	124100.62	2671550.82	-85407.89	102618.94	.210082962E 09	.571826102E 08	1
1986, 5,24,16,17,46,	73157.75	2653208.25	-71500.18	102430.80	.234666814E 09	.573053[illegible] 08	1
1986, 5,29,16,17,46,	24625.06	2633645.81	-65309.34	102350.06	.259228027E 09	.57127[illegible] 08	1

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASCENSION	RANGE	RANGE RATE	0=DAY 1=NIGHT
1985.11.25. 0. 0. 0.	33128.90	2902709.61	180719.40	20955.31	.9247025466E 08	-.5477528495E 01	1
1985.11.25. 0.30. 0.	-15655.10	2950425.77	180629.56	20940.76	.9246054786E 08	-.5427497456E 01	1
1985.11.25. 1. 0. 0.	-71234.15	3000449.66	180539.62	20926.21	.9245381946E 08	-.5384072866E 01	1
1985.11.25. 1.30. 0.	-121229.52	3052054.74	180449.66	20911.66	.9244114786E 08	-.5345759126E 01	1
1985.11.25. 2. 0. 0.	-165243.35	3110116.48	180359.65	20857.14	.9243167900E 08	-.5312664546E 01	1
1985.11.25. 2.30. 0.	-210454.25	3170951.67	180309.60	20842.65	.9242204570E 08	-.5284007395E 01	0
1985.11.25. 3. 0. 0.	-245556.83	3234954.36	180219.52	20828.15	.9241254602E 08	-.5257620175E 01	0
1985.11.25. 3.30. 0.	-280812.71	3310308.78	180129.48	20813.65	.9240311189E 08	-.5238483686E 01	0
1985.11.25. 4. 0. 0.	-303949.92	3384815.09	180039.29	20759.17	.9239370648E 08	-.5220188686E 01	0
1985.11.25. 4.30. 0.	-322517.18	3470038.06	175949.15	20744.69	.9238443291E 08	-.5203837745E 01	0
1985.11.25. 5. 0. 0.	-332009.78	3553142.92	175858.99	20730.21	.9237497958E 08	-.5188834096E 01	0
1985.11.25. 5.30. 0.	-332157.58	40946.17	175808.81	20715.73	.9236565750E 08	-.5174175552E 01	0
1985.11.25. 6. 0. 0.	-323035.59	124147.47	175718.41	20701.25	.9235636490E 08	-.5159178255E 01	0
1985.11.25. 6.30. 0.	-304825.07	205554.73	175628.41	20646.77	.9234704950E 08	-.5142945175E 01	0
1985.11.25. 7. 0. 0.	-281945.02	284317.76	175538.18	20632.29	.9233788816E 08	-.5128494345E 01	0
1985.11.25. 7.30. 0.	-251003.61	355321.76	175447.33	20617.80	.9232865688E 08	-.5113953986E 01	0
1985.11.25. 8. 0. 0.	-212513.62	414144.12	175357.66	20603.30	.9231949610E 08	-.5097693165E 01	0
1985.11.25. 8.30. 0.	-171053.55	485301.96	175307.35	20548.80	.9231031410E 08	-.5081382856E 01	0
1985.11.25. 9. 0. 0.	-123213.54	543556.72	175217.01	20534.28	.9230113840E 08	-.5018459895E 01	0
1985.11.25. 9.30. 0.	-73341.54	595420.67	175126.63	20519.76	.9229232920E 08	-.4985435597E 01	0
1985.11.25.10. 0. 0.	-21956.49	645300.40	175036.20	20505.22	.9228340725E 08	-.4953691282E 01	0
1985.11.25.10.30. 0.	30817.56	693627.32	174945.71	20450.67	.9227455687E 08	-.4887586938E 01	0
1985.11.25.11. 0. 0.	84544.27	740922.71	174855.14	20436.11	.9226558202E 08	-.4832257078E 01	0
1985.11.25.11.30. 0.	143050.95	783636.46	174804.55	20421.53	.9225714493E 08	-.4770826018E 01	0
1985.11.25.12. 0. 0.	202124.61	830319.20	174713.84	20406.90	.9224866030E 08	-.4703306030E 01	1
1985.11.25.12.30. 0.	261519.94	873522.47	174623.06	20352.35	.9224026320E 08	-.4629807650E 01	1
1985.11.25.13. 0. 0.	321026.45	921950.36	174532.18	20337.73	.9223200330E 08	-.4550555780E 01	1
1985.11.25.13.30. 0.	380415.77	972547.69	174441.20	20323.11	.9222389060E 08	-.4465876130E 01	1
1985.11.25.14. 0. 0.	435341.46	1030539.87	174350.11	20308.48	.9221593560E 08	-.4376175510E 01	1
1985.11.25.14.30. 0.	493426.54	1093652.02	174258.91	20253.83	.9220814590E 08	-.4281972420E 01	1
1985.11.25.15. 0. 0.	550004.10	1172526.38	174207.59	20239.18	.9220053320E 08	-.4183836380E 01	1
1985.11.25.15.30. 0.	600027.94	1270455.49	174116.15	20224.53	.9219309310E 08	-.4082430140E 01	1
1985.11.25.16. 0. 0.	641854.83	1393707.46	174024.58	20209.87	.9218583550E 08	-.3978457040E 01	1
1985.11.25.16.30. 0.	672942.93	1553455.06	173932.89	20155.20	.9217877960E 08	-.3872674570E 01	1
1985.11.25.17. 0. 0.	690045.35	1744402.00	173841.04	20140.54	.9217190920E 08	-.3765864890E 01	1
1985.11.25.17.30. 0.	683014.27	1944256.36	173749.10	20125.88	.9216523160E 08	-.3658845220E 01	1
1985.11.25.18. 0. 0.	660609.09	2122736.24	173657.01	20111.21	.9215874650E 08	-.3552411940E 01	1
1985.11.25.18.30. 0.	621804.01	2263844.62	173604.80	20056.56	.9215245450E 08	-.3447367900E 01	1
1985.11.25.19. 0. 0.	573605.93	2373908.81	173512.46	20041.91	.9214634510E 08	-.3344487940E 01	1
1985.11.25.19.30. 0.	522116.85	2462022.36	173419.99	20027.26	.9214042090E 08	-.3244502530E 01	1
1985.11.25.20. 0. 0.	464641.36	2532644.90	173327.41	20012.63	.9213467290E 08	-.3148016340E 01	1
1985.11.25.20.30. 0.	410023.43	2592941.50	173234.72	15958.01	.9212909600E 08	-.3055935020E 01	1
1985.11.25.21. 0. 0.	350735.32	2645334.01	173141.92	15943.40	.9212367780E 08	-.2968515145E 01	1
1985.11.25.21.30. 0.	291153.28	2694406.11	173049.01	15928.80	.9211841660E 08	-.2886323480E 01	1
1985.11.25.22. 0. 0.	231601.07	2742050.90	172956.02	15914.22	.9211329590E 08	-.2809736550E 01	1
1985.11.25.22.30. 0.	172219.38	2784846.54	172902.94	15859.65	.9210830770E 08	-.2739032120E 01	1
1985.11.25.23. 0. 0.	113241.89	2831417.13	172809.79	15845.10	.9210344090E 08	-.2674385910E 01	1
1985.11.25.23.30. 0.	54926.49	2874251.83	172716.56	15830.56	.9209868810E 08	-.2615867550E 01	1
1985.11.26. 0. 0. 0.	1445.15	2921930.56	172623.28	15816.04	.9209402830E 08	-.2563439090E 01	1

Table 5

Dushanbe

Comet visibility during 1 day

25 November 1985

Best visibility

Time reckoned from Greenwich midnight

Step = 30 minutes

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASSENSION	RANGE	RANGE RATE	0=DAY 1=NIGHT
1986. 4. 6. 0. 0. 0.	82647.63	1964801.52	-453233.08	165239.19	.6715169070E 08	-.1948762570E 02	1
1986. 4. 6. 0.30. 0.	42650.63	1980408.36	-453346.91	165212.17	.6711671060E 08	-.1937976300E 02	1
1986. 4. 6. 1. 0. 0.	25508.69	1971151.78	-453500.23	165145.11	.6708192330E 08	-.1927319890E 02	1
1986. 4. 6. 1.30. 0.	5324.87	2020823.01	-453613.05	165118.02	.6704732470E 08	-.1916843920E 02	0
1986. 4. 6. 2. 0. 0.	-13614.38	2065133.27	-453726.36	165050.88	.6701291550E 08	-.1906603920E 02	0
1986. 4. 6. 2.30. 0.	-43128.33	2111954.27	-453837.20	165023.71	.6697868660E 08	-.1896648330E 02	0
1986. 4. 6. 3. 0. 0.	-74949.88	2153234.06	-453948.58	164956.52	.6694463390E 08	-.1887020670E 02	0
1986. 4. 6. 3.30. 0.	-112852.20	2192909.60	-454059.50	164929.29	.6691075120E 08	-.1877756300E 02	0
1986. 4. 6. 4. 0. 0.	-152613.45	2230937.85	-454210.00	164902.03	.6687703080E 08	-.1868921780E 02	0
1986. 4. 6. 4.30. 0.	-193939.95	2263406.78	-454320.09	164834.76	.6684346770E 08	-.1860444600E 02	0
1986. 4. 6. 5. 0. 0.	-240707.64	2294245.52	-454429.80	164807.45	.6681005210E 08	-.1852432290E 02	0
1986. 4. 6. 5.30. 0.	-284642.38	2323535.08	-454539.15	164740.13	.6677677670E 08	-.1844862580E 02	0
1986. 4. 6. 6. 0. 0.	-333639.44	2351217.16	-454648.17	164712.78	.6674363350E 08	-.1837736070E 02	0
1986. 4. 6. 6.30. 0.	-382528.00	2372159.82	-454756.87	164645.41	.6671061590E 08	-.1831041400E 02	0
1986. 4. 6. 7. 0. 0.	-434118.96	2392255.92	-454905.28	164618.01	.6667771280E 08	-.1824764940E 02	0
1986. 4. 6. 7.30. 0.	-485301.50	2411146.98	-455013.43	164550.59	.6664492050E 08	-.1818881880E 02	0
1986. 4. 6. 8. 0. 0.	-540857.56	2422236.28	-455121.33	164523.14	.6661223050E 08	-.1813346940E 02	0
1986. 4. 6. 8.30. 0.	-592721.87	2425434.48	-455229.00	164455.66	.6657963720E 08	-.1808164320E 02	0
1986. 4. 6. 9. 0. 0.	-644952.42	2422702.79	-455336.46	164428.15	.6654713630E 08	-.1803284220E 02	0
1986. 4. 6. 9.30. 0.	-700040.69	2401702.87	-455443.73	164400.61	.6651471920E 08	-.1798643390E 02	0
1986. 4. 6.10. 0. 0.	-750347.87	2344718.88	-455550.81	164333.03	.6648238600E 08	-.1794056770E 02	0
1986. 4. 6.10.30. 0.	-793348.57	2214430.54	-455657.72	164305.41	.6645013290E 08	-.1789671580E 02	0
1986. 4. 6.11. 0. 0.	-822332.00	1922651.33	-455804.46	164237.76	.6641795800E 08	-.1785348770E 02	0
1986. 4. 6.11.30. 0.	-813647.87	1635855.50	-455911.01	164210.09	.6638586080E 08	-.1781027940E 02	0
1986. 4. 6.12. 0. 0.	-775437.50	1320520.59	-460017.39	164142.28	.6635384210E 08	-.1776648540E 02	0
1986. 4. 6.12.30. 0.	-730745.31	1225103.99	-460123.59	164114.47	.6632190280E 08	-.1772150720E 02	0
1986. 4. 6.13. 0. 0.	-675912.85	1185756.63	-460229.61	164046.60	.6629004600E 08	-.1767476590E 02	0
1986. 4. 6.13.30. 0.	-624308.69	1173601.91	-460335.43	164018.67	.6625827530E 08	-.1762571180E 02	0
1986. 4. 6.14. 0. 0.	-572520.94	1173532.77	-460441.03	163950.68	.6622659370E 08	-.1757383290E 02	1
1986. 4. 6.14.30. 0.	-520834.65	1182446.78	-460546.39	163922.62	.6619501130E 08	-.1751866890E 02	1
1986. 4. 6.15. 0. 0.	-465553.36	1194743.48	-460651.80	163854.49	.6616352990E 08	-.1745981010E 02	1
1986. 4. 6.15.30. 0.	-414756.09	1213608.93	-460756.33	163826.30	.6613215680E 08	-.1739691290E 02	1
1986. 4. 6.16. 0. 0.	-364433.05	1234500.56	-460900.84	163758.03	.6610090280E 08	-.1732970580E 02	1
1986. 4. 6.16.30. 0.	-315313.87	1261146.22	-461005.03	163729.69	.6606977280E 08	-.1725798470E 02	1
1986. 4. 6.17. 0. 0.	-270931.82	1285501.95	-461108.86	163701.28	.6603877590E 08	-.1718162980E 02	1
1986. 4. 6.17.30. 0.	-223706.66	1315408.92	-461212.30	163632.80	.6600792080E 08	-.1710059810E 02	1
1986. 4. 6.18. 0. 0.	-181746.44	1350854.76	-461315.31	163604.24	.6597721640E 08	-.1701492790E 02	1
1986. 4. 6.18.30. 0.	-141328.54	1393921.74	-461417.87	163535.61	.6594666090E 08	-.1692473620E 02	1
1986. 4. 6.19. 0. 0.	-102615.66	1422535.46	-461519.98	163506.91	.6591628970E 08	-.1683020090E 02	1
1986. 4. 6.19.30. 0.	-65835.00	1462736.04	-461621.58	163438.14	.6588608200E 08	-.1673164030E 02	1
1986. 4. 6.20. 0. 0.	-35235.96	1504508.76	-461722.66	163409.31	.6585605630E 08	-.1662936340E 02	1
1986. 4. 6.20.30. 0.	-11046.34	1551735.31	-461823.18	163340.40	.6582621610E 08	-.1652376580E 02	1
1986. 4. 6.21. 0. 0.	10933.82	1600346.00	-461923.14	163311.44	.6579657260E 08	-.1641531050E 02	1
1986. 4. 6.21.30. 0.	25112.87	1650153.98	-462022.51	163242.42	.6576712450E 08	-.1630452020E 02	1
1986. 4. 6.22. 0. 0.	40718.78	1700933.49	-462121.28	163213.34	.6573787760E 08	-.1619192640E 02	1
1986. 4. 6.22.30. 0.	45127.42	1752343.03	-462219.44	163144.21	.6570883470E 08	-.1607611040E 02	1
1986. 4. 6.23. 0. 0.	50246.63	1804054.07	-462316.99	163115.03	.6567999730E 08	-.1596366710E 02	1
1986. 4. 6.23.30. 0.	44103.38	1855724.86	-462413.91	163045.81	.6565135610E 08	[illegible]	1
1986. 4. 7. 0. 0. 0.	34644.23	1910936.01	-462510.21	163016.55	.6562290327E 08	-.1573511170E 02	1

Table 6

Dushanbe

Comet visibility during 1 day

6 April 1986

Close to second approach the comet is not visible

Step = 30 minutes

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASSENSION	RANGE	RANGE RATE	D-DAY 1-NIGHT
1985.10.10.19.25.	262442.56	840838.85	202448.46	60535.29	.2540987540E 09	-.5596819497E 02	0.
1985.10.11.19.25.	272319.08	844335.93	202947.55	60439.58	.2520922250E 09	-.5586978628E 02	0.
1985.10.12.19.25.	282245.03	852618.84	203253.10	60339.38	.2472974480E 09	-.5575866950E 02	0.
1985.10.13.19.25.	292314.09	860781.71	203405.29	60234.48	.2428127180E 09	-.5563100240E 02	0.
1985.10.14.19.25.	302455.88	865019.40	203924.27	60184.58	.2377395071E 09	-.5548559880E 02	0.
1985.10.15.19.25.	312741.80	873347.83	204250.14	60009.30	.2327972330E 09	-.5532276650E 02	0.
1985.10.16.19.25.	323134.71	881021.70	204622.99	55948.50	.2282337940E 09	-.5514074680E 02	0.
1985.10.17.19.25.	333630.03	890407.99	205002.80	55721.79	.2235045740E 09	-.5493749680E 02	0.
1985.10.18.19.25.	344319.25	895119.18	205349.83	55546.81	.2187934480E 09	-.5471368070E 02	0.
1985.10.19.19.25.	355110.11	903951.13	205743.80	55409.20	.2141022940E 09	-.5446706040E 02	0.
1985.10.20.19.25.	370026.46	914008.66	210144.46	55222.57	.2094331010E 09	-.5419464450E 02	0.
1985.10.21.19.25.	381118.36	922209.75	210552.31	55028.47	.2047879780E 09	-.5390047910E 02	0.
1985.10.22.19.25.	392331.97	931615.99	211004.42	54826.45	.2001691740E 09	-.5357743370E 02	0.
1985.10.23.19.25.	403729.71	941234.96	211426.66	54616.02	.1955790500E 09	-.5322557830E 02	0.
1985.10.24.19.25.	415309.99	951135.42	211852.53	54356.65	.1910203740E 09	-.5284299330E 02	0.
1985.10.25.19.25.	431037.20	961324.91	212323.38	54127.77	.1864952610E 09	-.5242754660E 02	0.
1985.10.26.19.25.	442956.70	971430.35	212758.42	53848.79	.1820077010E 09	-.5197659230E 02	0.
1985.10.27.19.25.	455110.71	982714.40	213236.62	53559.04	.1775591150E 09	-.5148874150E 02	0.
1985.10.28.19.25.	471425.52	994021.56	213716.70	53257.64	.1731543400E 09	-.5096039490E 02	0.
1985.10.29.19.25.	483744.19	1005127.21	214157.12	52944.45	.1687964630E 09	-.5038791540E 02	0.
1985.10.30.19.25.	500759.77	1022151.13	214635.79	52619.09	.1644893330E 09	-.4976924790E 02	0.
1985.10.31.19.25.	513641.45	1034158.93	215111.03	52237.91	.1602371150E 09	-.4909780710E 02	0.
1985.11. 1.19.25.	530421.49	1052346.54	215539.50	51843.04	.1560442730E 09	-.4837634840E 02	0.
1985.11. 2.19.25.	544221.55	1071437.70	215958.15	51432.56	.1519156250E 09	-.4759441940E 02	0.
1985.11. 3.19.25.	561818.19	1091414.07	220403.13	51005.48	.1478563630E 09	-.4674944710E 02	0.
1985.11. 4.19.25.	575610.02	1112442.94	220749.90	50520.79	.1438721400E 09	-.4583651230E 02	0.
1985.11. 5.19.25.	593542.63	1135044.04	221113.14	50017.45	.1399687930E 09	-.4485035410E 02	0.
1985.11. 6.19.25.	611633.03	1163538.78	221406.66	45454.40	.1361533020E 09	-.4378538610E 02	0.
1985.11. 7.19.25.	625806.54	1194343.04	221623.32	44910.56	.1324322190E 09	-.4263573040E 02	0.
1985.11. 8.19.25.	643931.82	1232018.69	221754.91	44309.88	.1288132120E 09	-.4139527330E 02	0.
1985.11. 9.19.25.	661934.84	1273209.46	221832.11	43636.31	.1253043320E 09	-.4005774840E 02	0.
1985.11.10.19.25.	675626.69	1322727.50	221804.39	42943.91	.1219141750E 09	-.3861685630E 02	0.
1985.11.11.19.25.	692738.17	1381542.23	221620.05	42224.82	.1186518420E 09	-.3706441930E 02	0.
1985.11.12.19.25.	704941.09	1450640.36	221306.17	41444.35	.1155272590E 09	-.3540042330E 02	0.
1985.11.13.19.25.	715833.15	1530759.09	220804.88	40635.94	.1125500400E 09	-.3361416830E 02	0.
1985.11.14.19.25.	724713.24	1622329.58	220113.32	35801.37	.1097310110E 09	-.3170274250E 02	0.
1985.11.15.19.25.	731119.22	1723233.23	215204.10	34900.69	.1070810440E 09	-.2966328730E 02	0.
1985.11.16.19.25.	733522.84	1831701.90	214025.66	33934.77	.1046112140E 09	-.2759943740E 02	0.
1985.11.17.19.25.	722646.55	1935617.22	212602.90	32943.16	.1023326130E 09	-.2519496930E 02	0.
1985.11.18.19.25.	711408.31	2033340.16	210847.16	31929.97	.1002555520E 09	-.2278120390E 02	0.
1985.11.19.19.25.	693636.27	2124310.54	204815.74	30853.71	.9839196410E 08	-.2020393010E 02	0.
1985.11.20.19.25.	673109.35	2203104.29	202424.39	25758.24	.9674956890E 08	-.1758803408E 02	0.
1985.11.21.19.25.	650550.28	2270538.62	195707.30	24446.53	.9533936740E 08	-.1488403450E 02	0.
1985.11.22.19.25.	622418.03	2324028.33	192623.04	23521.90	.9416627180E 08	-.1201281840E 02	0.
1985.11.23.19.25.	593006.84	2372526.47	185215.13	22348.16	.9324242420E 08	-.9125112360E 01	0.
1985.11.24.19.25.	562617.50	2412942.57	181452.36	21209.35	.9256603870E 08	-.6199676730E 01	0.
1985.11.25.19.25.	531523.72	2450107.57	173428.74	20029.70	.9214139580E 08	-.3240539960E 01	0.
1985.11.26.19.25.	495937.69	2480600.83	165123.18	14853.43	.9196860740E 08	-.3349341460E 00	
1985.11.27.19.25.	464054.39	2504328.31	160858.67	13724.63	.9204558450E 08	.2554228170E 01	

Table 7

Dushanbe

Comet visibility during 3 months

From 10 October 1985 to 15 January 1986

Step = 1 day

Time corresponds to local mean midnight

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASSENSION	RANGE	RANGE RATE	D-DAY 1-NIGHT
1985.11.28.19.25.	432054.23	2531320.43	151841.32	12407.11	.9234407180E 08	.5380382680E 01	0.
1985.11.29.19.25.	400105.05	2552656.43	142959.17	11504.32	.9292977060E 08	.8121260530E 01	0.
1985.11.30.19.25.	364242.36	2572452.57	134020.87	10419.24	.9372253580E 08	.1075640880E 02	0.
1985.12. 1.19.25.	332650.51	2591637.83	125019.57	5354.33	.9473663200E 08	.1327019700E 02	0.
1985.12. 2.19.25.	301422.89	2605424.73	120006.80	4351.53	.9596102730E 08	.1564819290E 02	0.
1985.12. 3.19.25.	273622.44	2620315.79	111021.70	3412.25	.9738370520E 08	.1788120560E 02	0.
1985.12. 4.19.25.	240222.46	2640217.17	102120.49	2457.43	.9899719710E 08	.1996315040E 02	0.
1985.12. 5.19.25.	210347.33	2652621.92	93321.08	1407.54	.1007727440E 09	.2189114530E 02	0.
1985.12. 6.19.25.	181033.89	2664614.08	84638.07	742.68	.1027128140E 09	.2366509640E 02	0.
1985.12. 7.19.25.	152250.26	2680230.54	80122.91	235942.62	.1047995540E 09	.2528722800E 02	0.
1985.12. 8.19.25.	124043.03	2691542.62	71743.63	235206.87	.1070186130E 09	.2676160340E 02	0.
1985.12. 9.19.25.	100409.05	2702616.87	63546.15	234456.73	.1093590450E 09	.2809366470E 02	0.
1985.12.10.19.25.	73704.16	2713436.17	55533.66	233805.36	.1118064050E 09	.2928981730E 02	0.
1985.12.11.19.25.	50720.29	2724100.38	51707.40	233137.77	.1143553360E 09	.3035712280E 02	0.
1985.12.12.19.25.	24457.94	2734546.47	44027.22	232530.97	.1169890830E 09	.3130840620E 02	0.
1985.12.13.19.25.	3115.19	2744909.72	40531.41	231943.87	.1196995250E 09	.3213433570E 02	0.
1985.12.14.19.25.	-13930.75	2755123.59	33217.36	231415.38	.1224771770E 09	.3285901250E 02	0.
1985.12.15.19.25.	-34543.19	2765234.87	30041.72	230904.41	.1253131650E 09	.3348330160E 02	0.
1985.12.16.19.25.	-54735.72	2775309.49	23040.60	230439.90	.1281992090E 09	.3401573780E 02	0.
1985.12.17.19.25.	-74571.99	2785302.96	20709.73	225930.82	.1311275900E 09	.3446056470E 02	0.
1985.12.18.19.25.	-93915.37	2795226.39	13504.64	225506.16	.1340911140E 09	.3482519900E 02	0.
1985.12.19.19.25.	-112928.94	2805130.86	10920.75	225054.98	.1370830750E 09	.3511421420E 02	0.
1985.12.20.19.25.	-131415.22	2815022.27	4453.45	224656.37	.1400972140E 09	.3533253660E 02	0.
1985.12.21.19.25.	-148948.30	2824909.89	2138.19	224309.48	.1431277010E 09	.3548596040E 02	0.
1985.12.22.19.25.	-164013.96	2834758.29	-29.49	223933.43	.1461690550E 09	.3557745040E 02	0.
1985.12.23.19.25.	-181747.77	2844654.59	-2133.92	223607.53	.1492161540E 09	.3561117320E 02	0.
1985.12.24.19.25.	-198239.12	2854604.95	-4139.29	223281.08	.1522641780E 09	.3559051300E 02	0.
1985.12.25.19.25.	-212407.09	2864535.28	-10049.60	222943.23	.1553005770E 09	.3551849600E 02	0.
1985.12.26.19.25.	-228450.59	2874531.44	-11908.69	222643.52	.1583450610E 09	.3539781730E 02	0.
1985.12.27.19.25.	-242227.87	2884559.08	-13640.22	222351.29	.1613695490E 09	.3523089830E 02	0.
1985.12.28.19.25.	-254756.61	2894703.90	-15327.66	222105.97	.1643781400E 09	.3501970720E 02	0.
1985.12.29.19.25.	-271123.91	2904851.51	-20934.31	221827.08	.1673671090E 09	.3476618500E 02	0.
1985.12.30.19.25.	-283256.27	2915127.55	-22503.31	221554.02	.1703329000E 09	.3447186540E 02	0.
1985.12.31.19.25.	-295239.75	2925437.77	-23957.64	221326.42	.1732720480E 09	.3413837940E 02	0.
1986. 1. 1.19.25.	-311039.51	2935927.94	-25420.11	221103.81	.1761811920E 09	.3376534870E 02	0.
1986. 1. 2.19.25.	-322701.40	2950504.07	-30813.45	220845.77	.1790571160E 09	.3335637050E 02	0.
1986. 1. 3.19.25.	-334149.40	2961152.05	-32140.12	220631.94	.1818965660E 09	.3291008140E 02	0.
1986. 1. 4.19.25.	-345507.45	2971956.26	-33442.60	220421.94	.1846964410E 09	.32427[illegible] 02	0.
1986. 1. 5.19.25.	-360659.41	2982929.13	-34723.18	220215.43	.1874536440E 09	.3190931140E 02	0.
1986. 1. 6.19.25.	-371728.46	2994031.34	-35944.06	220012.07	.1901650910E 09	.313554[illegible] 02	0.
1986. 1. 7.19.25.	-382437.45	3005311.87	-41147.35	215811.57	.1928277280E 09	.307659[illegible] 02	0.
1986. 1. 8.19.25.	-393428.72	3020737.91	-42335.05	215613.04	.1954384840E 09	.3014077180E 02	0.
1986. 1. 9.19.25.	-404107.39	3032357.06	-43509.09	215416.30	.1979942790E 09	.2947971[illegible] 02	0.
1986. 1.10.19.25.	-414625.73	3044217.16	-44631.31	215224.39	.2004920030E 09	.28782[illegible] 02	0.
1986. 1.11.19.25.	-425034.18	3060246.40	-45743.51	215032.56	.2029285120E 09	.2805[illegible] 02	0.
1986. 1.12.19.25.	-435330.43	3078533.90	-50847.37	214842.29	.2053006120E 09	.2727675310E 02	0.
1986. 1.13.19.25.	-445514.73	3085047.00	-51944.58	214653.35	.2076050400E 09	.2644713000E 02	0.
1986. 1.14.19.25.	-455547.17	3101836.73	-53036.70	214505.34	.2098385070E 09	.2561859410E 02	0.
1986. 1.15.19.25.	-465507.02	3114912.72	-54125.31	214318.65	.2119975960E 09	.2473020400E 02	0.

Continuation of Table 7

Table 8

Dushanbe

Comet visibility during 2 months

15 February 1986 – 4 April 1986

Step = 1 day

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASCENSION	RANGE	RANGE RATE	0=DAY 1=NIGHT
1986. 2.15. 0. 0. 0.	-141749.37	942119.19	-121232.40	204695.87	.2238687791E 09	-.2200905081E 02	1
1986. 2.16. 0. 0. 0.	-132049.79	952713.42	-122911.59	204704.27	.2220961561E 09	-.2143969132E 02	1
1986. 2.17. 0. 0. 0.	-122416.08	962252.79	-126406.96	204921.29	.2201918036E 09	-.2314000812E 02	1
1986. 2.18. 0. 0. 0.	-112810.77	973038.06	-130317.67	204335.05	.2181601541E 09	-.2458822271E 02	1
1986. 2.19. 0. 0. 0.	-103234.72	984416.20	-132049.32	204149.61	.2160056440E 09	-.2593358619E 02	1
1986. 2.20. 0. 0. 0.	-93729.48	995333.29	-139430.08	204000.43	.2137330284E 09	-.2732229347E 02	1
1986. 2.21. 0. 0. 0.	-84299.80	1005529.70	-139438.48	203920.33	.2113571119E 09	-.2860508484E 02	1
1986. 2.22. 0. 0. 0.	-74951.84	1020115.98	-141484.01	203636.59	.2088527830E 09	-.2983202786E 02	1
1986. 2.23. 0. 0. 0.	-65540.18	1030712.96	-143375.12	203463.19	.2042849230E 09	-.3100137760E 02	1
1986. 2.24. 0. 0. 0.	-56254.07	1041320.61	-148237.20	203310.11	.2035584082E 09	-.3211436838E 02	1
1986. 2.25. 0. 0. 0.	-41050.31	1051755.46	-151201.77	203127.17	.2007640421E 09	-.3317171620E 02	1
1986. 2.26. 0. 0. 0.	-31923.93	1062649.84	-153153.32	202944.19	.1978886594E 09	-.3417437290E 02	1
1986. 2.27. 0. 0. 0.	-32834.02	1073412.78	-155205.68	202800.99	.1947247030E 09	-.3517234452E 02	1
1986. 2.28. 0. 0. 0.	-23832.95	[illegible]	-161247.57	202617.17	.1918824905E 09	[illegible]	1
1986. 3. 1. 0. 0. 0.	-14912.21	[illegible]	-167359.11	[illegible]	.1887417428E 09	[illegible]	1
1986. 3. 2. 0. 0. 0.	[illegible]	[illegible]	-168844.80	202047.72	[illegible]	[illegible]	1
1986. 3. 3. 0. 0. 0.	-1242.43	1121317.36	-171823.75	201801.20	.1823153725E 09	[illegible]	1
1986. 3. 4. 0. 0. 0.	3423.09	1132126.84	-174171.43	201913.10	.1789745560E 09	[illegible]	1
1986. 3. 5. 0. 0. 0.	12040.27	1143341.11	-183591.28	201723.24	.1756816968E 09	[illegible]	1
1986. 3. 6. 0. 0. 0.	20607.33	1154737.60	[illegible]	201530.76	.1721028960E 09	[illegible]	1
1986. 3. 7. 0. 0. 0.	25042.27	1170154.35	-189418.70	201335.71	.1686369440E 09	-.4092920810E 02	1
1986. 3. 8. 0. 0. 0.	33422.65	1181439.93	-190074.66	201137.47	.1651440760E 09	-.4154611230E 02	1
1986. 3. 9. 0. 0. 0.	41705.95	1193407.40	-194724.04	200935.52	.1615941260E 09	-.4191879390E 02	1
1986. 3.10. 0. 0. 0.	45849.28	1205340.24	-201633.77	200729.30	.1579409320E 09	-.4203450270E 02	1
1986. 3.11. 0. 0. 0.	53920.58	1221725.41	-204447.19	200514.20	.1543322480E 09	-.4252483146E 02	1
1986. 3.12. 0. 0. 0.	61300.41	1234116.18	-211519.08	200301.51	.1506522750E 09	-.4304492190E 02	1
1986. 3.13. 0. 0. 0.	65770.00	1250729.44	-214700.76	200039.48	.1469446540E 09	-.4335630430E 02	1
1986. 3.14. 0. 0. 0.	73422.01	1263618.96	-222019.01	195808.25	.1432136960E 09	-.4357534380E 02	1
1986. 3.15. 0. 0. 0.	81000.31	1280759.32	-225601.21	195529.05	.1394635200E 09	-.4378596130E 02	1
1986. 3.16. 0. 0. 0.	84407.85	1294246.45	-233130.29	195242.21	.1356945950E 09	-.4393359910E 02	1
1986. 3.17. 0. 0. 0.	91636.44	1312057.59	-240949.80	194944.11	.1319235870E 09	-.4400623590E 02	1
1986. 3.18. 0. 0. 0.	94716.73	1330251.55	-245008.92	194634.17	.1281934510E 09	-.4402715010E 02	1
1986. 3.19. 0. 0. 0.	101357.80	1344848.82	-253237.50	194310.80	.1243634360E 09	-.4398485410E 02	1
1986. 3.20. 0. 0. 0.	104227.07	1363311.22	-261725.73	193932.23	.1205893060E 09	-.4387305050E 02	1
1986. 3.21. 0. 0. 0.	110630.05	1383422.76	-273444.50	193536.40	.1168274030E 09	-.4368542540E 02	1
1986. 3.22. 0. 0. 0.	112749.95	1403449.23	-275444.99	193120.94	.1130843740E 09	-.4341456040E 02	1
1986. 3.23. 0. 0. 0.	114607.47	1424058.40	-284738.48	192643.12	.1093677780E 09	-.4305174530E 02	1
1986. 3.24. 0. 0. 0.	120100.31	1445319.89	-294336.05	192139.78	.1056459150E 09	-.4258690530E 02	1
1986. 3.25. 0. 0. 0.	121158.14	1471221.92	-304250.35	191607.70	.1020376890E 09	-.4200916650E 02	1
1986. 3.26. 0. 0. 0.	121841.01	1493844.19	-314526.16	191001.71	.9845369770E 08	-.4130295040E 02	1
1986. 3.27. 0. 0. 0.	122031.04	1521258.14	-325131.42	190317.33	.9493562640E 08	-.4045359600E 02	1
1986. 3.28. 0. 0. 0.	121650.70	1545537.99	-340108.20	185548.80	.9149644150E 08	-.3944362320E 02	1
1986. 3.29. 0. 0. 0.	120657.90	1574715.05	-351412.37	184729.48	.8815092160E 08	-.3825311300E 02	1
1986. 3.30. 0. 0. 0.	115006.40	1604831.03	-363030.87	183811.75	.8491534550E 08	-.3686013190E 02	1
1986. 3.31. 0. 0. 0.	112526.17	1635946.21	-374938.08	182746.94	.8180815970E 08	-.3524076280E 02	1
1986. 4. 1. 0. 0. 0.	105204.65	1672127.45	-391051.32	181405.42	.7884785050E 08	-.3337072950E 02	1
1986. 4. 2. 0. 0. 0.	100908.60	1705350.47	-403305.54	180256.79	.7604305870E 08	-.3122444650E 02	1
1986. 4. 3. 0. 0. 0.	91547.09	1743659.92	-415447.56	174510.44	.7347263280E 08	-.2877876610E 02	1
1986. 4. 4. 0. 0. 0.	81115.98	1783046.22	-431350.77	173136.43	.7110509320E 08	-.2601409680E 02	1

Table 9

Perth

Comet visibility during 2 months

10 October 1985 – 27 November 1985

Step = 1 day

Time corresponds to local mean midnight

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASCENSION	RANGE	RANGE RATE	0=DAY 1=NIGHT
1985.10.10.16.17.46.	32315.59	631811.65	202631.18	60542.26	.2575233256E 09	-.5600316580E 02	1
1985.10.11.16.17.46.	41636.50	623316.68	202929.52	60447.09	.2527187970E 09	-.5591012640E 02	1
1985.10.12.16.17.46.	51020.91	615113.77	203234.37	60347.50	.2479227660E 09	-.5580138030E 02	1
1985.10.13.16.17.46.	60429.45	610552.14	203545.77	60243.19	.2431366430E 09	-.5567530450E 02	1
1985.10.14.16.17.46.	65902.78	601908.60	203903.97	60133.97	.2383618580E 09	-.5553245320E 02	1
1985.10.15.16.17.46.	75401.50	593357.58	204229.06	60019.42	.2335993040E 09	-.5537135800E 02	1
1985.10.16.16.17.46.	84926.21	584113.01	204601.13	55859.36	.2288523720E 09	-.5519120420E 02	1
1985.10.17.16.17.46.	94517.42	574948.35	204940.24	55733.43	.2241209300E 09	-.5477094130E 02	1
1985.10.18.16.17.46.	104135.56	565636.48	205326.41	55601.29	.2194073960E 09	-.5476944640E 02	1
1985.10.19.16.17.46.	113821.09	560129.66	205715.61	55422.97	.2147134850E 09	-.5452549100E 02	1
1985.10.20.16.17.46.	123534.05	550419.52	210115.75	55236.47	.2100413180E 09	-.5425774120E 02	1
1985.10.21.16.17.46.	133314.76	540456.85	210526.66	55043.77	.2053929410E 09	-.5396473720E 02	1
1985.10.22.16.17.46.	143123.07	535711.71	210940.11	54842.81	.2007705750E 09	-.5364448410E 02	1
1985.10.23.16.17.46.	152958.58	515333.19	211359.75	54633.50	.1961765870E 09	-.5329643850E 02	1
1985.10.24.16.17.46.	162900.90	505149.43	211825.09	54415.32	.1916134390E 09	-.5291749390E 02	1
1985.10.25.16.17.46.	172828.72	494147.47	212255.52	54147.72	.1870840040E 09	-.5250596390E 02	1
1985.10.26.16.17.46.	182820.97	482833.10	212730.26	53910.08	.1825909800E 09	-.5205956600E 02	1
1985.10.27.16.17.46.	192436.43	471150.98	213208.35	53621.77	.1781375130E 09	-.5157580280E 02	1
1985.10.28.16.17.46.	202910.17	455123.27	213646.43	53322.10	.1737269100E 09	-.5105154310E 02	1
1985.10.29.16.17.46.	213001.22	442453.64	214129.11	53010.34	.1693627230E 09	-.5048500220E 02	1
1985.10.30.16.17.46.	223104.84	425400.05	214608.52	52645.71	.1650487730E 09	-.4987172190E 02	1
1985.10.31.16.17.46.	233214.77	412421.25	215044.43	52307.38	.1607891690E 09	-.4920855050E 02	1
1985.11. 1.16.17.46.	243325.09	394533.54	215519.16	51914.47	.1565883420E 09	-.4849162490E 02	1
1985.11. 2.16.17.46.	253427.19	380111.24	215934.55	51506.07	.1524510650E 09	-.4771675400E 02	1
1985.11. 3.16.17.46.	263510.76	361046.85	220341.80	51041.20	.1483824910E 09	-.4687940810E 02	1
1985.11. 4.16.17.46.	273523.27	341350.91	220731.49	50558.86	.1443881620E 09	-.4597470850E 02	1
1985.11. 5.16.17.46.	283449.51	320952.36	221058.40	50054.01	.1404740650E 09	-.4499743550E 02	1
1985.11. 6.16.17.46.	293311.25	295418.64	221354.45	45537.98	.1366466560E 09	-.4394204490E 02	1
1985.11. 7.16.17.46.	303006.63	273436.39	221618.64	44956.91	.1329128670E 09	-.4280266570E 02	1
1985.11. 8.16.17.46.	312509.92	251012.05	221756.89	44353.72	.1292801340E 09	-.4157327460E 02	1
1985.11. 9.16.17.46.	321750.54	223237.89	221842.05	43728.18	.1257564510E 09	-.4024755200E 02	1
1985.11.10.16.17.46.	330733.61	194508.53	221823.73	43038.93	.1223503430E 09	-.3881921570E 02	1
1985.11.11.16.17.46.	335338.72	164732.64	221650.38	42325.09	.1190708660E 09	-.3728206150E 02	1
1985.11.12.16.17.46.	343520.31	133325.38	221349.28	41545.34	.1159276050E 09	-.3563019020E 02	1
1985.11.13.16.17.46.	351147.81	102036.22	220906.56	40740.93	.1129307980E 09	-.3385826360E 02	1
1985.11.14.16.17.46.	354206.22	65106.04	220327.58	35709.76	.1100909750E 09	-.3196181810E 02	1
1985.11.15.16.17.46.	360517.33	31111.70	215316.95	35012.46	.1074179840E 09	-.2993757360E 02	1
1985.11.16.16.17.46.	362021.35	3542127.75	214219.12	34049.39	.1049740740E 09	-.2774394350E 02	1
1985.11.17.16.17.46.	362619.37	3502849.15	212818.87	33101.38	.1026199600E 09	-.2580119790E 02	1
1985.11.18.16.17.46.	362813.78	3511457.22	211127.34	32051.15	.1005160490E 09	-.2309996010E 02	1
1985.11.19.16.17.46.	360722.68	3470436.11	205121.60	31017.57	.9862348810E 08	-.2057134930E 02	1
1985.11.20.16.17.46.	354105.16	3424304.87	202756.93	25724.46	.9695282820E 08	-.1793184580E 02	1
1985.11.21.16.17.46.	350257.63	3362324.70	200107.03	24614.65	.9551147300E 08	-.1519405680E 02	1
1985.11.22.16.17.46.	341252.24	3341052.49	193049.84	23651.47	.9430887670E 08	-.1237406210E 02	1
1985.11.23.16.17.46.	331101.38	3295446.40	185708.28	22518.70	.9335072200E 08	-.9491191910E 01	1
1985.11.24.16.17.46.	315751.29	3254230.99	182010.26	21340.32	.9264172620E 08	-.6567574290E 01	1
1985.11.25.16.17.46.	303407.60	3213706.01	174009.35	20200.54	.9218423000E 08	-.3627442570E 01	1
1985.11.26.16.17.46.	290049.24	3173841.65	165723.65	15023.59	.9197268990E 08	-.6962543850E 00	1
1985.11.27.16.17.46.	271906.00	3134903.34	161210.81	13853.59	.9202331500E 08	.2200316000E 01	1

Table 10

Perth

Comet visibility during 3 months

15 February 1986

23 May 1986

Step = 1 day

Time corresponds to local mean midnight

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASSENSION	RANGE	RANGE RATE	0-DAY 1-NIGHT
1986. 2.15.21. 0. 0.	16288.45	1031101.26	-129659.21	206721.47	.2223332345E 09	-.2160077[illegible]E 02	1
1986. 2.16.21. 0. 0.	31264.59	1030[illegible]4.29	-129392.13	204534.64	.2224382810E 09	-.2298465[illegible]E 02	1
1986. 2.17.21. 0. 0.	43264.69	1027237.18	-133101.19	204348.33	.2185191596E 09	-.2295177454E 02	1
1986. 2.18.21. 0. 0.	53260.46	1020159.10	-131836.69	202202.67	.2162796950E 09	-.258[illegible]306297E 02	1
1986. 2.19.21. 0. 0.	71254.16	1013303.26	-13[illegible]629.21	200017.73	.2140215220E 09	-.2714914[illegible]E 02	1
1986. 2.20.21. 0. 0.	83328.16	1016532.01	-135439.47	202433.37	.2116499467E 09	-.2847846[illegible]E 02	1
1986. 2.21.21. 0. 0.	95325.31	1003715.75	-141228.36	203649.53	.2091683774E 09	-.2921177735E 02	1
1986. 2.22.21. 0. 0.	111348.80	1001103.48	-143134.46	203504.18	.2065431379E 09	-.3248795433E 02	1
1986. 2.23.21. 0. 0.	123420.27	997740.48	-149806.10	203323.01	.2078986370E 09	-.3203749177E 02	1
1986. 2.24.21. 0. 0.	135301.81	998234.40	-150987.76	201149.06	.2011196966E 09	-.3307134607E 02	1
1986. 2.25.21. 0. 0.	151854.67	995426.71	-152913.11	208957.10	.1942510735E 09	-.3406039[illegible]E 02	1
1986. 2.26.21. 0. 0.	143763.38	943466.69	-154924.05	202913.94	.1952274348E 09	-.3503547476E 02	1
1986. 2.27.21. 0. 0.	175824.67	991204.67	-161001.79	202630.54	.1922614926E 09	-.3593519[illegible]E 02	1
1986. 2.28.21. 0. 0.	193017.27	979354.79	-163110.79	202446.12	.1891633020E 09	-.3678986615E 02	1
1986. 3. 1.21. 0. 0.	203230.16	974028.41	-165251.22	202300.97	.1859771617E 09	-.3759185186E 02	1
1986. 3. 2.21. 0. 0.	220812.39	970746.11	-171506.65	202114.62	.1827224046E 09	-.3834327735E 02	1
1986. 3. 3.21. 0. 0.	232925.25	964749.67	-173759.45	201926.74	.1795103430E 09	-.3905485506E 02	1
1986. 3. 4.21. 0. 0.	[illegible]4.39	962841.33	-1[illegible]31.43	201736.38	.1767347317E 09	-.3972[illegible]07[illegible]E 02	1
1986. 3. 5.21. 0. 0.	[illegible]61704.75	961423.79	-[illegible]1.82	2[illegible]64.97	.1774123[illegible]E 09	-.4[illegible]3186[illegible]E 02	1
1986. 3. 6.21. 0. 0.	274235.87	[illegible]	[illegible]8.44	[illegible]	[illegible]	[illegible]	1
1986. 3. 7.21. 0. 0.	[illegible]	[illegible]	-19[illegible]	[illegible]47	.1686391652E 09	-.41[illegible]E 02	1
1986. 3. 8.21. 0. 0.	373637.[illegible]	998113.78	-194357.19	200951.01	.1620[illegible]331E 09	-.4168846055E 02	1
1986. 3. 9.21. 0. 0.	[illegible].07	[illegible]3.83	-2[illegible]1185.67	200745.35	.1584337692E 09	-.4231712260E 02	1
1986. 3.10.21. 0. 0.	393523.29	[illegible]57.85	-204059.15	200530.90	.1547473376E 09	-.4273654270E 02	1
1986. 3.11.21. 0. 0.	35[illegible]260.63	944229.56	-211117.26	200319.76	.1511103970E 09	-.4304616916E 02	1
1986. 3.12.21. 0. 0.	364[illegible]28.19	943231.17	-214246.51	200054.77	.1474064740E 09	-.4334699520E 02	1
1986. 3.13.21. 0. 0.	351525.69	942419.70	-22[illegible].36	199827.48	.1436781600E 09	-.4354741318E 02	1
1986. 3.14.21. 0. 0.	39[illegible]2[illegible].17	941310.15	-22[illegible]05.14	1995[illegible].16	.1359300130E 09	-.4378369736E 02	1
1986. 3.15.21. 0. 0.	413226.57	941470.84	-232695.46	195103.74	.1361666050E 09	-.4392733990E 02	1
1986. 3.16.21. 0. 0.	431902.95	941314.51	-239445.37	195007.02	.1323926130E 09	-.4401583456E 02	1
1986. 3.17.21. 0. 0.	445844.24	941519.18	-244449.24	194650.64	.1286126654E 09	-.4404414070E 02	1
1986. 3.18.21. 0. 0.	446627.43	942110.23	-252760.89	194337.04	.1248322289E 09	-.4400392766E 02	1
1986. 3.19.21. 0. 0.	463729.63	947112.76	-261130.43	194003.48	.1210564227E 09	-.4392355709E 02	1
1986. 3.20.21. 0. 0.	503203.56	944723.14	-268829.92	193626.92	.1172930730E 09	-.4372644640E 02	1
1986. 3.21.21. 0. 0.	523046.43	950257.37	-274829.71	193154.06	.1135471080E 09	-.4346586310E 02	1
1986. 3.22.21. 0. 0.	543341.25	954254.04	-280040.29	192719.20	.1098267490E 09	-.4311140240E 02	1
1986. 3.23.21. 0. 0.	544118.13	962729.79	-293613.99	192217.04	.1061399540E 09	-.4266140540E 02	1
1986. 3.24.21. 0. 0.	545331.35	971753.97	-303403.11	191651.02	.1024886340E 09	-.4202920097E 02	1
1986. 3.25.21. 0. 0.	611103.97	983115.74	-315718.83	191049.47	.98[illegible]41318E 08	-.4161067581E 02	1
1986. 3.26.21. 0. 0.	673345.31	1020902.02	-324251.41	190410.11	.9536722826E 08	-.4057496830E 02	1
1986. 3.27.21. 0. 0.	695122.70	1027000.93	-335201.54	185647.51	.9191713410E 08	-.3958478270E 02	1
1986. 3.28.21. 0. 0.	683308.39	1052531.52	-353640.08	184823.24	.8855884728E 08	-.3841659770E 02	1
1986. 3.29.21. 0. 0.	710711.49	1073256.85	-362035.07	183924.95	.8530867060E 08	-.3704861519E 02	1
1986. 3.30.21. 0. 0.	733934.94	1153502.06	-373578.81	182903.03	.8218452930E 08	-.3546743750E 02	1
1986. 3.31.21. 0. 0.	745235.27	1247755.34	-390023.19	181737.64	.7920579910E 08	-.3361823670E 02	1
1986. 4. 1.21. 0. 0.	780024.05	1373424.11	-402834.06	180440.48	.7639615740E 08	-.3155597310E 02	1
1986. 4. 2.21. 0. 0.	775644.91	1554222.03	-414426.12	175006.90	.7377961470E 08	-.2909693680E 02	1
1986. 4. 3.21. 0. 0.	785149.65	1743345.08	-430357.15	173346.83	.7138258900E 08	-.2637096350E 02	1
1986. 4. 4.21. 0. 0.	770723.39	1930300.54	-441626.70	171532.17	.6923239939E 08	-.2233143651E 02	1

Continuation of Table 10

TIME	ELEVATION	AZIMUTH	DECLINATION	R ASSENSION	RANGE	RANGE RATE	0-DAY 1-NIGHT
1986. 4. 5.21. 0. 0.	741150.97	2043216.44	-452446.52	165519.05	.6735953700E 08	-.1992339460E 02	1
1986. 4. 6.21. 0. 0.	702463.67	2174040.29	-461309.19	163310.21	.6679071130E 08	-.1620790720E 02	1
1986. 4. 7.21. 0. 0.	641351.24	2235135.58	-465740.39	160917.90	.6455348680E 08	-.1219446830E 02	1
1986. 4. 8.21. 0. 0.	613745.54	2280757.06	-471707.31	154405.38	.6367178446E 08	-.7928164970E 01	1
1986. 4. 9.21. 0. 0.	464736.81	2310722.20	-471436.38	151806.31	.6310492607E 08	-.3471936610E 01	1
1986. 4.10.21. 0. 0.	514917.27	2332008.73	-464904.24	145201.37	.6304411181E 08	.1096177050E 01	1
1986. 4.11.21. 0. 0.	464737.79	2345528.20	-460104.84	142632.13	.6332142000E 08	.5687801500E 01	1
1986. 4.12.21. 0. 0.	419701.42	2360510.76	-445260.70	140214.98	.6398945232E 08	.1028142930E 02	1
1986. 4.13.21. 0. 0.	365122.81	2365544.11	-432748.54	133936.68	.6504151700E 08	.1461040590E 02	1
1986. 4.14.21. 0. 0.	320345.79	2373144.05	-415604.20	131852.86	.6646250570E 08	.1878935040E 02	1
1986. 4.15.21. 0. 0.	272637.92	2376414.57	-400348.30	130007.09	.6823822100E 08	.2270806940E 02	1
1986. 4.16.21. 0. 0.	233150.00	2381136.06	-381250.26	124323.10	.7032691660E 08	.2633463960E 02	1
1986. 4.17.21. 0. 0.	185020.98	2381327.05	-362023.30	122428.09	.7272082772E 08	.2965412100E 02	1
1986. 4.18.21. 0. 0.	145243.31	2382104.94	-342659.04	121514.23	.7538751270E 08	.3266371430E 02	1
1986. 4.19.21. 0. 0.	110859.58	2381733.19	-324029.10	120331.10	.7830093100E 08	.3527928840E 02	1
1986. 4.20.21. 0. 0.	73851.57	2380931.14	-305605.85	115308.19	.8143619520E 08	.3781190470E 02	1
1986. 4.21.21. 0. 0.	42146.34	2375736.96	-291647.35	114355.70	.8477008230E 08	.3998488510E 02	1
1986. 4.22.21. 0. 0.	11701.77	2374217.40	-274253.68	113544.79	.8828124095E 08	.4192146540E 02	1
1986. 4.23.21. 0. 0.	-19609.40	2372354.63	-261432.82	112827.67	.9195048980E 08	.4364513480E 02	1
1986. 4.24.21. 0. 0.	-41636.39	2370252.47	-245145.41	112157.52	.9576038940E 08	.4517853170E 02	1
1986. 4.25.21. 0. 0.	-65138.12	2363919.52	-233428.41	111608.46	.9969553950E 08	.4654278370E 02	1
1986. 4.26.21. 0. 0.	-91431.77	2361130.81	-222209.94	111088.43	.1037422340E 09	.4775717190E 02	1
1986. 4.27.21. 0. 0.	-112932.46	2354535.45	-211451.32	110414.06	.1078683395E 09	.4883901230E 02	1
1986. 4.28.21. 0. 0.	-133651.30	2351541.93	-201808.48	110200.40	.1121231210E 09	.4980368790E 02	1
1986. 4.29.21. 0. 0.	-153704.49	2344357.04	-191342.93	105811.85	.1164370910E 09	.5066474840E 02	1
1986. 4.30.21. 0. 0.	-173053.56	2341026.34	-181916.46	105445.02	.1208210490E 09	.5143406940E 02	1
1986. 5. 1.21. 0. 0.	-191843.60	2333514.44	-172831.91	105137.72	.1252693510E 09	.5212202050E 02	1
1986. 5. 2.21. 0. 0.	-210105.47	2325825.13	-164111.47	104847.87	.1297747860E 09	.5273763650E 02	1
1986. 5. 3.21. 0. 0.	-228474.92	2322001.47	-156700.74	104613.69	.1343304620E 09	.5328876120E 02	1
1986. 5. 4.21. 0. 0.	-241108.11	2314006.01	-151544.86	104353.51	.1389317450E 09	.5378209780E 02	1
1986. 5. 5.21. 0. 0.	-253924.90	2305440.71	-143710.44	104146.05	.1435739090E 09	.5422414260E 02	1
1986. 5. 6.21. 0. 0.	-270344.84	2301547.25	-140105.19	103950.08	.1482527380E 09	.5461950750E 02	1
1986. 5. 7.21. 0. 0.	-282427.69	2293126.85	-132717.82	103804.54	.1529644240E 09	.5497292100E 02	1
1986. 5. 8.21. 0. 0.	-294138.31	2284540.42	-125538.02	103628.47	.1577052580E 09	.5528635200E 02	1
1986. 5. 9.21. 0. 0.	-305534.14	2275428.79	-122556.31	103501.04	.1624725800E 09	.5556924760E 02	1
1986. 5.10.21. 0. 0.	-320627.52	2270952.39	-115804.07	103341.56	.1672633400E 09	.5581865560E 02	1
1986. 5.11.21. 0. 0.	-331427.92	2261381.89	-113153.42	103229.32	.1720747340E 09	.5603924890E 02	1
1986. 5.12.21. 0. 0.	-341946.11	2252324.58	-110717.15	103123.75	.1767049810E 09	.5623338210E 02	1
1986. 5.13.21. 0. 0.	-352230.27	2243537.47	-104408.67	103024.92	.1817512650E 09	.5640313430E 02	1
1986. 5.14.21. 0. 0.	-362247.92	2234124.26	-102721.97	102930.86	.1866118270E 09	.5655034750E 02	1
1986. 5.15.21. 0. 0.	-378045.97	2224546.91	-100191.52	102852.00	.1914847220E 09	.5667660330E 02	1
1986. 5.16.21. 0. 0.	-381630.46	2214845.40	-94232.26	102758.39	.1963682510E 09	.5678[illegible]0450E 02	1
1986. 5.17.21. 0. 0.	-391006.81	2205019.40	-92419.62	102712.24	.2012607690E 09	.5687219560E 02	1
1986. 5.18.21. 0. 0.	-400135.81	2195028.29	-90713.14	102645.39	.2061512350E 09	.5694513230E 02	1
1986. 5.19.21. 0. 0.	-403110.18	2184713.86	-85100.91	102613.33	.2110372720E 09	.569[illegible]9430E 02	1
1986. 5.20.21. 0. 0.	-413849.17	2174635.16	-83543.83	102545.92	.2159686150E 09	.5703970350E 02	1
1986. 5.21.21. 0. 0.	-422436.22	2164232.38	-82117.69	102521.91	.2208831880E 09	.5706680930E 02	1
1986. 5.22.21. 0. 0.	-430834.28	2152708.44	-80740.33	102501.10	.2258000080E 09	.5707937750E 02	1
1986. 5.23.21. 0. 0.	-435048.92	2143018.44	-79448.64	102443.28	.2307179710E 09	.5707971700E 02	1