

## EPHEMERIDES SOFTWARE OF NATURAL SATELLITES

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To make a photograph of a satellite, we have to know how it is located relative to the planet. After processing the plates, the identification of satellites is to be made. Precise coordinates of natural satellites need to be known for this purpose.

The accuracy of determination of relative coordinates of satellites increases with the decreasing of their apparent angular distance. If the CCD-matrix is used, the field of view is small. It is necessary to precalculate the moment when the images of satellites are close to each other.

In some rare moments, mutual phenomena occur: the image of one satellite overlaps with another or one satellite enters the shadow of the other. In this case, the relative coordinates of satellites are obtained with maximal accuracy than it can be achieved from the Earth. These phenomena are very rare and short-term. For their detection, it is necessary to calculate satellite coordinates with highest accuracy.

In every case of satellite observations the condition of planet visibility for a given observatory, at a given time moment, is required. It is necessary to know definitely whether it is possible to observe or not.

The problems listed above lead to the necessity of calculations of ephemerides of natural satellites. The printed almanacs and the existing tables for this purpose are not convenient enough in modern conditions. In some cases, they are unsuitable.

Therefore, we have considered the problem of creating an ephemeris means which best satisfies all modern requirements. Some version of ephemerides software of natural satellites is suggested in the present report.

The main idea consists in the refusal of using the tables with beforehand calculated coordinates of a satellite, for a number of moments of time. The coordinates will be calculated for any moment and only when they will be required to inform an observer how the satellites are located in the telescope field of view and what are the conditions of visibility of a planet

on the observatory. Therefore, the main ephemerides tool is a screen of a computer on which a planet and satellites are seen how they can be viewed through the telescope. A field of sight is displayed on a screen in a kind of window and around it the comments and menus are placed to control the "telescope". Pressing the keys, you can turn the model telescope to the left and to the right, upwards or downwards, as well as quickly change its magnification. Inscriptions beside the window show where the "telescope" is directed and what is the magnification. On the screen are given also: the time moment, elevation of a planet over the horizon and angular "depth" of the sun under the horizon. Position and phase of the moon are also given. Satellite coordinates can instantly be issued on the screen in digital form. A copy of the window can be printed together with the digital table of all calculated data. All this can be done for any given moment of time both in the past and in the future. The mutual phenomena of satellites are reproduced as they could be viewed through the telescope with the resolution of 0.005 seconds of arc per pixel. You can see as the disk of one satellite occults or eclipses the disk of the other.

The constructed tool comprises a program product ensuring the handling problems for natural satellites ephemerides. It includes the theories of planets motion and their satellites, as well as a facility of control and visualization of ephemeris data.

This idea of natural satellite ephemerides was already realized earlier in Bureau des Longitudes (the program SATELL11). We have known about this program after the first version of our program had been made. We have endeavored to make our software more advanced and convenient.

The created means permits to predict apparent approaches of the satellites at any given angular distance. Mutual occultations and eclipses of satellites are also automatically registered. The moments of the phenomena are recorded in the table. Subsequently, the program allows to take a moment of the phenomena from this table and reproduce the phenomenon. Eclipses can be demonstrated as they were viewed from the Sun.

At present, the moments of all mutual phenomena of the major satellites of Saturn in 1995 – 1996 and all mutual phenomena of Galilean satellites of Jupiter in 1997 – 1998 are calculated and saved in the files.

In this version, the motion of those satellites for which there exist good analytical theories is calculated with maximal accuracy. For the other satellites, simplified models of movement are accepted.

The existing version of the program is adapted for personal computers IBM PC and compatible. The program is transmitted free of charge to all astronomical institutions by inquiry to the author. It can be copied through the computer network Internet from our FTP-server with anonymous access. The designation of the software is MONS-EPH.