

## **Canon of solar eclipses in Russia for the interval 1000–2050**

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Solar eclipses are quite rare events. But as well as any other events related to the movement of bodies in space they occur with a certain regularity caused by the laws allowing to compute their time in the future and in the far past. Eclipses contain information about evolution of the Earth and the Moon orbits, about rotation of the Earth, about some physical parameters of the Sun, the Earth and the Moon. Each record of the solar eclipse observation found in manuscripts helps to specify dates of the historical events and even to correct their sequence. That is why not only observers take great interest in eclipses, but also the researchers in the field of ephemeris astronomy, history and chronology do.

The Canon contains the basic data about the solar eclipses observed in territory of the former USSR (in boundaries of 1990) from 1000 to 2050 with the magnitude of phase exceeding 0.1. In total as many as 2498 solar eclipses took place on our planet for this period of time. And only 992 of them with the phase exceeding 0.1 were visible in the territory of the USSR, i.e. 39.7% of total amount of the eclipses. This time interval is not chosen accidentally — it covers almost the entire historical period of our state existence. This work was taken by the authors in order to provide for specialists interested in the solar eclipses with the accessible and convenient reference book.

Beginning from 1887 several canons of solar eclipses were published. They differed in the accuracy of given materials and in value of the period covered with the tables. The most known of them is the canon of Mucke H., Meeus J. covering the period from –2003 to 2526. However all these canons possess certain shortcomings. There are inexact theories in the old canons, and the modern ones can be characterized by the publication of material in the Ephemeris Time and the insufficiently convenient maps which do not allow choosing the certain eclipse quickly.

In our Canon we have tried to input the maximum information in the maps of eclipses. Our intention was to create a model which would allow to avoid the use of additional calculations while searching for some certain eclipse.

Each page of the Canon includes the fixed set of necessary data and the detailed maps for six eclipses. These data are enough to form a common view about the eclipse: the type and the date of the eclipse according to the Gregorian Calendar (until 1582 October 4 — according to the Julian Calendar); the time of the geocentric conjunction in the right ascension of the Sun and the Moon expressed in the Universal Time (UT); the week day; the ephemeris correction to UT; the apparent right ascension and declination of the Sun for the time of the geocentric conjunction with the Moon; the beginning, the greatest magnitude and the end times of the eclipse on the Earth respectively; the magnitude of the greatest phase of the eclipse or the duration of the central phase of the eclipse near to the time of the geocentric maximum of the eclipse. Each eclipse description has a detailed map containing the information about places of the eclipse visibility.

All necessary data allowing independently to draw the path of the central phase of the eclipse and to compute the local circumstances are given for the 49 chronicle eclipses. One page is allotted for each eclipse which contains also: the tables of the apparent geoequatorial coordinates and the radii of the Sun and the Moon, the Besselian elements of the eclipse represented in form of the Tchebyshev polynomials; the information on the path of the central phase (the width of the path of central eclipse at some time, the duration of the central eclipse and the height of the Sun above horizon on the central line); the local circumstances of the eclipse in some large cities and populated places.

Calculations are based on the numerical ephemerides DE404/LE404 and the recent results in researches are taken into account in the field of investigation of non-uniform rotation of the Earth. This allows to calculate equally precisely both the present eclipses and the ancient eclipses. The Bessel analytical theory was used for computations of solar eclipses in the software package PHENOMENA created by the Canon authors. All numerical data are published with accuracy sufficient for calculating the circumstances of the present solar eclipses.

The basic idea of the Canon is to give the most complete notion about geographical space where the eclipse of the certain phase is observed. Therefore, each eclipse has the map on which the basic curves describing the course of the eclipse for the Earth as a whole are drawn: the western and east limits of visibility of the eclipse on the Earth, the curve of maximum eclipse in the horizon, the isophases are put with the interval 0.2, the outline curves of the partial eclipse. The map is made in the azimuth equidistant projection of Postel.

The example of the calculation of the local circumstances of one of 49 chronicle eclipses is given in the Explanation to Canon.