

# RUSSIAN ASTRONOMICAL EPHEMERIS EDITIONS AND SOFTWARE

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**ABSTRACT.** Institute of Applied Astronomy has published “The Astronomical Yearbook”, “The Nautical Astronomical Yearbook”, “The Nautical Astronomical Almanac” biennial. Ephemerides are calculated according to resolutions of GA IAU of 2000-2006. The EPM domestic theory of movement of the Solar system bodies is used in Russian astronomical ephemeris editions and software since 2009 according to the recommendations of the conference CTNS-2007. Along with printing the astronomical software are elaborated. “The Personal Astronomical Yearbook” (PersAY) allows the user to solve tasks of calculation of ephemerides for any moment in various time scales, and for any position of the observer on a terrestrial surface. System of the removed access the “Scturman” is developed also intended to solve some the navigating tasks.

## 1. EPHEMERIDES HARD COPY

Institute of Applied Astronomy of RAS has published “The Astronomical Yearbook” (AY) since 1921, “The Nautical Astronomical Yearbook” (NAY) since 1930, “The Nautical Astronomical Almanac” (NAA-2) biennial since 2001. The latest resolutions of IAU have essentially changed theoretical basis ephemeris calculations. They were deal with new IAU2006/2000 precession-nutation models of rotation of the Earth and new concept of a sidereal time. The system ICRS was entered, which is based on VLBI observations of extragalactic radio sources and extended on optical area by catalogues HIPPARCOS and FK6. Relativistic definitions of coordinate systems and time scales were redefined more exactly. During 2003–2007 according to these resolutions the reform of theoretical and computing base of AY was completed and beginning from the issue AY for 2008, all relevant resolutions of IAU have been implemented in all ephemerides. In 2007 EPM2004 lunar and planetary ephemerides is accepted as the national standard fundamental ephemerides by the resolution of All-Russian conference “Coordinate, time and navigational support” (CTNS-2007) and are used in our ephemerides. At present all ephemerides in AY are referred to the “classical conception of equinox” system. Besides the parameters for reduction to new system are also given. All calculations are work out on the basis of ERA multifunctional software system.

Despite of lower accuracy navigation ephemerides (0.1′) for unification of creation of editions NAY is prepared on the same theoretical and technological basis as AY. For ships at long-run sailing new navigating manual has worked out. The biennial NAA-2 includes the star charts, examples for the determination of the compass’ correction and the position of a ship by the Sun and stars. Fixing position plotter for laying off line of position (L.O.P.) is also given. The NAA-2 contains the explanation both in Russian and English.

A part of published in AY data and the natural satellites ephemerides are located on a site <http://www.ipa.nw.ru/PAGE/EDITION/RUS/rusnew.htm>.

## 2. THE SHTURMAN

Besides system of the removed access the “Shturman” was developed. It intended to solve some the navigating tasks described in NAA-2. The system calculates positions of navigating stars and solves the task of the determination of the position of a ship, and the task of correction of a compass from observations of the Sun and stars. The solving of tasks is carried out in accordance with the accepted in these editions accuracy (0.1′). 21 examples are accessible to the decision in the Internet’ system now.

The solution report of task is output, and therefore the system can be considered and as the manual. The system is accessible on a site <http://shturman.ipa.nw.ru> (in Russian). However the system possesses a number of lacks. It is the fixed accuracy of the decision, a small set of examples, dependence on the Internet, etc.

### 3. THE PERSAY

The electronic versions are developed for two editions. The important stage of reform of AY is creation of “The Personal Astronomical Yearbook” (PersAY). Program system PersAY covers the basic types ephemerides published in AY and also provides possibility to calculate topocentric ephemerides, which it is necessary for observers. The system enables to calculate the data for four types of tasks (different package sections): ephemerides, astronomical events, planetary configurations, daily ephemerides.

Calculations in system PersAY are carried out as well as in AY with accuracy  $0.01''$  for fundamental ephemerides. Except EPM2004 in PersAY also it is possible to calculate by means of DE405/LE405 theory to make comparison with others ephemeris editions. In general it is possible the choice of equatorial, horizontal, ecliptic, apparent and mean coordinates and various types of equinox. As objects it can be chosen the Sun, the Moon, any major planet, star from any catalogue. The set of time scales covers all used in ephemeris. The important feature of system PersAY is presence of the detailed description of all used algorithms allows receiving objective information about accuracy calculated ephemerides. The system can be considered as electronic version AY. The demo version of system PersAY with interval of ephemerides 2010–2012 is available via FTP from the Internet <ftp://quasar.ipa.nw.ru/pub/PERSAY/persay.zip>. The time intervals of validity of the system makes 2010–2015, 2016–2020.

### 4. THE NAVIGATOR

At present, the off-line electronic version of nautical ephemeris software package for the decision of the basic tasks by definition of a place of a ship on observations of celestial bodies is worked out. The system should provide the decision of following basic astronavigation tasks:

1. planning and definition of conditions of observation (selection of objects, the moments of rising/setting and the culminations of stars and so on);
2. equalization and a reduction of the measured heights and azimuths of celestial bodies;
3. definition of a site of a ship with an estimation of accuracy of the decision on any method of improvement of computed places or direct;
4. definition of compass correction in the various ways;
5. the decision of a problem should be accompanied by the report on standard templates;
6. the system should include the graphic means preparation, carrying out and processing of observation;
7. the system should contain the help block (school) and the contextual help;
8. the results of calculations should be registered (archive).

Navigation astronomy still keeps the value though against satellite navigation and inertial navigating systems. And the compass correction as total influence of a terrestrial and ship magnetic field on a compass reading is defined while only by astronomical methods.

### 5. CONCLUSION

The reform of ephemeris editions of IAA of RAS has led to complete theoretical identity in Russian astronomical yearbooks and software package, thus providing the ephemeris support of astronomical studies and solution of astronavigation tasks at modern level. Existence of electronic versions of yearbooks does not mean the end of the editions at hard copies. The electronic version should facilitate access to ephemerides, including input data at the computing equipment. The astronavigation software package help to user will help the user to process easier observation of astronavigation bodies.