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Orbit Modeller — Virtual Astronomical Laboratory

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Abstract

The celestial mechanics and astrometry department of Tomsk State University presents a virtual astronomical laboratory project — "Orbit Modeller" (OM). This should be an interactive web-tool enabling one to simulate numerically the orbital motion of any celestial body both within the solar system and beyond it. Another function of OM is a repository of old observations and documents.

1. Introduction

Our department exists about 40 years and we accumulated a huge amount of astronomical software. This year our university joined to the Europlanet Consortium, what motivated us to bring our soft libraries in order and to make them accessible to the scientific community.

The laboratory tools are designed for simulation of motion of the following space objects: I) AES (unguided artificial Earth satellites, including space debris); II) Asteroids and comets; III) Natural satellites (mainly outer satellites of the giant planets); IV) Meteoroids; V) Exoplanets.

The differential equations of motion are integrated numerically. The model of forces in the equations depends on what kind of orbit is simulated. For example, the most complicated model is for AES [1]. It includes: the gravity of the nonspherical Earth, other major planets, Sun and Moon; the influence of Earth atmosphere and solar radiation pressure; relativistic and other weak effects. Another example is meteoroids' motion, where the force model could include radiation and relativistic effects [2].

2. The first-selection tools

The first stage of our project is developing the user interface for existing programs and subroutines modelling the asteroid and AES motion.

The span of the orbit simulation is limited by that of the JPL DE (ftp://ssd.jpl.nasa.gov/pub/eph/planets/) which is used for computing the positions of solar system massive bodies, which are required in the model of forces.

The differential equations are integrated by Everhart method [3]. The observation-based orbit refinement (differential correction) is realized by the Gauss–Newton method [3].

3. The document repository

Our department inherited the archive of data of radar observations of Geminid, Quadrantid, Daytime Arietid, Perseid, Ursid, Lyrid, Orionid and Leonid meteor showers in Tomsk in 1965–1966 [4]. We scanned thousands of handwritten pages of the meteor echoes measurements having in mind to open these data to research community.

In addition to usual software manuals, we plan to form a small library of related publications (in Russian and English).

4. What next?

Besides the mentioned tools and divisions, we are going to add educational and outreach parts, e.g. a playing room with interactive orbital models.

We plan to launch the first stage of this project and our web site by the 2017 end. Realization of the next stages depends on the available financial support.

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