Paper ID: 65390
oral

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (2) (7)

Author: Dr. Martin Lara
Universidad de La Rioja, Spain, mlara0@gmail.com

IMPROVING EFFICIENCY OF ANALYTIC ORBIT PROPAGATION

Abstract

The efficiency of analytic orbit prediction programs is improved in two ways. On the one hand, memory requirements are minimized when the transformation from mean to osculating elements is split into different partial reductions. Traditionally, the process is divided into a preliminary simplification used to remove non-essential short-period effects, the following elimination of long-period effects, and the final averaging of the remaining short-period terms. To this chain we add a new, intermediate link with the removal of non-essential long-period terms. In this way we achieve an additional 30% reduction in the size of the transformation equations with respect to the traditional approach.

On the other hand, while dividing the transformation from mean to osculating elements into different parts clearly simplifies the periodic corrections and notably reduces their size, this splitting procedure has the undesired side effect of slowing the evaluation of the analytical solution for dense output. This paradox stems from the fact that the eccentricity and inclination polynomials that comprise the periodic corrections of the theory remain constant in mean elements. Because of that, these polynomials only need to be evaluated once, at the initialization of the analytical solution, when the different transformations used in the construction of the analytical theory are composed into a single transformation. In this way the evaluation of the solution in the repeated computation of ephemeris is notably accelerated. On the contrary, when a sequence of different transformations is used these polynomials only remain constant in the first transformation, although some of them may also remain constant in the second one. Therefore, the need of reevaluation of these terms penalizes the efficiency of the analytical theory for dense evaluation.

We illustrate these facts —improving evaluation efficiency using a single set of periodic corrections vs. reducing memory requirements using a new intermediate transformation— with two alternative higher-order implementations of Brouwer's classical solution. Besides, we show how the proper calibration of the mean semi-major axis reduces at least by one order of magnitude the long-term secular drift in the position that is characteristic of perturbation solutions.