ATESAT: A SYMBOLIC PROCESSOR FOR ARTIFICIAL SATELLITE THEORY

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We are dealing with the problem of the analytical simplifications in the artificial satellite theory. The satellite is assumed to be a negligible mass point and the Earth's attraction is the only force acting on it.

The main goal is to obtain —automatically— an integrable Hamiltonian by means of a set of canonical transformations based on the Lie transform [4] and without expansions in the eccentricity. The first simplification to be made is the algorithm of relegation [7] that avoids the effect of the tesseral harmonics. The second one is the elimination of the parallax [5] that transforms all the terms of the form r^{-n} into r^{-2}. The elimination of the perigee [3] eliminates this variable from the Hamiltonian. After these transformations we reach a one degree of freedom problem, that an its ready to integrate easily by the Delaunay Normalization [6].

MALISIAS (MAthematica LIe SImplification in Artificial Satellite) was our first attempt to solve symbolically this dynamical system. MALISIAS [7] is a set of packages built in *Mathematica*, that provides the generating function, the reduced Hamiltonian and the equations of the transformations after performing the above mentioned simplifications. This approach helped us to understand the characteristics of the symbolic manipulation of the Lie transformation, but unfortunately, the size of the expressions involved exceeded the capacity of the general symbolic systems.

In this theory, as well as in other fields of non-linear dynamics, the main mathematical object to manipulate belongs to a particular algebraic structure: the Poisson Series. The only way to obtain high orders of the transformations is by means of an specific algebraic manipulator written specially for handling efficiently these objects. In order to have a more efficient tool for the satellite theory we create PSPC [1], a Poisson Series Processor in language C.

By using PSPC we build ATESAT (Automatization of Theories and Ephemeris in the SATellite problem). With ATESAT [2] we reviewed and enlarged the possibilities of MALISIAS and added to it a few new utilities. In particular, ATESAT writes automatically a C–code of an ephemeris program for the chosen theory. With ATESAT we are able to reach high orders in the satellite theory including not only the main problem but zonal or tesseral harmonics.

References

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