AOGS 2005

Efficient Orbit Integration by Manifold Correction Methods

TOSHIO FUKUSHIMA

Nat'l Astron. Obs. Japan, Mitaka, Tokyo, Japan, Toshio.Fukushima@nao.ac.jp

Recently we developed a new formulation of numerical integration of orbital motion named *manifold correction methods* [1,2,3,4,5,6]. The main trick is to keep rigorously the consistency of some physical relations such as that of the orbital energy of a binary subsystem. This maintenance is done by applying a sort of correction, such as the spatial scaling or the domain reduction of angle variables into the range $[-\pi, \pi)$, to the integrated variables at every integration step. The finally-evolved form of the manifold correction methods is the orbital longitude methods [6,7,8,11,12], which enable us to conduct an extremely precise integration of orbital motions. In the unperturbed orbits, the integration errors are suppressed at the machine epsilon level for an infinitely long period. In the perturbed cases, on the other hand, the errors initially grow in proportion to the square root of time and then increase more rapidly, the onset time of which depends on the type and the magnitude of perturbations. This feature is also realized for highly eccentric orbits by applying the same idea to the Kustaanheimo-Stiefel (KS) regularization [9,10,13]. Especially the introduction of time element greatly enhances the performance of numerical integration of KS-regularized orbits whether the scaling is applied or not.

Keywords: Numerical integration; orbital motion; scaling method.

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