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APPROXIMATION FOR GRAVITATIONAL FIELD OF A SMALL CELESTIAL BODY BY A TRIPLE OF UNIFORM BALLS

Abstract

Studies on the dynamics of a material point in the Newtonian attraction field of several masses date back to works of Euler and Lagrange. In the case of two centers the equations of motion turn out to be completely integrable [1]. When the number of attracting centers surpasses two, the nonintegrability of the equations of motion was proved in [2,3]; even though such approximations might allow one to examine dynamics of a point using analytical tools [4].

The principal question is how to determine the positions and masses of the gravitating points to substitute a real celestial body [5]. Naturally, such a distribution of masses can well approximate the inertia tensor of a body only when there are at least four such masses, all of them real and located in the real domain. If the body is dynamically symmetrical, its field of attraction is approximated by a set of massive points located on the axis of symmetry, and the axial moment of inertia of such a system vanishes. A system of three non-collinear points can approximate the inertia tensor only for flat bodies.

Recently, we propose to approximate the original body by a set of balls [6]. For a body close to dynamically symmetric, we first identify the masses of the balls and the positions of their centers, and afterwards find their radii. The technique was applied to approximate, by two uniform balls, the gravitational field and the inertia tensor of asteroids Geograf and Itokawa.

Here the proposed approach is applied to approximate, by a triple of uniform balls, the attraction field of asteroids Bacchus, Kleopatra, and Eros. Refinement of the potential improves the approximation, though makes more difficult to analytically solve the equations of motion.

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