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Orbits with osculation of higher orders and their use in celestial mechanics

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The idea of the generalized or intermediate orbits with osculation of the second and third order was proposed and considered rigorously in 1981 [1]. The motion along these orbits is a combination of the non–perturbed motion of a particle about a non-changeable fictitious point mass and the motion of the fictitious mass, or an attracting centre, itself. The latter is considered to have a constant velocity vector or to be non–moving. These orbits can be constructed for any point of the actual perturbed trajectory. The position, velocity, and acceleration vectors and even the time derivatives of the acceleration, if the third order osculation is dealt with, are the same as in the real motion.

The idea of [1] was used in [2], and it was found that the generalized orbits with high order osculation show sensible advantage when being used as the reference ones in the Encke method. Another family of the generalized orbits was proposed in [3]. The fictitious mass is placed in one of the real attracting bodies (major planets), and it was considered to be changeable with time according to the Gylden-Meshchersky law. The motion of a particle around this variable mass is not a Keplerian one. These orbits are computed easily and they are also effective as the reference ones. So, the rather wide range of the new, effective and simple reference orbits have been proposed for computing the perturbed trajectories by the Encke method. Attempts of solving the classical problem of orbit determination from two known heliocentric positions of a particle, if the orbit is the generalized one [4], are also of certain interest.

The further steps in developing the theory of the osculation of higher order have been made in [5,6]. The equations of the perturbed motion in the elements of the generalized (intermediate) orbits were derived for the first time in [5,6]. They are quite similar to the known Newton–Euler (N–E) equations for the usual osculating elements (osculation of the first order). The difference between them is in the number of variables (six in N–E and nine in [5]) and in the form of the perturbation forces (the force components in N–E and their time derivatives in [5]; the coefficients at the forces are also different). Testing these equations for the efficiency in practice is now carried out. The work was partly supported by the RFBR grant No. 01-02-17078.

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