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Determination of preliminary orbits including perturbations

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On the basis of the theory of intermediate orbits developed earlier by the author [1], a new approach to the solution of the problem of preliminary orbit determination is suggested. This approach enables to take into account the main perturbations in celestial body motion. The motion under consideration is represented as a combination of two motions and the corresponding orbit is constructed. The first motion is the uniform rectilinear motion of the fictitious attracting centre, the mass of which varies in accordance with the first Meshchersky law. In this case we suppose that the mass of the fictitious centre can take not only positive values but negative ones as well. The second motion is the motion around the fictitious centre. It is described by the equations of the Gylden-Meshchersky problem [2]. The parameters of the required orbit are determined from the boundary conditions of the problem solved and from a number of additional conditions making it possible to choose the most optimal solution. These parameters are such that their limiting values at the reference epoch determine the superosculating intermediate orbit with the third–order tangency. The construction of the orbit sought is not related with any restrictions in the choice of forces acting on a body. The only requirement to them consists in the fact that the expressions for the total vector of acceleration must be a non–zero vector at the reference epoch. The orbit constructed approximates the real perturbed motion in the neighbourhood of the reference epochs better than the Keplerian orbit of the two–body problem and analogous orbits of other authors.

By the approach suggested the classical problems of orbit determination from two positions and three complete observations are solved. The algorithm for solving the second problem includes the solution of the first problem and can be considered as a generalization of the well–known Lagrange–Gauss method [3, 4]. By the example of orbital motion of the minor planet 1566 Icarus the comparison of the results of the classical Lagrange–Gauss method and the generalized method

has been performed. The comparison shows that the new method is a highly efficient tool for studying the perturbed motion. Its advantage over the classical method is especially significant in case when we have high accurate observations, which span short orbit arcs.

Aside from the application to the determination of an unknown orbit from astronomical positional observations, the method proposed can be very useful in solving a set of problems of space flight dynamics.

References

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