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Properties and applications of the modified Kepler problem

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The classical Kepler problem gives a very good description of planetary motion, but is not realistic when the distance approaches zero (because the velocity becomes unbounded), and does not extend to the motion of massless particles (even though light is deflected by gravity). We show that it is possible to extend the Kepler problem by defining a new Hamiltonian for the problem where the velocity is always less than the velocity of light c, and even goes to zero when approaching collision; and also the motion of massless particles can be realistically described since it obeys Fermat's principle of least time. At the same time, Kepler's three famous laws governing planetary motion are equally well accounted. We then describe some non-classical properties of the motion, such as the existence of a new type of hyperbolic motion, which we call super-hyperbolic motion, characterized by a velocity that is always increasing with the distance (contrary to classical hyperbolic motion, whose velocity is always decreasing), and which corresponds to the motion of very high energy objects. As it turns out, the gravitational action is repulsive in this case as well as in the case of collision and near-collisions motions. And most remarkably, the motion of massless particles is always repulsive. Finally, we indicate briefly how this generalization of the Kepler problem can be extended to the N-Body problem where, as before, the velocities are always bounded, and the motion of massless particles can be realistically described.

Biography

John G Bryant completed his thesis (Doctorat d'Etat) on Contact Systems in Mechanics in 1983 at the Université Pierre et Marie Curie (Paris VI). He has held academic positions at the Université de Franche Comté (France) and UAM University (Mexico City). His publications include papers on the symmetries of Hamiltonian Systems, and the Reformulation of the N-Body Problem. He is currently retired but still active in research, having recently written a book on the Universal N-Body Problem.

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