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ORIGINAL ARTICLE

Effects in the anomalistic period of celestial bodies due to a logarithmic correction to the Newtonian gravitational potential

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Abstract We study the motion of a secondary celestial body under the influence of the logarithmic corrected gravitational force of a primary one. This kind of correction was introduced by Fabris and Campos (Gen. Relativ. Gravit. 41(1):93, 2009). We derive two equations to compute the rate of change of the anomalistic period with respect to the eccentric anomaly and its total variation over one revolution. In a kinematical sense, this influence produces an apsidal motion. We perform numerical estimations for some celestial bodies. We also compare our results to those obtained by considering a Yukawa correction.

Keywords Logarithmic potential · Gauss' planetary equations · Periastron passage time · Anomalistic period · Keplerian period

1 Introduction

The explanation of the discrepancies between the predictions of Newtonian mechanics and the observation data for the orbital elements and other quantities related to the motion of celestial bodies has been a very important problem for many years. To resolve these discrepancies, modified versions of the Newtonian potential or general relativity have been called forth. For example, the advance of Mercury's perihelion, which is the most famous case of the problem, has been faced successfully by general relativity (see, Brumberg 1972; Nobili and Will 1986). Nevertheless, the study of astrometric anomalies is in progress. General relativity is the main tool but modifications of Newton's or relativity theory are very useful, too. This can be ascertained by many contributions that have been recently published on the above mentioned subject and the related theories. For example, Iorio (2005) has studied the secular perturbations induced on all the Keplerian orbital elements of a test body by the weak-field long-range modifications of the usual Newton–Einstein gravity due to the Dvali–Gabadadze–Porrati braneworld model. The same author used the corrections to the secular precessions of perihelia of some inner planets, phenomenologically estimated by Pitjeva (2005), in order to constrain some long-range models of modified gravity (Iorio 2007a) and on the range parameter of the Yukawa-like modifications of the Newtonian law of gravitation (Iorio 2007b). Afterwards, he considered a two-body system representing binary stars in eccentric orbits and examined the post-Newtonian relativistic gravitoelectric part of the precession of the mean anomaly which is not produced by the variation of the orbital period (Iorio 2007c). Adkins and McDonnell (2007) worked on the calculation of the pericenter precession of Keplerian orbits under the influence of arbitrary central-force perturbations. Schmidt (2008) calculated the pericenter precession for nearly orbits in a central potential that is not necessarily close to the Newtonian one. Iorio (2009) worked on the anomalous perihelion precession of Saturn. Ruggiero (2010)

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