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ORIGINAL ARTICLE

Increase of the mean Sun–Earth distance caused by a secular mass accumulation

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Abstract Based on many planetary observations between the years 1971 and 2003, Krasinsky and Brumberg (Celest. Mech. Dyn. Astron. 90:267–288, 2004) have estimated a rate of increase in the mean Sun-Earth distance of (15 ± 4) m per century. Together with other anomalous observations in the solar system, this increase appears to be unexplained (Lämmerzahl et al. in Astrophys. Space Sci. Lib., vol. 349, pp. 75–101, 2008). We explain these findings by invoking a recently proposed gravitational impact model (Wilhelm et al. in Astrophys. Space Sci. 343:135–144, 2013) that implies a secular mass increase of all massive bodies. This allows us to formulate a quantitative understanding of the effect within the parameter range of the model with a mass accumulation rate of the Sun of $(6.4 \pm 1.7) \times 10^{10}$ kg s^{-1}.

Keywords Mean Sun-Earth distance · Astronomical unit · Gravitational-impact model · Secular mass increase

1 Introduction

A secular increase of the mean Sun-Earth distance (closely related to the definition of the astronomical unit, cf. Sect. 3) with a rate of (15 ± 4) m per century has been reported using many planetary observations between 1971 and 2003 (Krasinsky and Brumberg 2004). The authors concluded that 0.3 m per century could be explained by a solar-wind mass loss of the Sun. However, they miscalculated the electromagnetic radiation contribution, which is more than a factor of two larger than the solar-wind loss (cf. Noerdlinger 2008). Consequently, only about 1 m per century will result from these losses. Neither the influence of cosmic expansion nor a time-dependent gravitational constant seem to provide an explanation (Lämmerzahl et al. 2008). A recently proposed gravitational impact model implies a secular mass increase of all massive bodies fuelled by a decrease in energy of a hypothetical background flux of massless entities—named "quadrupoles" (Wilhelm et al. 2013).

Our model allows us to formulate a quantitative understanding of the effect within the parameter range of the model. In Sect. 2, we briefly introduce the salient features of the gravitational impact model. It should be pointed out that its most important consequence, a general mass increase, had been considered under various assumptions by many authors in the past (Jeans 1928; Dirac 1937; Hoyle 1948; Arp 1994; Fahr and Heyl 2007). The increase of the Sun-Earth distance is then treated in Sect. 3; followed by a discussion and conclusion section.

2 The gravitational impact model

According to the gravitational impact model, the relative mass accumulation rate of a body with mass M from an omnidirectional background flux of the hypothetical quadrupoles will be

$$\frac{1}{M}\frac{\Delta M}{\Delta t} = \frac{4\pi G_{\mathrm{N}}}{c_0}\sigma_{\mathrm{G}} = A, \tag{1}$$

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