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Does a Gravitational Aberration Contribute to the Accelerated Expansion of the Universe?

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Abstract. An arbitrarily small positive value of the gravitational aberration slightly increases the angular momentum of a two-body and multiple body system. This could potentially contribute to the accelerated expansion of the whole Universe. We present some geometrical, physical, geophysical, heliophysical, climatological, cosmological, and astronomical observational arguments, and also numerical tests to support this conjecture. We found a remarkable coincidence between the Hubble constant and the increasing distance of the Moon from the Earth, that is not only due to tidal forces. Numerical examples illustrating the expansion caused by the gravitational aberration are given. This will be modeled by a nonautonomous system of ordinary differential equations with delay.

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Key words: Hubble constant, causality, gravitation, Earth, Moon, Mars, Runge-Kutta method.

1 Introduction

Gravitational waves were predicted already by Henri Poincaré. In 1905 he conjectured that their speed is the same as the speed of light c (see [1, p. 1507]), i.e., before the same result was postulated by Albert Einstein. If these speeds differ (cf. [2, 3]), then it would be difficult to identify a source of gravitational waves with its optical counterpart, e.g., during (asymmetric) explosions of supernovae. At present, several large projects (GEO, LIGO, VIRGO, LISA, $\cdots$) are being developed to measure the speed of gravitational waves and determine the direction, from which they come. However, for the time being these waves have not yet been detected.

First of all, we will focus our attention on the following classical geometrical example inspired by Sir A. Eddington (see [4, pp. 94 and 204]). Let A and B be two bodies of

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equal masses. Assume for a moment that their orbits are circular about their common centre of gravity. If A attracts B at its instantaneous position and also B attracts A at its instantaneous position (i.e., the speed of their mutual gravitational interaction is infinite), then by Newtonian mechanics these forces are in the same line and in balance.

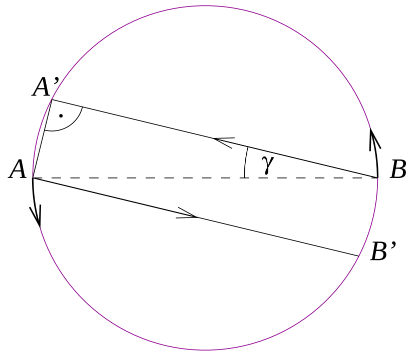

Figure 1: Schematic illustration of two interacting bodies of equal masses. The gravitational aberration angle $\gamma = \angle ABA'$ is extremely small.

On the other hand, suppose now that the speed of their mutual gravitational interaction is finite, i.e., B is attracted by A towards its previous position A' (see Fig. 1). Similarly A is attracted by B in the direction of its previous position B'. Then a couple of nonequilibrium forces arises which acts permanently and thus, increases the angular momentum and total energy of this system (see [5]). By the Thales theorem the triangle $AA'B$ is right and

$$|A'B| < |AB|. \tag{1.1}$$

Hence, the attractive forces (in this postnewtonian mechanics) are sightly larger than if they would act along the hypotenuse AB.

Let us point out that Fig. 1 is slightly imprecise. Since (1.1) is valid, the attractive force is larger than that from the Newtonian theory. Consequently, an arbitrarily small positive value of the gravitational aberration γ of the considered binary system increases not only its angular momentum, but also prolongs the orbital period. Thus, the corresponding trajectories constitute two very slowly expanding spirals (see Fig. 2).

The value $\gamma \leq 0$ evidently contradicts to causality. For instance, if one of the bodies (asymmetrically) explodes, then the second body has to orbit for some time along the unchanged trajectory, because the speed of gravitation is finite and the associated gravitational fields need a time interval of positive length to change.

In 2000, Steven Carlip [6] showed that in general relativity the gravitational aberration is almost cancelled out up to the order v^3/c^3 by velocity-dependent interactions, where v is the speed of an observed object. Thus, the real value of gravitational aberration is probably also much smaller than the aberration of light v/c. Due to this property the orbit of two bodies is seemingly very stable. Also sunrays arriving at the Earth are not parallel with the vector of the attractive gravitational force of the Sun. How to interpret