Velocity Dependent Inertial Induction - a Case for Experimental Observation

Amitabha Ghosh
Department of Mechanical Engineering
Indian Institute of Technology
Post Office I.T.T.
Kanpur, 208016 India

This purpose of this article is to highlight the various aspects of a dynamic model of gravitational interaction proposed by the author in an earlier paper. A number of interesting results are obtained when the proposed velocity and acceleration dependent inertial induction terms are used in conjunction with an extended version of Mach's principle. Universal induction results in exact equivalence of gravitational and inertial masses, while a cosmological redshift of the proper order of magnitude is obtained, even when a quasistatic, infinite universe is assumed. Inertial induction on a local scale can also explain a number of unexplained or ill-understood observations, viz. the secular retardation of the earth's spin, the secular acceleration of Phobos and the extra redshift at the solar limb. Velocity dependent inertial induction also provides a servo-mechanism that distributes matter in spiral galaxies in a unique manner, such that a constant rotation curve is observed. Finally, velocity dependent inertial induction can act as a mechanism for the transfer of solar angular momentum, thus explaining the observed distribution of angular

momentum. Although there is sufficient indication that the proposed model has validity, a direct observational test would still be desirable. A scheme to test the hypothesis directly is thus proposed.

Introduction

The author has proposed a dynamic model of gravitation interaction (Ghosh 1984, 1986a) in which the interactive force depends not only on the relative positions of the two bodies, but also on their relative velocity and acceleration. According to this model, the interactive force between two particles A and B is given by:

$$\vec{F} = -\frac{GM_A M_B}{r^2}\hat{u}_r - \frac{GM_A M_B}{c^2 r^2}u^2 \hat{u}_r f(q) - \frac{GM_A M_B}{c^2 r} a\hat{u}_r f(f), \qquad (1)$$

where $\vec{F}$ is the force on A due to B, c is the velocity of light, G is the coefficient of the gravitational interaction*, $\bar{r}\left(=r\hat{u}_r\right)$, $\bar{u}\left(=v\hat{u}_u\right)$ and $\bar{a}\left(=r\hat{u}_a\right)$ are the position, velocity and acceleration of body A with respect to B; $f(q)$ and $f(f)$, with $\cos q = \hat{u}_r \cdot \hat{u}_u$, and $\cos f = \hat{u}_r \cdot \hat{u}_a$, represent inclination effects; and M_A and M_B are the masses of bodies A and B.

The first term on the right hand side of equation (1) is the well-known static term. The second and third terms represent inertial induction depending on velocity and acceleration, and are of much smaller order of magnitude compared to the static term. Though no experiment has been conducted to verify the existence of these two terms, application of the model yields a wide variety of interesting results. The inertial induction effect can be classified into two groups: a) Universal interaction, i.e. inertial induction of an object with the

* G is not a constant in this model. Instead, it decreases with distance, as will be shown later.

matter present in the rest of the universe; b) local interaction, i.e. the interaction of an object with a nearby large gravitating body.

Universal interaction

The universe is assumed to be homogeneous, infinite and quasi-static. The inertia force due to inertial induction acting on a body of mass m moving with respect to the rest of the universe is found to be (Ghosh 1986a)

$$\vec{F} = -\frac{k}{c} m u^2 \hat{u}_u = m a \hat{u}_a \qquad (2)$$

when the inclination effect is assumed to be†

$$f(q) = \cos q \cdot |\cos f| \qquad (2)$$

where k is given by $(pG_0 r)^{1/2}$, $G = G_0 \exp[-(k/c)r]$ and r is the density of matter in the universe. From (2) it is interesting to note that the acceleration dependent term of the force is identically equal to $-ma$. The static term cancels out because of symmetry and the velocity dependent drag is too small to be easily detected. However, this drag will cause the photons from distant galaxies to loose energy and be redshifted, with k representing the Hubble constant (Ghosh 1984). The value of k is found to be quite close to the observed value.

Local interaction

The universe is, in reality, lumpy, and the inertial induction effects due to the presence of nearby bodies are much more prominent than the effect due to inertial induction with respect to the rest of the universe. A few interesting cases are presented below:

† Determination of the inclination effect needs further investigation.

1. Secular retardation of the earth's rotation

It is well established that the earth is gradually slowing down. The transfer of angular momentum from the earth to the moon (which causes the earth to slow down and the moon to spiral out) has been attributed to tidal friction. The magnitude of the tidal friction has been estimated from the observed values of the angular velocity of the earth's spin (Ω), the orbital angular velocity of the moon (w_M) and the radius of the moon's orbit (R_M), and it has been found that, while the magnitude is feasible, the mechanism suggests a very close approach of the moon to the earth about 1300 million years ago. Such a close approach would have been devastating for both the earth and the moon. Moreover, the tides would have been much stronger in the past, since tidal amplitude is proportional to R_M^{-3}. These predictions do not agree with the geological evidence, which clearly indicates the presence of tidal phenomena as much as 3500 million years ago, and no catastrophic events. This has remained a major problem for the simple tidal friction model. Although the effects of the acceleration-dependent inertial induction terms are comparatively negligible, when the velocity-dependent terms are included in the calculation, the problem of a close approach of the moon does not arise (Ghosh 1986a).

2. Secular acceleration of Phobos

Recent observations have confirmed older information about the secular acceleration of Phobos. The magnitude of this acceleration has been estimated to be approximately 10^{-3} deg. yr.$^{-2}$. Since there is no ocean on Mars and the atmosphere is very thin, it has not been easy to explain a continuous loss of angular momentum by Phobos. Some have attributed it to the possibility of a molten core inside Mars. However, it is doubtful whether a molten core could produce such a large secular acceleration. When the inertial induction model is applied to the Mars-Phobos context, it yields a secular acceleration of about 1.5×10^{-3} deg.yr.$^{-2}$ (Ghosh 1986a).

3. Extra redshift at the solar limb

A considerable amount of work has been done on the redshift characteristics of the solar spectrum. The most interesting feature of the results is the gradual rise of redshift magnitude from the centre of the solar disc to the limb. The redshift magnitude at the centre is equivalent to a recessional speed of 0.26 km/sec. while the value at the limb is approximately 0.9 km/sec. Though the variation in the redshift magnitude can be explained by solar granulation, it has remained a puzzle how the value at the limb can exceed the value predicted by the principle of equivalence (equivalent to a recessional speed of 0.636 km/sec.). It has been shown (Ghosh 1986b) that the extra redshift may be due to velocity dependent inertial induction between the sun and the emitted photons.

4. Matter distribution in spiral galaxies

The stars in all spiral galaxies rotate around the respective galactic centres in almost circular orbits. The most interesting point to note is that the orbital velocity is almost constant (except near the centre). Such a flat rotation curve can be obtained only when the matter in the galaxy is distributed in a particular way. Since flat rotation curves are a universal feature for all spiral galaxies, there must be a servomechanism that distributes matter in a unique pattern. When the model of velocity dependent inertial induction is used, it is found that the requisite matter distribute is always obtained (Ghosh *et al.* 1988).

5. Transfer of solar angular momentum

Modern science unanimously accepts the nebular hypothesis for the origin of the solar system. However, in all such models, it has been necessary to account for the observed distribution of angular momentum by proposing a mechanism for the transfer of solar angular momentum. None of the proposed mechanisms has been universally accepted. It is very interesting to note that velocity dependent inertial induction is capable of transferring the required amount of angular momentum in the available time (Ghosh 1988).

Suggestion for a direct test

Since the proposed model of dynamic gravitational interaction yields correct results in so many different problems, there is a strong case for attempting a direct test of the hypothesis. Such a test is described below.

The object of the test is to detect the redshift of electromagnetic waves as they graze a heavy object. If R is the grazing radius, and M is the mass of the object, the redshift will be given by:

$$z \approx \exp\left[\frac{4GM}{3c^2R}\right]-1 \tag{3}$$

when the distance of the source and the observer from the object are both much larger than R. The bending of the wave's trajectory has been neglected in deriving (3), even though for very large values of M/R it may be quite substantial. The table below shows the orders of magnitude of z for various types of object:

Type of central body	M	R	z
Sun	$M_\oplus$	$R_\oplus$	0.141×10^{-5}
Typical white dwarf	$M_\oplus$	$R_\oplus/40$	1.128×10^{-4}
Typical neutron star	$2M_\oplus$	10 km	0.492*
Black hole	–	Schwarzschild radius	0.95‡

($M_\oplus$ and $R_\oplus$ are solar mass and radius respectively.)

‡ May change when the bending of the wave trajectory is taken into consideration.

An experiment can be conducted to measure the redshift of starlight (in the plane of the ecliptic) from two diametrically opposite locations in the earth's orbit. The velocity dependent inertial induction should result in an extra redshift of $z = 0.141 \times 10^{-5}$ (equivalent to a recessional speed of 0.9 km/sec) when the sun is between the star and the earth. If the redshift of starlight grazing the solar disc has been measured with enough accuracy during total solar eclipses in the past, the data can be compared with the redshifts in light from the same stars in the night sky, after allowance for the earth's orbital motion. It is possible that adequate data already exists, and no further experiment is needed.

More accurate observation can be made from space observatories, and redshift measurements need not always be confined to visible light only. It can also be seen from the table that substantial redshifts may result when photons graze neutron stars of black holes.

References

Ghosh, Amitabha. (1984) Velocity-dependent inertial induction: An extension of Mach's principle. *Pramana* 23 5 L671-L674.

Ghosh, Amitabha. (1986a) Velocity-dependent inertial induction and the secular retardation of the earth's rotation. *Pramana* 27 1 1-8.

Ghosh, Amitabha. (1986b) Velocity-dependent inertial induction - a possible explanation for supergravity shift at solar limb. *Pramana* 27 6 725-730.

Ghosh, Amitabha, Sudendu Rai and Ajay Gupta. (1988). A possible servomechanism for matter distribution yielding flat rotation curves in spiral galaxies. *Astrophysics and Space Science*, 140 1, 1-

Ghosh, Amitabha. (1988) Transfer of solar angular momentum by inertial induction. *Earth, Moon and Planets* May/June 1988.