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Velocity Dependent Inertial Induction: A Possible Mechanism for Cosmological Red Shift in a Quasi Static Infinite Universe

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Abstract. The paper shows that a phenomenological model of inertial induction based on a proposed extension of Mach's Principle can produce the observed cosmological red shift in a quasi-static infinite universe. Unlike all other theories (except the Doppler effect) to explain the observed red shift this model can be verified from other local effects predicted by this mechanism. A number of such phenomena have been investigated and these expected effects are not only found to be present but they also explain a number of unexplained or ill explained observational results. It is suggested that attempts should be made to verify the model through further tests and observations.

Key words. Cosmological red shift—stationary universe.

1. Introduction

The central issue in cosmology is the true nature of the observed cosmological red shift. Though it is assumed to be due to an expansion of the universe, till now there is no conclusive evidence in favour of the dopplerian origin of the cosmological red shift. Zwicky (Zwicky 1929) was the first to propose a mechanism for a non Doppler origin of the redshift and subsequently quite a few other 'tired light' mechanisms have been proposed: The major problem with all these proposals is that there is no way to test these hypotheses. A phenomenological model of inertial induction [Ghosh (1984, 1986a)] has been found to explain the cosmological red shift without any universal expansion.

Besides this the model also yields exact equivalence of the gravitational and inertial masses and an exponential attenuation of G eliminating the gravitational paradox. The important point to be noted is that this model suggests a number of other observable effects also and such effects are not only found to be present but also explain a number of unexplained results. The model does not have any adjustable free parameter though it yields excellent quantitative results in all these different problems.

2. Proposed model of inertial induction

According to this model the gravitational interaction between two main particles generates a force which depends not only on their separation but also on their relative velocity and acceleration. In an attempt to quantify Mach's principle Sciama (Sciama 1953, 1969) proposed a model of dynamic gravitational interaction in which there are position and acceleration dependent terms. He coined the term 'inertial induction' to

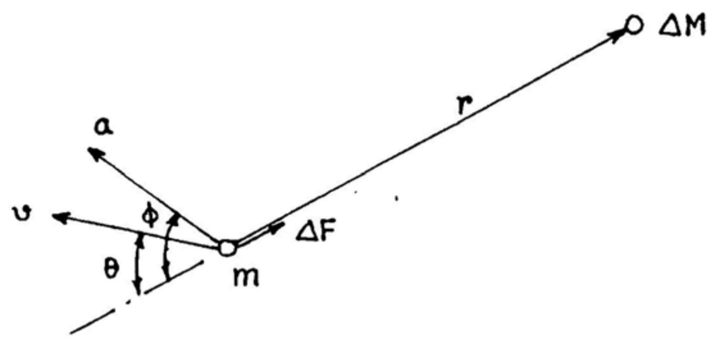

Figure 1. Inertial induction between two point masses.

represent gravitational interaction dependent on acceleration. Figure 1 shows two objects with gravitational masses m and ΔM, the position of ΔM with respect to m been given by $\mathbf{r}(=\hat{\mathbf{u}}_r r)$. If has a velocity $\mathbf{v} = \hat{\mathbf{u}}_v \cdot v$ and acceleration $\mathbf{a}(=\hat{\mathbf{u}}_a a)$ with respect to ΔM then the total force on m due to inertial induction is as follows:

$$\Delta F = \frac{Gm\cdot\Delta M}{r^2}\,\hat{\mathbf{u}}_r + \frac{Gm\cdot\Delta M}{c^2 r^2}\,v^2 f(\theta)\cdot\hat{\mathbf{u}}_r + \frac{Gm\cdot\Delta M}{c^2 r}\,af(\phi)\hat{\mathbf{u}}_r \qquad (2.1)$$

where G is the gravitational coefficient, c is the speed of light, θ and ϕ are the angles $\mathbf{v}$ and $\mathbf{a}$ make with $\mathbf{r}$ as shown in the figure, $f(\theta)$ *and* $f(\phi)$ are the inclination effects so that

$$f(\theta) = f(\phi) = 1 \qquad \text{when } \theta = \phi = 0,$$
$$f(\theta) = f(\phi) = 0 \qquad \text{when } \theta = \phi = \pi/2,$$
$$f(\theta) = f(\phi) = -1 \qquad \text{when } \theta = \phi = \pi.$$

This kind of gravitational interaction can produce two types of effects: (**i**) interaction of a body with the matter present in the rest of the universe and (**ii**) interaction of a body with a nearby massive object.

3. Interaction of a particle with the rest of the universe

The universe is assumed to be infinite, homogeneous and quasi-static (i.e., though an object moves with some random motion with limited magnitude there is no universal motion) satisfying the perfect cosmological principle. With that it is possible to conceive a mean rest frame of the universe and the particle's velocity **u** and acceleration a are defined with respect to this frame. The result of this universal interaction is a force as given below [Ghosh (1986a, 1993)]:

$$\mathbf{F} = \frac{k}{c} m v^2 \hat{\mathbf{u}}_v - m\mathbf{a}, \qquad (3.1)$$

With $k = \sqrt{\pi G_0 \rho}$ with $f(\theta) = \cos\theta \cdot |\cos\theta \cdot|$ and $f(\theta) = \cos\phi \cdot |\cos\phi|$, ρ being the mean density of the universe. The gravitational coefficient $G = G_0 \exp(-kr/c)$ with $G_0 = 6.67 \times 10^{-11}\ \text{m}^3\ \text{kg}^{-1}\ \text{s}^{-2}$. Equation (3.1) implies the exact equivalence of gravitational and inertial mass and it indicates that a body moving even with a uniform velocity is subjected to a velocity dependent drag too small to be detected by terrestrial experiments with present day technology. But when this drag acts on photons travelling through the universe a red shift is resulted whose value agrees well with the observed cosmological redshift (equivalent Hubble constant of this redshift = 40 km/s per Mpc. with $\rho = 7 \times 10^{-27}$ kgm^{-3}).

4. Local interactions and verification of the proposed model

In the vicinity of massive objects the force law given by (1) is expected to produce some extra measurable effects not suggested by the conventional theory. These can be due to (**i**) the interaction of photons with matter and (**ii**) the interaction of matter with matter. The details of a number of such effects have been studied and the gist of these results is given below.

5. Interaction of photon with matter

A few predicted effects of this type are as follows:

- Excess red shift in the spectrum of the solar limb (Ghosh 1986b): An unexplained excess redshift has been observed in the spectrum of the sun's limb. The velocity dependent inertial interaction predicts an excess redshift of the same magnitude (Fig. 2a).
- Redshift of photons grazing massive objects (Ghosh 1991): As per the conventional theory no redshift is produced when photons graze massive objects. But according to the proposed theory a resultant redshift should be observed. When photons graze the Sun a red shift of about 10^{-7} is expected. Such a redshift has been observed when the signals from Pioneer and the light from Taurus A grazed past the Sun (Fig. 2b, c).
- Mass Discrepancy of White Dwarf Stars (Ghosh 1993): According to the conventional theory light coming from stars is subjected to a redshift due to gravitational pull. The amount of the redshift will be significantly more due to the velocity dependent inertial drag as per the proposed theory. So if the mass is determined from the observed redshift following the conventional theory the estimated mass will be significantly more than the actual one. The effect will be pronounced in case of white dwarf stars. Actually such a discrepancy between the gravitational and astrophysical masses has been observed since 1967. When the proposed model is used the discrepancy is eliminated. Table 1 shows the results.

6. Interaction of matter with matter

The velocity dependent inertial induction of this type gives rise to a number of interesting effects. This can be a mechanism for transfering angular momentum from a spinning body. However the magnitude of the effect is very small and can be detected only where very accurate observation is possible. A few cases are presented:

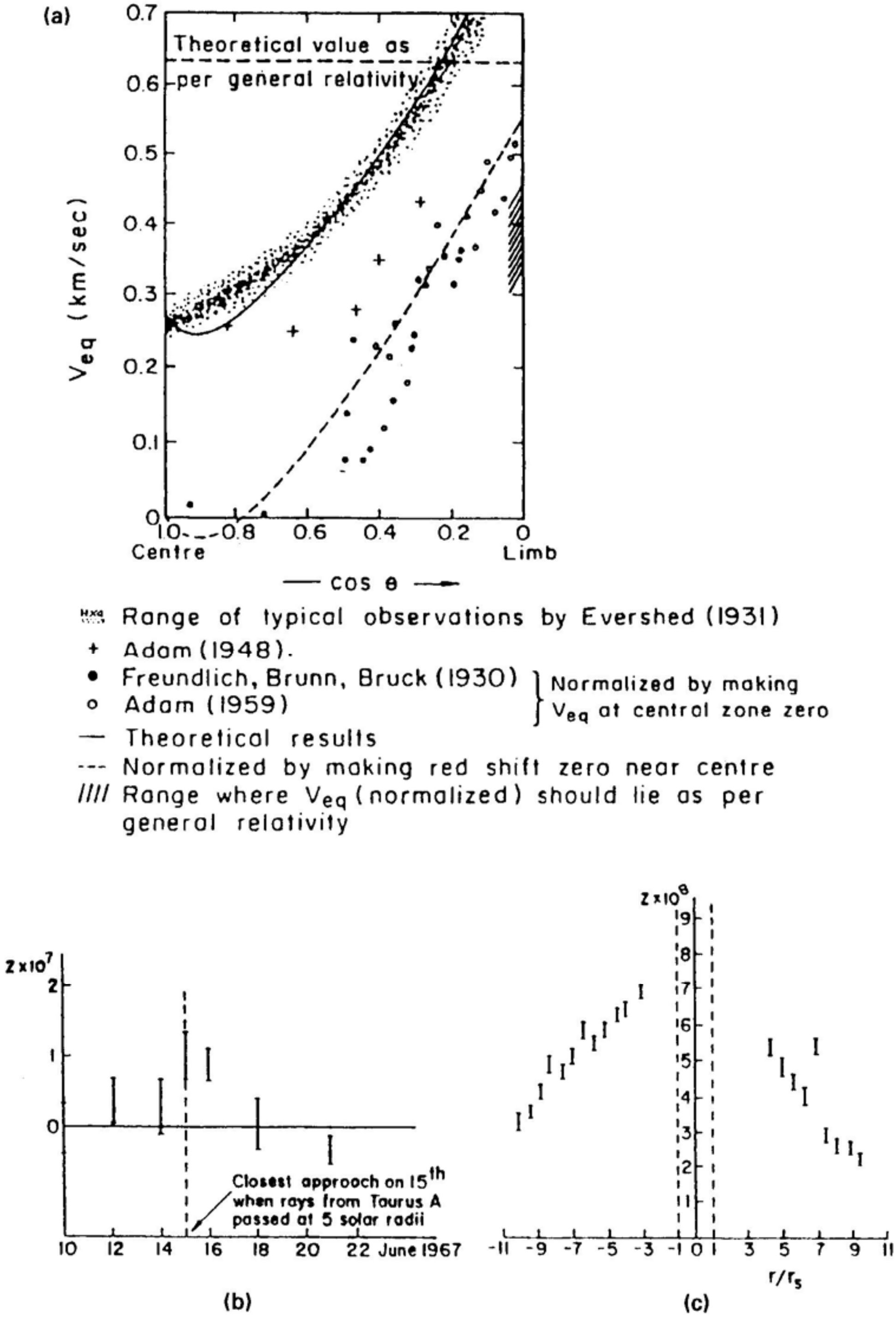

Figure 2(a–c). Excess unexplained red shifts.

Table 1. 'Astrophysical' and 'relativistic' masses of white dwarfs (Shipman and Sass 1980, Ghosh 1993)

Method	No. of stars	Mean mass
Photometry	110	$0.55\ M_\odot$
Photometry	31	$0.60\ M_\odot$
Binary Stars	7	$0.73\ M_\odot$
Two-colour diagram	40	$0.60\ M_\odot$
Two-colour diagram	35	$0.45\ M_\odot$
H-line profiles	17	$0.55\ M_\odot$
All together	240	Average $M_{as} \approx 0.55 M_\odot$
Gravitational red shift (conventional)	0	Average $M_{gr} \approx 0.80 M_\odot$
Gravitational red shift (proposed theory)	80	Average $M_{gr} \approx 0.50 M_\odot$

- Secular Retardation of the Earth's Rotation (Ghosh 1986a): A secular retardation of the earth's spin is now well established. Its magnitude is about 6×10^{-22} rad/s^2. the conventional explanation for this is the tidal friction. But the tidal friction theory brings the moon too close to the earth about 800 million years ago which goes against all observational data. This poses a major problem to the theory. Velocity dependent inertial induction of the earth with the sun produces a secular retardation of 5.5×10^{-22} rad/s^2!! Only about 0.5×10^{-22} rad/s^2 has to be taken care of by the tidal friction and with this combined action the moon's close approach problem is eliminated. Obtaining a retardation rate so close to the actual value purely from theory is very encouraging.

A similar mechanism produces a secular retardation of the Mars' spin of about 10^{-22}rad/s^2. if it is found to exist it will be difficult to explain by tidal friction and the proposed theory will gain further respectability.

- Secular Acceleration of Phobos and Diemos (Ghosh 1986a): It is now known that Phobos is spiralling down and accelerating at the rate of 10^{-20}rad/s^2 (Sinclair 1989) in its orbital motion. In this case also the tidal theory is invoked. The proposed theory, when applied to the problem, produces a secular acceleration of 0.81×10^{-20} rad/s^2. Quite a close agreement! Diemos is decelerating at the rate of 2.46×10^{-23} rad/s^2 according to Sinclair's analysis of observational data but it is very uncertain as the standard error magnitude is about three times this value. The predicted theoretical value of this declaration is equal to 0.12×10^{-23} rad/s^2.
- Transfer of Solar Angular Momentum (Ghosh 1988): The transfer of solar angular momentum to the protoplanetary disc and the planets is a major issue in the nebular hypothesis of the solar system. In the conventional theory such transfer could take place only during the short pre-main-sequence period and the required intensities of the mechanisms involved are found to be too high. It has been shown that if the proposed model of induction is true then the amount of transfered angular momentum matches very well with the observation; the main difference is that the major part of the transfer takes place during the long main sequence period. This agrees with the observation that all new born stars are fast rotators, which has no basis in the conventional mechanisms.

- Servomechanisms for Mass Distribution in Spiral Galaxies (Ghosh *et al.* 1988). The proposed model can act as a servomechanism to distribute matter in the spiral galaxies in a unique manner. And this unique mass distribution pattern leads to a flat rotation curve as found to be true in most cases.

If this tired light mechanism is considered to be valid then the velocity dispersions in the clusters of galaxies are found to be much less than those obtained from the conventional estimates (Ghosh 1995). In case of Coma cluster it is found to be about 350 km s^{-1} instead of 1000 km s^{-1}. This results in a mass-to-light-ratio of about 30 which is of the same order as those observed in the spiral galaxies.

7. Concluding remarks

The model does not include any adjustable free parameter but is still capable of yielding quantitatively correct results in so many different problems and removes some difficulties in the existing explanations. This can hardly be possible by pure coincidence and attempts should be made to investigate the proposed model through new observations and further tests.

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