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Velocity-dependent inertial induction—possible explanation for supergravity shift at solar limb

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Abstract. A quantitative model of inertial induction has been earlier proposed by the author which not only results in the exact equivalence of inertial and gravitational masses but also gives rise to an exceedingly small drag dependent on the velocity with respect to the mean rest frame of the universe. This leads to a cosmological redshift in close agreement with the observation. When this velocity drag due to local interaction is considered it is seen that a significant proportion of the secular retardation of the earth's spin and the moon's orbital motion can be attributed to this drag. This also resolves the problem of the moon's close approach to the earth in the past as suggested by a purely tidal friction theory. The observed large secular acceleration of the Phobos is also explained. The present article shows that local interaction also yields a redshift. When applied to the solar radiation it is seen that the observed supergravity shift at the limb can be very satisfactorily explained.

Keywords. Inertial induction; supergravity shift; solar limb

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1. Introduction

A quantitative model of inertial induction, based on a proposed extension of Mach's principle was earlier proposed (Ghosh 1984) and corrected in a subsequent paper (Ghosh 1986) by the present author. This model results in an exact equivalence of inertial and gravitational masses. According to the original work by Sciama (1972) the equivalence is not exact and the mismatch is attributed to the uncertainties in the value of the average mass density of the universe etc. However, it is difficult to accept that an exact equivalence can be dependent on mass density as that will be too coincidental.

Apart from this the proposed model also yields an inertial drag dependent on the velocity of an object with respect to the mean rest frame of the universe. This drag due to inertial induction with the whole universe is very small to be easily detected but when applied to the photons coming from distant stars and galaxies a cosmological redshift is predicted even without bringing in the concept of an expanding universe. The predicted magnitude agrees very well with the observed results.

It has been shown (Ghosh 1986) that local interaction results in (when applied to the sun-earth-moon system) a secular retardation of the earth's spin and the moon's orbital motion. A model combining the velocity drag and tidal friction yields results in agreement with the observation and no close approach of the moon about 1300 million years ago is suggested. Apart from this a model based on the velocity drag also results in a large secular acceleration of Phobos which has been observed. It is difficult to explain this using only a tidal friction theory.

2. Redshift due to local interaction

In this work the effect of velocity drag on photons due to local interaction with massive objects is shown. It is shown that the order of magnitude of the resulting redshift is same as that due to gravitational pull. However, in the case of gravitational pull the photon suffers either a redshift or a blue shift depending on whether the photon is rising or falling. However, the velocity drag gives rise to a redshift irrespective of the direction of motion. The terrestrial experiments (Pound and Rebka 1960, 1965; Vessot *et al* 1980) on redshift measurement are based on the difference between the shifts observed during the forward and backward journey of photons along a given path. Thus, the redshift due to the velocity drag cancels out. The average value (Pound and Rebka 1960) of the fractional frequency shift is about $-19{\cdot}7 \times 10^{-15}$ with the source at the bottom whereas this is about $-15{\cdot}5 \times 10^{-15}$ when the source is at the top. This makes it very clear that these values are much larger than the expected fractional shift magnitude of about $\pm 2 \times 10^{-15}$. Pound and Snider (1965) mentioned some 'one-way' experiments but the detailed results are missing. These authors also pointed out with concern that these experimental results are also obtained by comparison of two tests in each case where the geometric similarity is lost. So, unless more extensive tests are conducted it is not sufficient to discard the existence of the suggested velocity drag. Direct measurement (with enough accuracy) of redshift should, however, be able to detect the extra redshift. If the results of the one-way experiment (Pound and Snider 1965) agreeing with the standard general relativistic prediction to within 15% are confirmed the present model of velocity-dependent inertial induction has to be discarded.

Considerable amount of work has been done during the last 50 years on the redshift of solar spectrum. A general characteristics of the results is the gradual rise of the redshift magnitude from the centre to the limb and near the limb the redshift exceeds the value predicted by the equivalence principle considerably (Bertolli *et al* 1962; Brandt and Schröter 1982). This variation has been attributed to the granulation and supergranulation phenomena. Though it has been attempted (Beckers and Nelson 1978) to explain the excess redshift at the limbs (supergravity shift) also using the granulation and supergranulation phenomena the result is not perfectly satisfactory. However, it has also been reported (Snider 1972) that the redshift of the potassium absorption lines at 7699 Å, measured by means of an atomic-beam resonance scattering technique, is in perfect agreement with the value predicted by equivalence principle and exhibit no centre-limb effect. The results are obtained in this experiment in an indirect manner and unless further work establishes this firmly the author intends to concentrate on the results of the very large number of experiments (both old and recent) which confirm the extra redshifts at the limbs.

This paper explores the possibility of explaining the characteristics of the redshift of the solar spectrum taking the velocity drag term into consideration.

3. Theory

The density of the sun increases very sharply towards the centre. To make the analysis simple the solar mass is assumed to be concentrated at the centre. Figure 1 shows a photon emitted from point A on the solar surface travelling towards the earth. The earth is considered to be at infinity (considering the size of the sun with respect to the earth's distance this assumption is acceptable). The velocity drag is given by (Ghosh 1986)

$$F = \frac{GM_s m_p}{\zeta}\cos^3\phi, \tag{1}$$

where G is the gravitational constant, M_s is the solar mass, m_p is the mass of the photon; ζ and ϕ are indicated in the figure and can be expressed as follows:

$$\zeta^2 = r_s^2\sin^2\theta + (r_s\cos\theta + x)^2,$$

$$\cos\phi = \frac{r_s\cos\theta + x}{[r_s^2\sin^2\theta + (r_s\cos\theta + x)^2]^{1/2}},$$

where r_s is the radius of the sun, θ and x are as indicated in figure 1. The loss of energy when the photon travels through a small distance dx

$$\mathrm{d}E = -\frac{GM_s m_p(r_s\cos\theta + x)^3}{[r_s^2\sin^2\theta + (r_s\cos\theta + x)^2]^{5/2}}\mathrm{d}x,$$

or

$$h\,\mathrm{d}\nu = -\frac{GM_s h(r_s\cos\theta + x)^3}{c^2[r_s^2\sin^2\theta + (r_s\cos\theta + x)^2]^{5/2}}\mathrm{d}x,$$

where h is the Planck's constant, ν is the frequency and c is the speed of light. Finally

$$\ln\left(\frac{\nu - \Delta\nu}{\nu}\right) = -\frac{GM_s}{c^2 r_s}(1 - \tfrac{1}{3}\sin^2\theta), \tag{2}$$

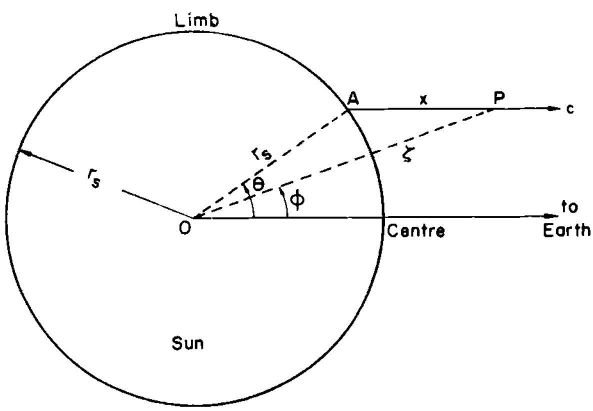

Figure 1. Photon from point A on the solar surface travelling towards the earth.

where ν and $\nu - \Delta\nu$ are the frequencies at the source and on the earth, respectively. From (2)

$$\frac{\Delta\nu}{\nu} \approx \frac{GM_s}{c^2 r_s}(1 - \tfrac{1}{3}\sin^2\theta). \tag{3}$$

Now the fractional frequency shift due to the gravitational pull is given by $GM_s/c^2 r_s$ irrespective of the location from which the photon is emitted. Hence the total frequency shift is given by

$$\frac{\Delta\nu}{\nu} \approx \frac{GM_s}{c^2 r_s}(2 - \tfrac{1}{3}\sin^2\theta). \tag{4}$$

The resultant redshift (after subtracting other redshifts due to the earth's orbital motion and sun's rotation) can be represented by an 'equivalent velocity of recession' and the magnitude corresponding to the term $GM_s/c^2 r_s$ is equal to 0·636 km/sec. However the material in the photosphere is not stationary because of the granulation and supergranulation phenomena (Beckers and Nelson 1978; Bray and Loughhead 1967; Cloutman 1980; Küveler 1983). The flow characteristics are schematically indicated in figure 2. The orders of magnitudes of the average radially upward and the average transverse flow velocities are about 1 km/sec and 0·2 km/sec, respectively (Bray and Loughhead 1967; Cloutman 1980; Küveler 1983)*. Hence the order of magnitude of the resultant 'equivalent velocity' can be expressed as follows:

$$v_{eq}(\theta) \sim 0{\cdot}636(2 - \tfrac{1}{3}\sin^2\theta) - v_r\cos\theta - v_t\sin\theta,$$

where v_r and v_t are the average orders of magnitudes of the radially upward and

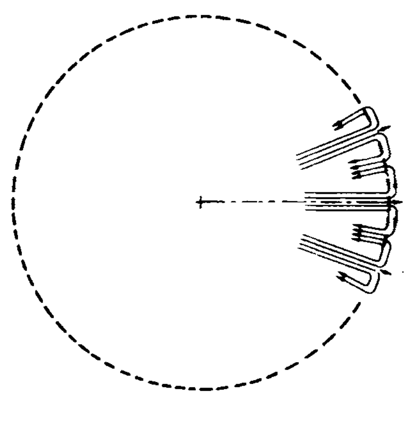

Figure 2. Flow characteristics of solar granules.

* The radially upward average velocity takes care of the radially inward sinking velocity (which is smaller than the outward velocity). Similarly the average transverse velocity is to take care of the radial variation and inclination with the line of sight.

transverse velocities. Finally

$$v_{eq}(\theta) \sim 0{\cdot}636(2 - \tfrac{1}{3}\sin^2\theta) - \cos\theta - 0{\cdot}2\sin\theta \quad \text{km/sec.} \tag{5}$$

4. Results and discussion

The analysis presented above is, of course, a very simple and approximate one. The resulting nature of variation of v_{eq} with $\cos\theta$ is shown in figure 3 along with the observations by earlier researchers (Bertolli 1962). The figure also shows the normalized equivalent velocity (given by the value obtained by subtracting the redshift at the centre). It is clear from the figure that in spite of the simplicity of the analysis the agreement is quite remarkable. The results of very recent studies (Brandt and Schröter 1982) also are of the same nature. The supergravity shift near the limb comes out quite clearly. Another point to be noted is that the redshift is not minimum at the centre but around $\cos\theta = 0{\cdot}9$. This has also been verified in recent studies (Brandt and Schröter 1982).

5. Conclusion

Inclusion of the velocity drag in the calculation of the redshift of the solar spectrum yields results in good agreement with the observation. It also very satisfactorily explains the supergravity shift at the limb.

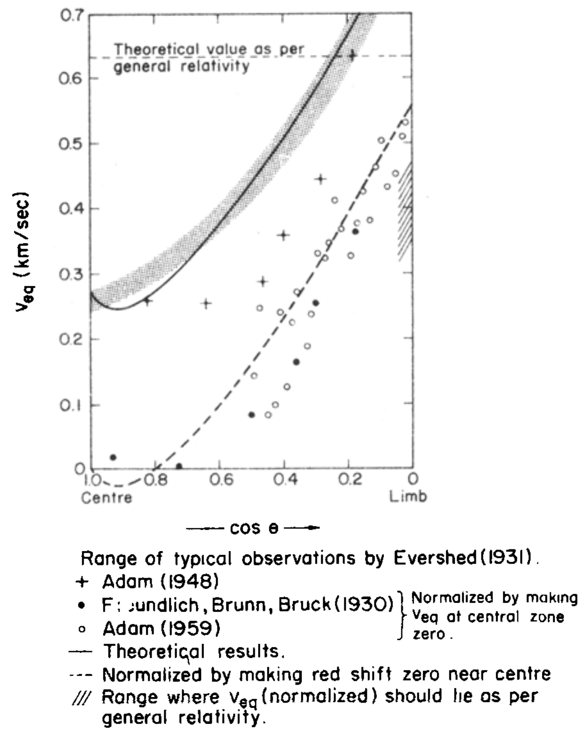

Figure 3. Nature of variation of equivalent velocity with $\cos\theta$.

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