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Comment on 'The Allais Effect and an Unsuspected Law of Gravity' by J.D. Francis

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The author presents a kinematic model of the tidal effects of the Moon and the Sun on a pendulum bob acting as a Foucault pendulum, a static pendulum or a torsion balance. An interesting correlation seems to exist between the azimuthal behaviour of the horizontal component of the gravitational field and the observed azimuthal behaviour of torsion balances. From that correlation, he concludes that a causal link exists between the angular acceleration of the horizontal gravitational field vector and a torque causing the onset of rotations of the torsion balances.

In my humble opinion, the claimed torque could be presented as a hypothesis leading to the proposed new law of gravity, but not as evidence inferred from the correlation, since the correlation can also be due to a common unknown cause yielding both phenomena (the observed anomalies on one end, the horizontal gravitational field on the other hand), without any direct causal link between the correlated phenomena themselves.

As a whole, the correlation between the kinematics of the author's model and the kinematics of torsion balances constitutes an interesting step towards a theory explaining the behaviour of torsion balances and possibly also static pendula. It has the merit of connecting the model and the corresponding experimental phenomena rigidly in time. However, Foucault and paraconical pendula are non-linear devices where gyroscopic effects predominate, so that one cannot readily conclude that a unidirectional torque exerted on the bob about the vertical line will result in a precession of the oscillation plane. It is rather an ovalization (elliptical orbit) of the originally planar oscillation that will occur (Pippard, 1988) instead of a change in azimuth of the oscillation plane. The azimuthal change occurs thereafter via the Airy effect due to the nonlinear response of the spherical pendulum in amplitude along the a- and b-axes respectively.

With the sole intention of informing the author, spherical pendulum response can be summarized as follows:

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1) Long Foucault pendula operating at small angular amplitudes ($<$ 0,015 rad) respond to a torque about the vertical axis by developing elongated elliptical bob orbits after a fraction of an hour with no immediate change in swinging azimuth of the major axis. So the effect claimed by the author is not realized with true Foucault pendula. Contrary to the case under study, those long Foucault pendula rather respond to lateral pseudoforces which do not change sign from maximum elongation to maximum elongation during one half-cycle, but change sign for the next half-cycle, as does the Coriolis pseudoforce. The result of that force, which incidentally exerts no net torque during each half-cycle, is pure precession without elliptic orbit, i.e. exclusively a change in swinging azimuth. The anisotropy of the gravitational (or inertial) field causing that effect is called circular anisotropy. It is characterized by two different natural rotation periods for left-handed and right-handed circular orbits of the bob respectively (ex.: the Foucault effect). The true question which now arises is the following: "Does a gravitational field which is linearly anisotropic due to aligned masses, but which rotates relative to the laboratory, generate different natural rotation periods for the spherical pendulum, as does the rotation of the Earth?" The experiments tend to show that the answer is Yes.
2) Shorter paraconical pendula operating with large amplitudes (Allais, Olenici: $\sim$ 0.1 rad) respond to a torque about the vertical axis by developing elliptical bob orbits within minutes, and consequently undergoing large Airy precession speeds due to non-linear dependence of the swinging period on amplitudes along a- and b-axes. The field anisotropy causing that effect is called linear anisotropy. It is characterized by two different natural swinging periods for two mutually perpendicular swinging directions of rectilinear oscillations. This type of anisotropy includes suspension anisotropy, as well as the horizontal field anisotropy generated by non-revolution-symmetric surrounding masses (Moon, Sun). As a matter of fact, the pendulum period is longer in the plane containing the perturbing mass than in the

plane perpendicular to it. The experiments tend to show that for a quasi-static linearly anisotropic field of that sort, the azimuth of a short pendulum tends to oscillate about the azimuth of longest period while the sense of the elliptical orbit alternates clockwise and counter clockwise[1] ("quasi-static" means that the characteristic time of the azimuthal changes of the field is much larger that the pendulum period).

3) Independently of the device itself, Allais's unique procedure of chained 14-minute runs is characterized by the fact that the initial quest for the slow azimuth (longest period) is constantly interrupted and restarted, so that the 14-minute azimuth undergoes a critically damped approach toward the slow azimuth. If, on the other hand, the slow azimuth is slowly rotating due to the rotating Earth-Moon axis, then the 14-minute azimuth follows that gravitational potential valley in real time. Allais's procedure thus responds to linear anisotropy of the gravitational field. However, the pseudo torques needed to explain the rate of ellipse growth of the paraconical pendulum are 8 orders of magnitude greater than those calculated from classical mechanics. Whence the need for a new explanation here too.

In conclusion, the author's model appears to possess a temporal structure similar to the structure of the time series of the experimental phenomena, but there are no quantitative data whatsoever proving that the claimed pseudo-torques explain the observed motions of the suspended devices. The problem of quantitatively explaining the Allais effects and the like remains unsolved.

[1]Kamerlingh Onnes, H., (1879), Nieuwe Bewijzen voor de Aswenteling der Aarde, Thesis, Rijksuniversiteit te Groningen, Groningen, NL, 290 p.