THE ALLAIS EFFECT – COINCIDENCE BETWEEN NEWTONIAN AND LeSAGIAN GRAVITY?

Dr. Raymond H.V. Gallucci, P.E.
8956 Amelung St., Frederick, MD 21704, gallucci@localnet.com

Abstract. This paper reviews the alleged Allais Effect, i.e., anomalous behavior of pendulums or gravimeters sometimes observed during a total solar eclipse. With the Moon in a direct line between the Earth and Sun, the potential for an additional gravitational perturbation is examined as a possible contributor to the effect. Both a classical Newtonian "attractive" gravitational approach and one based on a "pushing" gravitational concept first introduced around Newton's time by Fatio and LeSage are examined. Results indicate that both yield surprisingly equivalent results – a possible explanation, or part of one; or merely a coincidence?

1. INTRODUCTION

"The Allais effect is the alleged anomalous behavior of pendulums or gravimeters which is sometimes purportedly observed during a [total] solar eclipse. The effect was first reported as an anomalous precession of the plane of oscillation of a Foucault pendulum during the solar eclipse of June 30, 1954, by Maurice Allais, a French polymath who went on to win the Nobel Prize in Economics. Allais reported another observation of the effect during the solar eclipse of October 2, 1959 using the paraconical pendulum he invented … Maurice Allais emphasized the 'dynamic character' of the effects he observed:

> 'The observed effects are only seen when the pendulum is moving. They are not connected with the intensity of weight (gravimetry), but with the *variation of weight* (or of inertia) *in the space swept by the pendulum*. Actually, while the movement of the plane of oscillation of the pendulum is *inexplicable* by the theory of gravitation, the deviations from the vertical are *explained perfectly* by that theory. The deviations from the vertical […] correspond to a *static* phenomenon, while my experiments correspond to a *dynamic* phenomenon'."

"Besides Allais' own experiments, related research about a possible effect of the Moon's shielding, absorption or bending of the Sun's gravitational field during a solar eclipse have been conducted by scientists around the world [See Table 1]. Some observations have yielded positive results, seemingly confirming that minute but detectable variations in the expected behavior of devices dependent on gravity do indeed occur within the umbra of an eclipse, but others have failed to detect any noticeable effect." [1]

Table 1 lists attempts to reproduce the Allais effect through 1995. Subsequently, NASA's Marshall Space Flight Center tried to encourage coordination worldwide among several observatories during the total solar eclipse of August 11, 1999, to test the Allais effect. However, Allais was critical of the results, finding that "the period of observation was 'much too short […] to detect anomalies properly'." Further observations conducted by Xin-She Yang and Tom Van Flandern found that "the gravitation anomaly discussed here is about a factor of 100,000 too small to explain the Allais excess pendulum precession […] during eclipses," concluding that "the original Allais anomaly was merely due to poor controls." More recent experiments during the solar eclipses of July 22, 2009, and July 11, 2010, in China and Argentina, respectively yielded mixed results. One scientist from the China attempt observed the effect. However, an automated Foucault pendulum used in Argentina yielded "no evidence of a precession change of the pendulum's oscillation plane (< 0.3 degree per hour)." [1]

This paper assumes the Allais Effect is possible and examines both a classical Newtonian "attractive" gravitational explanation as well as one based on "pushing gravity," as per Fatio and LeSage. [2]

Table 1. Review of the Different Eclipse Experiments [3] (Yellow highlight indicates positive result)

Name	Date	Place	Device	Result
M. Allais	June 30, 1954	Saint-Germain-en-Laye, France	Paraconical pendulum	"The plane of oscillation of the paraconical pendulum approximately shifted 15 centesimal degr. during the eclipse."
M. Allais	October 2, 1959	Saint-Germain-en-Laye, France	Paraconical pendulum	"An analogous perturbation of amplitude approximately 10 grads has been observed"
G. T. Jeverdan *et al.*	February 15, 1961	Iasi, Romania	Foucault pendulum	The oscillation period of the pendulum decreased by about 1 part in 2000 – the so-called 'Jeverdan effect,' but his report was not published in a mainstream English-language scientific journal.
L. Slichter *et al.*	February 15, 1961	Florence, Italy	Gravimeter	"Gravity observations during the solar eclipse of February 15, 1961, failed to detect an associated gravitational signal"
E. J. Saxl and M. Allen	March 7, 1970	Harvard, Massachusetts	Torsion pendulum	Increase in the period of a torsion pendulum during the solar eclipse: "Quantitative observations made with a precise torsion pendulum show ... that the times required to traverse a fixed fraction of its total angular path vary markedly during the hours before the eclipse and during its first half, i.e., up to its midpoint."
R. Latham	June 20, 1974	Perth, Australia	Gyroscope and electronic level	"No eclipse effect was noticed of a form suggested by the observations of Allais and Saxl & Allen (with the gyroscope) ... To monitor a possible change in the direction of 'g' we took a Taylor Hobson 'Talyvel' electronic level, mounted it on the gyroscope turntable and monitored a possible E/W change of direction of 'g.' Such an effect was observed, and a large one (5 secs of arc) ..."
R. Latham	August 10, 1980	Lima, Peru	Gyroscope and electronic level	"... the experiments could possibly be consistent with an eclipse couple, though the fluctuations prevent a firm decision being reached. With regard to the Talyvel effect at Perth the results are quite definite. Such an effect was not observed at Lima."
T. Kuusela	July 22, 1990	Turku, Finland	Torsion pendulum	"Contrary to previous experiments, no increase in the period was observed"
Jun *et al.*	July 22, 1990	Bielomorsk, Russia	Torsion pendulum	"We cannot say what possible systematic error or errors would account for the results of Saxl and Allen, but to the limit of our experimental sensitivity, there is no observed anomalous period increases of the torsion pendulum during the solar eclipse at a level much smaller than the effect they reported."
J. Kääriäinen	July 22, 1990	Lohja, Finland	Water level	"no gravitational shielding was found at the level of the above accuracy."
J. Mäkinen	July 22, 1990	Finland	Gravimeter	No effect detected
K. Ullakko *et al.*	July 22, 1990	Helsinki, Finland	Torsion pendulum	No effect detected
T. Kuusela	July 11, 1991	Mexico City	Torsion pendulum	"In our experiment no significant change was found as the relative change in the period associated with the eclipse was less than 2.0×10^{-6} (90% confidence) ... However, two small but distinct shifts were observed in the horizontal position of the pendulum wire which were well correlated with the beginning and the end of the eclipse."

L. Savrov	July 11, 1991	Mexico City	Paraconical pendulum	"it is clear that the sharp deviation of the azimuth of the plane in which the pendulum swings by 12° at the start of the eclipse (first contact) is noteworthy. The variation in the rate of rotation during the eclipse ... proves to be three times greater than the local Foucault effect ... the Foucault pendulum responded to the remanent shock wave at the maximum of the total eclipse phase, and the rate of rotation of its oscillation plane changed"
M. Denis	July 11, 1991	Mexico City	Paraconical pendulum	Variation of the rate of rotation of the Foucault pendulum's plane of swinging
Zhou S. W. *et al.*	December 24, 1992	China	Atomic clocks	The influence of the solar eclipse on the rate of atomic clocks has been observed although the effect of this solar eclipse was very weak.
L. Savrov	November 3, 1994	Pato Branco, Brazil	Paraconical pendulum	"an increase in the rate of rotation of the pendulum's oscillation plane in the direction of the Foucault effect was observed in the Brazilia-94 experiment, just as had been observed in the Mexico-91 experiment, though its magnitude was only one-fifth that of the latter experiment."
Mishra and Rao	October 24, 1995	Dhoraji, Saurashtra, India	Gravimeter	"A one hour feature of the gravimeter record of 10^{-12} microGal (10^{-8} cm/s^2) ... can neither be classified under short period variations due to tidal effect or drift of the gravimeter nor under high frequency noise which have special patterns. Therefore, this variation is highly significant as it occurs with the onset of an eclipse"

2. NEWTONIAN EXPLANATION

A strict Newtonian explanation for an attractive gravitational perturbation during a solar eclipse being responsible for, or at least contributing to, the Allais Effect is fairly straightforward. The Sun's gravitational "pull" on the Earth is GM_sM_e/D^2, where G = Newton's Gravitational constant (6.67 x 10^{-11} m^3/kg-s^2), M_s = Sun's mass (1.99 x 10^{30} kg), M_e = Earth's mass (5.97 x 10^{24} kg), and D = Earth-Sun distance (1.50 x 10^{11} m). The Moon's gravitational pull on the Earth is GM_mM_e/d^2, with M_m = Moon's mass (7.35 x 10^{22} kg) and d = Earth-Moon distance (3.84 x 10^8 m). When these two gravitational pulls are calculated (Sun's = 3.54 x 10^{22} N and Moon's = 1.98 x 10^{20} N), the Moon is found to contribute an additional 0.56% to that of the Sun in a direct line during a total solar eclipse. If the Allais Effect is real, might this be an explanation, or at least be part of one?

3. LeSAGIAN EXPLANATION

First, consider Figure 1 (D = Earth-Sun distance [1.50 x 10^{11} m], R_e = Earth's radius [6.37 x 10^6 m], R_s = Sun's radius [6.96 x 10^8 m]). The area (actually, a volume in three dimensions) within the solid red lines shows the "shadow" imparted by the Sun on the Earth with respect to impingement by LeSagian "particles." A cone subtended by angle 2α has a shadowed base area of πx^2 once it is recognized that $D \gg R_s \gg R_e$, allowing the solid red lines to be closely approximated by the dashed red lines such that we are dealing strictly with right triangles. By symmetry, with α being a very small angle due to $D \gg R_s \gg R_e$, $\tan \alpha \approx x/R_e = R_s/D \rightarrow x \approx R_eR_s/D \approx 2.96 \times 10^4$ m, corresponding to a shadowed base area of 2.76 x 10^9 m^2.

Next, consider Figure 2 (d = Earth-Moon distance [3.84 x 10^8 m] and R_m = Moon's radius [1.74 x 10^6 m]). As with Figure 1, but now with the Moon in place of the Sun, the area (actually, a volume in three dimensions) within the dashed red lines (again observing that $d \gg R_e \gg R_m$) shows the "shadow" imparted by the Moon on the Earth with respect to impingement by LeSagian "particles." A cone subtended by angle 2β has a shadowed base area of πy^2 since we are again essentially dealing strictly with right triangles. By symmetry, with β being a very small angle due to $d \gg R_e \gg R_m$, $\tan \beta \approx y/R_e = R_m/d \rightarrow y \approx R_eR_m/d \approx 2.88 \times 10^4$ m, corresponding to a shadowed base area of 2.60 x 10^9 m^2. Both of these values are very close to the corresponding ones for the Sun's shadowing of the Earth (2.96 x 10^4 m and 2.76 x 10^9 m^2, respectively), the expected result given how the Moon almost perfectly matches the Sun's size when viewed during a total eclipse.

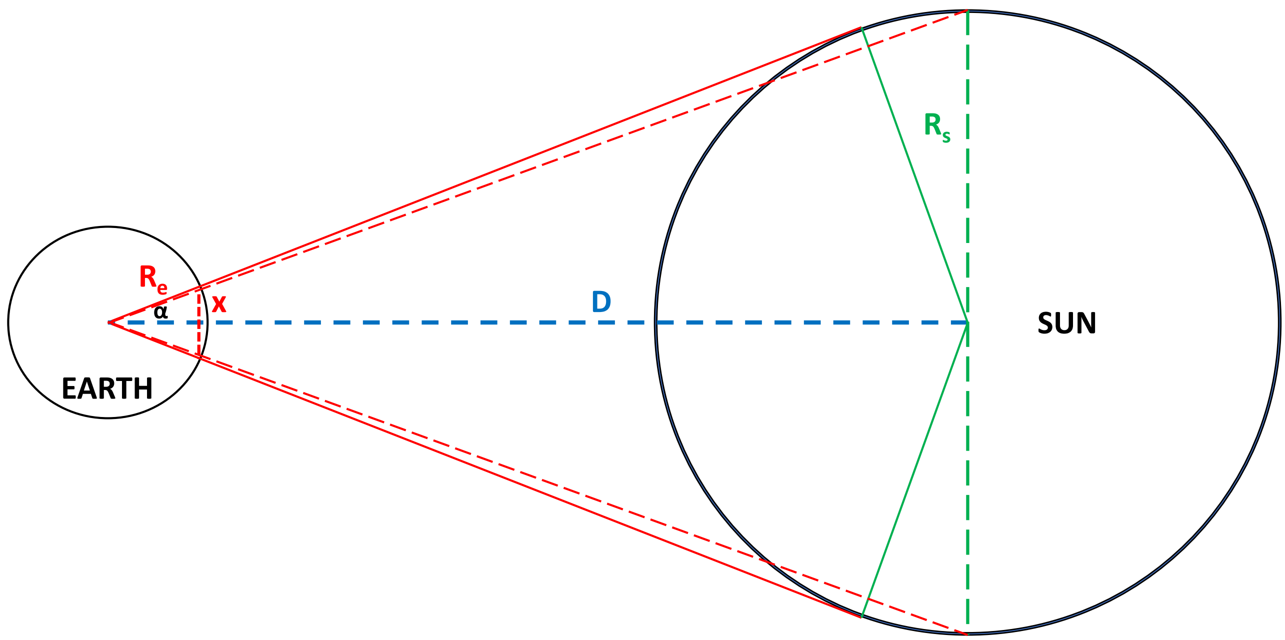

Figure 1. **Schematic of LeSagian "Shadowing" by Sun on Earth (not to scale)**

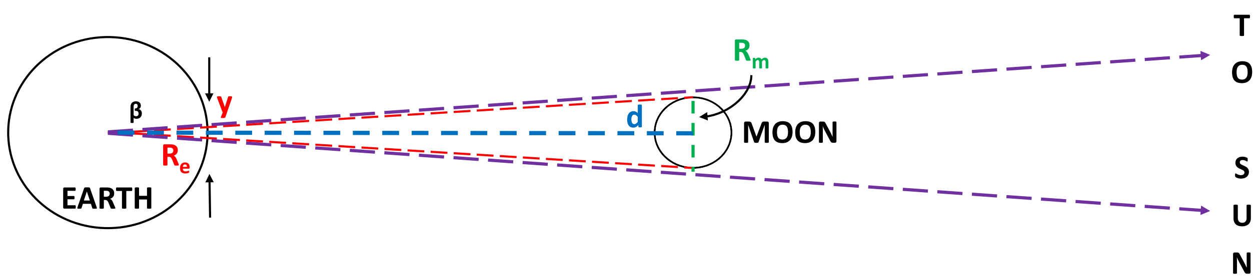

Figure 2. **Schematic of LeSagian "Shadowing" by Moon on Earth (not to scale)**

3.1. Mingst and Stowe

If the Sun were to completely block the flow of LeSagian particles, then the Moon's presence within the shadow already caused by the Sun on the Earth (to produce its gravitational "pull" on the Earth) would be moot, since there would already be no LeSagian particle left to block. However, LeSage and most followers who advocate "pushing" gravity do not consider objects completely opaque to the particles, but rather allow for passage with some sort of interaction/attenuation occurring. Barry Mingst and Paul Stowe are prime examples of this, and it is through this interaction that they account for the effect of mass when deriving Newton's gravitational equation based on the LeSagian "pushing" concept. Specifically,

> "We begin our development [of the Newtonian gravitational equation in its entirety from LeSagian models] … with … the form of the interaction of some physical flux [Φ] … based upon standard exponential removal equations … The change in flux … is generally given in a differential distance by $d\Phi = -\mu_l \Phi dx$, where μ_l is the linear flux attenuation (loss) coefficient … and x is the thickness … This … gives rise to a standard thin-shield reduction equation of $\Phi_i = \Phi_0 e^{-\mu x}$, where Φ_i is the flux after interaction and Φ_0 is the initial flux … [W]hen only a small fraction of the flux is removed … the exponential term may be replaced by the first two terms of the power series approximation … [which, after integration] simplifies to

$\Phi_{net} = \frac{\Phi_0}{d^2}\left(\frac{4\pi r^3}{3}\right)\mu_l$ [at a distance d]. The term in brackets is the volume of the sphere [with radius r]. The linear attenuation coefficient is generally a function of the density of the material. A more general parameter is the mass attenuation coefficient … $\mu_s = {}^{\mu_l}/_{\rho}$, where ρ is the material density, … such that the above equation becomes … $\Phi_{net} = \Phi_0 \frac{\mu_s}{d^2} M$ [where M = mass of sphere] …"

"If a second body is placed in the vicinity of the first, it will be affected by the field's vector potential created by the first body … Up to this point, we have been working in very general terms of flux … [T]o convert to the observed Newtonian gravitational force equation, … Newton's second law requires a specific form of flux change: $\boldsymbol{F} = \frac{d(\boldsymbol{mv})}{dt}\delta\Phi A$, where A is the effective cross-sectional area of the body and [the **bolding** of the terms **F** and **mv**] indicate vector quantities … Because the average path distance through sphere 2 is $4r_2/3$, and the cross-sectional area of sphere 2 is πr_2^2, we can combine [the previous equations]: $F = \Phi_{net}\left(\mu_{l2}\frac{4r_2}{3}\right)\pi r_2{}^2 = \Phi_{net}\left(\frac{4\pi r_2{}^3}{3}\right)\mu_{l2}$ … Substituting for Φ_{net} [above] then gives the net interaction as: $F = \frac{\Phi_0}{d^2}\left(\frac{4\pi r_1{}^3\mu_{l1}}{3}\right)\left(\frac{4\pi r_2{}^3\mu_{l2}}{3}\right) \ldots = \frac{\Phi_0}{d^2}(M_1\mu_{s1})(M_2\mu_{s2})$. For ordinary matter … $\mu_{s1} = \mu_{s2} = \mu_s$. We therefore obtain $F = (\Phi_0\mu_s{}^2)M_1M_2/d^2$ … [With $G = \Phi_0\mu_s{}^2$,] this is the same form as the standard Newtonian gravitational force equation … The Newtonian 'field' is purely a mathematical concept. The LeSagian field is a physical measure of the local current momentum imposed … It is not mass alone, but the mass interaction coefficient of matter that gives rise to the force of gravity." [4]

4. COINCIDENT EQUIVALENCE?

Mingst and Stowe demonstrate that LeSagian gravitation involves linear attenuation that is proportional to the product of density and distance through a "shadowing" sphere. Therefore, during the total solar eclipse, the Moon can further attenuate the already somewhat attenuated LeSagian "particle flux" via the Sun that is shadowing the Earth. Due to the unique geometrical alignment, the Moon effectively further attenuates this entire shadowed flux from the Sun. The average path length of travel through the Sun and Moon is 4/3 times the radius of each, as per Mingst and Stowe above. The Sun has a mass of 1.99×10^{30} kg and a volume of $4\pi R_s{}^3/3 = 1.41 \times 10^{27}$ m^3, giving it an average density of 1.41×10^3 kg/m^3. The corresponding values for the Moon are 7.35×10^{22} kg, 2.20×10^{19} m^3 and 3.35×10^3 kg/m^3, respectively. The "attenuation factors" through the Sun and Moon, i.e., the product of their densities and 4/3 of their radii (mean LeSagian "path lengths"), become 1.31×10^{12} kg/m^2 and 7.75×10^9 kg/m^2, respectively. The ratio of these shows that the Moon's is 0.59% of the Sun's, quite comparable to the 0.56% previously derived for Newtonian gravitation, and actually equivalent to one significant figure (0.6%). That is, even using the LeSagian gravitational concept, the Moon is found to contribute essentially the same 0.6% in gravitational "pull" to that of the Sun in a direct line during a total solar eclipse. While this may be purely coincidental, it does raise an intriguing potential for equivalence between the empirical formula for gravitation derived by Newton and the physical explanation of gravitation first developed by Fatio and LeSage, and significantly enhanced by Mingst and Stowe. Once again, if the Allais Effect is real, might LeSagian gravity be an explanation, or at least be part of one?

This is not the first intriguing "coincidence" that I have come across, making one reluctant to *a priori* dismiss such "coincidences" in lieu of at least entertaining the possibility that they might be meaningful. Lyndon Ashmore, one of the prime champions of "Tired Light" theory, found that "Experimental results show that the Hubble constant, H, is the same as hr/m for the electron in each cubic meter of space," from which he concluded that "the universe is not expanding." Expressing the Hubble constant in SI units of 2.06×10^{-18}/s, Ashmore observed that "the expression hr/m in each cubic meter of space, where 'h' is the Planck constant, 6.63×10^{-34} J-s, 'm' is the rest mass of the electron, 9.10×10^{-31} kg, and "r' is the classical radius of the electron, … 2.82×10^{-15} m, hr/m = 2.05×10^{-18} m^3/s [= 2.05×10^{-18}/s per cubic meter] … [I]n magnitude, they have the same value and units." Ashmore proceeds to discuss why he believes this "coincidence" may be significant, not reproduced here, but available in Reference [5].

I myself uncovered another intriguing "coincidence" during my investigation of asymmetry with regard to the ocean tides. Noting that "neither the exact solution to the differential gravitational force approach nor incorporating the effect of the Earth's barycentric centrifugal force was able to establish the alleged symmetry of the tides across the Earth's hemispheres," I found that "if one combines the barycentric effect with the Moon's gravitational force directly, i.e., without the differential effect, … the differences between [the net forces at] corresponding locations in each hemisphere are quite small, … < 1% of their average value. Similarly, the differences between the angles for these net forces at corresponding locations is quite small, … again < 1% of their average value. What this suggests is that combining the barycentric centrifugal force and the Moon's gravitational (direct, not differential) forces vectorially produces the alleged symmetry between the tides on the opposite hemispheres … We are left to ponder whether there is an alternative explanation for the alleged symmetry of the tides other than accepting the approximation employed when deriving the differential gravitational effect … Might the combination of the barycentric centrifugal and Moon's direct gravitational forces explain what has so far been attributed to an approximation in the differential gravitational force derivation?" [6]

5. CONCLUSION

Whether or not the Allais Effect is real remains in question. Repeated experiments sometimes reproduce the effect, or something similar, and other times show no effect at all. Starting from the premise that the Allais Effect is possible, this paper sought to examine the plausibility of a gravitational explanation from both the classical Newtonian "attractive" perspective and equally contemporary, but much less accepted, "pushing" model for gravity first introduced by Fatio and LeSage. The results indicate that, using either approach, the Moon may contribute an additional 0.6% to the gravitational force from the Sun on the Earth during a total solar eclipse, which may explain, or be part of an explanation for, the alleged Allais Effect. Therefore, if one accepts Newton's gravitational equation as empirically correct, then a LeSagian gravitational "pushing" concept is at least consistent with the quantitative results.

6. REFERENCES

1. https://en.wikipedia.org/wiki/Allais_effect
2. Gallucci, R. 2016. "Gravity: When Push Comes to Shove?" http://vixra.org/pdf/1608.0416.pdf; https://principia-scientific.org/gravity-when-push-comes-to-shove/ (May 2, 2018); Proceedings of the Fifth Annual Chappell Natural Philosophy Society Conference, June 26-29, 2019, Seattle, WA, pp. 87-89
3. https://en.wikiversity.org/wiki/Allais_effect
4. Mingst, B., and P. Stowe, "Derivation of Newtonian Gravitation from LeSage's Attenuation Concept," http://www.mountainman.con.au/le_sage.htm
5. http://lyndonashmore.com/ashmores_paradox.htm
6. Gallucci, R. 2016. "Tidal Asymmetry," Proceedings of the Second Annual Chappell Natural Philosophy Society Conference, July 20-23, 2016, College Park, MD, pp. 74-88; http://vixra.org, item 1606.0129; https://principia-scientific.org/tidal-asymmetry-proceedings-of-the-second-annual-chappell-natural-philosophy-society-conference/ (April 25, 2018)