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Astral Actions on Allais' Pendulum Apparently Inexplicable by Classical Factors: A Point of the Situation

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Abstract

1) The observation by Allais of the precession of pendulums from 1954 to 1960 highlighted regularities of astral origin an in-depth analysis of which showed that, apparently, no classical phenomenon can explain them. These regularities were diurnal waves whose periods are characteristic of astral influence (the main ones being 24 h and 24 h 50 min), annual and semi-annual components, and a multi-annual component of approximately 6 years, an influence of Jupiter being a very good candidate to explain it. 2) Allais had experimentally established that all these astral influences were expressed globally on the pendulum by an action tending to call back its plane of oscillation towards a direction variable in time, and which ovalized its trajectory. In 2019 the observation of 2 pendulums in Horodnic (Romania), thanks to the use of an automatic alidade, made it possible to identify the main mechanism that, very probably, acted on the pendulum to achieve this result. This perturbation model, called "linear anisotropy", is characterized by its "coefficient of anisotropy" η, and by the azimuth of its "direction of anisotropy". The composition of 2 linear anisotropies is always a linear anisotropy. 3) In the search for the phenomena which could be at the origin of all what precedes, the fact that they must create an ovalization immediately eliminates some of them. 4) We have calculated the values of η corresponding to the 24 h and 24 h 50 min waves both for the observations in Horodnic and the Allais observations. The order of magnitude (some 10^{-7}) is effectively the same in both cases. 5) Mathematically, the regularities discovered may result of a new force field but also, as Allais proposes, from the creation, under the astral influences, of a local anisotropy of the medium in which the pendulum oscillates. In the first

case the length of the pendulum is involved, in the second one not. The data available do not make it possible to decide. 6) The joint exploitation, in mechanics and optics, of Allais observations and of observations by other experimenters provides additional information: a) Allais, and after him several other scientists, discovered also marked anomalies in the precession of pendulums during certain eclipses, and maybe certain other syzygies. For the few eclipses for which both something was observed and sufficient data were available (one of them being a lunar eclipse for which nothing had been published until now), it was always the above perturbation model which acted on the pendulum, but sometimes with quite exceptional magnitude. b) There are quite possible links with optics. During the observation campaign of August 1958, which had implemented both two pendulums and an optical device, all the 24 h 50 min waves were almost in phase. In the precession of the Allais pendulum, in Miller's interferometric observations in Mont Wilson, and in Esclangon's observations in Strasbourg, a same peculiarity is found: the extrema of the annual influence are at the equinoxes, not at the solstices.

Keywords

Allais Effect, Pendulum, Lunisolar Influence, Jupiter Influence, Lunar and Solar Eclipses, Syzygies, Sunspots, Solar Cycles

1. Introduction

1.1. Regularities of Astral Origin Apparently Inexplicable by Classical Factors in the Precession of a Pendulum

- Between 1954 and 1961, in his laboratory in Saint-Germain, Allais conducted 6 continuous 1-month observations of the azimuth of the oscillation plane of a pendulum which was regularly restarted. That of 1958 also implemented a second pendulum, identical to the first, located 6.5 km away in an underground quarry, as well as optical observations. All these observations were presented in 1997 in his synthesis book, "The Anisotropy of Space" ([1] or [2]). They had previously, between 1955 and 1960, given rise to numerous publications, in particular in the "*Comptes rendus de l'Académie des Sciences*" [3]-[11] and in "*Aerospace Engineering*" [12] [13], at the request of Wernher von Braun, director of the NASA. They even earned Allais two scientific prizes[1].

  In 2019, in Horodnic (Romania), a 1-month continuous observation campaign of the precession of 2 pendulums was carried out [14]. It found again the diurnal lines highlighted by Allais from the isolated analysis of 1 month's observations. Using an automatic alidade (Allais only had manual means), it also provided very numerous and precise information on the movement of the pendulum.

[1]The 1959 Galabert Prize from the *Société Française d' Astronautique* and the 1959 Gravity Research Foundation Prize.

- Besides very marked anomalies on the occasion of eclipses (which is in fact the discovery which most contributed to making his work as a physicist discovered), they had highlighted regularities related to the astral situation apparently inexplicable by classical phenomena, and much too important to be explained by general relativity:

1) The 1-month observations analyzed separately revealed diurnal lines of 24 h, 24.84 h (=24 h 50 min), 12 h and 25.82 h. Since, over 1 month, it is not possible to completely separate, around 24 h, lines with periods distant by less than 50 minutes, the 24 h and the 24.84 h lines correspond in fact to groups of lines.

The group of lines around 24 h results either directly from the anti-clockwise rotation around its axis, in a sidereal day (23.98 h), of the Earth relative to the rest of the Universe, or from the composition of this rotation with slow astral phenomena. The main one of them is the annual revolution of the Earth around the Sun (which gives the 24 h line), with possibly its first harmonics: 6 months, 4 months. An influence of the position of celestial bodies other than the Sun and the Moon, if it exists, affects only this group of lines: their angular velocities in the equatorial system being nil, or very small, only a range of few minutes around the 23.98 h period is concerned.

In the case of the Moon, a 24.84 h wave results from the composition of the rotation of the Earth around its axis and of the revolution of the Moon around the Earth in a sidereal month, which are in the same anticlockwise sense. But an action of the rotation of the Sun around its axis would also produce a component having approximately this period (as the Sun is not a solid system, the period varies with the latitude, from 25 days in the equator to 36 days in the poles). In view of the available data, we cannot exclude that it played a role in the observed 24.84 h wave. The 24 h and 24.84 h waves correspond to harmonics 1. Due to non-linearities, there are also harmonics, beats, harmonics of beats, etc…By limiting ourselves to harmonics 2, we obtain the period of 12 h and the period of 25.82 h (composition of the rotation of the Earth with the harmonic 2 of the revolution of the Moon around the Earth).

2) Considered globally ([1] or [2], chap. V.A and V.B; and [15]), the 6 observations revealed both an action of the annual revolution of the Earth around the Sun and a multi-annual action whose period of harmonic 1 is about 6 years. This action concerns both the evolution, from one observation to another, of the average azimuth and the amplitudes of the 24 h and 24.84 h lines.

The analysis shows that Jupiter is an excellent candidate for explaining a significant part of this multi-year action, without being able to exclude an action of the current solar cycle, whose half-period is also approximately 6 years. It also revealed a very possible daily action of the hour angle of Jupiter, which would be of the same order of magnitude as that of the solar hour.

As regards the annual action, it is mainly semi-annual, but the annual component is also important, at least for the average azimuth. It is remarkable that the extrema are at the equinoxes, and not at the solstices, which is the case for all the known geophysical factors, except variations in the Earth's magnetic field.

1.2. The Objective Is Now to Accumulate as Much Information as Possible on the Unknown Actions Which Are at the Origin of All These Regularities

- The hypothesis to be examined first is that only one new unknown action is at the origin of these regularities.
- From Allais' work and the observations in 2019 of two pendulums in Horodnic (Romania) [14], it results that the unknown action creates an ovalization of the trajectory of the pendulum.
    - Allais established ([1] or [2], chap. I, §E.1 to §E.4) that, at least for the most part, the precession of the pendulum resulted from a very important noise which he had attributed to the defects of the balls[2], from the Foucault effect, from the anisotropy of the support, and from other causes in which was the unknown cause of the regularities of astral origin that he had discovered.

      He had also established, during observations of a few days in which he measured both the precession and the minor axis of the ellipse, that the precession out of noise and Foucault effect (which therefore includes the found regularities and the effect of the anisotropy of the suspension) resulted, at least for the main part, from ovalization, through Airy's precession ([1] or [2], chap. I, §A.4).
    - It was established in Horodnic ([14] §3.3) that it was the derivative of ellipticity which was at the origin of the main part of the precession out of the Foucault effect and out of the noise resulting from the initial ovalization. It is therefore this derivative, and not the precession, which was used for the spectral analysis ([14] §4): it is absolutely certain that the regularities of astral origin found again in Horodnic resulted from the creation of an ovalization.
- The fact that the unknown action acts on the pendulum by creating an ovalization directly eliminates a number of explanations.
- It was further shown in Horodnic that, most likely, at least for the main part, the precession out of the Foucault's effect and the noise created by the initial ovalization resulted from the existence of a force which calls back the pendulum towards its rest position, and which varies with the azimuth of the plane of oscillation in the simplest way: by a sinusoid the period of which is 180 deg (we can limit ourselves to considering only harmonic 1).

This kind of perturbation on the precession of a pendulum, which acts in the horizontal plane, has been called a "linear anisotropy"[3]. It has been studied in

[2]The defects in the balls may have been a cause of this noise, but there was certainly also the initial ellipticity resulting from the fact that, when the wire is burned, the pendulum is never completely still, what is a very important cause of noise: cf [14], §3.2 and §3.3.

[3]This designation results from the fact that an analogy can be drawn between this kind of anisotropy affecting the behaviour of a plane oscillator and the notion of "linear polarization" of a field perpendicular to its propagation direction [16].

detail ([14], Appendix B2), or [15], §A.2 and §A.3). A linear anisotropy is defined by its "coefficient of anisotropy" $\eta(t)$ (which is $\ll 1$) and by the azimuth $\theta_A(t)$ of its "direction of anisotropy". Hence an "anisotropy vector", the modulous of which is $\eta(t)$, and the argument $2\theta_A(t)$. The composition of 2 linear anisotropies is always a linear anisotropy, whose the anisotropy vector is the sum of the anisotropy vectors of its components.

It was shown ([14] §7.4 and appendix §B.5) that in Horodnic a linear anisotropy can explain most of the ellipticity after deducing the initial ellipticity which results from that, when the wire is burned, the pendulum is never completely still. Besides we verify, in the analysis of runs, that the smoothed slope of the ellipticity generally varies little over the course of 50 minutes (see for example **Figure 1** of [14]), which is consistent with the Formula (7) of [15].

A linear anisotropy makes it possible to account for the action on the pendulum of a certain number of classical perturbations. In particular of an anisotropy of its suspension[4], or of the action of a field of forces whose source is sufficiently distant so that the lines of forces can be considered as parallel in the space swept by the pendulum.

- The hypothesis that, in Allais' observations, the precession out of the Foucault effect and out noise, results, at least mainly, from a linear anisotropy, well accounts for what was observed:
    - Then the total anisotropy vector is the sum of the vector corresponding to the anisotropy of the suspension (for which we saw that the coefficient η was approximately 10^{-5}), which is fixed, and of the vector corresponding to the total anisotropy of external origin, which is variable. The azimuth of the direction variable in time towards which the plane of oscillation of the pendulum is called back[5] is none other the azimuth of the direction of anisotropy of the total linear anisotropy ([15], §A.2, Formulas (6) and (11), and §A.5, Formula (18)).
    - Taking into account the values of η and of the angular amplitude α, only the indirect precession (the Airy precession) is to be considered ([15], §A.5.), in accordance with what is observed.
    - At a given moment, the plane of oscillation of the pendulum tends towards the azimuth for which the speed of the precession resulting from the total anisotropy is exactly opposed to the speed of the Foucault precession. Over all the observations, the average influence of the anisotropy of external origin being small, we find almost exactly the average value of the azimuth (163.6 grads, the calculated value being 162.6 grads): see [15] §A.6.
- Allais made the hypothesis that a celestial body A_i acted on the pendulum by creating an anisotropy of the medium in which the pendulum oscillates: [1] or [2], chap. I, §F, p. 211, Table XII, Formulas (1) and (2). In fact (see §5 be-

[4]The coefficient of anisotropy of the suspension of Allais pendulum is approximately 10^{-5} (value calculated from the data provided in ([1] or [2], §E.3 pp. 176-182).

[5]See [1] or [2], §I.B.1, p. 103-104. The graph VI is very demonstrative.

low), the perturbing action defined by these equations is exactly a linear anisotropy.

- Considering that the 24 h and 24 h 50 min waves each resulted not from a single celestial body A_i, but, more generally, from a set S_i of astral actions of periods indistinguishable from T_i over 1 month, an estimate of the average coefficient of anisotropy associated with S_i was carried out, both for the Allais's observations and the observations in Horodnic.
- For eclipses or syzygies for which, on the one hand, anomalies in the precession of a pendulum had been observed, and, on the other hand, we had sufficiently detailed information, we investigated whether it was by creation of a linear anisotropy that these anomalies had been caused.
- Several optical observations which provided results remarkably consistent with those of Allais were presented:
    - Optical deviations of sightings at marks, in Saint-Germain in July 1958 ([1] or [2]; chap. III B), simultaneously with the observation of two pendulums, one in Saint-Germain, the other in the underground quarry of Bougival.
    - Miller's interferometric observations in Mount Wilson (1925-1926).
    - Optical observations of Esclangon in Strasbourg (1927-1928).

2. The Fact That, at the Origin of These Regularities, There Must Be an Action Which Creates an Ovalization Eliminates Directly a Certain Number of Explanations

- Remark: that follows does, however, imply procedures for using the pendulum that remain close to those used by Allais and in Horodnic. In particular, the pendulum must be restarted regularly (at least every hour, to fix ideas), and the ellipticity must remain small (under 0.01).
- The Coriolis force resulting from the rotation of the Earth creates on the pendulum an action which has a circular symmetry, and which does not cause ovalization[6]:

This therefore directly eliminates, as a cause of what has been observed (even if it creates a significant action on the precession):

1) Any action which cannot have a significant effect other than a variation in the Coriolis force resulting from the rotation of the Earth.

This eliminates the tilt resulting from an acceleration applied to the bob which is slowly variable (period of at least several hours, to fix ideas), and which remains $\ll g$ (tilt $\ll 10^{-4}$ rad, to fix ideas), which is the case of all tilts which may result from the direct or indirect gravitational action of the celestial bodies, and of the resulting motion of the Earth. Indeed we have seen that, in this case, only the modification of the Foucault precession caused by the tilt was capable of having a significant action ([14], §5.2 b), preliminary remark; or ([15], §4.1.2 1), preliminary remark.

We therefore find again, but this time much more directly, and much more

[6]This then results in a "circular anisotropy": cf [16].

globally, an essential conclusion of the analysis carried out in [14] and [15].

2) The action of the Earth magnetic field on an electrically charged bob. The action of the Lorentz force on that charge is:

$$\boldsymbol{F}_L = q\boldsymbol{v} \wedge \boldsymbol{B} \tag{1}$$

where $\boldsymbol{F}_L$ is the Lorenz force, $\boldsymbol{v}$ the bob speed, which is in the horizontal plane, and $\boldsymbol{B}$ the Earth magnetic field. The Lorentz force is of exactly the same form as the Coriolis force $\boldsymbol{F}_C = q\boldsymbol{v} \wedge \boldsymbol{\Omega}$ ($\boldsymbol{\Omega}$ being the rotation of the Earth), and the Coriolis force, which causes the Foucault effect, does not create ovalisation.

3. If the Pendulum Is Non-Magnetic, Variations in the Earth's Magnetic Field Cannot Explain What Was Observed

Indeed, if the pendulum is non-magnetic (which was, very nearly, the case of the Allais pendulum[7]), there are only 2 possible modes of action:

1) If the bob has an electric charge q, the action of the Lorentz force on that charge: see above.

2) If the pendulum is conductive (which is the case for Allais' and Horodnic pendulums), the oscillation of the pendulum in the Earth's magnetic field creates eddy currents. Laplace's forces tend to oppose the speed $\boldsymbol{v}$ of the bob. With each oscillation, there is therefore an action on the force which calls back the pendulum towards its rest position, and this force varies with the azimuth of the plane of oscillation[8].

Only the horizontal component $\boldsymbol{B}_h$ of $\boldsymbol{B}$ can create approximatively a linear anisotropy. Its direction of anisotropy θ_A is determined by the azimuth of $\boldsymbol{B}_h$, that is to say by the magnetic declination. The variations of the latter over 1 month being less than 2 degrees, they absolutely cannot explain the variations of several tens of degrees in both directions observed on the Allais' pendulum during the observations of one month: see for example [1] or [2], graph II, p. 89 (remember that Allais's pendulum was each time released from the final azimuth of the previous run).

4. Estimate, for Each of Allais' Observations, and for That in Horodnic, of the Magnitude of the Disturbances Causing the 24 h and the 24 h 50 min (=24.84 h) Waves

4.1. Principle of This Estimate

- We consider the wave the period of which is T_i (T_i = 24 h or 24.84 h).
  Recall that, as a first approximation (see §1.2), we can consider that, globally, out of the Foucault effect and noise, what acts on the precession of the pendulum is only, in the local horizontal plane, a linear anisotropy.

[7] If the pendulum is not non-magnetic, this does not mean that there is actually an action. Simply, there is then a calculation or experiments to be done to verify that there is no action, or that this action is negligible.

[8] Which creates, at least approximatively, a linear anisotropy. So it was wrong to write, in [14] (§5.3), and in [15] (§4.1.3), that "the action during one half-oscillation cancels the action during the previous one".

It is besides hypothesized that, always in first approximation, it results from each source of perturbation contributing to this global linear anisotopy, in the horizontal plane, an elementary linear anisotropy. The global linear anisotropy is then the vector sum of these elementary anisotropies.

The wave T_i, which is the result of a spectral analysis carried out over 1 month may result, in fact, from several astral actions which we cannot distinguish over this duration[9]. We therefore consider that, at the origin of T_i, there is not a single celestial body, but an astral source of anisotropy S_i, which is the set of astral actions of periods indistinguishable from T_i over 1 month. Each of these astral actions generates in the horizontal plane a linear anisotropy, and the vector sum of them is the linear anisotropy created by S_i.

- The objective is to estimate the average value over one month of the coefficient of anisotropy η_i resulting from S_i. Obviously, there is no reason that it results from S_i only a harmonic 1. 24 h and 24.84 h corresponding to harmonics 1, one must at least consider harmonics 2 (12 h and 12.42 h).
- The direction of the anisotropy associated with S_i is $\theta_{Ai}(t)$.
  S_i being of astral origin, it is considered that, every day, $\theta_{Ai}(t)$ makes a 360 deg turn, with a duration that remains close to T_i (and which is T_i on average over one month). The diurnal variation of $\theta_{Ai}(t)$ depends on the elevation of S_i (or on the elevations of the sources that compose it). It can be mathematically complex, but we will consider that it remains close to a linear function of time. The latitudes of Horodnic and Saint-Germain being very close to 45˚N, this condition is met if S_i remains close to the plane of the ecliptic. That covers the whole constituted by the Sun and its planetary system, with the exception perhaps of Pluto. This is quite consistent with the conclusions of [14] and [15], from which it appears that at least a large part of the unknown action results from the Moon, the Sun, and the planetary system, especially from Jupiter.

4.2. Horodnic

- The quantity chosen for analysis, because it was the most representative of the unknown action ([14], §3.3), was the average derivative of the ellipticity over the run j[10], $\overline{e'(t_j)}$.
  So was carried out the spectral analysis of the time series: $\overline{e'(t_j)}$ with $j = 1, \cdots, N$, and $N = 869$.
  We are interested here in the periodic component whose period is T_i (T_i: 24 h or 24.84 h), with its harmonics. This periodic component is the serie $\overline{e_i'(t_j)}$. We have:

$$\overline{e_i'(t_j)} = c_{1i} \cos 2\pi f_i (t_j - t_{0i}) + \cdots + c_{ni} \cos 2n\pi f_i (t_j - t_{0i}) + \cdots \quad (2)$$

[9]Thus a wave of 24 h 50 min might result from an influence of the Moon, but also from the rotation of the Sun on itself, or from both ([14] §4.1).

[10]We call "run" every continuous observation of the pendulum from its launch to its stop. In Horodnic, a run lasts about 50 min, and the pendulum is restarted every hour.

By expanding $\frac{1}{N}\sum_{j=1}^{N}\overline{e_i'(t_j)}^2$, we find a sum of terms independent of t and the average over 1 month of a sum of sinusoids whose periods at most equal to half a day, that is at least 60 periods. As we can neglect this average, we therefore have:

$$\frac{1}{N}\sum_{j=1}^{N}\overline{e_i'(t_j)}^2 \approx \frac{c_{1i}^2}{2}+\frac{c_{2i}^2}{2}+\cdots+\frac{c_{ni}^2}{2}+\cdots \tag{3}$$

- As we hypothesized that this periodic component resulted from an action that acted on the pendulum by a linear anisotropy, the unknown action acts directly on the derivative of the ellipticity ([15], Formula 7):

$$e_i'(t) = -\omega\eta(t)\sin\left(2\left(\theta(t)-\theta_A(t)\right)\right) \tag{4}$$

ω being the pulsation of the pendulum, and $\theta(t)$ the azimuth of the major axis of the ellipse described by the pendulum.

We have, for the run j:

$$\overline{e_i'(t_j)} = -\omega\overline{\eta_i(t)\sin\left(2\left(\theta(t)-\theta_{Ai}(t)\right)\right)} \tag{5}$$

Over the duration of a run (50 min), we can consider that $\eta_i(t)$ and $\theta_{Ai}(t)$, whose period is one day or close to one day, varies little, and confuse them with $\eta_i(t_j)$ and $\theta_{Ai}(t_j)$. Similarly, the precession of the pendulum with respect to its starting azimuth θ_L being small on a run, one can confuse $\theta(t)$ and θ_L. Hence:

$$\overline{e_i'(t_j)} \approx -\omega\eta_i(t_j)\sin 2\left(\theta_L-\theta_{Ai}(t_j)\right) \tag{6}$$

As we saw in §4.1 above, we can consider that, on a 360 degrees turn, $\theta_{Ai}(t_j)$ is a linear function of time. As θ_L is fixed, $\sin 2\left(\theta_L-\theta_{Ai}(t_j)\right)$ is a sinusoid the period of which is $T_i/2$ [11].

- As regards $\eta_i(t_j)$, we also take into account the harmonics:

$$\eta_i(t_j) = k_{0i} + k_{1i}\cos 2\pi f_i\left(t_j-t_{0i}\right) + k_{2i}\cos 4\pi f_i\left(t_j-t_{0i}\right)+\cdots \tag{7}$$

Hence, from Equations (6) and (7):

$$\frac{1}{N}\sum_{j=1}^{N}\overline{e_i'(t_j)}^2 = \frac{\omega^2}{2}\sum_{j=1}^{N}\left(\eta_i(t_j)^2 + B_j\right) \tag{8}$$

with

$$B_j = \eta_i(t_j)^2\cos 4\left(\theta_L-\theta_{Ai}(t_j)\right) \tag{9}$$

- Let us expand the 2nd member of Equation (8):

1) We find in the development of $\eta_i(t_j)^2$:

  - the squares of its constituents:

$$(a) = k_{0i}^2 + k_{1i}^2/2 + k_{2i}^2/2+\cdots \tag{10}$$

[11] That does not prohibits that there is a wave of period T_i in $\overline{e_i'(t_j)}$. For example, if S_i is a single celestial body, and if η_i is positive when the elevation of S_i is positive, and zero when it is negative, a wave T_i appears.

and:

$$(b)=\left(k_{1i}^2/2\right)\cos 4\pi f_i\left(t_j-t_{0i}\right)+\left(k_{2i}^2/2\right)\cos 8\pi f_i\left(t_j-t_{0i}\right)+\cdots \quad (11)$$

- the crossed terms :

$$(c)=2k_{0i}\left(k_{1i}\cos 2\pi f_i\left(t_j-t_{0i}\right)+k_{2i}\cos 4\pi f_i\left(t_j-t_{0i}\right)+\cdots\right) \quad (12)$$

and:

$$(d)=2k_{1i}k_{2i}\cos 2\pi f_i\left(t_j-t_{0i}\right)\cos 4\pi f_i\left(t_j-t_{0i}\right)+\cdots \quad (13)$$

Let us group (b) and (c):

$$\begin{aligned}(b)+(c)&=2k_{0i}k_{1i}\cos 2\pi f_i\left(t_j-t_{0i}\right)\\&\quad+\left(\left(k_{1i}^2/2\right)+2k_{0i}k_{2i}\right)\cos 4\pi f_i\left(t_j-t_{0i}\right)+\cdots\end{aligned} \quad (14)$$

The average of (b) + (c) is nil for $t_j=\infty$. Over 30 days the maximum of the absolute value of this average is:

$$\frac{1}{30}\left(2k_{0i}k_{1i}\right)+\frac{1}{60}\left(\left(k_{1i}^2/2\right)+2k_{0i}k_{2i}\right)+\cdots$$

The average of (d) is nil for $t_j=\infty$. Over 30 days the maximum of the absolute value of this average is:

$$\frac{2}{60}\left(k_{1i}k_{2i}\right)+\frac{2}{90}\left(k_{1i}k_{3i}\right)+\cdots$$

2) Ultimately the uncertainty on (b) + (c) + (d) remains sufficiently small in front of (a) that we can neglect it. Hence:

$$\frac{1}{N}\sum_{j=1}^{N}\eta_i\left(t_j\right)^2\approx(a)=k_{0i}^2+k_{1i}^2/2+k_{2i}^2/2+\cdots \quad (15)$$

3) Furthermore, as we saw above, $\cos 4\left(\theta_L-\theta_{Ai}\left(t_j\right)\right)\approx$ sinusoid whose frequency is $2f_i$.

From Equation (9), which provides the expression of B_j, it follows that only the product of this sinusoid by the sinusoid of the same frequency $2f_i$ in $\eta_i\left(t_j\right)^2$ may have a non-zero average.

From Equation (14), it results that the maximum value of this average, which corresponds to the case where the 2 sinusoids are in phase, is:

$$\frac{1}{2}\left(\left(k_{1i}^2/2\right)+k_{0i}k_{2i}\right)=k_{1i}^2/4+k_{0i}k_{2i}/2 \quad (16)$$

4) In the end, in Equation (8):

- B_j introduces an uncertainty given by (16).
- If we do not take into account this uncertainty, which cannot modify the order of magnitude of the result[12], it follows from Equation (8) and Equation (15) that:

[12]This results from Equation (17), and from the comparison between Equations (15) and (16).

$$\frac{1}{N}\sum_{j=1}^{N}\overline{e_i'\left(t_j\right)}^2=\frac{\omega^2}{2}\left(k_{0i}^2+k_{1i}^2/2+k_{2i}^2/2+\cdots\right)=\frac{\omega^2}{2}\overline{\eta^2} \quad (17)$$

where $\overline{\eta^2}$ is the square of the root mean square of $\eta_i\left(t_j\right)$ over the duration of the observation, as deduced from the expression of $\eta_i\left(t_j\right)$, which is given by Equation (7).

- From Equation (3) and Equation (17):

$$\sqrt{\overline{\eta_i^2}}=\frac{1}{\omega}\sqrt{c_{1i}^2+c_{2i}^2+\cdots+c_{ni}^2+\cdots} \quad (18)$$

4.3. Allais

- We recall that, in the case of the Allais pendulum, the starting azimuth was the final azimuth of the previous run, while, in the case of the Horodnic pendulums, it was always the same.
- The latitude of Saint-Germain (46.857˚N) was very close to that of Horodnic (48.899˚N).
- Allais made the hypothesis that the 24.84 h component resulted from the influence of the Moon, by the creation of an anisotropy of the space in which the pendulum oscillates, and whose direction was that of the Moon.

  During a run of duration Δt, the average precession speed is given ([1] or [2], p. 212, Table XIII) by Formula (3), where the 2nd member must in fact be divided by 2[13].

  Hence, on a given run:

$$\overline{\Phi_l'}=\frac{3}{64}p^2\overline{\alpha^2}\Delta t\varepsilon_l\overline{\sin 2\left(X_l-\Phi\right)} \quad (19)$$

  where:

  X_l = azimuth of the Moon.

  Φ = azimuth of the major axis of the ellipse described by the pendulum.

  $\overline{\Phi_l'}$ = average velocity of the precession attributable to the Moon.

  $p=\sqrt{g/l}$.

  α = angular major axis.

  ε_l = average value over the run of the coefficient of anisotropy (with Allais's definition) of the anisotropy resulting from the Moon. It takes into account the average influence, over the run, of the elevation of the Moon.

- The anisotropy model considered by Allais is in fact exactly a "linear anisotropy" (see §5), with:

  $\varepsilon=4\eta$.

  X_l = azimuth of the direction of anisotropy θ_A associated with the Moon.

  With notations of [14] or [15], where $\theta=\Phi$, $\omega=p$, $\alpha=\alpha$, $\beta=\beta$, $X_l=\theta_{Ai}$, Equation (19) becomes:

$$\overline{\theta_i'}=\frac{3}{16}\omega^2\overline{\alpha^2}\Delta t\eta_i\overline{\sin 2\left(\theta_{Ai}-\theta\right)} \quad (20)$$

[13]In Formulas (7) and (8) of Table XII, which are deduced from Formulas (1) and (2) of this Table XII, the second members are in fact, after verification, to be divided by 2.

Which can also be written:

$$\overline{\theta_i'} = K\eta_i \overline{\sin 2(\theta_{Ai} - \theta)} \quad (21)$$

with:

$$K = \frac{3}{16}\omega^2 \overline{\alpha^2} \Delta t \quad (22)$$

Over a run, $(\theta_L - \theta)$ remains small. Hence $\overline{\sin 2(\theta_{Ai} - \theta)} \approx \sin 2(\theta_{Ai} - \theta_L)$, where θ_L is the starting azimuth.

Hence, considering the run *j*:

$$\overline{\theta_i'(t_j)} \approx K\eta_i(t_j) \sin 2(\theta_{Ai} - \theta_L) \quad (23)$$

The influence of the astral source S_i on the precession of the pendulum is:

$$\overline{\theta_i(t_j)} = a_{1i} \cos 2\pi f_i (t_j - t_{0i}) + \cdots + a_{ni} \cos 2n\pi f_i (t_j - t_{0i}) + \cdots \quad (24)$$

Hence:

$$\overline{\theta_i'(t_j)} = b_{1i} \cos 2\pi f_i (t_j - t_{0i}) + \cdots + b_{ni} \cos 2n\pi f_i (t_j - t_{0i}) + \cdots \quad (25)$$

With $b_{ni} = 2n\pi \frac{a_{ni}}{T_i}$

- Equation (6) and Equation (23) have the same form, the first one concerning $\overline{e_i'(t_j)}$, and the second one $\overline{\theta_i'(t_j)}$.
  To calculate the root mean square of $\eta_i(t)$, we therefore use the approach[14] which led to Equation (8), then ultimately to Equation (17).
  In Equation (18), we replace c_{ni} with b_{ni}, and ω with *K*. Hence:

$$\sqrt{\overline{\eta_i^2}} = \frac{2\pi}{KT_i}\sqrt{a_{1i}^2 + 4a_{2i}^2 + \cdots + n^2 a_{ni}^2 + \cdots} \quad (26)$$

4.4. Numerical Values

The calculation was carried out by considering, in Equations (18) and (26), only the amplitudes of harmonics 1 and 2 (the amplitudes of harmonics 3 are significantly smaller).

See Tables 1-3.

Table 1. Horodnic: $\sqrt{\overline{\eta_i^2}}$ for the 24 h and 24.84 h components for each pendulum.

pendulum	pendulum A	pendulum B	average
24.84 h	1.22×10^{-7}	2.21×10^{-7}	1.71×10^{-7}
24 h	2.70×10^{-7}	2.35×10^{-7}	2.53×10^{-7}

[14]The only difference is that, this time, the starting azimuth θ_L varies continuously, this variation being significant over the month of observation (several tens of degrees). With the consequence that, the term $\cos(4\pi f_i(t_j - t_{0i}))\cos(4(\theta_L - \theta_{Ai}(t_j)))$ no longer being the product of a sinusoid by a function of the same period, its average this time is zero.

Table 2. Allais: $\sqrt{\overline{\eta_i^2}}$ for the 24 h and 24.84 h components for each observation.

observation	1954/1	1954/2	1955	1958 (Bo + SG)	1959	1960
24.84 h	1.63×10^{-7}	4.29×10^{-7}	3.05×10^{-7}	9.14×10^{-8}	1.77×10^{-8}	5.81×10^{-8}
24 h	2.62×10^{-7}	4.27×10^{-7}	4.39×10^{-7}	1.22×10^{-7}	1.16×10^{-7}	9.29×10^{-8}

Table 3. Average $\sqrt{\overline{\eta_i^2}}$ for the 24 h and 24.84 h components.

	Horodnic	Allais
24.84 h	1.71×10^{-7}	2.04×10^{-7}
24 h	2.53×10^{-7}	2.43×10^{-7}

The Horodnic average concerns the 2 pendulums of the same observation, while the Allais' average concerns different observations.

4.5. Analysis and Comments

- As shown in Table 1 and Table 2, the Horodnic values are in the range of the Allais' values, which is entirely consistent with that they indeed resulted from the action of the same underlying astral phenomenon on 2 observation sites whose latitudes are very close. This is all the more significant since:
    - The launch procedures not being the same, this underlying phenomenon has not been observed from the same point of view. As we have just seen, therefore the calculations are quite different.
    - In the case of the Horodnic pendulums, we started from the derivative of the ellipticity, in that of the Allais' pendulum from the precession.
    - The pendulums themselves were noticeably different.
- The average of the found coefficients of anisotropy is about 2×10^{-7}. Each of these two anisotropies is only a part of the external anisotropy that acts on the pendulum. In view of the data collected in Horodnic, the average total anisotropy is some 10^{-6}. The pendulums being weakly anisotropic (order of magnitude 10^{-6}), some 10^{-6} is also the average order of magnitude of the external anisotropy.

5. Do the Regularities Discovered by Allais Result from a New Force Field, or, According to Allais' Hypothesis, from an Anisotropy of the Medium in Which the Pendulum Oscillates?

- We saw that they act on the precession of the pendulum, at least mainly, through a linear anisotropy.
  This notion was defined in [15], §A.2. Formula (5), which gives the restoring coefficient of the pendulum to its rest position, can also be written:

$$\omega^2 = \omega_0^2 \left(1 + 2\eta \cos 2\left(\theta - \theta_A\right)\right) \quad (27)$$

where ω is the pulsation of the pendulum, or, by taking into account that $\eta \ll 1$:

$$\omega^2\left(1-2\eta\cos 2\left(\theta-\theta_A\right)\right)=\omega_0^2 \tag{28}$$

If, in the horizontal plane, we take as axis Ox the direction of anisotropy (then $\theta_A=0$), the equations of the pendulum movement are:

$$\left(1+2\eta\right)x''+\omega_0^2 x=0 \tag{29}$$

$$y''+\omega_0^2 y=0 \tag{30}$$

These equations are exactly, with different notations, and $\varepsilon=4\eta$, the Allais' equations (see [1] or [2], p. 211, §I.F.3, Table XII).

- A force field acts on the movement of the pendulum by the difference between its action on the point of suspension and on the pendulum itself. If the source of this field is sufficiently distant[15], the lines of force remain parallel in the space swept by the pendulum, and we then easily find that it results in a linear anisotropy, and that the coefficient of anisotropy is proportional to the length of the pendulum[16].
- If the coefficient of anisotropy is independent of the length of the pendulum, the unknown action cannot be explained by a force field. All that remains then as an explanation is an anisotropy of the space swept by the pendulum.

  If we consider not the accelerations, but the forces, Equation (29) becomes (m being the mass of the pendulum):

$$m\left(1+2\eta\right)x''+m\omega_0^2 x=0 \tag{31}$$

  As everything happens as if the inertia mass varied with the direction of the plane of oscillation, Maurice Allais made the hypothesis that there was an anisotropy of the inertia space ([1] or [2], §I.F).
- The comparison of the results of Allais and Horodnic does not allow to decide.

  The Horodnic pendulums (length 6.40 m) were 7.7 times longer than the Allais pendulums (0.83 m), but, on the 6 Allais' observations (**Table 1**), the largest value of the coefficient of anisotropy is 7.4 time larger than the smallest one.

6. Analyzes of the Phenomena Highlighted in the Precession of a Pendulum on the Occasion of Eclipses or, More Generally, of Syzygies

6.1. Eclipses

We limited ourselves to cases where, on the one hand, an eclipse effect had been observed and where, on the other hand, the ovalization had been measured.

[15]If this is not the case, there is still an anisotropy of the pendulum's restoring force, but the calculation is more complicated, and it may no longer be exactly a linear anisotropy.

[16]See for example, in [15] §4.1.2, the formula giving the coefficient of anisotropy resulting from the attraction of an attractive body linked to the Earth (Formula 2).

There are in fact very few eclipses for which these conditions have been met[17].

6.1.1. Observations Conducted under the Direction of Professor Mihaïlia

3 observations were published: those of the solar eclipses of 11 August 1999 [18], 31 May 2003 [19], and 3 October 2005 [20].

- The first one used 2 long pendulums (14.21 m), started initially in perpendicular directions, then restarted regularly every hour from the final azimuth of the previous run. The azimuth of the oscillation plane was measured every 10 minutes. It appeared, approximately during the duration of the eclipse, a very clear deviation ΔA, compared to the evolution that there would have been in the absence of disruptive action.

  As shown in **Figure 1**, ΔA was almost identical for the two pendulums, which suggested that the disruptive action was circularly symmetrical.

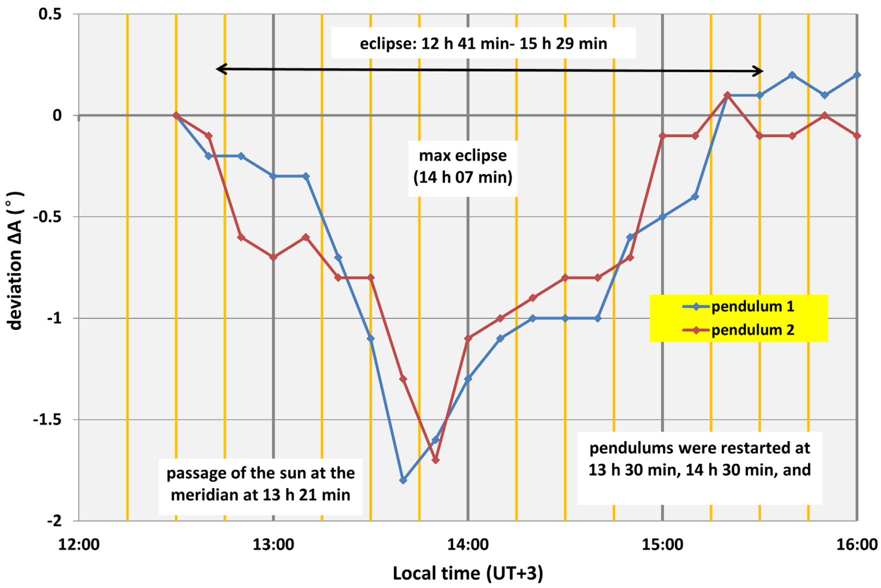

Figure 1. Solar eclipse of 08/11/1999—Deviation of the plane of oscillation of the pendulums.

- In fact, as explained below, this almost certainly resulted from a linear anisotropy, which is a directional action. But, this time, it is the direct precession which is predominant, and not the Airy's precession.

  In [15], the speed of the direct precession resulting from a "linear anisotropy" is given by Formula (6) of the appendix A:

$$\theta'_d = 2\eta\omega e \cos 2(\theta - \theta_A), \tag{32}$$

  where θ_A and η are the direction and the coefficient of the total anisotropy

[17]A number of experimenters have endeavoured to research this eclipse effect, using pendulums and other devices: see for example [17]. It emerged from a number of observations, and in particular from observations carried out with several devices, that marked anomalies did occur during certain eclipses. But number of observations did not notice significant anomalies.

(intrinsic anisotropy + external anisotropy) of the pendulum. The derivative e' of the ellipticity resulting from this anisotropy is given by Formula (7) of this Appendix A:

$$e' = -\eta\omega\sin 2(\theta - \theta_A). \tag{33}$$

If we replace θ by $\theta + \pi/2$, $\cos 2(\theta - \theta_A)$ and $\sin 2(\theta - \theta_A)$ both change sign. In the end, in Equation (32), the value of θ'_d does not change.

Analysis of the third observation [20], which used exactly the same pendulum, and for which the measurement of the minor axis was published, confirms that it is almost certainly what happens:

Indeed Figure 2 shows:

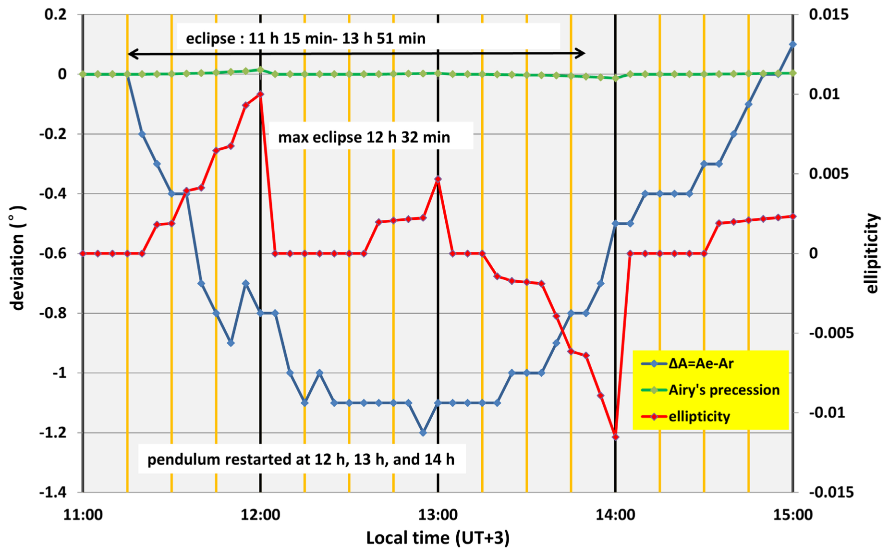

Figure 2. Solar eclipse of 03/10/2005—Precession and ellipticity of the Foucault pendulum.

- That the ovalization, which appears exactly at the beginning of the eclipse, can only result from an external cause.
- That the resulting Airy precession is very small, due to the importance of the length of the pendulum and the smallness of the amplitude of the oscillations. We remember (cf [15], Formula 3) that Airy' precession is given by formula:

$$\theta' = \frac{3}{8}\frac{ab}{l^2}\sqrt{\frac{g}{l}} \tag{34}$$

where θ is the azimuth (defined modulo 180˚) of the major axis of the ellipse described by the pendulum, g the acceleration of gravity, l the length of the equivalent simple pendulum, and a and b the half major axis and half minor axis of the ellipse. Here l = 14.21 m, and, in average over a run of 1 hour, a = 28 cm.

In formulas above, azimuths are counted positively counter-clockwise from the North. In Pr Mihaïlia's observations, they are counted positively clockwise from the South. We therefore have $\theta' = -\Delta A'$.

The pendulum was restarted every hour, which reset the ellipticity e to zero, and therefore, according to Equation (32), θ'_d. We see that this is indeed what happens for $\Delta A'$ at 12 h, 13 h and 14 h. We also note that, in general, ΔA varies in the opposite direction to e.

- Moreover, it is possible to have some estimations of the coefficient and of the direction of anisotropy.

  From the analysis of the curves in **Figure 2**, between 11 h 20 min and 12 h (in local time: UTC-3), we can deduce an estimate of average value of η. Over this interval:

$$\text{average value of } e = 4.9 \times 10^{-3}$$

$$\text{average value of } e' = 4.2 \times 10^{-6}$$

$$\text{average value of } \Delta A' = -4.4 \times 10^{-6} \text{ rad/s}$$

  Hence, as $\theta'_d \approx -\Delta A'$, and from Equations (32) and (33):

$$\eta \cos 2(\theta - \theta_A) = 5.33 \times 10^{-4}$$

$$\eta \sin 2(\theta - \theta_A) = 5.01 \times 10^{-6}$$

  Hence estimations of the average values, between 11 h 20 min and 12 h in local time, *i.e.* at the average local time 11 h 40 min, of the coefficient and the direction of anisotropy :

$$\eta = 5.33 \times 10^{-4}$$

  $\theta_A = \theta - 0.5\,\text{deg} = 13.6 - 0.5 = 13.1\,\text{deg}$, as the average value of θ is 13.6 deg[18] (counted positively from the North).

- Remarks:

  1) The value of the coefficient of anisotropy is really very important (at least one hundred times greater than the total external anisotropy which can be usually observed on Horodnic pendulums).

  2) The value found for the direction of anisotropy is entirely compatible with the hypothesis of an action in the direction of the eclipse.

  3) It is also a similar phenomenon which very probably occurred during the eclipse of 31 May 2003 [19].

  In this case the period (which is the period in the direction of the major axis) had been measured, the report having concluded ([19], p. 6), to a relative variation of the period during the eclipse of 2.6 × 10^{-5}. According to [15] (Formula 4), this can be explained by a linear anisotropy whose coefficient $\eta \geq 2.6 \times 10^{-5}$.

  4) Whether the precession created by linear anisotropy is mainly direct precession, as in the case of Professor Mihaïlia's observations, or mainly indirect precession, in all cases there must be ovalization. As we saw in §2, this di-

[18]Refer to the data provided by [20].

rectly eliminates a certain number of explanations.

6.1.2. Observations in Horodnic

Two eclipses observed with a pendulum equipped with an automatic alidade are concerned: the total lunar eclipse of 26/07/2018, where an eclipse effect seems very probable, and the solar eclipse of 1/09/2016. These observations had never been published.

- Lunar eclipse of 26/07/2018

The pendulum was one of the two pendulums used during the 2019 observations (see [14], in this case the pendulum B). This one was already equipped with the ball suspension used in 2019, which is weakly anisotropic. The pendulum (equivalent length 6.38 m) was started from azimuth 65˚, with an amplitude of 450 mm, and stopped after 50 min. The observations, which were not always regularly spaced, were spread from 27/07/2018 3 a.m. to 29/07/2018 2:02 p.m. As in 2019, the quantity studied was the average value over the run of the derivative of the ellipticity $\mathrm{d}e/\mathrm{d}t = e'$ (cf [14] §3).

Figure 3 shows a very clear concomittance between the eclipse and the peak of e'.

Temperature and humidity had been measured: **Figure 4** shows that nothing particular happened at that time.

Note further that, the anomaly highlighted in **Figure 3** relating to the derivative of ellipticity, the disturbing action can only be a variation of the ovalization, which directly eliminates a certain number of explanations (§2).

At each run, an estimate of the coefficient of anisotropy η was made, using the method b described in [14], appendix B4, which gives a very noisy result when η is low (several 10^{-6}, to fix ideas). **Figure 5** shows that there were 2 very significant peaks, one of 1.2×10^{-5} just before the eclipse, and the other (0.95×10^{-5}) inside the eclipse.

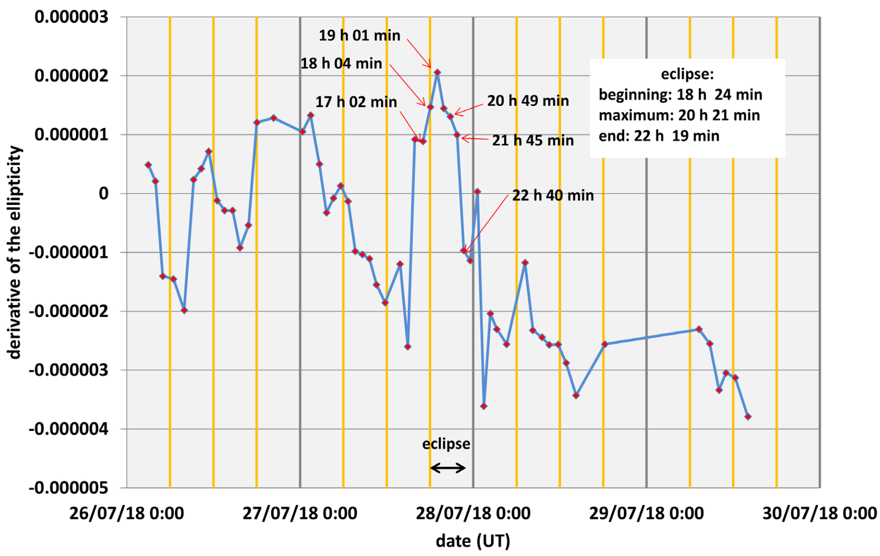

Figure 3. Lunar eclipse of 28/07/2018—Derivative of the ellipticity.

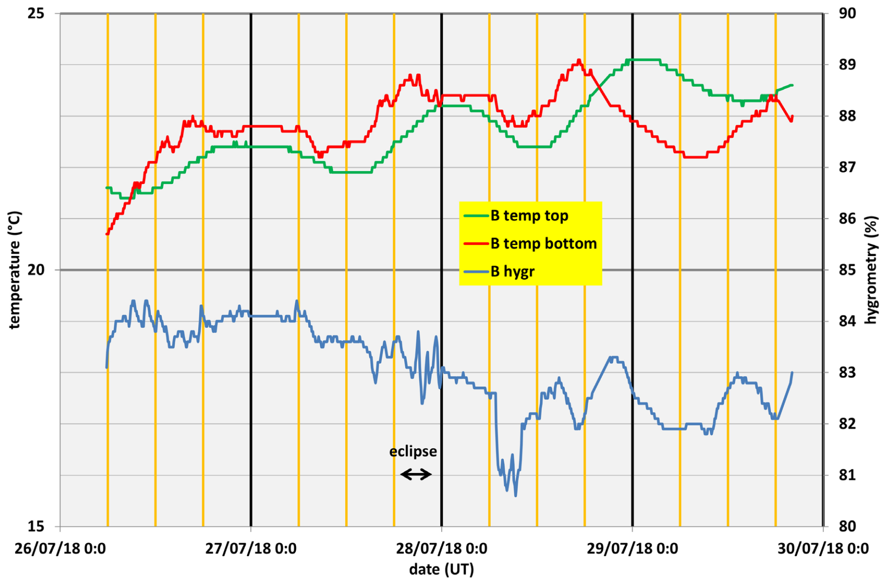

Figure 4. Lunar eclipse of 28/07/2018—Temperature and hygrometry.

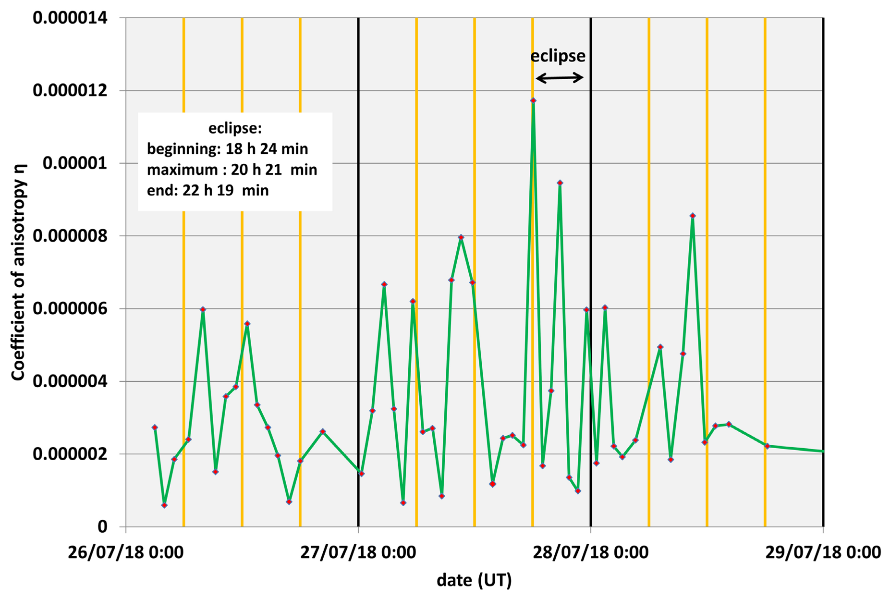

Figure 5. Lunar eclipse of 28/07/2018—Coefficient of anisotropy.

- Solar eclipse of the 01/09/2016

This time, the pendulum was equipped with a chuck suspension (to prevent the 1 mm wire from breaking, the latter was connected to the chuck by an 8 mm diameter intermediate rod). This suspension being strongly anisotropic, the intrinsic anisotropy of the pendulum was this time the main component of its total anisotropy. Figure 6 presents both e' and η.

On each of the 3 days of the observation, a diurnal action clearly appears, a little after 12 p.m. This is most likely the lunisolar action highlighted by Allais, and found again in Horodnic in 2019. The anomaly concerned, which coincides quite well with the eclipse itself, is clearly before 12 p.m.

There was no temperature recording at that time (the device was not yet installed).

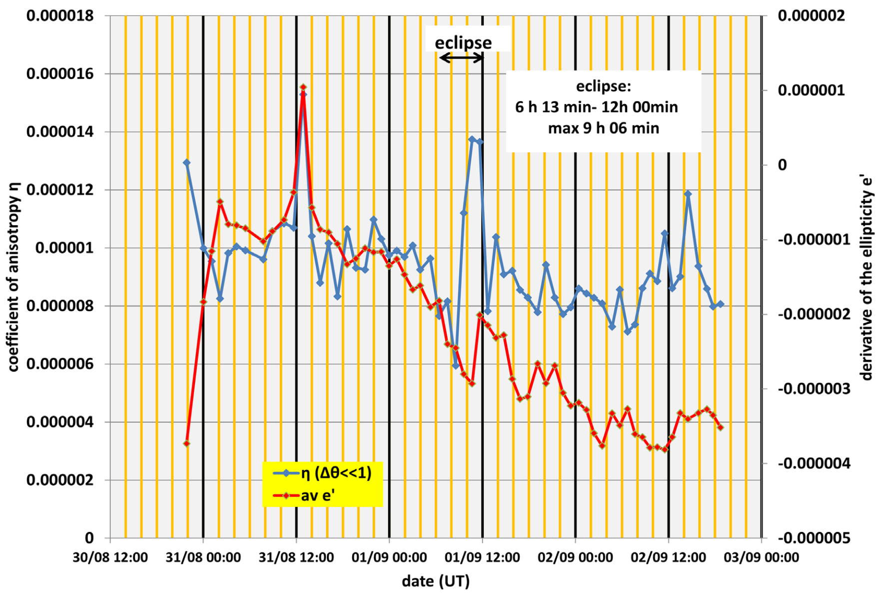

Figure 6. Solar eclipse of 01/09/2016.

6.1.3. Commentaries

- In the case of Horodnic, it is legitimate to think that what was observed resulted from the unknown same phenomenon as that which resulted in the regularities discovered by Allais, and found again in 2019 in Horodnic. In 2019 the insensitivity of the derivative of the ellipticity to classical environmental factors was verified [14]. Only a possible action of seisms remains, whose influence cannot be found in spectral analyses carried out over periods of 1 month, but which can obviously, on a given run, significantly modify the movement of the pendulum.
  It should also be noted that, for the two eclipses concerned, the observed coefficients of anisotropy (about 10^{-5}) were important, but not exceptional.
- Regarding the observations in Bucharest, these coefficients (about 5×10^{-4}) were around a hundred times higher than what had been observed in Horodnic. This cannot be explained by the length of the pendulums: they were only 2.5 times longer than in Horodnic. We are assuredly facing a quite exceptional phenomenon. In the hypothesis that they would in fact result from classical disturbances, the only real candidate seems to be an action of variations in the Earth electric field induced by the eclipse, which can, if the bob has been electrilized, create this kind of anisotropy. This seems quite unlikely: there are plenty of equipotentials in a building. But, due to lack of information, we cannot exclude it.

6.2. Syzygies

- A very possible effect of the conjunction Sun Jupiter of May 8, 2000 on the precession of a pendulum:

The observations concerned 50 days, scattered from April, 2000 till June, 2000: cf [21], §7, p. 670, and Fig XVa, p. 686 (Figure 7 is a copy of Fig XVa).

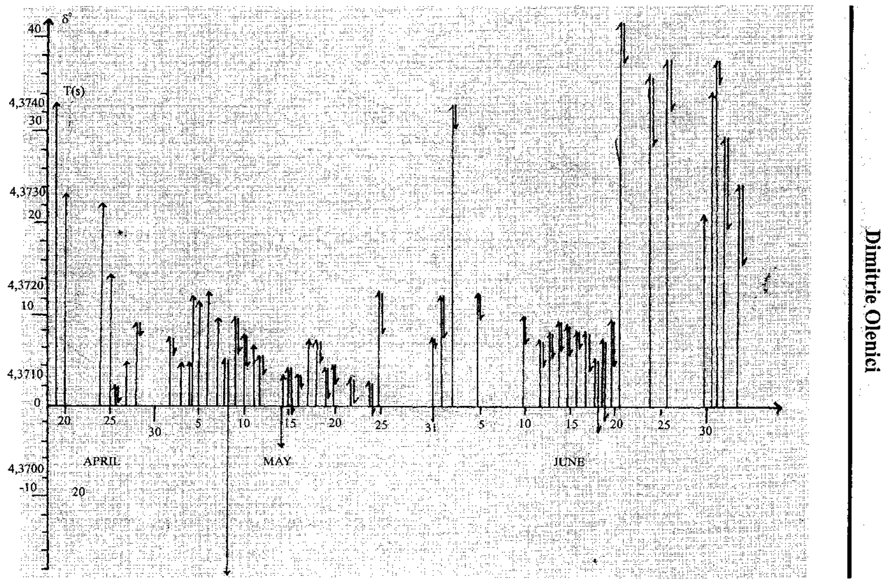

Figure 7. Conjunction Sun-Jupiter of May 8, 2000.

The pendulum (about 14.75 m long) was installed in Stefan cel Mare High School in Suceava (Romania). It was always started from the same azimuth.

In Figure 7, the tip of the arrow pointed upwards shows the value of the higher angular deviation of the plane of oscillation (usually, this was reached after about 20 minutes). The arrow pointing downwards shows the position of the oscillation plane when the pendulum is stopped, one hour after it was set in motion. May 8th was the day of a conjunction Sun-Jupiter. Obviously something very unusual occurred this day. There was only 1 chance among 50 that it occurs so.

It appears from Formula (11) of [15] that the precession resulting from the total linear anisotopy of the pendulum (intrinsic anisotropy + anisotropy of external origin) increases quadratically from the beginning of the run. When exercised in the opposite direction of the Foucault effect, after a certain time it reverses the direction of precession. This is exactly what is observed with each run. Very probably, on May 8, 2000, external anisotropy was exceptionally important.

- The famous solar eclipse of June 30th, 1954 practically coincided with an alignment Earth-Sun-Jupiter.

  Indeed, the maximum of this alignment took place approximately 6 hours after that of the eclipse. Let us recall that it was on the occasion of this eclipse, during which particularly marked deviations of his pendulum were observed (see Figure 8) that Allais discovered the "eclipse effect", with which his name was subsequently associated.

It cannot be said that there was then actually an influence of Jupiter, but the coincidence is so noticeable that it deserves to be reported.

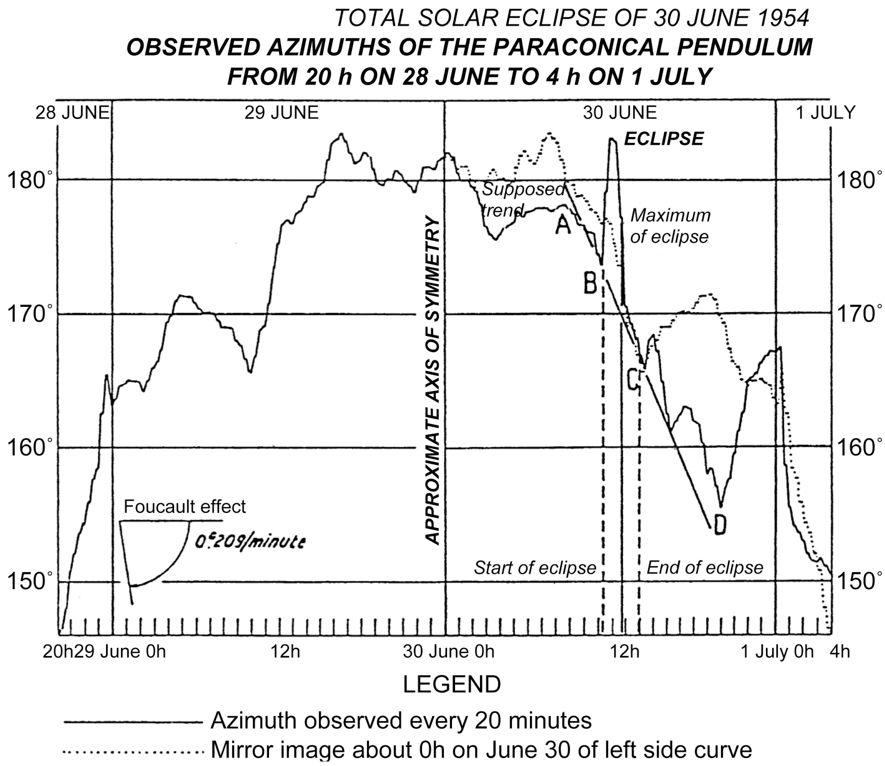

Figure 8. Solar eclipse of 30/06/1954 (GRAPH XXIX of [2], p. 165).

7. Optical Observations of Allais in 1958

- Simultaneously with the observations carried out, from 02/07/1958 to 31/07/1958, using two identical pendulums located one in Saint-Germain and the other, about 6.5 km away, in an underground quarry, where it was protected from most conventional perturbating actions (and in particular from variations in temperature, in hygrometry, and in Earth's electric field), Allais organized optical observations. The device had been installed in the basement of the Saint-Germain building. These observations were published in [1] and [2] (Chap. III.B, pp. 334-345). Two pedestals were installed in the basement below the laboratory in St-Germain. A fixed mark and a telescope with an azimuthal circle were installed on each of these pedestals, about three meters below ground level. The mark sighted at was a vertical line. A positive variation of the reading corresponded to a displacement of the image of the mark towards the right of the observer. The front of each telescope was spaced from its corresponding mark by about 8.30 m. The directions of the sightings were substantially North-South and South-North. Ten readings were performed with a micrometer every twenty minutes.

  Due to certain faults in the mounting of the telescopes which were not remedied until 15 July 1958, only the observations of the second half of July can be considered as worthy of consideration. The spectral analysis therefore only covered the 2nd half of July.

- For calculation convenience (there were no computers in 1958), Allais considered 25 h, and not 24 h 50 min. The results obtained are given in Figure 9 and Figure 10. In these figures, R is the amplitude of the concerned wave.

  There is very little difference between the results for the raw readings and those for the readings that were corrected as much as possible for the personal equations of the observers. It is seen that the variations are in the same sense for both of the telescopes, and that the amplitudes of the waves of 24 h and 25 h are of the same order of magnitude.

  The waves of 12 h and 12 h 30 min were completely separated over a period of fourteen days, but the waves of 24 h and 25 h could not be. However, calculation shows that a sinusoid of 24 h analyzed with a Buys-Ballot filter of 25 h over a period of 14 days suffers an amplitude reduction of 47%. As a result, the cycles of 25 h obtained over the fortnight in question cannot be considered as a non-eliminated residue of the wave of 24 h.

TABLE I

TELESCOPES

RESULTS OF BUYS-BALLOT FILTER

FITTING SINUSOIDS

JULY 1958 – SECOND HALF (3+4)

RAW READINGS

	24^H		12^H		25^H	
	2R	Θ	2R	Θ	2R	$\Theta.\Theta_{12L}$
North Telescope	1.174	10^H58	0.348	7^H53	1.106	-8^H49
South Telescope	1.364	9^H17	0.250	9^H02	1.172	-7^H25

CORRECTED READINGS

	24^H		12^H		25^H	
	2R	Θ	2R	Θ	2R	$\Theta.\Theta_{12L}$
North Telescope	1.234	10^H17	0.348	7^H35	1.340	-8^H57
South Telescope	1.198	9^H55	0.356	7^H38	1.050	-7^H37

2R is expressed in centesimal seconds

Θ = UT time of the summit

Θ_{12L} = time of lunar meridian passage on an average day

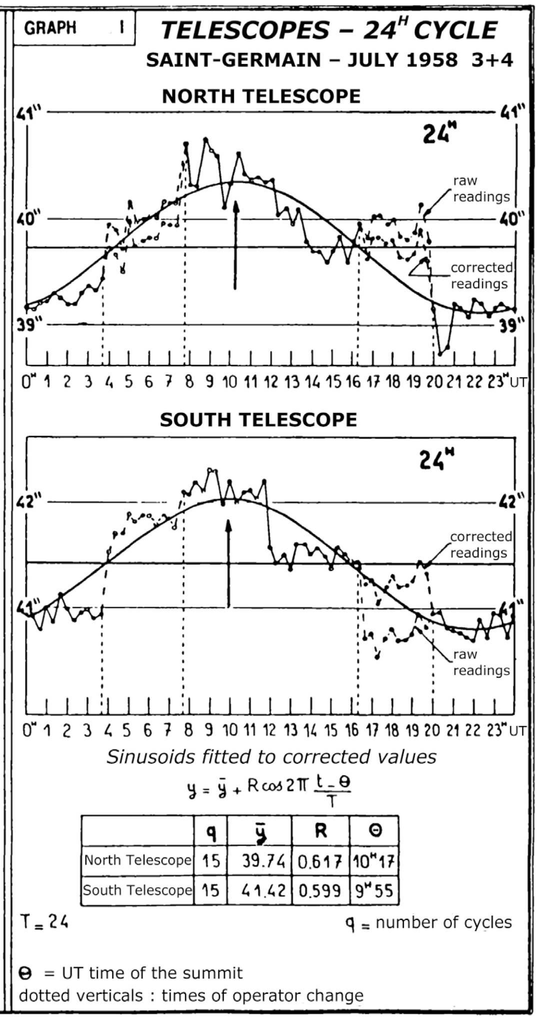

Figure 9. Results of the spectral analysis.

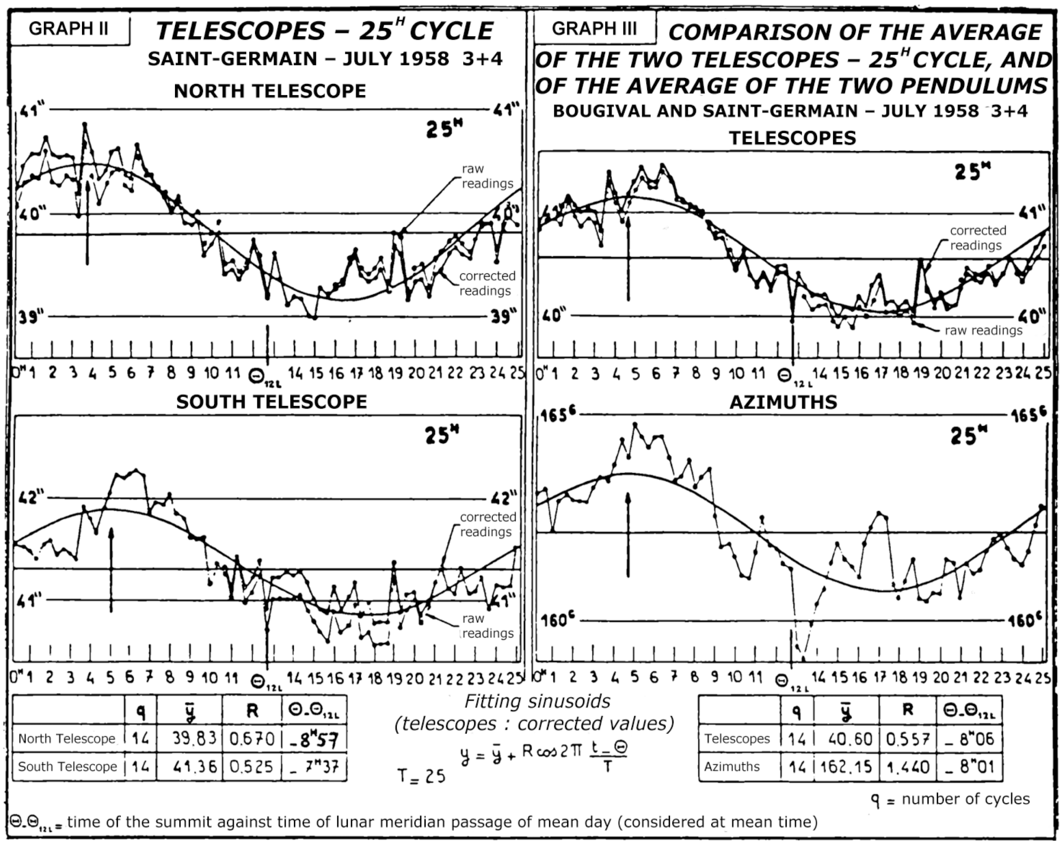

Figure 10. 25 h wave graphs.

It is remarkable that the 24 h and 25 h waves have similar amplitudes, which excludes the possibility that they could, for the most part, result from known geophysical factors: for the latter, indeed, apart for gravitation (but here we do not see how it could have intervened), the amplitude of the 24 h wave is always much greater than that of the 25 h wave.

There is also an extremely remarkable situation: if the cycles of 25 h for the half-sum of the azimuths of the two pendulums installed at Bougival and at Saint-Germain and for the half-sum of the readings of the two telescopes are considered for the second fifteen days of July 1958, these cycles are substantially in phase. The agreement of the phases is accurate to five minutes (Figure 10, bottom right). When we compare the 2 curves in more detail, we see that there are also a lot of surprising similarities (see at $\theta = 5$ h, 13 h, 17 h, 19 h, 23 h, 24 h)[19].

- The observed effects can only be attributed to modifications of the space between the telescopes and the marks, in other words to anisotropy of optical space. For the 25 h wave, the average of the amplitudes R of the two telescopes is 1.195 centesimal seconds, that is 3.48×10^{-6} rad.

[19]Around 13 h (lunar time), there is a very marked negative peak for both the average azimuths and the average deviations. As regards the pendulums, it is marked for the two pendulums, and especially for the Bougival pendulum, which was at the bottom of a chalk quarry ([1] and [2], p. 252, graphs XXII and XXIII).

8. Interferometric Observations of D. Miller in Mount Wilson in 1925-1926 [22]

- Following Michelson and Morley in 1887, numerous interferometric observations had been carried out (all of very limited duration: at most a few hundred interferometer revolutions, in 2 or 3 series of consecutive revolutions). They had almost systematically revealed variations in the speed of light of 3 to 10 km/s. However, such values did not correspond to anything known: we expected to find speeds equal to the speed of movement of the solar system relative to the fixed stars (several hundred km/s). This, combined with the fact that the azimuth of the maximum speed varied inexplicably from one experiment to another, led the experimenters to conclude that the result was "null".

  For his part Miller, as Morley's assistant, had always had doubts about the reality of this invariance of the speed of light and, with the 14 - 18 war over, and himself having become President of the American Physical Society, he decided, in order to be sure, to take up Michelson's experiments on new bases: the experimental campaign should this time include several periods spread over the whole year, each period to be spread over about ten days, with measures evenly distributed over the hours of the day.

  He was thus led, from 1921 to 1926, to carry out work of an exceptional magnitude, which is described in detail in his report [22]. This led to the measurement campaign itself, conducted at Mt Wilson from April 1925 to February 1926, and which included 6000 rounds of interferometer, spread over 4 periods centered on April 1, 1925, August 1, 1925, September 15, 1925 and February 8, 1926.

  It then appeared that, analyzed over a long period of time, what had until now been considered as "noise" in fact included a significant periodic diurnal component with an average value of 8.41 km/s, and that moreover this periodicity was sidereal diurnal, not solar diurnal. Furthermore, this sidereal diurnal periodicity was found both on the module of the maximum of the speed variation over a revolution, and on the azimuth of this maximum.
- Miller's results were re-examined by Allais:

  1) For each campaign, he traced the speed hodograph: **Figure 11** and **Figure 12**, extracted from ([1] or [2]; chap. IV)[20] An action coming from a fixed direction of space cannot explain what was observed: in this case, as Allais pointed it out, the hodograph would always have been symmetrical with respect to the N/S direction. There are therefore certainly actions internal to the solar system. However, we have far too little data to highlight the origin of these actions by spectral analysis.

  2) He found ([1] or [2]; §V.D.4) that, according to the parameter considered, Miller's observations are characterized by either a dominant semi-annual pe-

[20]This also gave rise to a certain number of publications in the "*Comptes Rendus de l'Académie des Sciences*" [23]-[26].

riodicity, or by a dominant annual periodicity. When the dominant periodicity is annual, it is remarkable that, as with the azimuths of Allais, the maxima are found at the solstices, and not at the equinoxes.

- Miller's observations have never been conclusively challenged. R.S Shankland [27] had attributed Miller's results to temperature influences, but this explanation absolutely cannot be accepted, due to the simple fact that the diurnal period found was sidereal (23 h 56 min), and not solar (24 h)[21]. Contrary to what is often written, these observations have never been made again ([28], §4.2).

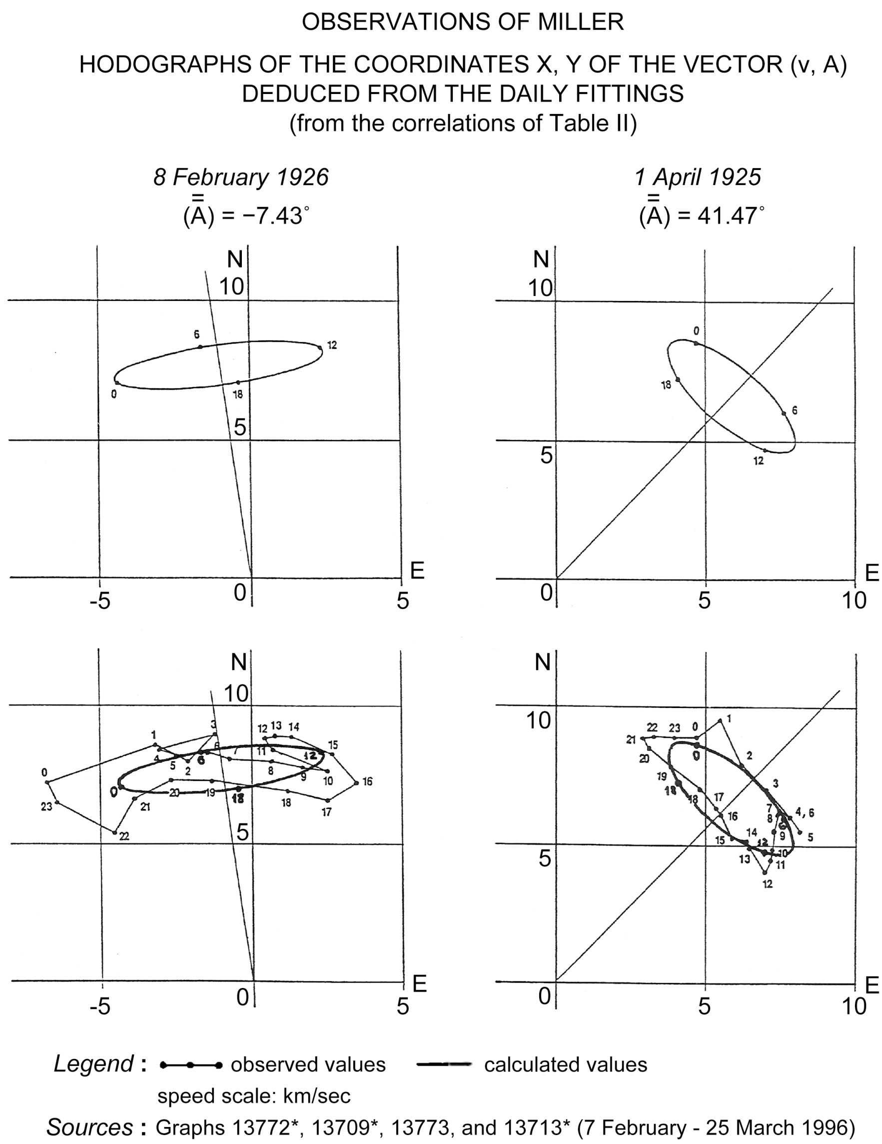

Figure 11. Hodographs April 1925 and February 1926.

[21]Moreover, nowhere is it indicated in Shankland's article that the diurnal periodicity was sidereal diurnal, and not solar diurnal…

Generally speaking, a careful analysis of this article shows that it was totally biased.

Published in a leading journal, it played an essential role in burying Miller's observations. Until his death, in 1941, Miller had refuted all challenges to his results. But, in 1955, he was no longer there to defend them.

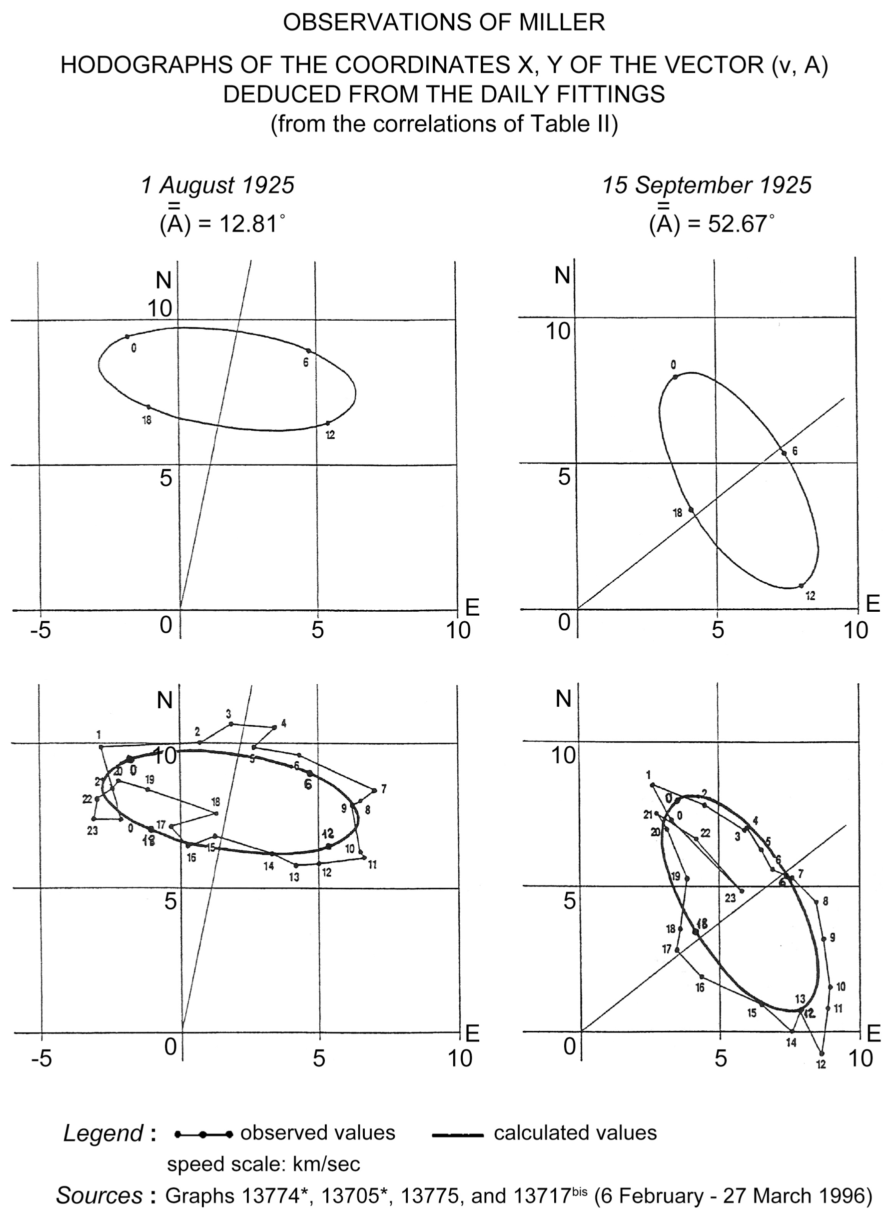

Figure 12. Hodographs August 1925 and September 1925.

9. Optical Observations of E. Esclangon in Strasbourg (1927-1928)

- The optical observation campaign carried out in the Strasbourg Observatory from February 25, 1927 to January 9, 1928 is presented in [29] and [30]. [30] gives a detailed description of the device used and provides all the experimental data, in a form very close to the raw data. The procedure is as follows:
  - An astronomical telescope placed in a horizontal plane being in the North-West position, we make coincide by autocolimation a horizontal wire located at the focus of the telescope and its image reflected on a mirror attached to the telescope. The angular displacement necessary to obtain this coincidence is c.

- The device is this time oriented North-East, we repeat this operation; the angular displacement necessary to obtain this coincidence is c'.
- The quantity whose evolution is studied is (c-c').

- As Miller, E. Esclangon highlighted a very marked sidereal diurnal influence. From the data provided in [30], Allais determined its amplitude and phase ([1] or [2]; §IV.B.2). He also highlighted an influence of the Earth's revolution around the Sun, which he estimated semi-annual. A more in-depth analysis by the author of Esclangon's data showed that it was in fact an annual influence, with a maximum on September 18, 1926, practically at the autumn equinox. Given the irregularity of the measurements, it was impossible to go further in the spectral analysis and, in particular, to know whether or not there was a lunar influence.
- These observations were never repeated.
  They were absolutely not refuted by the observations spread over 18-month made by Esclangon in 1932-1933 in the Paris Observatory [31]. His conclusion was that, at least to the precision of the measurements, there was only noise, both in sidereal time and in solar time. However, the device used was significantly different from that of Strasbourg. Moreover, the statistical analysis of the published data, which are limited to few summary data, shows that it could not have been noise. Indeed, the values in civil time having been calculated from averages made from 3 times more data than the values in sidereal time, their standard deviation should have been $\sqrt{3}=1.7$ times smaller. In fact, the standard deviation is 7.16 in sidereal time, and 6.36 in civil time.

10. Conclusions

- **With regard to the actions at the origin of the regularities of astral origin apparently inexplicable by classical factors discovered by Allais, it appears from Allais' works, supplemented by the results of Horodnic, that:**
  - They create an ovalization (which implies that they are directional).
  - It happens as if, at least mainly, they acted by creating, in the horizontal plane, a force which calls back the pendulum towards its rest position, and which varies with the azimuth of the plane of oscillation in the simplest way: by a sinusoid the period of which is 180 deg (that means that we can limit ourselves to considering only harmonic 1). This kind of perturbation on the precession of a pendulum, which has been called "linear anisotropy", has been studied in detail ([14] and [15]). A linear anisotropy is defined by its "coefficient of anisotropy" $\eta(t)$ (which is $\ll 1$) and by the azimuth $\theta_A(t)$ of its "direction of anisotropy". Hence an "anisotropy vector", the modulous of which is $\eta(t)$, and the argument $2\theta_A(t)$. The composition of 2 linear anisotropies is always a linear anisotropy, whose the anisotropy vector is the sum of the anisotropy vectors of its components.
- **This therefore eliminates directly, as causes of theses unknown actions,**

the disturbances which do not create ovalization.

As we saw in §2, this eliminates the numerous disturbances which essentially result in a tilt: the main consequence of a tilt is a modification of the Coriolis force, which modifies the speed of Foucault's precession, but does not create ovalization. The Laplace force having exactly the same mathematical expression as the Coriolis force, this also eliminates any action of the Earth's magnetic field on an electrically charged bob.

We also saw, in §3, that we can eliminate an action of the variations of the Earth magnetic field on the eddy currents induced in the bob by its movement (the variations in the direction of the Earth magnetic field are much too small to explain the deviations of the oscillation plane observed in Allais's experiments).

In [14] and [15], the classic disruptive factors falling under the previous categories have already been eliminated as possible causes of what had been observed. But it was based on much less simple and general considerations.

- **We have estimated, for both the astral sources of anisotropy which are at the origin of the 24 h wave and the 24.84 h wave, the root mean square of the corresponding η.**
    - We made this estimation for each of the 6 Allais' observations, and for each of the 2 pendulums of the observation in Horodnic.
    Thus, for the 24.84 h wave, the Horodnic average is 1.71×10^{-7}, and the Allais values are between 1.77×10^{-8} and 4.29×10^{-7}. Results for the 24 h wave are very similar.
    - We can see that Allais' values and values in Horodnic have the same order of magnitude, which is entirely consistent with the fact that they indeed resulted from the same astral action on 2 observation sites whose latitudes are very close (Saint-Germain 46.857˚N; Horodnic 48.899˚N). This is all the more significant since:

1) The launch procedures not being the same (start from the final azimuth of the previous run in the case of Allais; start from always the same azimuth in Horodnic), this underlying phenomenon has not been observed from the same points of view. The calculations are quite different.

2) In the case of the Horodnic pendulums, we started from the derivative of the ellipticity, in that of the Allais pendulum from the precession.

3) The pendulums themselves were noticeably different.

These waves constitute only a part of the anisotropy of external origin which acts on the pendulum, whose average order of magnitude, which could be measured in Horodnic, is some 10^{-6}.

- **For the few eclipses where, on the one hand, anomalies in the precession of a pendulum were observed, and where, on the other hand, the small axis of the ellipse was measured, the perturbation that acted on the pendulum was also a linear anisotropy.**
    - These eclipses are:

1) Observed in Horodnic, the solar eclipse of September 1, 2016, and the total lunar eclipse of July 28, 2018.

These observations had never been published. Concerning the second eclipse, for which the concomitance with the eclipse of the observed anomaly being very clear, we are allowed to think that there is really a cause and effect link, it is besides remarkable that it is a lunar eclipse.

2) Observed in Bucharest, under the direction of Professor Mihaïlia, the solar eclipses of August 11, 1999 and October 3, 2005.

- A linear anisotropy creates both a direct precession of speed θ'_d and an indirect precession of speed θ'_i, with (cf [15], Formula 18):

$$\frac{\theta'_i}{\theta'_d}=\frac{3\alpha^2}{16\eta\cos2\left(\theta-\theta_A\right)}\geq\frac{3\alpha^2}{16\eta} \tag{35}$$

  where α is the angular amplitude. In Horodnic, the starting α was 0.068 rad, and in Bucharest 0.012 rad.

  In Horodnic, at least during the periods of observation, indirect precession always remained very largely predominant. During the 2 eclipses concerned, η variations of around 10^{-5} were observed, which was significantly above the average, but not exceptional. It was not at all the same in Bucharest during the solar eclipse of October 3, 2005: a variation of η of 5.3×10^{-4} was observed, and it was direct precession which was largely predominant.
- During the 1999 eclipse, 2 pendulums were used. They had been started in perpendicular directions. As their deviations during the eclipse had been the same, it was then concluded that this was the result of an action with circular symmetry. In fact it was wrong. This actually resulted from that, in the case of direct precession, a variation $\Delta\theta_L$ of the starting azimuth θ_L leads to a deviation $2\Delta\theta_L$ of the direction towards which the plane of oscillation of the pendulum tends to be called back. This plane being defined to within 180˚, when $2\Delta\theta_L=\pi$, there is no influence.
- The pendulums in Bucharest being only 2.2 times longer than those in Horodnic, it is impossible to explain the enormity of the η values observed by this difference in length. It is therefore certain that actions on the pendulum of an exceptional magnitude can occur during certain eclipses.

  An action of variations in the Earth electric field can, if the bob has been electrilized, create this kind of anisotropy. This seems quite unlikely: there are plenty of equipotentials in a building (the pendulums were in a stairwell at the University of Mathematics in Bucharest). But, due to lack of information, we cannot exclude it.

- **Actions on pendulums of alignments Sun-Jupiter.**
  - There was a very possible effect of the conjunction Sun -Jupiter of May 8, 2000 (observation of D. Olenici in Suceava, Romania). Besides, in view of the information available, the quite remarkable anomaly that then appeared was the result of a very important anisotropy.

  - The solar eclipse of June 30th, 1954, on the occasion of which Allais discovered the effect to which his name was given, practically coincided with an alignment Sun-Jupiter, which took place approximately 6 hours after the eclipse. It cannot be said that there was then actually an influence of Jupiter, but the coincidence is so noticeable that it deserves to be reported.
- **With regard to the optical observations carried out by Allais in July 1958 in Saint-Germain.**

  These observations consisted in measuring in Saint-Germain the deviations in sighting at marks by two telescopes, one aiming North-South, and the other South-North, at the same time that was mesured the precession of two pendulums, one in Saint-Germain, and the other in the underground quarry of Bougival:
  - Due to technical problems, only the second half of July could be used for spectral analysis. The results obtained, however, remain extremely interesting, since the 25 h wave cannot be considered as a non eliminated residue of the 24 h wave (over a period of 14 days, its amplitude is only reduced by 47%):
  - The fact that the amplitude of the 24 h wave is not much higher than that of the 25 h wave excludes an influence of classical geophysical factors (it does not seem that the gravitational action of the celestial bodies can play a role here).
  - The deviations are in the same sense for both of the telescopes.
  - It is remarkable that the average 25 h wave (on the 2 telescopes) of the optical deviations is almost in phase with the average 25 h wave corresponding to the 2 pendulums (within 5 min). This (as well as some surprising similarities in the detailed examination of the curves) suggests strongly that it is the same underlying phenomenon that acts in both cases.
- **With regard to Miller's interferometric observations and Esclangon's observations in Strasbourg.**

  The only regularity highlighted by Miller and Esclangon had been a very important sidereal diurnal component.

  In fact, as Allais has shown, there is also an annual influence, which has the particularity, as the azimuths of Allais, of having its extrema at the equinoxes, and not at the solstices. There are likely other diurnal components than the sidereal diurnal component, but the observations are too few and too irregular to highlight them.
- **At the origin of the regularities discovered by Allais, and perhaps, of anomalies observed during éclipses or syzygies, is there an unknown force field? Or, according to Allais' hypothesis, because of astral actions, an anisotropy of the medium in which the pendulum oscillates?**
  - In the first case, η is proportional to the length of the pendulum (§5), in the second one, it is independent of it. The unknown action then presents itself mathematically, as Allais noted, as an anisotropy of the space of

inertia.

As we saw in §5, although Horodnic's pendulums are 7.7 times longer than those of Allais, and the average value of the amplitude of the 24.84 h wave almost the same, we cannot conclude, as over the 6 observations Allais values vary with the same order of magnitude.

- If the interposition of a celestial body between two others acts by creating, remotely, an anisotropy of the medium in which the pendulum oscillates, this can only be by mechanisms which are unlikely to be simple. This could explain the irregularity of the manifestations of the eclipse effect or, more generally, of a possible sizygy effect.
- An anisotropy of astral origin in the space crossed by the light rays could also be at the origin of the optical phenomena recalled in this article, which, too, are apparently inexplicable by classical factors.

- **Influence of the latitude**

  All the observations took place in the northern hemisphere, at a latitude of approximately 45˚. It would be quite interesting to know what would be observed in the southern hemisphere, or at the equator.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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