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Continuation given to Maurice Allais's experimental works
State of the situation (2015)

1- Reminder concerning Maurice Allais's experimental works

▪ They are a part of a very general approach in which he played a pioneering role: the methodical research of the existence of deviations with regards to the known laws of mechanics and electromagnetism bound to the configuration and the movements of the celestial bodies.

▪ In a number of publications (especially in his work of synthesis "The Anisotropy of Space" ref. 1), Maurice Allais indicates having found, in the deviations of the plane of oscillation of a "short" pendulum[1] (what he called "paraconic" because of the type of suspension used), the existence of periodic components connected to the movement of the Earth of apparently inexplicable amplitude within the frame work of the current theories, as well as the existence of a direction variable over time towards which tends to be called back the plane of oscillation of a short pendulum (direction he called the "direction of anisotropy of space"). He also found very unusual deviations during the solar eclipse of 30 June 1954, such a phenomenon having be reproduced (but less clearly), on the occasion of the solar eclipse of 2 October 1959: see Annex 1.
The observation of June 30th, 1954 having been the first highlighting of gravitational anomalies[2] on the occasion of eclipses, this effect was afterward called "the Allais effect".

▪ To can assert that we are in front of a phenomenon which is apparently inexplicable within the frame work of the current theories (and which obviously deserves to be studied deeper), it is necessary:

- to have the assurance of the existence of this phenomenon, or, more accurately, in the most general case, to have a good statistical assurance of its existence. In theory, indeed, we can never have an absolute certainty, because the phenomenon is never isolated, and must be distinguished from the rest of the studied signal, whose we have generally only a statistical knowledge, and which therefore behaves as "noise";
- to have justified the impossibility, at least as far as we can judge, to explain it in a conventional frame, ie to have eliminated the possible conventional causes by a methodical approach (experimentally, or theoretically, or both).

▪ In view of the analysis made by Maurice Allais[3] all these conditions can be considered satisfied at least as regards:
- a lunar diurnal periodic component of 24 h 50mn
- a diurnal periodic component of 24 h (or more accurately, of about 24 h[4])

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[1] See below §2.3.4.1
[2] Or at least which look like gravitational anomalies.
[3] See detailed information in ref.1
[4] The duration of the observations (1 month) allowed to distinguish the lunar diurnal component of 24 h 50mn and the about 24 h components, but it did not allow to distinguish adjacent components of the 24 h component (for example a solar diurnal component of 24 h and a sidereal diurnal component of 23 h56mn).

-a lunar monthly periodic component (estimated sidereal Lunar : period 27,32 days).
- a semi-annual periodic component, the maximum of which is near the spring equinox[5].
- a slow variation which appears as a long periodic component of 5,9 years (and which can be considered as resulting of a global action of the solar system)

As regards the direction variable over time towards which the plan of oscillation was called back (the so-called "direction of anisotropy of space"), Maurice Allais experimentally eliminate any role of the anisotropy of the support and of the suspension of the pendulum[6]. We can thus think that this variable direction results only from causes **external** to the pendulum, and it remains today apparently inexplicable by conventional causes.
Over a period of 1 month, the order of magnitude of the average speed of rotation of this direction was 1/10th of the Foucault effect.
Note that the aforementioned diurnal and monthly periodic components[7], which are really apparently inexplicable in a conventional frame, are components of the evolution of this direction.

▪ Moreover no convincing contesting was ever brought to what precedes, while the main conclusions of Maurice Allais, had been, from 1957 to 1960, the subject of extensive discussions within the scientific community, and at a high level.

The few observations which were performed afterwards gave very similar results (cf. 2.2.1 and 2.2.2).

In 1998 a new harmonic analysis of data collected during 5 of the 7 continuous observations of one month made from 1954 to 1960 by Maurice Allais has confirmed the existence of the aforementioned diurnal periodic components (ref. 31). Furthermore, in the same study, the existence of a diurnal lunar influence was highlighted by a quite different method[8] on the two observations conducted simultaneously in July 1958 in Saint-Germain and Bougival (in Bougival, deep inside an underground career of chalk)

2- <u>Continuation given to Maurice Allais's experimental works</u>

Today, it is mainly in mechanics that they were carried on.

2-1 Two main categories of abnormal phenomena are to be distinguished :

a) Those which are bound to the continuous movement of celestial bodies (the rotation of the Earth on itself, the rotations of the planets around the Sun, the Moon around the Earth, ...). They are continuous phenomena, which, the solar system containing periodic movements, are a priori translated by the existence of multiple periodic components, which can only be

[5]Maurice Allais underlined that it is very particular: generally the known phenomena have not a semi-annual component the extrema of which are near the equinoxes, but an annual component the extrema of which are near the solstices. One exception: the magnetic activity, which is in the same situation than the pendulum's azimuths (ref. 1, p. 478).
[6] In this purpose Maurice Allais built a new pendulum, which was really very weakly anisotropic.
[7] About the longer components, it is impossible to know, as the direction of anisotropy of space could be measured during only 2 experiments of 1 month.
[8] By expressing the azimuth of the plane of oscillation as a function of the hour angle of the moon.

distinguished by observations over long periods of time (at least 1 month, which corresponds to the time required to completely separate a lunar diurnal component of 24 h 50 and a diurnal solar component of 24 h).
Let us note that it exists, to highlight the influence of a celestial body, another method than an harmonic analysis: the search for correlations between the experimental data and a coordinate of the concerned (for example the azimuth of the plane of oscillation of the pendulum and the hour angle or the elevation of the moon[9]). For an observer on the Earth, this method seems to be the best adapted in search of a possible influence of the movement of a planet, as it generally don't generate obvious periodic components.

In any case the phenomena of this category can be highlighted only **by long-duration observations**.

b) Those which are bound to limited events: in particular eclipses and other celestial body alignments. A thorough difficulty is that, this time, we cannot distinguish them from other phenomena by using the classic methods of search for correlations, which are effective only when we know the shape of the sought anomaly.

But this is not the case: each celestial body alignment is a special event. Even if the rules governing the "eclipse effect" were simple geometric rules (and as far as we can judge it in view of the many observations accumulated today it is absolutely not the case), the phenomenon would never appear exactly in the same way.

2-2 Search for phenomena bound to the continuous movements of celestial bodies.

Very few observations, but they are fully in line with the conclusions of Maurice Allais.

2-2-1 The "direction of anisotropy of space"

Dimitrie Olenici (ref. 12, §5) verified, during 2 observations performed continuously over significant periods of time (2 weeks: from 25/08/2002 to 3/09/2002, and from 17/08/2002 to 30/08/2002) using a 2 m pendulum being able to be launched in any direction, the existence of a privileged direction variable in time to which tends to be called back the plane of oscillation, whatever is the azimuth of launch.

2-2-2 Lunar influence on the azimuth of the plan of oscillation of a pendulum

To date there was only one experiment conducted continuously long enough to allow the detection of such influence: the one conducted by the Institute for Gravityresearch (Waldaschaff, Germany: see ref. 13a and 13b) from February 2006 to January 2007, using an automated paraconic pendulum relaunched from the same azimuth at the beginning of each elementary observation.

The existence of a correlation of the variations of the azimuth of the plan of oscillation with changes in the declination of the moon is visually very clear in view of the 11 graphs

[9] See for example § 2.2.2 below.

representing over 11 consecutive months both the evolutions of the azimuth at the end of each launch and those of the elevation of the moon (see ref. 13c) : this confirms the existence of the lunar monthly sidereal influence discovered by Maurice Allais. Furthermore, we find, as in Maurice Allais, an opposite phase between changes in azimuth and declination, and the amplitudes are quite comparable.

Besides the representation of the azimuth of the pendulum as a function of the elevation of the moon, during about 1 month (ref. 13b, fig. 25) visually reveals a clear diurnal lunar influence. The amplitudes are comparable to those found by Maurice Allais.
All this is independent from the statistical study which is done also elsewhere in ref.13a and 13b to estimate the influences of the Sun, of the Moon and of Jupiter on the precession of the pendulum.
This statistical study ends in an equivalent influence of these 3 celestial bodies, but its methodology is very questionable.

2.3 Observations of eclipses (and more generally of sizygies)

Several categories of devices were used. The most used have been dynamic pendulums (observation of the motion of a suspended mass dropped from a point different from its equilibrium position), and miniature torsion balances.

2-3-1 Gravimeters

Few observations reported positive, at least published. The observations concerned only solar eclipses observed in their areas of visibility:

10/05/1994, Montreal (ref.17); 24/10/1995 , Dhoraji , India (ref.16) ; 07/03/97 , Moho , China (ref.18) ; 11/08/99 , Trieste , Italy (ref.20); 26/06/2001, Zambia (ref.19); 4/12/2002, Australia (ref.19).

The recorded variations of g are very small: between 1 and 10 µgal, which is extremely small (1 µgal = 10^{-8} m / s^2). As a guide, this corresponds to an altitude change of 3 cm.

2-3-2 Measures of deviations of the vertical line.

Very few observations (only solar eclipses):
11/07/91, Mexico (ref. 23); 30-31/05/2003, Marigliano, Italy (ref.20); 22/03/2006, Antalya, Turkey (ref. 21).
Every time were observed deviations corresponding to horizontal accelerations of one or more mgal, that is 3 orders of magnitude more than the accelerations recorded by gravimeters.
Note that the measure of the horizontal constraints exercised on a very fine suspended brass sheet revealed several times, in the days around the solar eclipse of 24/10/1995 an horizontal force corresponding to an acceleration of 10 mgal (Pr. Zhou, Kun Ming, China ref. 28; see also §2.3.7)

2-3-3 Torsion pendulums

The measured parameter is the period of oscillation of the pendulum. Very few observations (only solar eclipses in their areas of visibility):
03/07/1970 , Boston (ref. 24); 22.07.90 , Northern Europe, by 2 independent teams (ref. 22 and 25) ; 07.11.91 , Mexico (ref. 23) .
Only the first observation gave positive results. Note however that the observation of the eclipse of Mexico showed a deflection of the vertical line (see §2.3.2)

2-3-4 Dynamic pendulums

2-3-4-1 General information.
The pendulum is a device the dynamic behavior of which is very complex. We remind the main points with regards to the use of this device which was done.

▪**The main observed parameter is the rotation of the plane of oscillation** (the "precession" of the pendulum). The sensitivity of this parameter to various disturbances has been the subject of several studies, particularly in ref. 1 and ref. 2.
The period of oscillation, the major axis, the minor axis and the rotation of the bob were besides observed, more or less systematically.
In a general way the precession is especially sensitive to the actions **in resonance** with the movement of the pendulum, what is not the case of many sources of disturbance. The study of the influence of such actions is developed in ref. 2.

2 modes of perturbation of the precession (the perturbations can result either from defects of the pendulum or external actions, which can themselves be of conventional nature or not):

a) The "indirect" mode ("Airy's precession"): the disruptive action ovalizes the trajectory of the pendulum, and this ovalization mechanically makes turn the plane of oscillation of the pendulum, with a speed of rotation $\theta' = \frac{3}{8}\sqrt{\frac{g}{l}}\,\alpha\beta$, where l is the equivalent length of the pendulum, and α and β the half major angular axis and the half minor angular axis of the ellipse (α and $\beta \ll l$).
Most of the defects of the pendulum and the conventional disruptive actions act through the Airy's precession: hence the well-known fact that the movement of a pendulum is all the more chaotic **as the pendulum is short and the amplitude of its movement important**.

The most significant disturbances are those which result from actions in resonance with the pendulum. In this case β (and therefore θ') increases proportionally with time, and θ quadratically with time, that means **that θ remains small at the beginning**. Such is the case when there is an "anisotropy" of the suspension of the pendulum: it results from dissymmetries of the suspension that the period of oscillation varies with the direction of the plane of oscillation. This is the most classic default of the pendulums, and usually the most striking. See for more details in Annex 6.

b) The "direct" mode: the disruptive action makes directly the pendulum to precess, and its influence is therefore clear **from the start of the pendulum**.

The Foucault effect, to which would be reduced the movement of the pendulum in the absence of any disturbance, falls into this category (remember that this effect is a constant rate of precession $\theta' = - \sin L\ \omega$, ω being the speed of rotation of the earth, and L the latitude) .
A given physical disturbance can result both in a direct precession and in an Airy's precession. Such is the case of an "anisotropy" of the suspension. However the direct precession is then generally small before the Airy's precession: see annex 6.

▪An essential point is that the movement of the pendulum **must not be maintained**, so as not to add a source of additional disturbance. The pendulum is thus relaunched regularly every 20 mn (either from the same azimuth, either from the azimuth reached at the end of the previous elementary observation).
This has besides for consequence to limit strongly to the concerned elementary observation the impact of a fortuitous event (shock...), and make the pendulum insensitive to slow deformations of the building.

▪The observation shows that, at least as a general rule:
- At the beginning the movement of a pendulum is plane, and the precession is practically reduced practically to the Foucault effect.
- The velocity of the Airy's precession increases with time.

Hence the distinction between "long" pendulums, for which the Airy's precession remains negligible for a long time, and "short" pendulums, for which it quickly becomes predominant.

Following prolonged observations, Maurice Allais decided to emphasize the Airy's precession.
Hence the choice of a "short" pendulum (equivalent length = 83 cm), with an important amplitude (double amplitude of the movement: 0,22 rd), the duration of each elementary observation (14mn) having been further determined so that the Airy's precession has time enough to become predominant[10] .

▪The deviation measured at the end of each elementary observation takes into account both the direct precession and the Airy's. To be able to distinguish them is necessary to have the ovalization b/a, which allows to calculate the Airy's precession. This ovalization being however very small at the beginning of the observation, the initial slope of the azimuth will result a priori only from the direct precession.

It also takes into account both the result of circular actions and directional actions. To be able to distinguish them, it is necessary to have several pendulums launched in several directions.
Note that the method of the "mobile correlations" used by Maurice Allais in his observations with the isotropic pendulum to follow the evolutions of the "direction of anisotropy of space" (ref. 1, chap. II) eliminates circular actions by its principle[11].

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[10] The pendulum was relaunched all the 20mn, and stopped at the end of 14mn. The remaining 6 mn was used to prepare the following launch.
[11] The method consists in making 10 throws in 10 azimuths separated from 18°, and then, from the 10 azimuths thus obtained, to calculate the direction towards which the plane of oscillation tends to be called back. This provides a measure of this direction every 20 x 10 = 200 mm. If we are interested only in the slow evolutions (that is the case of the periodic components of Maurice Allais), it is as if we had 10 identical pendulums launched simultaneously in 10 azimuths separated from 18°.
The Foucault effect (as any possible other circular effect) is eliminated.

It is therefore certain that this direction (as well as the periodic components identified in its evolution) resulted only from a **directional action** variable in time.

This directional action acts as an **anisotropy of an unknown origin**[12] (see above and annex 6 about the meaning of "anisotropy": it means that the period of oscillation varies with the direction of the plane of oscillation; then this plane is called back towards the azimuth in which the period is maximum).
The "coefficient of anisotropy" (maximum relative variation of T) could be calculated by Maurice Allais: **the order of magnitude is 10^{-6}**.

Nothing says, however, that the periodic components highlighted by the method of the "chained observations" (which was the method used for the "anisotropic" pendulum) did not result partially from circular perturbations.

▪The precession of a pendulum **is insensitive to linear accelerations** (which cause only deviations of the vertical line), and **little sensitive to shocks**, which do not cause resonance. This can explain very well the differences of behavior with the gravimeters and the devices measuring the deviation of the vertical line which them are by construction very sensitive to such perturbations.

2-3-4-2 Observations
Many eclipse observations were performed using pendulums. As regards those which operate a single pendulum, which are the majority, few of them are actually conclusive, simply because, often, they framed little the eclipse.

We shall limit ourselves to quote the following observations:

a) The 2 solar eclipse observations of Maurice Allais (30/06/1954 and 02/10/1959): see graphs in annex 1 (and in reference 1)
These graphs show a basic problem: indeed a "short" pendulum is sensitive to the eclipse effect, but being sensitive to some other perturbations, it is little selective of this effect.

If the observation of the 30/06/1954 eclipse is very significant, it results that:

- Firstly the shape of the anomaly was really exceptional (no such thing had appeared during this observation campaign, which was performed continuously from 9 June to 9 July 1954).

- But it happens also that this anomaly differed very strongly from other disturbances, considering their slopes at this moment, which was not the case for the 02/10/1959 eclipse (where, however, the shape and the amplitude of the anomaly were quite comparable).
The enlarged graphs reveal also that the slope of the azimuth at the beginning of each elementary observation may deviate strongly from the Foucault effect: this means that, most likely, an other "direct" precession has sometimes added to the Foucault effect (see §2.3.4.1).

As there is only one pendulum, we cannot know whether the observed anomalous precession results from a circular action, a directional action, or a combination of both.

[12] Mathematically, it acts also as if the inertial mass was not the same in two perpendicular directions.

b) The observation of the 11/08/1999 solar eclipse by 2 "long" pendulums of 14,21 m thrown in perpendicular planes (Pr. Mihaïlia, Romania: ref. 8), with a small angular amplitude (0,036 rd): see annex 2
It could thus involve in this case **only a "direct" precession**, as the Airy's precession was negligible.
The deviations of the 2 pendulums are almost identical, that means that there was a **circular** unknown disruptive action.

c) The observation of the 01/08/2008 solar eclipse (see ref. 5 and annex 3)
The observations were made in Ukrainia in Kiev (5 non automated torsion balances; Alexander Pugach) and in Romania in Suceava (Dimitrie Olenici and Thomas Goodey) as regards the two paraconic short pendulums and the long Foucault pendulum. The distance between Kiev and Suceava is 440 km.
The 2 paraconic pendulums, one of them being automated, were in the same building, but in different rooms.
They were launched in directions which were nearby (less than 20° of gap), but probably not identical.
The long pendulum was in an another building, 1,5 km away.
Graphs providing the results are presented in annex 3.

The continuous observation over several days of the automated pendulum shows a particularly important deviation on the day of the eclipse.

There was besides something very remarkable, apparently related to the eclipse:
- First of all exactly at the beginning of the eclipse: the behaviors of the 2 short pendulums change abruptly.
Their oscillation planes deviating in opposite directions, the unknown action **cannot be a circular action**.
- Then at 11 h 30 a.m, that is half an hour after the end of the eclipse, the behaviors of the 2 short pendulums change again abruptly and, at the same time, the precession of the long pendulum, which had remained normal up to there, becomes abnormal. In addition, approximately at the same time, the behavior of several torsion balances in Kiev also changes.

d) The observation of the solar eclipse of 9-10/05/2013
The author of this study participated in this observation, which was the subject of a publication (ref. 15) and is presented in annex 4 (which also provides unpublished information).
This eclipse was invisible from the observation places (in the northern hemisphere, it was visible only in the Pacific).

Its observation operated:
- 3 automated torsion balances (1 in Kiev, 1 in Comanesti in northern Romania, and 1 in the salt mine in Cacica, 40 meters underground, 10 km from Comanesti). This was the last model used by Alexander Pugach (see §2.3.6) which (except manufacturing imprecision), has a symmetry of revolution, and is therefore a priori sensitive only to perturbations which have such a symmetry (this device was called "torsind");
- 2 pendulums of 6 m of length approximately, launched according the same procedure, with a large angular amplitude (double amplitude : 0,20 rd) : the Airy's precession quickly becoming important, they behave in fact as "short" pendulums " after about ten minutes.

One was installed in the "pendularium" of D. Olenici (in Horodnic, about fifty miles from Cacica), the other in the salt mine of Cacica.
However, as regards the last pendulum, if extremely marked abnormalities were note, too few observations were made so that we cannot really cross check with those found on the Horodnic pendulum (in view of the available information, however, there is no inconsistency).

It can be concluded:

- The existence of a highly probable influence of the eclipse on the 3 “torsinds”. The recorded deviations all have a minimum around 23:30 UT, approximately 1 hour before the maximum of the eclipse.

- The existence of a likely influence of the eclipse on the azimuth of the Horodnic pendulum measured 7 min after the beginning of each elementary observation, while the pendulum still behaves primarily as a “long” pendulum, that is to say that it is still little affected by the Airy’s precession : see §2-3.4.1 .
Indeed the curve giving this azimuth shows that there was **also** something remarkable around 23:30: it is at this date that this curve, which has 44 measurement points, has its minimum value. There was only 1 chance among 44 that it occurs so.

Further note that this deviation is **in the same direction** as those of torsinds, which is consistent with the fact that they would be the result of the same circular action.

- The existence of a possible influence of the eclipse on the Airy’s precession: observed over 6 days around the eclipse the curve giving the azimuth after 28mn, azimuth the variations of which depend essentially from those of the Airy’s precession, do show a really very marked deviation; the minimum of which precedes about 4 hours the minimum of the torsind’s deviations, and 5 hours the maximum of the eclipse .

e) The observation of the Sun-Jupiter conjunction of May 8th, 2000.
Dimitrie Olenici (Suceava, Romania) did observations on 50 days distributed over April, May and June 2000. On May 8th, the day of a conjunction Jupiter - Sun, appeared an extremely marked and very special anomaly.
There was only 1 chance among 50 that it occurs so.
See ref. 11 and annex 5.

2-3-5 Miniature torsion balances

This device is used for over 10 years by Alexander Pugach (Ukrainian Academy of Sciences).
His works follow those of the Russian astrophysicist NA Kozyrev (1908-1983), who had indicated, but without providing experimental justification, that miniature torsion balances should react on the occasion of astronomical events, especially eclipses.
This is a very simple device which, in its current version (called "torsind" by Alexander Pugach), is described in the ref. 3.
In a cylindrical quartz chamber hermetically closed 240 mm in high, an aluminum disk of 120 mm diameter and 100 µg is suspended by a silk thread of 20 µ of diameter. The inside of the chamber is covered by a grounded aluminium sheet.
The position of the disc is read 1 time per minute by a camera connected to a computer. This device allows continuous observations over long durations.

The insensitivity of this type of device to the conventional disturbances a priori likely to be encountered (including temperature, pressure, vibration of the soil, electrostatic phenomena, variations of gravity) could also be experimentally verified. Note however, as noted Alexander Pugach, that the shielding by an aluminum sheet only partially protects against magnetic fields (screening by a μ-metal shielding would be more appropriate).

Furthermore several observations led continuously **over an often significant number of days surrounding an eclipse** (Sun or Moon), or an alignment of the Earth with a planet (Venus transit of 5-6/06/2012) revealed on the occasion of the concerned event, and only then, much more marked deviations than the diurnal deviations usually observed: unlike "short" pendulums, this device looks both sensitive to the “eclipse effect”, and relatively selective of this effect.

Most of these observations operated at least two balances simultaneously. Two of them besides operated a balance installed in a salt mine, 40m underground, and thus placed under environmental conditions of an exceptional stability .
In addition to the document reference 3, which reminds some very significant observations, one can refer to the documents in 4,5,6,7 and 15 references, the references 5 and 15, where also intervene pendulums, having already been mentioned above.

In conclusion we have a significant number of observations where deviations observed not only could not been explained to date in a conventional frame, but are to be connected to eclipses or, it seems, in some cases, to planetary alignments.

Note that the continuous observation of a "torsind" over several years has also revealed a very interesting phenomenon: its "activity"[13] varied globally as the solar activity deducted from the observation of the sunspots: see ref. 29.

2-3-6 Atomic clocks

Variations of frequency of atomic clocks were repeatedly noticed on the occasion of eclipses by Pr S.W. Zhou (University of Huazong, China) in the 1990s (ref. 26 , 27, 28). It does not seem, however, that there were other publications on this subject.

2-3-7 Other anomalies during eclipses

In the document ref. 28, S.W. Zhou performs an inventory of the anomalous phenomena he observed during eclipses. In addition to already presented phenomena are quoted the following extremely curious phenomena:
- The highlighting of an horizontal "force" corresponding to an acceleration of 10^{-4} g (solar eclipse of 24 October 1995). The measurement was performed by means of a very specific device (measure of the horizontal constraints exercised on a very thin suspended copper sheet (1,5 x 0,3 x 0,000095 m)).
- The change in the texture of a molten tin-lead alloy during the solar eclipse of December 24th, 1992. Two groups of samples of this alloy were formed, one during the eclipse, the other during the days following the eclipse. It stood up from their analysis with the electron

[13] A diurnal indicator of the “activity” of a torsind was defined by Alexander Pugach. It is important all the more as the deviations are numerous and large.

microscopic that the texture of the samples made during the eclipse revealed in their structures orientations that were absolutely not found in the other group of samples. Moreover their electrical conductivity was superior of 5%.
- The highlighting, during the solar eclipse of September 23rd, 1987, by spectrum analyzers (6 analyzers used simultaneously in different rooms), of 10^{-4} amplitude variations in relative value of the wavelength of 8 emission lines. The shape of these variations during the eclipse was very similar in all cases. Sources of light emission were internal sources in the laboratory, not sunlight. The analysis was performed by means of a comparator much more accurate than the generally used comparator.

3-And now?

▪ The conditions so that we can assert that we probably are in front of an phenomenon inexplicable within the framework of the classic theories (and that obviously deserves to be studied deeper) were reminded in §1:

- To have verified its existence;
- To have verified that, at least as far as we can judge, it is inexplicable in a conventional frame.

We saw that these conditions were met for the main periodic components discovered by Maurice Allais and for the "direction of anisotropy of space".

Following the work of Alexander Pugach, as well as a number of other particularly significant observations, the existence of phenomena seemingly inexplicable connected to solar and lunar eclipses[14] can be considered as acquired.
As regards the existence of anomalous phenomena associated with syzygies other than eclipses, there is much less convincing information, but those available incite strongly to continue research.
As regards the actual impossibility to explain them in a conventional frame:
- The study of Christian Duif of 2011 (ref. 30), which incorporates a previous study of 2004, allows to rule out all the explanations that had been proposed.
- It appears that the eclipse effect could also occur even when the eclipse was visible at the other end of the earth, what makes much more difficult the explanation by the local variations of the environment resulting from the eclipse.
- It does not seem that there can be conventional explanations for anomalies associated with planetary alignments.

▪ The exploitation of the available observations shows besides:

- That the abnormal accelerations recorded during eclipses by **devices directly measuring accelerations** (§ 2.3.1 and 2.3.2):
. are very weak in the case of vertical accelerations (from 1 to 10 μgal, that is 10^{-9} to 10^{-8}g);
. are about 1000 times larger in the case of horizontal accelerations.

- That as regards the dynamic pendulums:
. The "direction of anisotropy of space" of Maurice Allais results from a directional action (§2-3-4-1).

[14] What does not mean that such phenomena occur at every eclipse. Remind that each eclipse is in fact a particular event.

. It is the same for the periodic components of his “isotropic” pendulum.
. As regards the periodic components of his "anisotropic" pendulum, it is certain that they result, at least partially, from directional actions, but nothing allows to rule out that they result also from circular actions.
. A circular disruptive action was exerted on the two “long” pendulums of Prof. Mihaïlia during the eclipse of 11/08/1999 (§2.3.4.2, b).
. The disruptive action that was exerted on the two “short” pendulums at the beginning of the eclipse of 1/08/2008 (§2.3.4.2,c) was certainly not a circular action.
. The observed directional actions, which mathematically act **as additional anisotropies of unknown origin**, whose the order of magnitude is 10^{-6}, do not behave as classical forces, and are therefore of a different nature than those observed by gravimeters and inclinometers (the precession of a pendulum, especially if it is frequently relaunched, is very little sensitive to linear acceleration: §2.3.4.1).

- That as regards the current model of torsion balance ("torsind"), where the beam is replaced by a disc, it is very likely that the deviations result from circular actions (the made reserve resulting from the possible defects of the circularity of the device). We can note that, when there are two close torsinds, they start in the same direction during the eclipse effect.

- That it is possible that this circular action exerted on torsinds also acts on a "long" pendulum: coincidence (§2.3.4.2, d) between the minimum deviation of torsinds and the minimum of the 41 measures of the precession after 7 minutes of the Horodnic pendulum (after 7mn, it still behaves as a "long" pendulum).

- That it is certain that the eclipse effect does not obey simple geometrical rules (to suppose that it obeys geometrical rules…).

- That the “eclipse effect” is not an isolated abnormal phenomenon, as showed it the long-durations observations of Maurice Allais. Obviously it does not simplify the study of this effect as such.

▪ Today, what can we do?

- We have passed the stage where the problem is simply to prove the existence of phenomena that objectively, taking in account all the available information, we can consider as very probably unconventional, and thus deserving to be seriously studied. The objective is now **also** to search the nature of these phenomena and the laws governing them.
Are they directional actions, or circular actions, or both (as it seems to be the case) ? Are they forces, or torques? Are they ordinary forces and torques, or inertial[15] forces and torques?

[15] The laws of the mechanics are valid only in the Copernic frame, which is bound to the fixed stars, or in a frame which can be deduced by an uniform translation motion (Galilean frame). We remind that, in an accelerated frame (that is the case of a frame bound to the surface of the Earth), we are brought, to keep the same formalism, to introduce inertial forces, which are fictitious forces. For example the acceleration of Coriolis, from which results the Foucault effect, enters this category.
The concept of frame has no physical meaning: it is a purely mathematical concept. To introduce a physical meaning, it is necessary to replace the concept of frame by the concept of "medium” If we consider that this medium is strictly isotropic and stationary relative to the fixed stars, it changes nothing, but it is not the same in the opposite case that we cannot rule out a priori.

Are they mechanical actions that remain uniform over long distances, in which case it could result from them, at the scale of the Earth, significant consequences?
Under what conditions does the " eclipse effect” happen "? Because there were also eclipses, where, apparently, nothing happened.
An essential factor of progress is the combined use of several types of devices: the fact that two different devices react, or that one reacts and the other not, may give precious information.

- In view of the accumulated experiments miniature torsion balance and pendulums (both "long" as "short") are extremely interesting devices.
As regards the pendulum, besides, as we are interested in the Airy’s precession or in the “direct” precession, we measure different things, and we saw also the interest to have several pendulums launched in different directions.

- We must not lose sight of the benefits that can be derived from a new exploitation of data from the few long-duration observations already made:

.those from the observations of Maurice Allais himself, in the light of all the numerous new elements since several decades, and also by taking advantage of the opportunities offered by the microcomputers today;
. those from the observations of the Institute for Gravityresearch in 2006 (see ref. 13a and 13b). The report of these observations concluded with an action of Jupiter on the azimuth of the pendulum. The used method of analysis is very questionable, but a more appropriate method is conceivable.
Note that a rare event (an Earth-Sun-Jupiter alignment) occurred during both these observations and the first long-duration observation campaign of Maurice Allais, in June 1954.

▪ It appears that there is a certain link (phase link) between the variations of the ground magnetic field and several periodic components of the precession of a pendulum highlighted by Maurice Allais: the diurnal components of 24 h and 24 h50mn (ref. 1, p.133) and the semi-annual component (ref.1, p. 478).
There is also a certain link between these variations and the deviations of the torsion balance (link highlighted by Antonio Iovane: ref. 32).
As well variations in solar activity as eclipses, by action on the solar wind, can affect the magnetosphere, and thus the ground magnetic field.

However, the experimental data, which are still incomplete (in particular, we have only records of the magnetic field distant from the location of the torsion balances) absolutely do not allow to say that there is a cause to effect relationship between changes in the magnetic field and the deviations observed.
In any case it is essential to deepen the nature of the relationship which seems to exist between variations of the Earth's magnetic field and the aforementioned phenomena (at least for some of them).
This means, for example, that it is necessary to examine what is happening not only on the occasion of eclipses, but also during magnetic storms.

- Searching conventional explanations of the observed phenomena must be pursued of course: we are never absolutely certain to have thought of everything!
But such explanations, before being taken in account, will have to be carefully verified, and these verifications may bring very interesting information.

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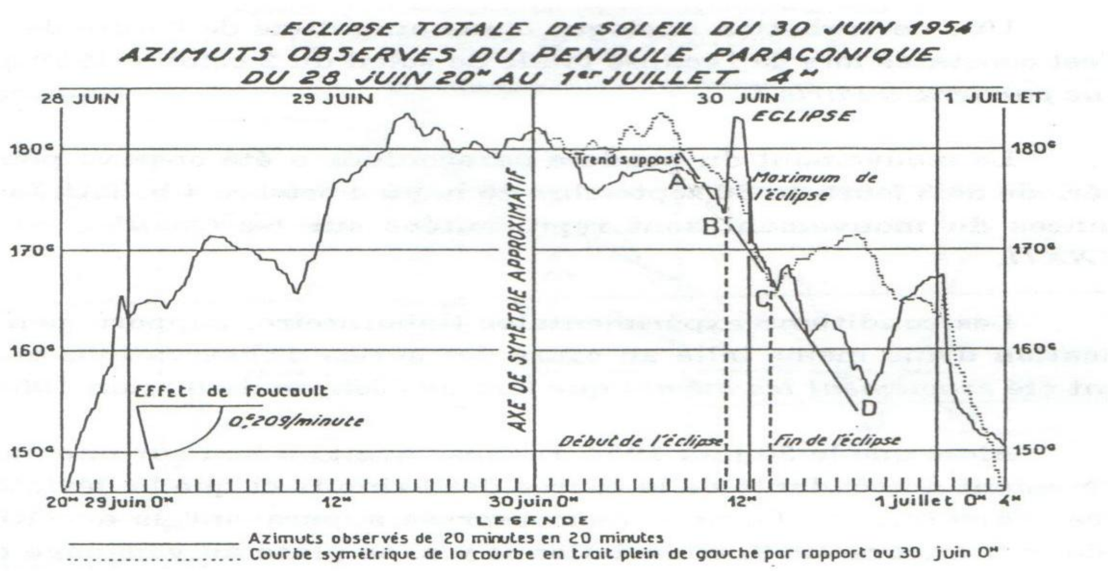
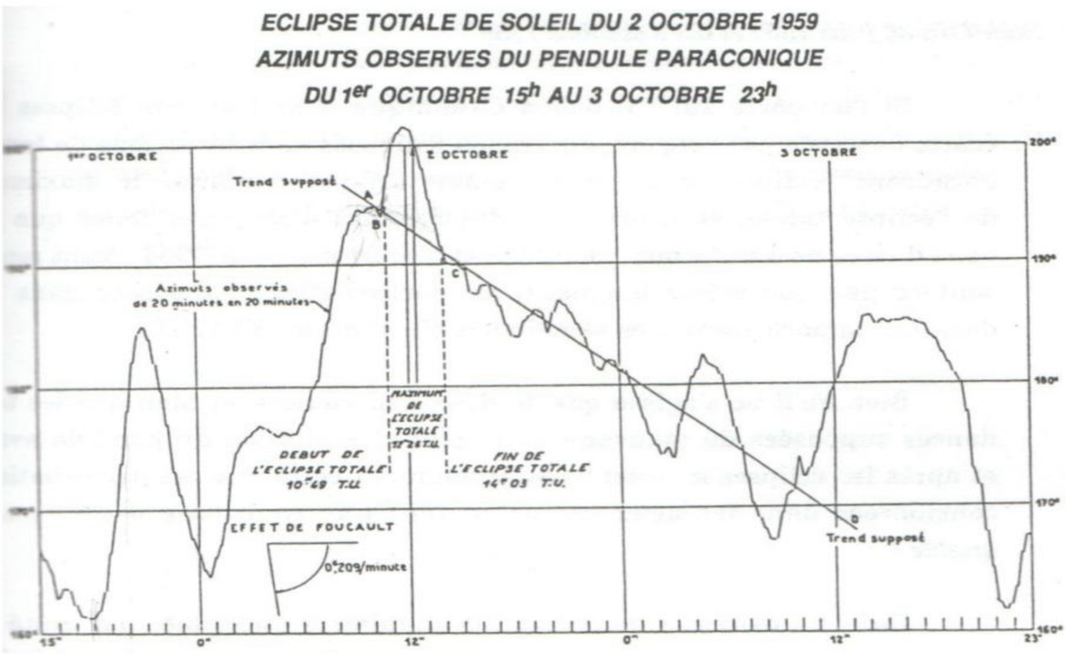
ANNEX 1
Eclipses observed by Maurice Allais.
(Total sun eclipses of June 30th, 1954 and October 2nd, 1959)

▪ Ordinate axis: azimuth of the plane of oscillation.

The observations were « chained »: in every elementary observation the pendulum was relaunched from the final azimuth of the previous one.

The duration of each elementary observation was 14 mn, and the pendulum was relaunched every 20 mn.

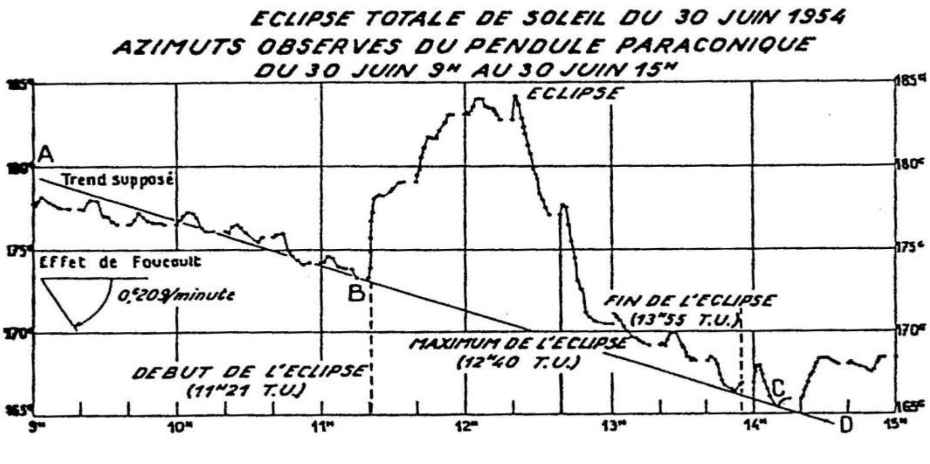




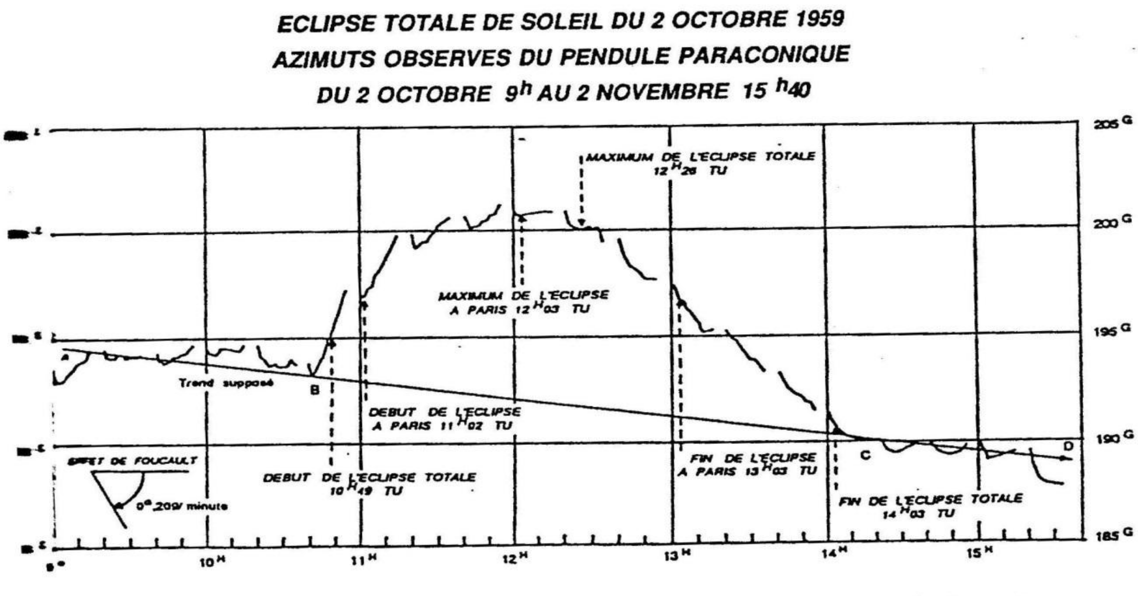
▪ During every elementary observation the azimuth was in fact measured several times, and not only at the end, as can be seen on the following enlarged graphs.

Very frequently, especially during the eclipse of of June 30th, 1954**,** the slope at the beginning of the observation differs strongly from the Foucault effect. As at the beginning the Airy's precession is generally very small (cf § 2.3.4.1), that means that probably, in addition to the Foucault effect, there is an unknown "direct" precession.

[...]phique XXX



Source : *Note du 4 décembre 1957* **à l'Académie des Sciences,** ***Mouvements du pendule paraconique et éclipse totale de Soleil du 30 juin 1954,*** **CRAS, T. 245, p. 2001-2003(reproduction photographique)**



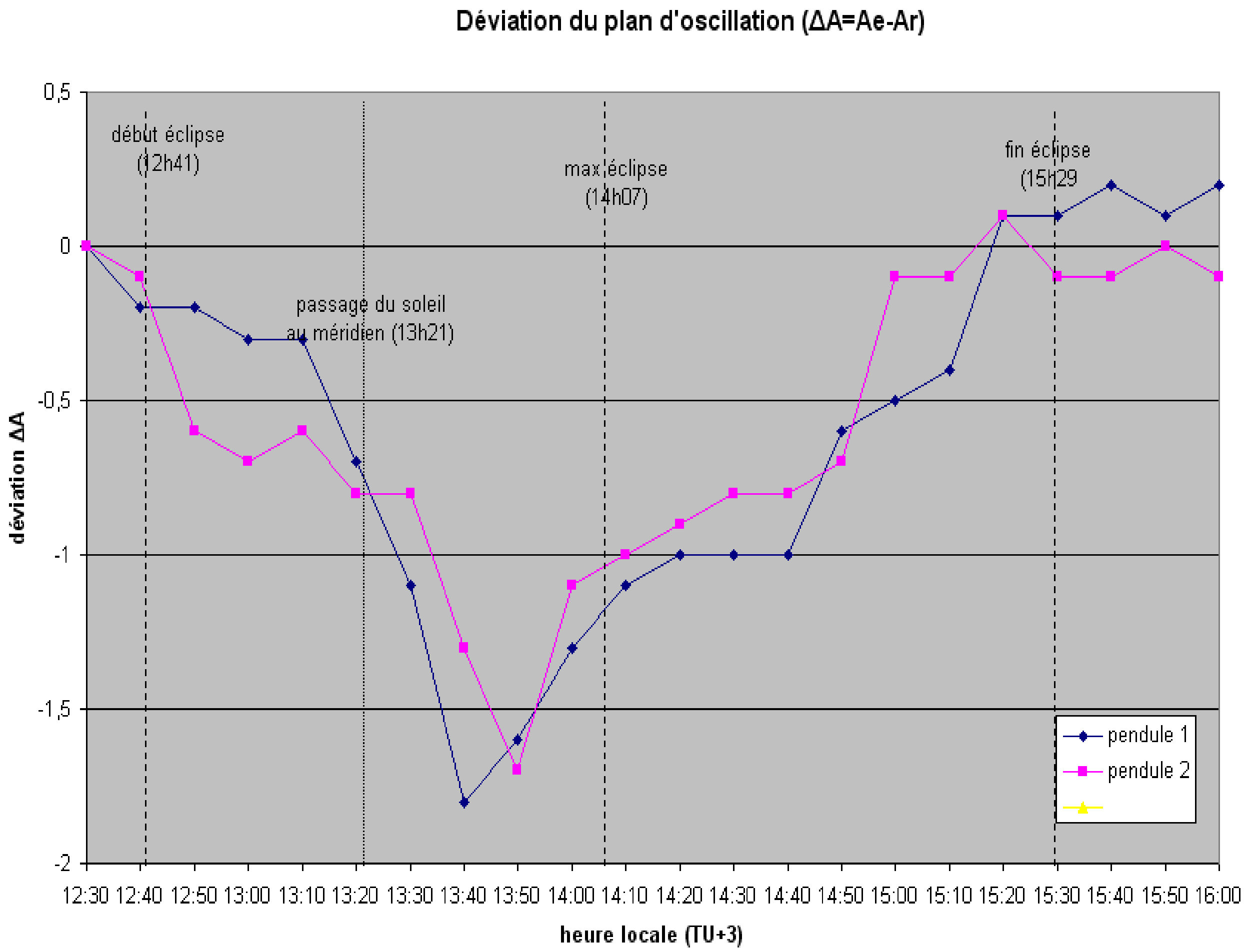
Source : **Allais,** ***Note,*** **non publiée, du 10 novembre 1959,** ***Mouvement du Pendule paraconique et Eclipse totale de soleil du 2 octobre 1959*** **(reproduction photographique).**

▪ Note that the eclipse of June 30th, 1954 practically coincided with an alignment Terre-Soleil-Jupiter, the maximum of which took place approximately 6 hours after that of the eclipse

ANNEX 2

Total sun eclipse of August 11th, 1999 (ref. 8)

The observation took place in Bucharest.
The pendulums were 2 pendulums of 14,21 m launched in perpendicular plans with a small angular amplitude (0,036 rd).
They were relaunched every 60 mn in their last azimuth. The Airy's precession remains negligible: therefore the precession is only a "direct" precession.
The graph represents, for each pendulum, the difference between the azimuth Ae of the plan of oscillation and a reference azimuth Ar calculated from observations of the pendulum made outside the eclipses (this to take in account the fact that a pendulum is never perfect and never follows exactly the Foucault effect).
The deviations of the 2 pendulums are almost exactly the same: the unknown action which causes them **seems circular.**



ANNEX 3
Solar eclipse of August, 1st, 2008 (ref. 5)

The observations were managed in Kiev (5 torsion balances non automated), and in Romania in Suceava, which is distant from 440 km (2 short paraconical pendulums and one long Foucault pendulum).
The 2 paraconical pendulums were in the same building, but in different rooms. One of them was automated, the other was manual, but they were mechanically almost equivalent. They were released in nearby directions (difference less than 20 °), but probably not identical.
The long pendulum was in another building, at 1,5 km from there.

The graph 1 gives the evolution of the azimuth of the automated pendulums during several days spanning the eclipse. It shows that there was a very large deviation in the day of the eclipse.

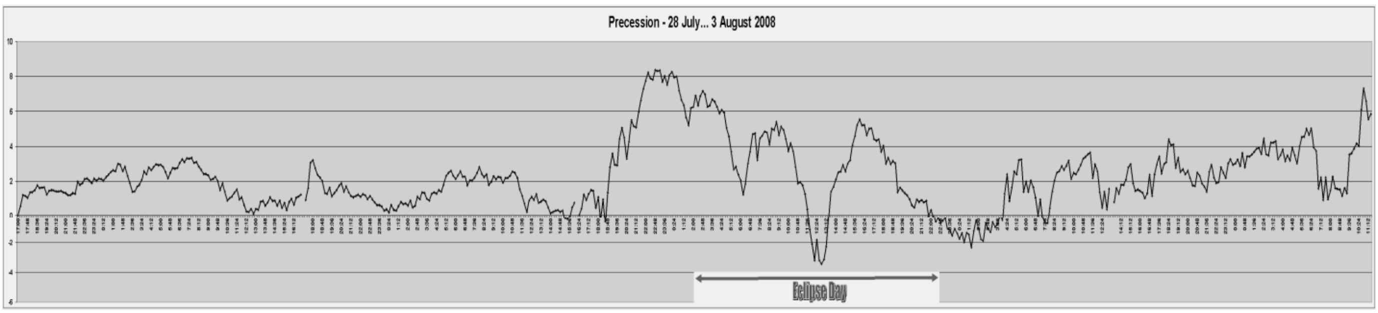
The graph 2 gives the evolution of the azimuths of the 2 short pendulums during 14 h spanning the eclipse. It shows that the large deviation of the automated pendulum starts exactly at the beginning of the eclipse, and that for the manual pendulum a large deviation starts also at this time, but in the opposite sense.

For the two pendulums the perturbed period goes from 9 am till 4 pm. Except in its middle (from 11:30 am till 2:12 pm), obviously it is not an isotropic precession. In fact it appears as a precession calling back towards a "direction of anisotropy" situated between the 2 plans of oscillation.

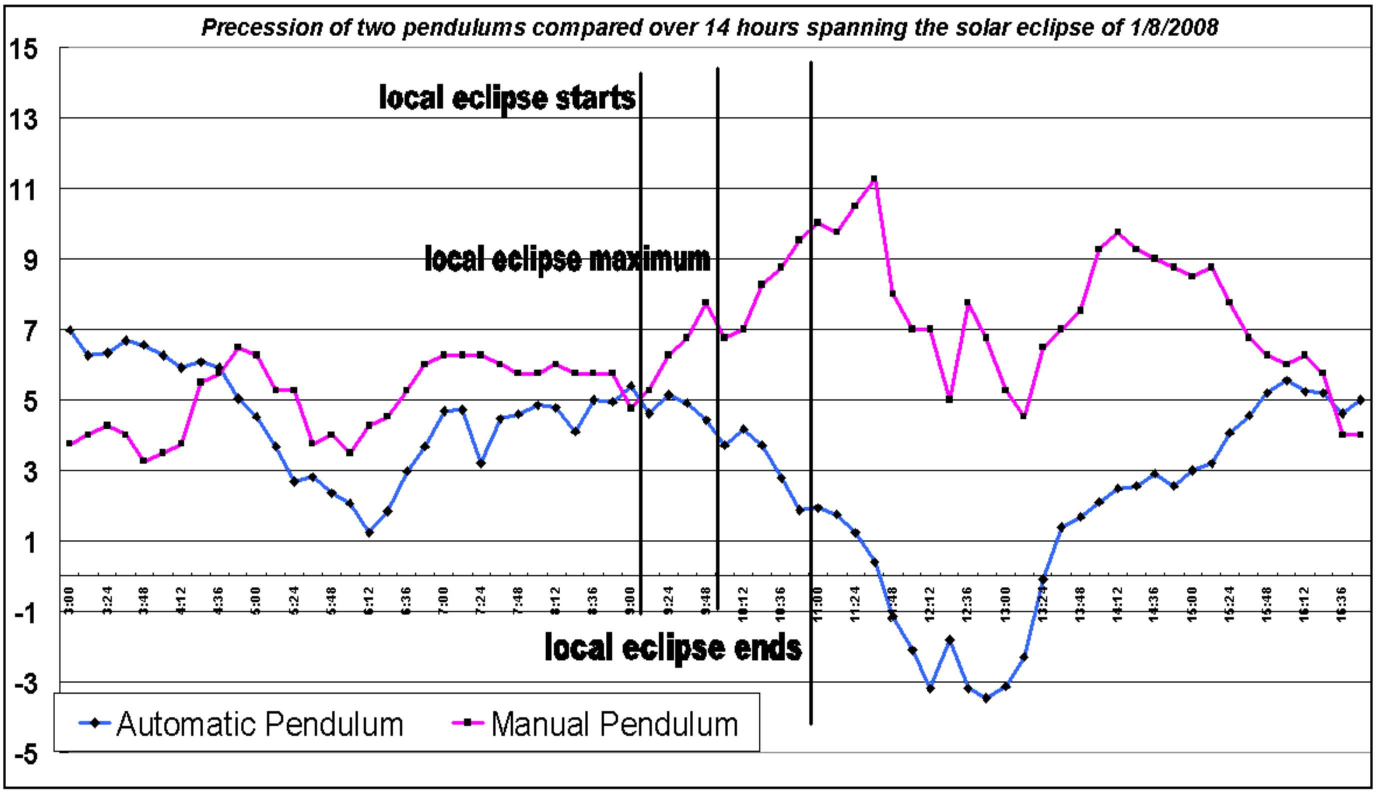
It is remarkable that the abnormal precession of the long pendulum (graph 3) begins only at 11:30 am, and that at this moment the behaviour of the 2 short pendulums changes also.

At about 11:30 am, the behaviour of several torsion balances changes also.

The recordings of the pressure and the temperature in Suceava showed nothing particular.

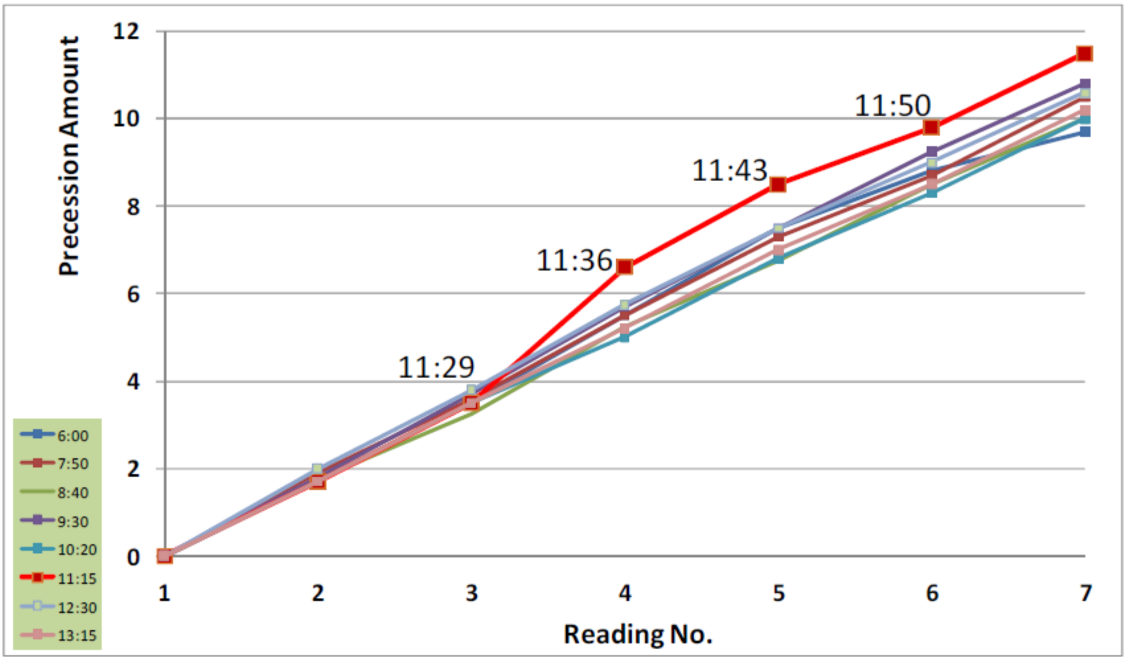


Graph 1


Precession of two pendulums compared over 14 hours spanning the solar eclipse of 1/8/2008
local eclipse starts
local eclipse maximum
local eclipse ends
Automatic Pendulum
Manual Pendulum
15
13
11
9
7
5
3
1
-1
-3
-5

Graph 2

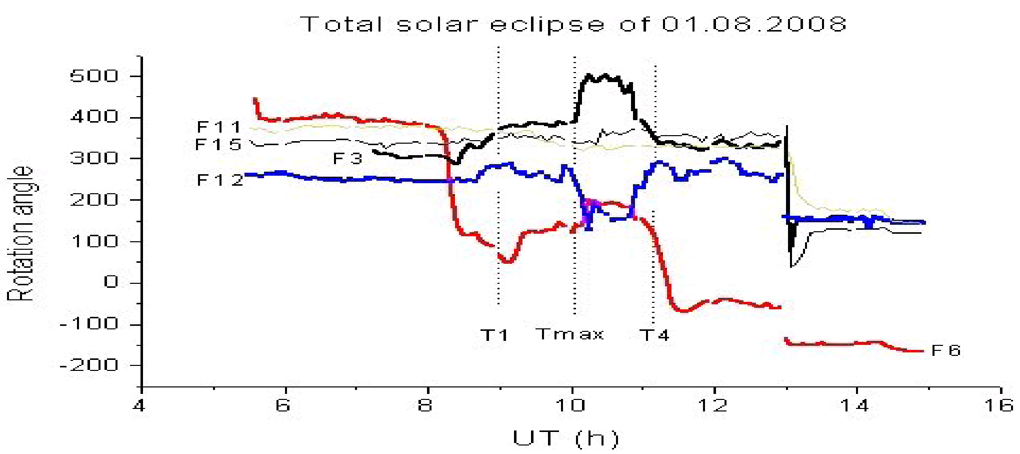
Long pendulum



Reading1, 2, 3, etc…: reading after 0mn, 7mn, 14 mn, etc…

Graph 3

Torsion balances in Kiev



Graph 4

ANNEX 4
Solar eclipse of May 10th , 2013

▪See ref. 15, which presents in a detailed way the conditions of the observation, which are reminded succinctly below:

- 3 automated torsion balances of the last type (they have a symmetry of revolution and they are called « torsinds » by the Pr Pugach) : one in Kiev, another in Comanesti, in the north of the Romania, and the third 40 m underground, in the salt mine of Cacica, 10 km far from Comanesti;
- 2 pendulums: one in the "pendularium" of Dimitrie Olenici, in Horodnic De Jos (about 50 km far from Cacica, the other in the salt mine of Cacica). The length of these pendulums was about 6 m. There were relaunched from the same azimuth at each elementary observation (at each "determination"). The double angular amplitude of the motion is large: about 0,2 rd. The small semi-axis b was measured: so it was possible to calculate the Airy precession.

▪The graph 1 shows the deviations of the 3 torsinds.
Obviously something which is remarkable happens at about 23 h 30 UT (about 1 hour before the maximum of the eclipse): there is a minimum of the deviations for the 3 torsinds.
We are allowed to say that, very probably, this is linked to the eclipse.

▪The graph 2 shows the deviations of the Horodnic pendulum after 7mn, 14mn, 35mn.
The measures (44 "determinations") are spread over almost 7 days (from May 5th 10 h UT to May 12th 4 h 35 UT), but they are not continuous (the pendulum was not automated).

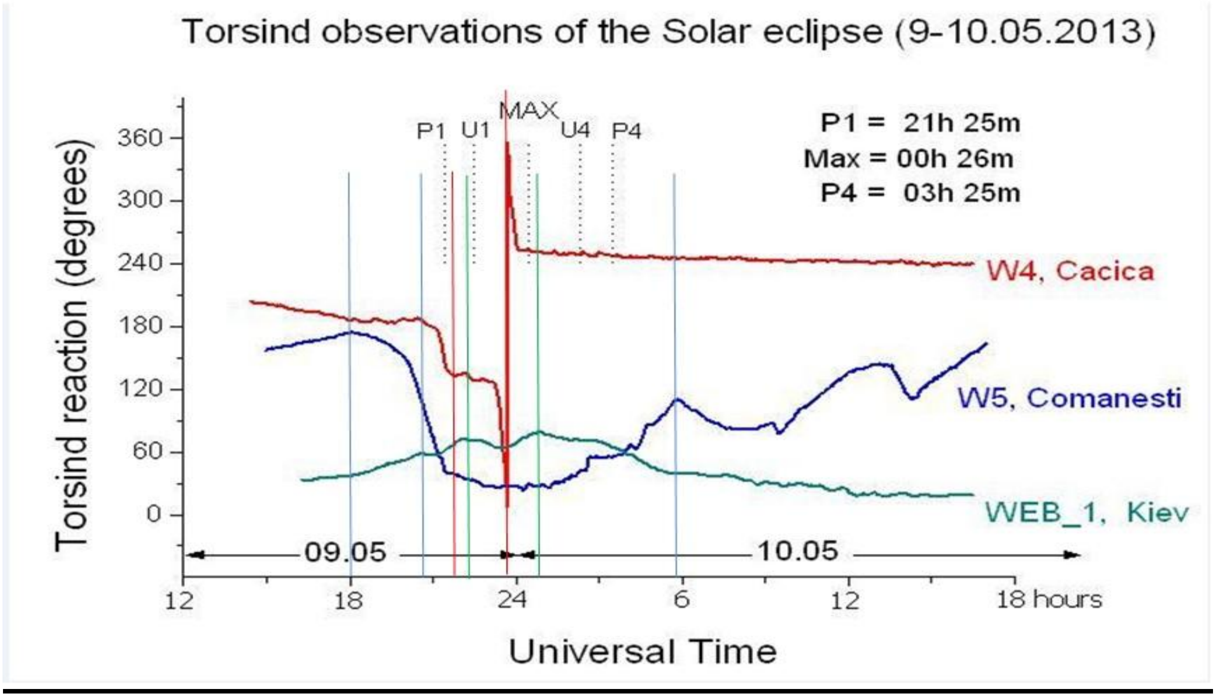
The curves of the deviations after 14mn, 21mn, 28mn and 35mn are very similar: it results from the fact that the Airy precession has become preeminent. Only the curve of the deviation after 7mn is very peculiar: it results from the fact that the precession is still mainly a "direct" precession". In fact this curve looks probably like the curve that we should have obtained with a "long" pendulum (see §2.3.4.1).

The graph 3 is devoted to this deviation after 7mn. In addition to the azimuth, it shows the calculated Airy's precession and the temperature.
The most large deviation is at 23 h 32, which coincides with the minimum of the deviations of the torsinds: **so we can think that it results also from the eclipse.**
The value of the deviation at 23 h 32 is the minimum of the 44 measures of the deviation after 7mn. That means that there was only 1 chance among 44 that it occurs so.

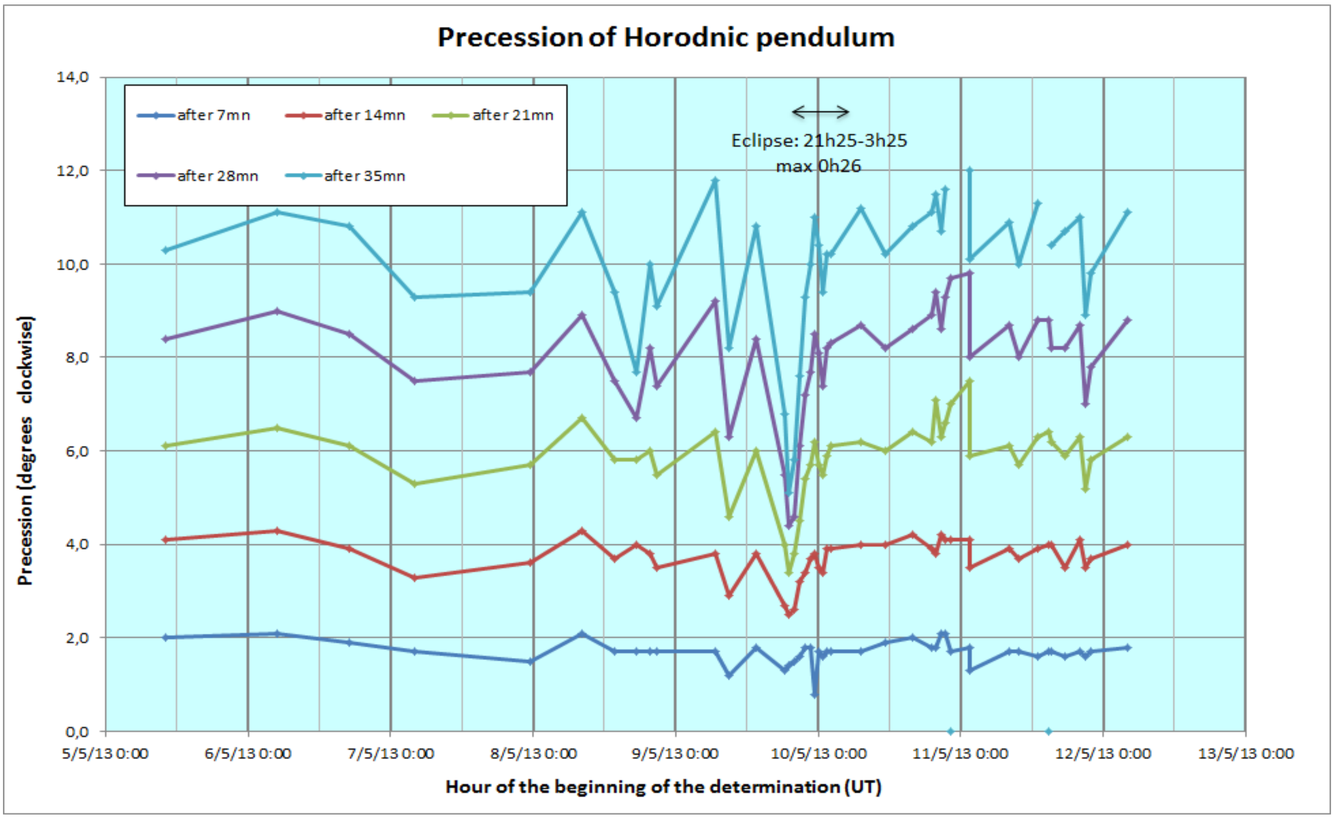
It is sure that this deviation **results only from a "direct" precession**: the curve giving the Airy precession is then flat.
It is important to note that the sense of the deviation of the plan of oscillation is the same that the sense of the deviations of the torsinds.

The graph 4 is devoted to one of the other deviations: the deviation after 28mn.
It confirms that the variation of the azimuth results mainly from the variations of the Airy's precession.

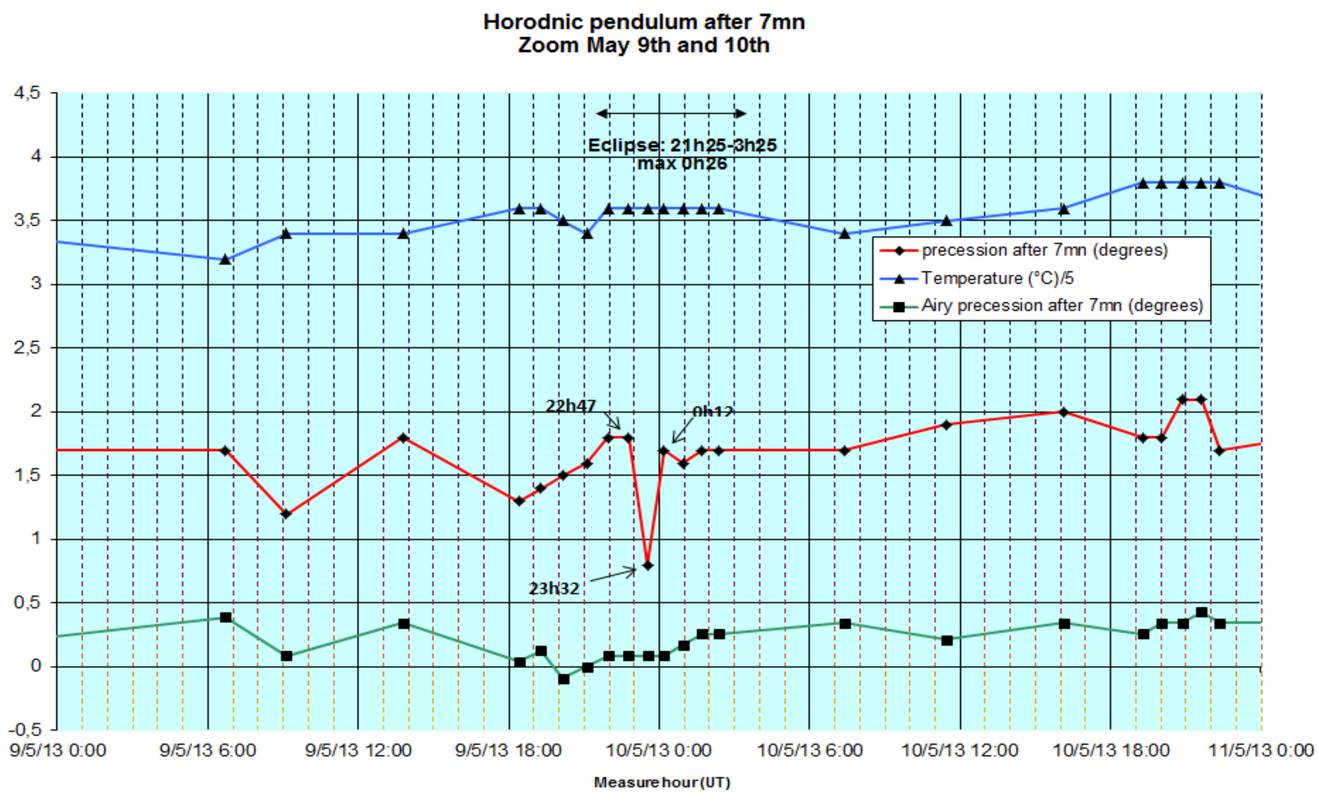
The minimum of the main deviation is at 19 h 38 UT. It seems rather unlikely that this deviation results from conventional causes, but the link with the eclipse is less certain than for the deviation at 23 h32 of the curve after 7mn.



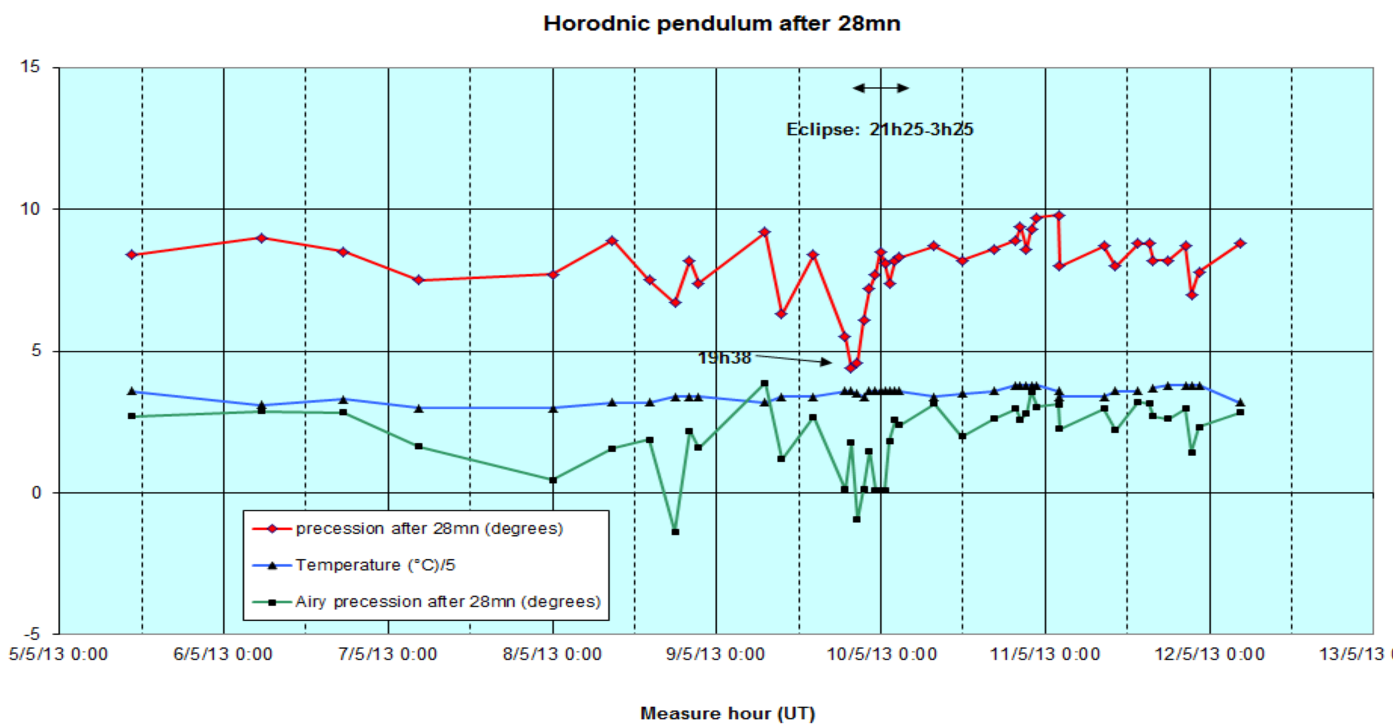
Graph 1



Graph 2



Graph.3

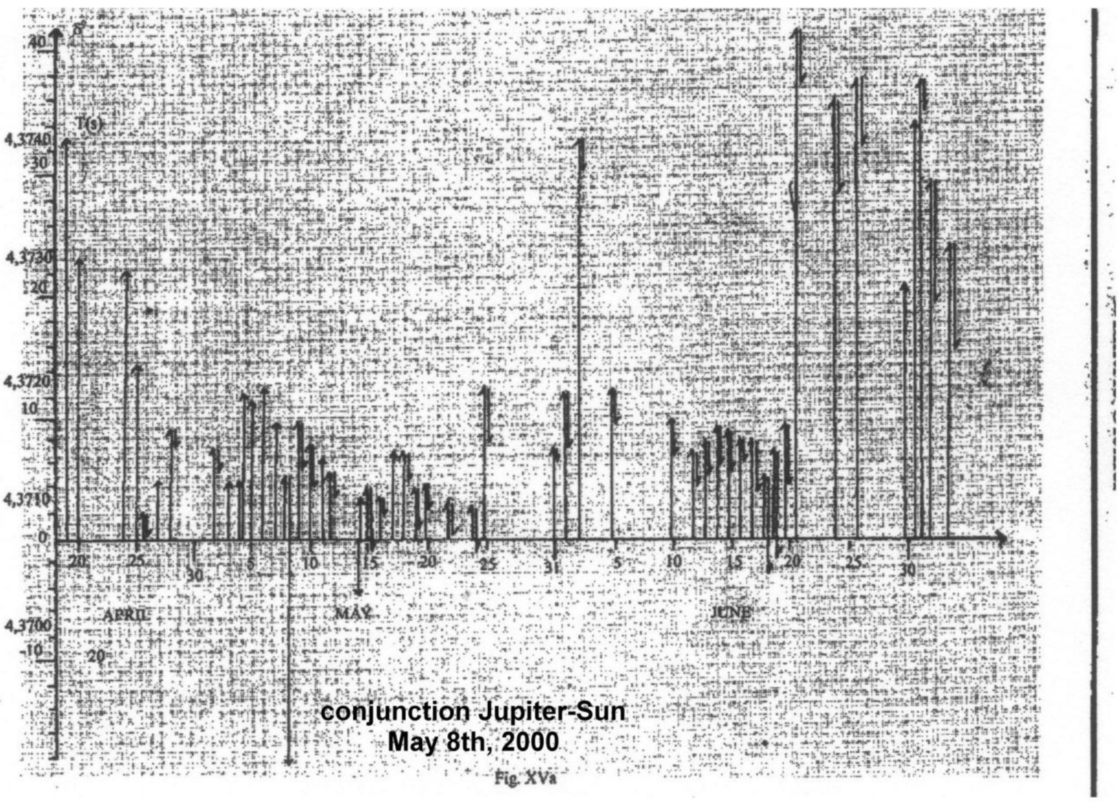


ANNEX 5
Conjunction Sun- Jupiter May 8th, 2000

D. Olenici (Suceava- Romania ; April 2000 - June 2000 ; paraconic pendulum ; length approximately 6m) : cf ref.11.
The pendulum was always launched from the same azimuth.
The tip of the arrow pointed upwards shows the value of the higher angular deviation of the plan 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.

The observations concerned 50 days, from April, 2000 till June, 2000.

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.



ANNEX 6
Ovalization of the trajectory and Airy's precession

The Airy's precession

The speed of the Airy's precession is:

(1) $\Theta' = \frac{3}{8} \sqrt{\frac{g}{l}}\ \alpha\ \beta$ (the plane turns in the same sense than the ellipse is described)

where α and β are respectively the 1/2 major angular axis and the 1/2 minor angular axis of the ellipse, and *l* the equivalent length of the pendulum.
Also we must have α«1 et β «1.

▪ If β remains constant, that is the case when the ovalization results from a **punctual** cause (a shock, for example), the influence of the perturbation is a speed of precession which is constant, and proportional to $\alpha / \sqrt{l}$

▪ "**Anisotropy**": For a lot of possible reasons, conventional or not[16], the periods in two perpendicular directions may be slightly different (to note that in this case you have a **resonant** perturbation):

(2) $T= T_0\ [1+ \eta \cos^2(\theta - \theta_0)\ ]$ ($\eta \ll 1$) (the period is maximum in the direction θ_0)

- We can demonstrate[17] that it results from that difference between periods both a « direct » precession, the speed of which is Θ'_d , and an ovalization of the trajectory, which causes an Airy's precession, the speed of which is Θ'_i:

(3) $\Theta'_d = \eta\ \omega\ (\beta/\alpha) \cos 2(\theta - \theta_0)$ (= direct action)

(4) $\beta' = - \eta\ \alpha\ \omega \sin 2(\theta - \theta_0) /2$.

Therefore (we can consider that α remains constant):

$\beta(t) = -[\ \eta\ \omega\ \alpha \int_0^t \sin(2(\theta - \theta_0))\ dt]/2 + \beta_0 = - ½\ t\ \eta\ \omega\ \alpha\ \overline{\sin(2(\theta - \theta_0))} + \beta_0$

where $\overline{\sin(2(\theta - \theta_0))}$ = average value of $\sin(2(\theta - \theta_0))$ on [0,t]

⇨ (5) $\Theta'_i = \frac{3}{8}\ \omega\ \alpha\ \beta = - \frac{3}{16}\ t\ \eta\ \omega^2\ \alpha^2\ \overline{\sin(2(\theta - \theta_0))} + \frac{3}{8}\ \omega\ \alpha\ \beta_0$

- The direct effect calls back the plane of oscillation towards the direction in which the period is minimum.

---

16 This can be an anisotropy of the suspension, the attraction of a mass, a dissymmetry of the bob, an "anisotropy of the space" as it was defined mathematically by Maurice Allais (ref. 1, p 211),…

17 Cf. the article of Pippard (ref. 2), p83 (with different notations), or Allais (ref. 1)

The indirect effect calls back the plane of oscillation towards the direction in which the period is maximum.

The ratio between the direct effect and the indirect effect can be deducted from (1) and (3):

$\Theta'_i / \Theta'_d = 3\alpha^2 / [(8\eta \cos 2(\theta - \theta_0)] > 3\alpha^2/(8\eta)$ (6)

- ⇨ In the case of the Allais's pendulum (α=0,1rd; l=0,83m), we have $\Theta_i' / \Theta_d' > 3{,}6.10^{-3} / \eta$

- ⇨ For such a pendulum the indirect effect is dominant if the anisotropy remains very small ($\eta < 10^{-4}$, for example).

- Besides **this indirect effect is proportional to** $\frac{\alpha^2}{l}$

Remarks:

- The indirect effect on the precession of a difference between the periods in two perpendicular directions is dominant and proportional to $\frac{\alpha^2}{l}$: so you can make a given pendulum much more sensitive to this kind of perturbation by increasing α.

However the ovalization remains proportional only to $\alpha/\sqrt{l}$

- Then, at least at the beginning, the speed of the precession (as β) is proportional to t, and the precession to t^2 :see (5).
=> at the beginning the Airy's precession remains very small
Therefore at the beginning the precession of a "short" pendulum is the same as the precession of a "long" pendulum.
But the ovalization becomes noticeable **before** the Airy precession.