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Maurice ALLAIS

THE "ALLAIS EFFECT"

AND MY EXPERIMENTS WITH THE PARACONICAL PENDULUM

1954-1960

A memoir prepared for NASA

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THE "ALLAIS EFFECT"

AND MY EXPERIMENTS WITH THE PARACONICAL PENDULUM

1954-1960

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The spirit of denial urges one to reject anything which is not immediately included in the hypotheses with which one is familiar.

Andre-Marie Ampère

Memoir on the Mathematical Theory of Electrodynamic Phenomena, 1887

I advise those who wish to learn the art of scientific prediction not to spend their time upon abstract reasoning, but to decipher the secret language of Nature from the documents found in Nature: experimental facts.

Max Born

Experiment and Physical Theory, 1943

The important facts are the crucial facts…. that is to say, those which can confirm or invalidate a theory. After this, if the results are not in accord with what was anticipated, real scientists do not feel embarrassment which they hasten to eliminate with the magic of hand-waving; on the contrary, they feel their curiosity vividly excited; they know that their efforts, their momentary discomfiture, will be repaid a hundredfold, because truth is there somewhere, nearby, still hidden and, so to speak, adorned by the attraction of the mystery, but on the point of being unveiled.

Henri Poincaré

Last Thoughts, 1913

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When a revision or a transformation of a physical theory is produced, one finds that at the starting point there is almost always a realization of one or several facts which cannot be integrated into the framework of theory in its current form. Facts remain always the key to the vault, upon which depends the stability of every theory, no matter how important.

For a theoretician really deserving of the name, there is accordingly nothing more interesting than a fact which contradicts a theory which has been previously considered to be true, and thus real work starts at this point.

Max Planck

Initiation to Physics, 1941

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THE PURPOSE OF THIS MEMOIR

The present memoir has been prepared at the occasion of the vast enquiry initiated by NASA under the direction of David Noever about the *“Allais Effect”* during the eclipse of 11 August 1999.

1 – The “Eclipse Effect” considered from a more general angle

First, this memoir is intended to present several essential observations on the “eclipse effect” which I brought to light during the eclipses of 1954 and 1959 during the experiments performed with an asymmetrical paraconical pendulum with anisotropic support (the “Allais Pendulum”).

It is also intended to bring to light connections between the “eclipse effect” and anomalies discovered during the continuous observations of the paraconical pendulum performed from 1954 to 1960, and to show that this effect is only a particular aspect of a much more general phenomenon.

2 – My experiments with the asymmetric paraconical pendulum 1954-1960

By explaining several essential points relating to my experiments, this memoir can also be very useful for the interpretation of results obtained with the Allais pendulum in light of those obtained with Foucault pendulums.

It can also help with the reading and understanding of those parts of my work "The Anisotropy of Space" devoted to the paraconical pendulum with anisotropic and isotropic supports[1].

[1] *The Anisotropy of Space*, pp. 79-235 and 237-330.

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Finally, this memoir will facilitate the effective rerun of my experiments on the paraconical pendulum (Appendix II, below).

3 – Imminent discussions with David Noever in Paris

An essential objective of this memoir is also to prepare for an effective exchange of views with David Noever when he passes through Paris in the near future.

4 – Principles of composition

This memoir includes a main text, annexes, and appendices.

- The main text includes three parts: - the "eclipse effect", my experiments 1954-1960 with the asymmetric paraconical pendulum, and an overall view.

In the main text, I limit myself to an analysis of the observed facts, without formulating any hypothesis.

- In the three annexes I reject the analysis of certain hypotheses.

- In the three appendices I present certain observations on the immense literature on the Foucault pendulum and related experiments, I make certain suggestions for an effective rerun of my experiments with the asymmetric paraconical pendulum, and I cite various supplementary references[2].

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[2] This memoir, which has been prepared in haste, is certainly imperfect, and is very incomplete in view of the great complexity of the questions discussed.
It also includes various repetitions, which are unavoidable due to the interconnections between the First and Second Parts.

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- On the opposite (left hand) pages (numbered with asterisks) I have presented various essential propositions, surrounded by blocks.
- Finally, in order to facilitate reading this memoir in its proper relationship with my 1997 work "The Anisotropy of Space", I have also reproduced on the opposite pages certain graphics and tables from that work, with short commentaries.

Translator's notes:

(a) In all his voluminous work on the pendulum, Prof. Allais uses an idiosyncratic angular unit, the "grade". 400 grades equal one full turn, so 100 grades are equal to a right angle. He also occasionally uses centesimal minutes and seconds which are respectively hundredths and ten-thousandths of these grades. Whatever may be the merits of this system, it is not conventional, at least in modern work presented in English. However I have not attempted to eliminate these grades in the translation, because they are deeply embedded in the tables and graphs, and all Prof. Allais's numerical results are expressed in terms of grades.

(b) Prof. Allais's many writings refer to one another in many places, usually by page number. Changing these references would be a difficult and open-ended task. Accordingly I have taken some pains to preserve the pagination of the original French documents.

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THE ALLAIS PENDULUM IS TOTALLY DIFFERENT FROM THE FOUCAULT PENDULUM

THE STRUCTURE OF THE PENDULUM IS DIFFERENT, THE SUPPORT IS DIFFERENT, AND THE OBSERVATIONAL PROCEDURE IS DIFFERENT

Part A

THE ECLIPSE EFFECT

I - THE ALLAIS PENDULUM AND THE FOUCAULT PENDULUM

1. - Arrangements

First, it is essential to underline that the Allais pendulum is completely different from the Foucault pendulum. The structure of the pendulum is different, the support is different, and the observational procedure is different[3].

a – Structure of the Allais pendulum

The differences between the Allais pendulum and the Foucault pendulum are essentially the following (pp. 81-86):

1 – The Allais pendulum is suspended with a ball (whence its appellation 'paraconical'), and this permits the pendulum to rotate around itself, whereas the Foucault pendulum is connected to a wire which supports it (p. 175).

2 – The Allais pendulum is a short pendulum whose length is 83 cm (p. 84), as against several meters or several tens of meters in the case of the experiments of Foucault and his successors.

In fact, it is well known that it is *very difficult, if not impossible*, to obtain the Foucault effect continuously with short pendulums (p. 174).

[3] All the page references below relate to my work "*The Anisotropy of Space*".

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3 – The Allais pendulum is suspended by a bronze rod (p. 81), whereas the Foucault pendulum is suspended by a metallic wire.

4 – The Allais pendulum has a vertical disk. It is an *asymmetric* pendulum (p. 81), whereas the Foucault pendulum is a *symmetric* pendulum.

b – Support of the Allais pendulum

In my experiments, the support of the Allais pendulum was *anisotropic* (pp. 79-235), or *isotropic* (pp. 237-330).

As far as can be judged, the support of the Foucault pendulum is in principle *isotropic*. But, as far as I know, no experiment has ever been performed to determine the actual degree of anisotropy of the support, in any experiment on a Foucault pendulum.

c – Observational procedure for the Allais pendulum

In the *Allais procedure*, the work continues over a period of one month, day and night, releasing the pendulum every 20 minutes, with *successive* chained observations each of 14 minutes, and with amplitudes which continue to be of the order of 0.1 radians (pp. 84-86).

By contrast, the period of observation for a Foucault pendulum is generally only a few hours, with steadily reducing amplitude.

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THE MOVEMENTS OF THE ALLAIS PENDULUM ARE TOTALLY DIFFERENT FROM THOSE OF THE FOUCAULT PENDULUM

2. – Entirely different movements

The movements of the Allais pendulum are entirely different from those of the Foucault pendulum.

a – The theoretical Foucault effect

Theoretically, the plane of oscillation of a Foucault pendulum turns with an angular speed of roughly $-\omega \sin L$, and its oscillations remain *approximately* planar, at least at the start of the experiment.

In fact, and to the best of my knowledge, no experiment on the Foucault pendulum has ever rigorously yielded the theoretical rotation $-\omega \sin L$ for several hours. In particular, small ellipses always appear, accompanied by the *Airy precession*:

$$\varphi' = (3/8)\, p\, \alpha\, \beta \qquad\qquad p = 2\pi / T = \sqrt{g/l}$$

where φ represents the azimuth of the plane of oscillation of the pendulum, α and β the major and minor axes in radians of the elliptical trajectory of the pendulum, and T its period of oscillation.

(For the precession of Airy, see p. 120)[4]

b – The formation of ellipses

While the oscillations of the Foucault pendulum remain *approximately plane* or become small – but not negligible - ellipses, the oscillations of the paraconical pendulum are characterized by *the formation of ellipses* which, as far as can be judged, play an *essential* role, notably due to the Airy effect.

[4] See below Section B.3, pp. 26.

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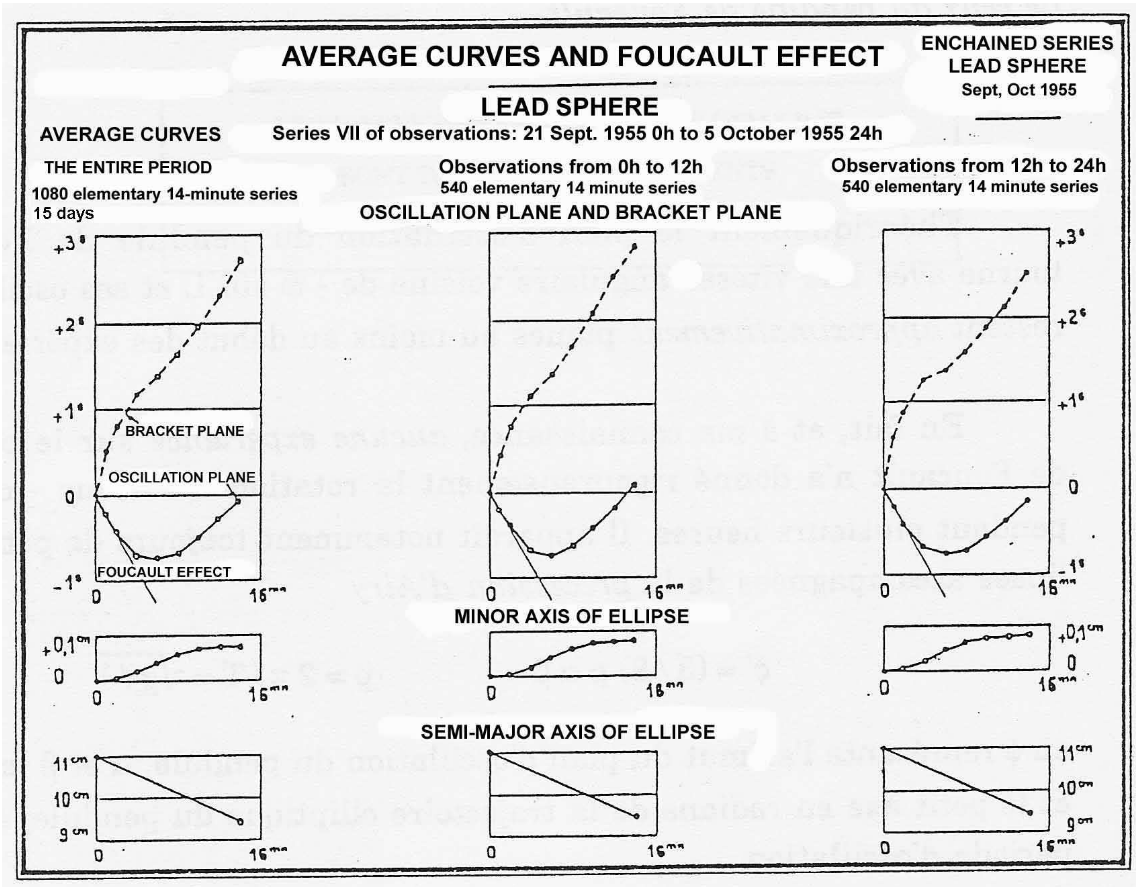
Graph IV



Legend: azimuth of the plane of oscillation; azimuth of the principal trihedral of inertia

Source: Graph III A 1 of my Conference of 22 February 1958

***The Anisotropy of Space*, p. 95.**

AT THE START OF EACH 14 MINUTE EXPERIMENT, IT IS SEEN THAT THE TANGENT AT THE BEGINNING OF THE GRAPH REPRESENTING THE AZIMUTH CORRESPONDS EXACTLY TO THE FOUCAULT EFFECT.

As long as the oscillations of a paraconical pendulum stay plane, which is the case at the beginning, it exhibits precisely the Foucault effect (pp. 94, 95).

In the case of the *anisotropic support*, the formation of ellipses is due to both the anisotropy of the support, which is *invariant over time* (p. 180), and to the anisotropy of space, which is *variable over time*.

In the case of the isotropic support (pp. 241-246), the formation of ellipses is only due to the anisotropy of space.

c – The paraconical pendulum and the Foucault effect

In all my experiments on the paraconical pendulum, the tangent to the curve representing the azimuth corresponded at the beginning exactly to the Foucault effect (pp. 93-96) (see Graph IV opposite, from page 95):

$$- \omega \sin L = - 0.55 \times 10^{-4} \text{ radian}$$

But the Foucault effect disappears rapidly with the formation of ellipses. These are due to *both* the anisotropy of the support (pp. 93-94 and 176-182) and to the anisotropy of space.

d – The existence of a limit plane

In the case of the Allais pendulum with anisotropic support (pp. 79-235), and with isotropic support (pp. 237-330), everything happens as though there would exist at each instant *a limit plane, variable with the passage of time, to which the plane of oscillation tends constantly over the 14 minutes of each elementary experiment.*[5]

In the case of the paraconical pendulum with an*isotropic support*, this limit plane depends on *both* the anisotropy of the support (p. 180) and on the anisotropy of space (pp. 193-196).

[5] On the existence of a limit plane, see Section III of Part Two, pp. 29-33 below.

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In the case of the paraconical pendulum with *isotropic support*, this limit plane only depends on the anisotropy of space (pp. 255-268).

The existence of a limit plane which is variable over time is perfectly illustrated by the triple-chained experiments (pp. 103-104)[6].

Apparently the existence of a limit plane variable with time has never been demonstrated with the Foucault pendulum, while, with the Allais pendulum, everything happens as though its plane of oscillation tends towards a limit plane at each instant during a 14 minute experiment (see in particular pp. 103-104).

While the plane of oscillation of a Foucault pendulum turns constantly in the retrograde direction with the angular speed - $\omega \sin L$, the principal component of the plane of oscillation of the paraconical pendulum *with isotropic support* can turn constantly in the prograde direction during a single month (pp. 259-261, Graph II)[7].

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[6] See Section III A.1 of Part B, pp. 29-29*

[7] See Section III A.2 of Part B, pp. 32-32*

THE ENQUIRY ORGANIZED BY NASA ON THE OCCASION OF THE TOTAL ECLIPSE OF 11 AUGUST 1999 MAY RESULT IN EXTREMELY USEFUL DATA FOR ELUCIDATING THE EXTENT TO WHICH LONG FOUCAULT PENDULUMS CAN EXHIBIT THE "ECLIPSE EFFECT," WHICH I DEMONSTRATED WITH A SHORT PENDULUM

3. – Implications

In fact, from all points of view, the Allais pendulum is profoundly different from the Foucault pendulum as far as its characteristics and its conditions of observation are concerned.

This implies that the research during the total eclipse of 11 August 1999, initiated by NASA, will be able to provide extremely useful information for determining to what degree the motion of long Foucault pendulums displays the "eclipse effect," which I brought to light with a short pendulum[8,9].

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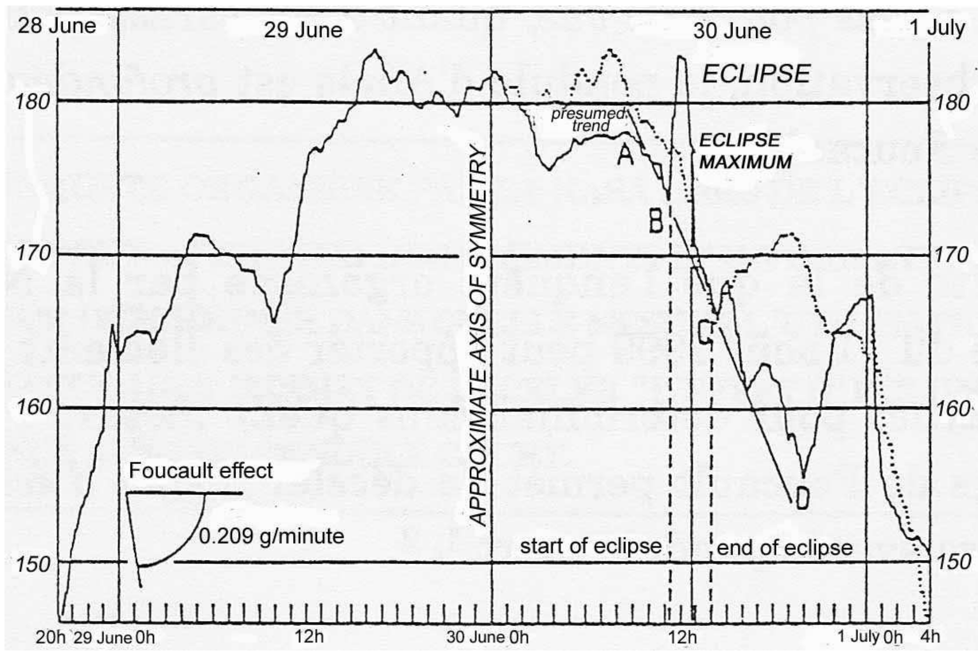
[8] On the eclipse of 11 August 1999, see Annex III below, p. 62.
[9] On long and short pendulums, see Annex II below, p. 54.

GRAPH XXIX: *TOTAL SOLAR ECLIPSE OF 30 JUNE 1954 OBSERVED AZIMUTHS OF THE PARACONICAL PENDULUM FROM 28 JUNE 20H TO 1 JULY 4H*

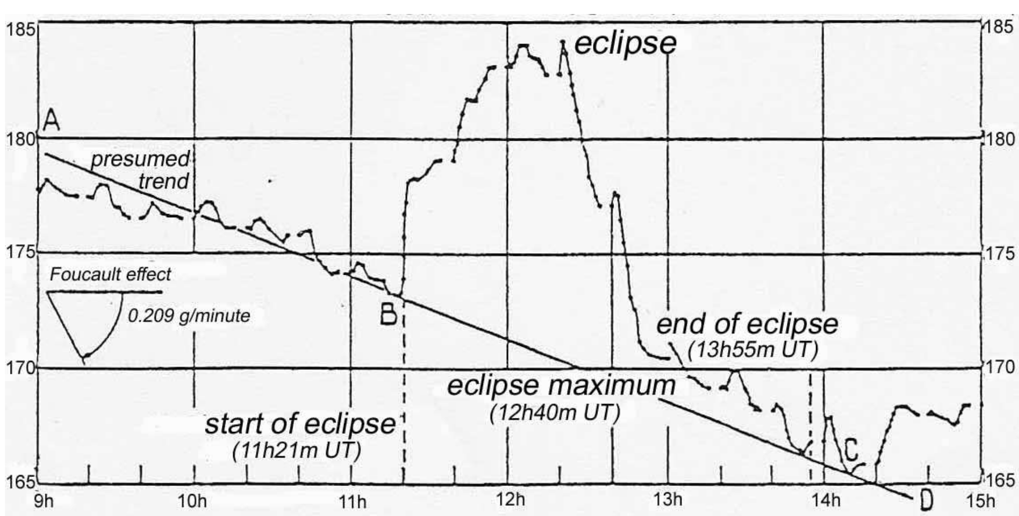


LEGEND

——— **Azimuths observed every 20 minutes**

………… **Curve symmetric to the solid curve on the left, with respect to 30 June 0h**

GRAPH XXX: *TOTAL SOLAR ECLIPSE OF 30 JUNE 1954 OBSERVED AZIMUTHS OF THE PARACONICAL PENDULUM FROM 30 JUNE 9H TO 30 JUNE 15H*



Source: Note of 4 December 1957 to the Academy of Sciences - Movements of the paraconical pendulum and the total solar eclipse of 30 June 1954, CRAS, vol. 245, pp. 2001-2003

***The Anisotropy of Space*, p. 165**

II – EFFECTS OBSERVED DURING THE ECLIPSES OF 30 JUNE 1954 AND 2 OCTOBER 1959

1. – Three series of observations

Three series of observations, designated below as A, B, and C, were performed during the eclipses of 1954 and 1959, which were partial at Paris.

The three series of observations A, B, and C were mutually independent.

These three series of observations were performed in my laboratory in Saint-Germain-en-Laye.

The eclipse of 1954

The first series A was performed during one month-long series of observations (from 9 June to 9 July 1954), using an anisotropic support (p. 92).

A *very marked* effect was noticed on the 30 June 1954. It was *totally unexpected* (pp. 162-165).

In fact, this effect was *spectacular*[10]. It seemed even more so, because no such *brutal* displacement had been seen over the previous period from the 9th to the 30th of June 1954, nor was seen over the subsequent period from the 30th of June to the 9th of July.

[10] It was particularly so for my laboratory head Jacques Bourgeot. He was the observer on duty at the moment of the eclipse, and he telephoned me a few minutes after the event to tell me of this utterly spectacular displacement.

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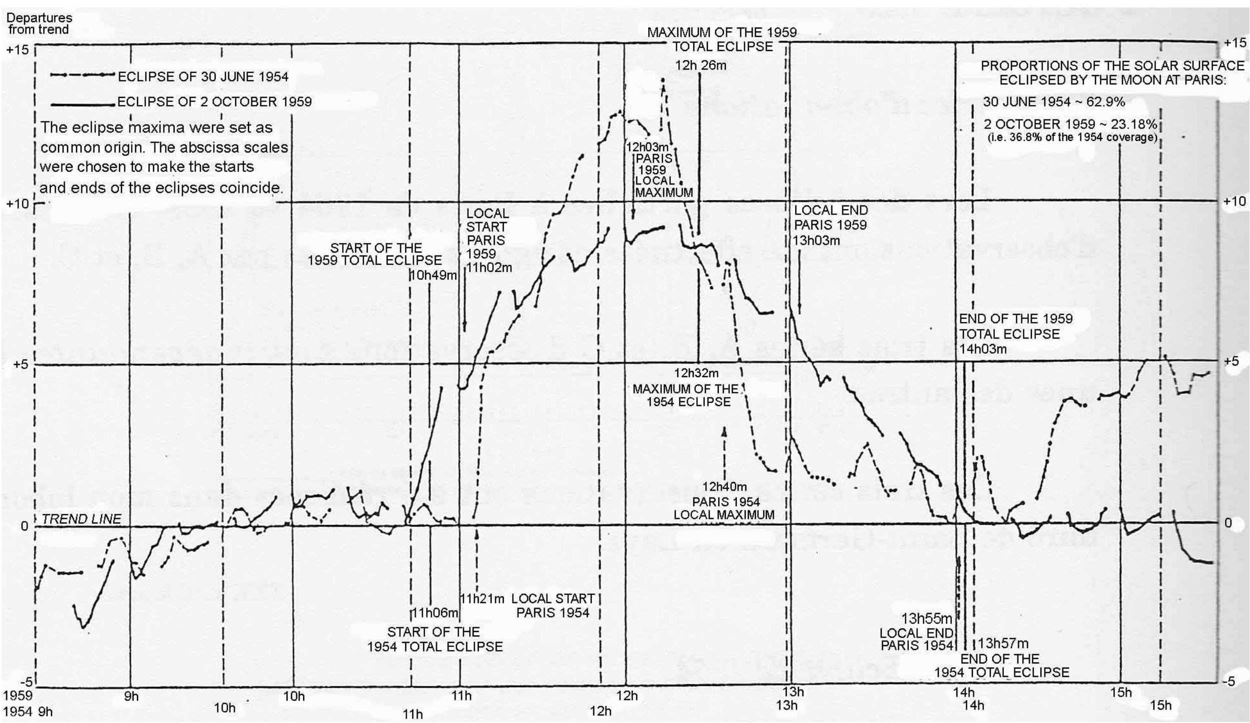
Graph XXXIII

COMPARISON OF THE AZIMUTHS OBSERVED
DURING THE TWO ECLIPSES
OF 30 JUNE 1954 AND 2 OCTOBER 1959



Source: Allais, unpublished note of 10 November 1959, Movement of the paraconical pendulum and the total solar eclipse of 2 October 1959

The eclipse of 1959

Two series of observations B and C were performed simultaneously in order to observe the movement of paraconical pendulums during the eclipse of 2 October 1959.

Series B (30 September - 4 October 1959) was performed with the anisotropic support (pp. 166-167). A comparison is made with Series A (pp. 168-170). Refer to Graph XXXIII opposite, from page 170.

Series C (28 September - 4 October 1959) was performed with the isotropic support (pp. 315-319)[11].

It should be appreciated that in 1959 the amount of the solar surface eclipsed was only 36.8% of the surface eclipsed in 1954 (p. 168, note 1).

[11] See below, p. 19*

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2. – Structures of the pendulums and processes of observation during the eclipses of 1954 and 1959

- *Series A*

Asymmetrical pendulum consisting of a vertical disk and two horizontal disks of bronze. Total mass 19.8 kgs (p. 91). Length of the equivalent pendulum: about 90 cm.

- *Series B and C*

Asymmetrical pendulum consisting of a vertical disk of 7.5 kgs (p. 81). Total mass of the pendulum 12 kgs (p. 84). Length of the equivalent pendulum: 83 cm.

In the case of an asymmetrical pendulum one can show, and experiment confirms, that the plane of the disk tends to bring itself to the plane of oscillation of the pendulum (p. 93).

- *Series A, B, and C*

Bronze rod and bracket: 4.5 kgs (p. 84); Bracket supported by a steel ball of 6.5 mm diameter (from which comes the term *paraconical pendulum* (p. 81)); Support: fixed for series A and B (p. 81); movable for series C (pp. 241-242) (in this last case the plane of oscillation was able freely to assume any position between 0° and 180°).

- *The experimental procedure for series A, B, and C*

Each experiment lasted for 14 minutes. The pendulum was released every 20 minutes from the final azimuth which was attained in the previous experiment (pp. 84-85). The azimuths were measured in *grades* (400 grades = 360°), from the north, in the prograde direction (p. 87).

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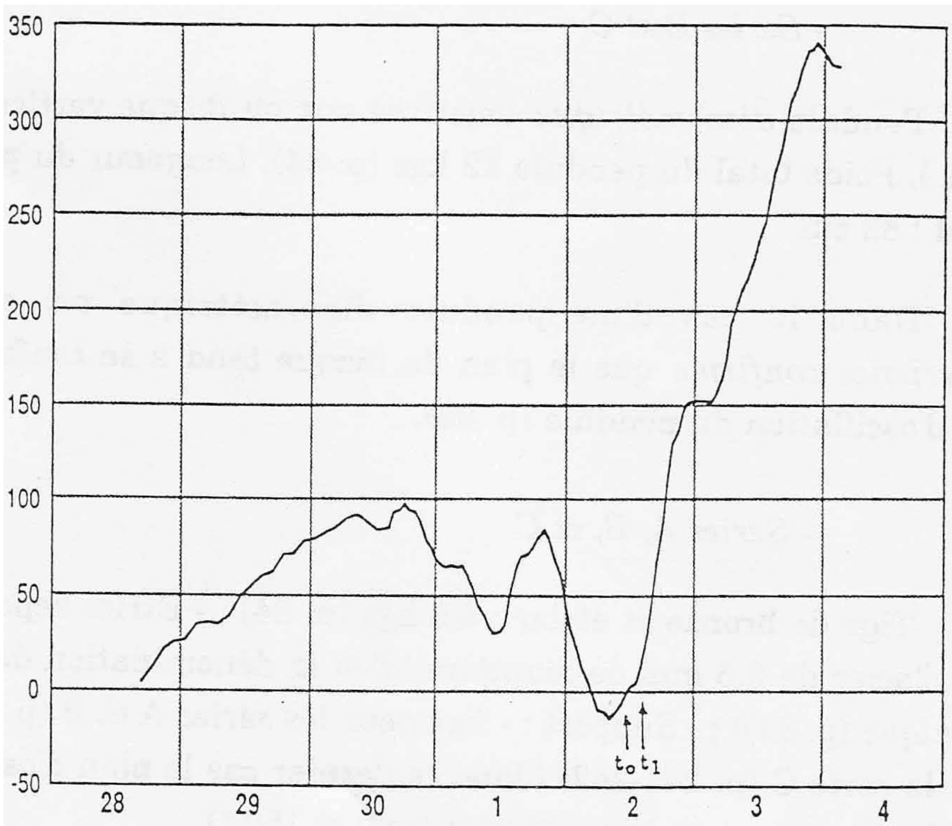
Graph XXIII

PARACONICAL PENDULUM WITH ISOTROPIC SUPPORT

Chained Series

28 September 1959, 16h 20m — 4 October 1959, 3h 40m

Hourly azimuths φ in grades



September *October*

Legend: t_0 and t_1 – beginning and end of the total solar eclipse of 2 October 1959
Azimuths 0 and 200 grades correspond to the meridian.
Azimuths 100 and 300 grades correspond to the East-West direction.
Sources: *Graph 8617* (20 May 1996) and *Table 7461* (4 November 1982)

Isotropic Support

***The Anisotropy of Space*, p. 318**

3. – Observations of the pendulums during the eclipses

a – Observations A and B with the anisotropic support

For the series A, it was seen that the plane of oscillation approached the meridian (azimuth 200 grades) during the eclipse (Graph XXIX, p. 165). The same thing happened for series B (Graph XXXI, p. 167).

Everything happened as though, in spite of the anisotropy of the support, the limit plane which was observed approached the Earth-Moon-Sun direction, which corresponded to the anisotropy of space.

I remind the reader that the direction of anisotropy of the support was 171 grades (p. 177).

b – Observations C with the isotropic support

The observations C were performed using the isotropic support, simultaneously with the observations B (pp. 315-319).

What was determined in this isotropic support case (Graph XXIII, p. 318, reproduced opposite) was that *at the moment of the eclipse the plane of oscillation approached the meridian, just as for the anisotropic support.*

By contrast, no spectacular deviation of the plane of oscillation was observed at the moment of the eclipse, as was the case with Graph XXIX (p. 165) for the observations A during the eclipse of 1954[12].

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[12] See above, p. 16*

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DURING THE THREE SERIES OF OBSERVATIONS, EACH INDEPENDENT FROM THE OTHERS, THE BEHAVIOR OF THE PARACONICAL PENDULUM WAS ABSOLUTELY COMPATIBLE WITH ITS BEHAVIOR IN THE MOST GENERAL CASE: A TENDENCY OF THE PLANE OF OSCILLATION OF THE PENDULUM TO APPROACH A LIMIT DIRECTION, VARIABLE OVER TIME, RESULTING FROM BOTH THE ANISOTROPY OF SPACE AND THE ANISOTROPY OF THE SUPPORT.

4. – Common characteristics of the observations A, B, and C

1. The observations B and C represent observations of the *same phenomenon* – the partial eclipse of 1959.

2. In the three series A, B, and C of observations, the plane of oscillation of the pendulum *approached the meridian.*

In cases A and B, the plane of oscillation of the pendulum was exposed to a force tending to bring it back to the direction of anisotropy of the anisotropic support (171 grades). *The influence of the anisotropy of space accordingly won out over the influence of the anisotropy of the support*.

3. *In all three cases, the behavior of the paraconical pendulum was completely analogous to its behavior in the most general case, i.e. a tendency of the plane of oscillation of the pendulum to approach a limit plane which was variable over time*[13].

[13] § B III below, pp. 29-34.

THE ECLIPSE EFFECT IS ONLY A VERY PARTICULAR CASE OF A MUCH MORE GENERAL PHENOMENON: THE EXISTENCE AT EACH INSTANT OF A DIRECTION OF ANISOTROPY OF SPACE, VARIABLE OVER TIME, TO WHICH THE PLANE OF OSCILLATION OF THE PENDULUM TENDS TO APPROACH DURING EACH ELEMENTARY EXPERIMENT OF 14 MINUTES.

DURING A TOTAL SOLAR ECLIPSE, THE DIRECTION OF ANISOTROPY OF SPACE BECOMES COINCIDENT WITH THE EARTH – MOON – SUN LINE.

III – THE ECLIPSE EFFECT –

A PARTICULAR CASE OF A GENERAL PHENOMENON

1. – A general phenomenon: the existence of a direction of anisotropy of space

1. The eclipse effect is only a very particular case of a much more general phenomenon: the existence at each moment of a direction of anisotropy, variable with the passage of time, towards which the plane of oscillation of the pendulum tends to approach during each elementary experiment of 14 minutes (pp. 193-195)[14].

2. In the case of the anisotropic support, the limit plane depends at the same time upon the anisotropy of the support, which is constant over time (pp. 176-183), and on the anisotropy of space, which is variable over time (pp. 193-196).

In the case of the isotropic support, the limit plane only depends upon the anisotropy of space. In this case, the limit plane is identified with the anisotropy of space (p. 240).

During a solar eclipse, the direction of anisotropy of space is the common direction of the Sun and the Moon.

2. – The relative significance of the eclipse effect

Actually there is a general phenomenon, of which the eclipse effect is only a special case – indeed, not the most interesting.

Part B of this memoir consists of an analysis of this matter.

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[14] Discussed in Part B, III below, pp. 29-34.

ALTHOUGH IT MAY BE VERY SPECTACULAR, THE ECLIPSE EFFECT IS MUCH LESS SIGNIFICANT THAN THE EFFECTS OF THE ANISOTROPY OF SPACE, AS DEMONSTRATED BY MY EXPERIMENTS WITH THE PARACONICAL PENDULUM WITH ANISOTROPIC AND ISOTROPIC SUPPORTS.

Indeed, the effects of the eclipse are spectacular and cannot be explained in the framework of currently accepted theories, b*ut they can give only a very partial amount of information.*

By contrast, the continuous experiments with the anisotropic and isotropic supports give *anytime* results which cannot be explained according to current theory.

Moreover, and above all, the experiments with the paraconical pendulum with isotropic support allow simultaneously determining the *direction* as well as the *periodic structure* of the anisotropy of space (pp. 184-187, 269-314).

23L **Table 1**

ASYMMETRICAL PARACONICAL PENDULUM WITH ANISOTROPIC SUPPORT
MONTH-LONG CHAINED EXPERIMENTS 1954-1960

Azimuths and periodic components of 24 and 25 hours in grades and in degrees
Σ = Azimuth of anisotropy of the support = 171.16 grades = 154.04 degrees

Period	Length in days (1)	Median date (2)	$\overline{\phi}$ (3)	ϕ_m (4)	ϕ_M (5)	$\frac{\phi_m + \phi_M}{2}$ (6)	$\frac{\phi_m + \phi_M}{2\overline{\phi}}$ (7)	D $= \phi_M - \phi_m$ (8)	$2R_{24}$ (9)	$2R_{25}$ (10)	R_{25}/R_{24} (11)	R_{24}/D (12)	R_{25}/D (13)
1 1954 9 June - 9 July	30	174,5	164 (148)	102 (92)	268 (241)	185 (166)	1,13	166 (149)	2,0 (1,8)	3,2 (2,9)	1,58	0,012	0,019
2 1954 16 Nov. - 22 Dec.	36	337,5	161 (145)	93 (84)	253 (228)	173 (156)	1,08	160 (144)	10,3 (9,3)	12,9 (11,6)	1,25	0,064	0,080
3 1955 7 June - 7 July	30	537,8	150 (135)	99 (89)	180 (162)	140 (126)	0,93	81 (73)	11,7 (10,5)	14,0 (12,6)	1,20	0,129	0,155
4 1958 B 2 July - 1 Aug.	30	1658,5	161 (145)	145 (130)	177 (159)	161 (145)	1,00	32 (29)	1,4 (1,3)	2,2 (2,0)	1,60	0,044	0,068
5 1958 2 July - 1 Aug.	30	1658,5	164 (148)	141 (127)	187 (168)	164 (148)	1,00	46 (41)	0,8 (0,7)	2,1 (1,9)	2,71	0,017	0,045
6 1959 20 Nov. - 15 Dec.	25	2161,75	171 (154)	142 (128)	200 (180)	171 (154)	1,00	58 (52)	2,5 (2,3)	1,3 (1,2)	0,54	0,043	0,023
7 1960 16 Mar. - 16 Apr.	31	2282	174 (157)	150 (135)	206 (185)	178 (160)	1,02	56 (50)	1,8 (1,6)	1,5 (1,4)	0,84	0,032	0,027
Averages			164 (148)	125 (112)	210 (189)	167 (150)	1,02	86 (77)	4,4 (4,0)	5,3 (4,8)	1,39	0,049	0,060

Notes:
1. All the experiments were performed at IRSID at Saint-Germain, except experiment 4 which was performed at Bougival.
2. The angular measurements are given in grades. Angles are reckoned from the North in the prograde sense. Measurements in degrees are shown in parentheses.
3. The median date of each month-long series is reckoned in days, starting at 1 January 1954.
4. φ_m and φ_M are the minimum and maximum values of the azimuth of the plane of oscillation. $\underline{\varphi}$ is the average value of the azimuths φ.

***The Anisotropy of Space*, p. 92.**

Note: In view of the very limited means of calculation which were available at the time, the calculations were made using 25h instead of 24h 50m. This approximation is acceptable as far as orders of magnitude are concerned.

Part B

MY 1954-1960 EXPERIMENTS

WITH THE PARACONICAL PENDULUM

I – NINE ONE-MONTH-LONG SERIES OF OBSERVATIONS

1. – The anisotropic support - Seven one-month-long series of observations

From 1954 to 1960 I undertook seven series of continuous month-long observations with the asymmetrical[1] paraconical pendulum with anisotropic support: over June-July 1954; over November-December 1954; over June-July 1955; in July 1958 at Bougival; in July 1958 at Saint-Germain, in parallel with the Bougival observations; over November-December 1959; and over March-April 1960 (pp. 79-235).

All these observational series were performed in my laboratory at IRSID in Saint-Germain, except for the fourth, which was performed in a underground gallery at Bougival, at a depth of 57 meters (pp. 90-92).

See Table I from page 92, opposite[2].

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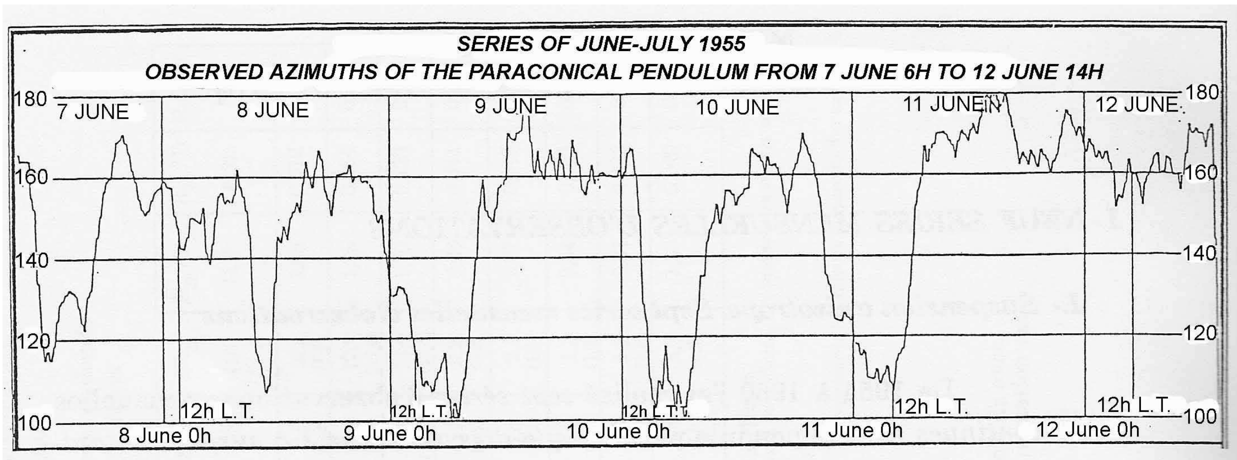
[1] B # A, pp. 84 note 4.

[2] The differences of amplitude and azimuth observed over the seven series of experiments can be explained by the existence of a periodic component of 5.9 years (*The Anisotropy of Space*, pp. 438-445).

Graph I



Legend: the angles are reckoned in grades from the North in the prograde sense.
An azimuth of 100 grades corresponds to the direction perpendicular to the meridian. An azimuth of 200 grades corresponds to the meridian
12h L.T.: moment of the passage of the Moon over the meridian..

Sources: Note to the Academy of Sciences of 18 November 1957, "*Harmonic analysis of the movements of the paraconical pendulum*"; and Graph IIIA of my Conference of 22 February 1958.

***The Anisotropy of Space*, p. 88.**

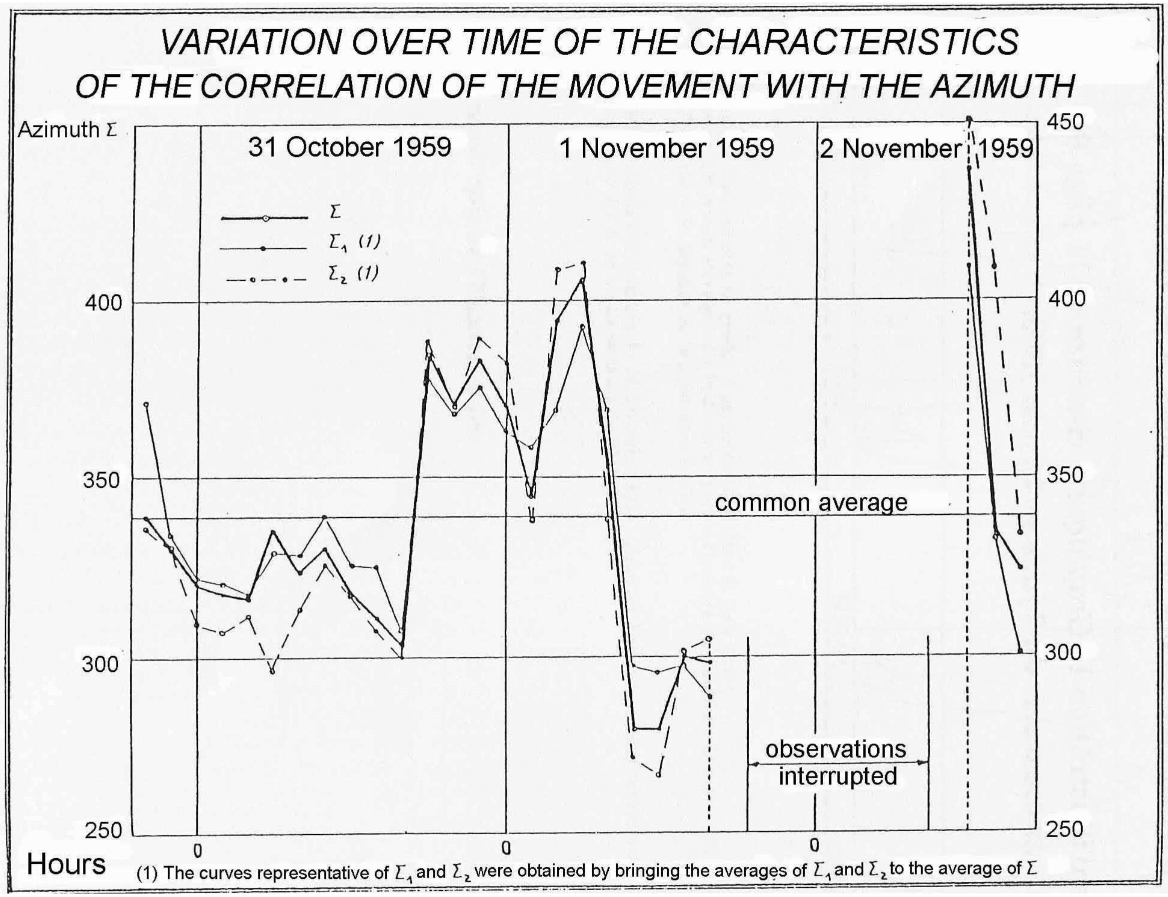
A team of seven observers was formed for implementing each month-long series of observations. For implementing the two simultaneous series of observations of July 1958 in identical conditions at Bougival and Saint-Germain, two teams of seven observers each were necessary.

All these experiments were *chained*[3] (pp. 85-88).

As an illustration, Graph I opposite from page 88 represents the azimuths observed from 7 June to 12 June 1955.

[3] See pp. 11 above.

25L **Graph I** ISOTROPIC SUSPENSION



Source: my *Note* of 10 November 1959 (see *Source* of Table II)

***The Anisotropy of Space*, p. 252.**

Legend: see Table II, p. 251.

$\varphi = a_0 + a_1 \sin 2(\varphi - \Sigma_1) + a_2 \sin 4(\varphi - \Sigma_2)$

The angles Σ_1 and Σ_2 are neighbors. The same holds for the coefficients a_1 and a_2.

2. – The isotropic support - Two one-month-long series of observations

a – Simultaneous observations with the anisotropic support and with the isotropic support

In November-December 1959 and March-April 1960 I performed two series of observations *using the pendulum with isotropic support, in parallel with the observations using the pendulum with anisotropic support* (pp. 237-372).

b – Experimental procedure and method of analysis utilized for the paraconical pendulum with isotropic support. The method of mobile correlations

The *experimental procedure* and the *method of analysis* utilized with the observations with the paraconical pendulum with isotropic support were *completely different* from those utilized with the paraconical pendulum with anisotropic support. *For the method of mobile correlations*, see pp. 247-254.

The experimental procedure consisted of performing successive series of 10 experiments of 20 minutes each. In each experiment the pendulum was released from a specific azimuth, the same for the entire 3 hours and 20 minutes.

Such a procedure enables the azimuth of the direction of anisotropy at each moment to be calculated by simple correlation calculations from observations performed with ten different azimuths during the month (pp. 247-254).

Graph I opposite, from page 252, illustrates the application of the method of chained correlations (31 October to 2 November 1959).

26L

3. – Factors determining the movement of the paraconical pendulum

a – The anisotropic support

The determining factors for the movement of the asymmetrical paraconical pendulum are essentially (pp. 171-187):

- the Foucault effect
- the anisotropy of the support
- the anisotropy of space
- the Airy effect
- perturbations due to the support balls

The combined anisotropy of the support and space generates ellipses. These cause a precession, termed the Airy effect (p. 173)[1]

$\varphi' = (3/8)\, p\, \alpha\, \beta$ $\qquad\qquad$ $p = 2\,\pi / T = \sqrt{g/l}$

where φ represents the azimuth of the plane of oscillation of the pendulum, α and β the major and minor axes in radians of the elliptical trajectory of the pendulum, and T its period of oscillation.

The Airy effect is a major factor in the theory of the Allais pendulum.

b – The isotropic support

In the case of the isotropic support, the determining factors for the movement of the asymmetrical paraconical pendulum are reduced to the Foucault effect, the anisotropy of space, the Airy effect, and perturbations due to the support balls.

[1] See pp. 12 above.

27L

II – FOUR MAJOR FACTS

Four major facts dominate the analysis of my experiments with the asymmetrical paraconical pendulum (B≠A) (p. 84, note 4), *both with anisotropic support and with isotropic support*.

1- A direction of spatial anisotropy

At each instant there exists *a direction of anisotropy of space*, towards which the plane of oscillation of the asymmetrical pendulum tends to displace itself during a 14 minute experiment, in spite of the disturbing effect due to the anisotropy of the support, (pp. 193-195, 255-268)[2].

2 – Periodic astronomical components

This direction of spatial anisotropy includes periodic components which are analogous to those of the theory of tides, linked with the movements of the Earth, the Sun, the Moon, the planets, and the stars, but the relative amplitudes of these periodic components are *entirely different* (pp. 271-272).

3 – Observed effects from twenty to a hundred million times greater than the effects calculated

The amplitudes of the periodic components of 24h 50m are of the order of *twenty to a hundred million times* greater than the amplitudes calculated from the theory of universal gravitation, both for the paraconical pendulum with anisotropic support and with isotropic support (pp. 123-124, 284-285).

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[2] See p. 31 below.

28L

4 – Two crucial experiments

The two crucial experiments of June-July 1958 at Saint-Germain and at Bougival (6.5 km away, in an underground gallery 57 meters deep) (pp. 142-161) gave identical results, in amplitude and in phase, for the luni-solar periodic component of 24h 50m (p. 146).

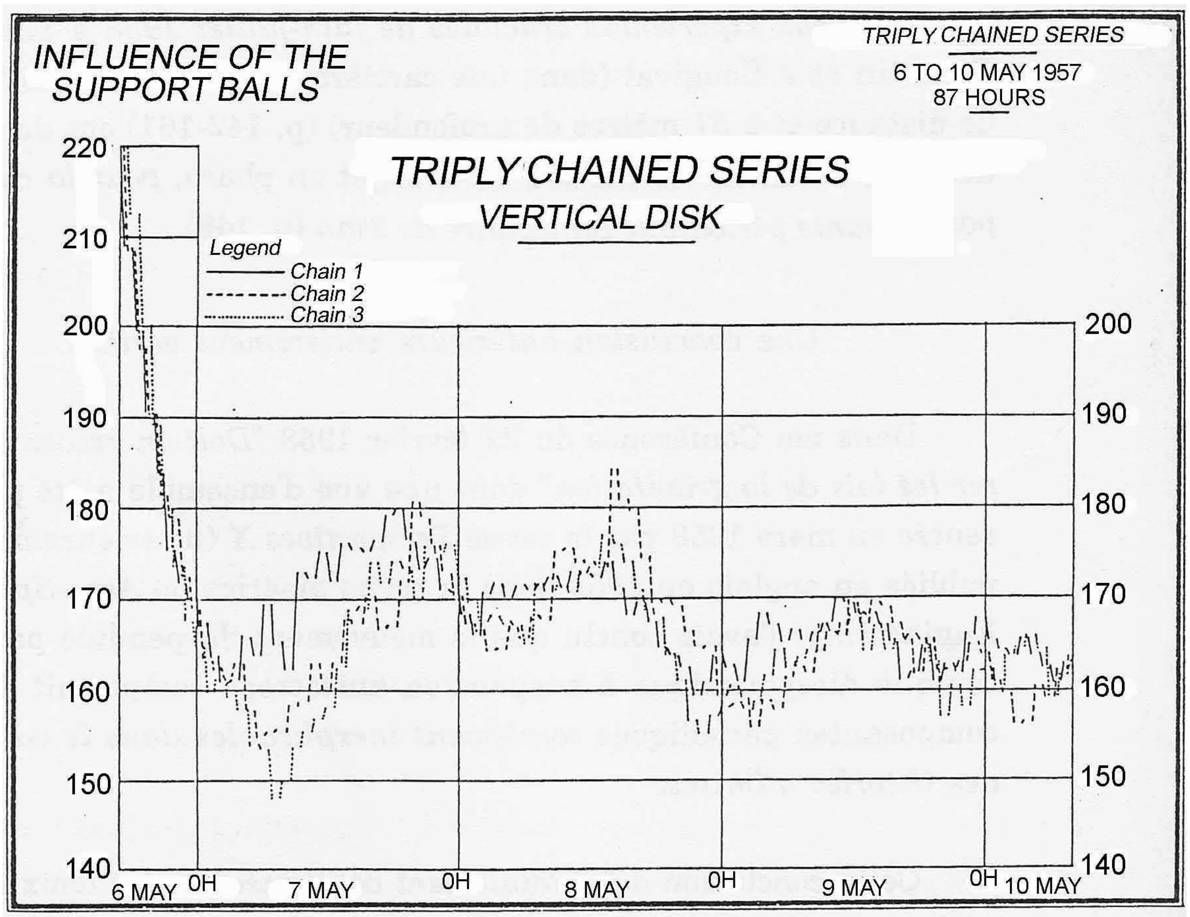
A previous conclusion completely confirmed

In my Conference of 22 February 1958 *"Must the laws of gravitation be reconsidered?"*, of which an overall view was presented in March 1958 by the magazine *Perspectives X* (and also was published in English in 1959 in the magazine *Aero-space Engineering*), I concluded that the movement of the asymmetrical paraconical pendulum with anisotropic support included periodic components which were *inexplicable within the framework of currently accepted theory*.

This conclusion was *confirmed* by the two crucial experiments of July 1958, which were performed five months after my Conference of 22 February 1958.

This confirmation was *electrifying*, and totally swept away all the objections which had been previously brought forward.

Graph VI



Source: Graph IV A 2 of my Conference of 22 February 1958.

***The Anisotropy of Space*, p. 104.**

CONVERGENCE TO A LIMIT PLANE VARIABLE OVER TIME IS DEMONSTRATED BY THE THREE INDEPENDENT SERIES OF CHAINED OBSERVATIONS (FOR EACH SERIES, THE STARTING POINT AT THE INSTANT T IS THE AZIMUTH ATTAINED AT THE INSTANT T-60 MINUTES)

III – A DIRECTION OF SPATIAL ANISOTROPY

1. – Movement of the asymmetrical paraconical pendulum with anisotropic support

What observation actually shows is that *everything happens as though*, during each *independent* experiment of 14 minutes, there exists a limit plane, to which the plane of oscillation of the pendulum tends, resulting both from the action of the support and also from astronomical influences such as luni-solar action.

This limit plane continually varies with the passage of time.

a – Triply chained experiments

The existence of a limit plane *which varies with time* is perfectly illustrated by the *independent triply chained* experiments (pp. 103-104). See Graph VI from page 104, opposite.

Table X ANISOTROPY OF THE SUPPORT

CHARACTERISTICS OF THE CORRELATION OF THE MOVEMENT WITH THE STARTING AZIMUTH

SUSPENSION	PENDULUM USED	q IN GRADES	r	TOTAL NUMBER OF EXPERIMENTS	PERIODS OF OBSERVATION	AZIMUTHAL DISPLACEMENT IN GRADES PER MINUTE $\Phi' = a_0 + a_1 \sin 2(\Phi - \Sigma_1) + a_2 \sin 4(\Phi - \Sigma_2)$					MINOR AXIS OF THE ELLIPSE IN CM AT THE END OF THE EXPERIMENT $2b = 2b_0 + 2b_1 \sin 2(\Phi - \Sigma'_1) + 2b_2 \sin 4(\Phi - \Sigma'_2)$				
						a_0	a_1	Σ_1	a_2	Σ_2	$2b_0$	$2b_1$	Σ'_1	$2b_2$	Σ'_2
Saint-Germain	P1	10	5	100	4 to 10 March 1955	-0,114	-0,838	370,67	+0,089	384,00	+0,003	-0,166	370,90	+0,015	375,78
"	P1	20	2	20	4 January 1956	-0,131	-0,607	383,58	-0,089	397,71	+0,030	-0,141	388,95	-0,047	391,24
"	P1	20	2	20	21 May 1958	-0,157	-0,781	371,54	+0,152	373,08	+0,016	-0,200	372,74	+0,065	373,05
"	P2	20	2	20	13 August 1958	-0,153	-0,541	365,51	-0,166	390,02	-0,010	-0,174	371,69	-0,065	402,63
Bougival	P1	20	2	20	13 August 1958	-0,078	-0,616	369,24	+0,087	382,09	+0,044	-0,188	369,19	+0,047	380,61
					AVERAGES	-0,127	-0,677	372,11	+0,015	385,38	+0,017	-0,174	374,70	+0,003	384,66

PENDULUMS USED

P1: pendulum used in the continuous 1-month experiments of November-December 1954 and June-July 1955 at St.-Germain and June-July at Bougival

P2: pendulum used in June-July 1958 at St.-Germain

FOUCAULT EFFECT

$\Phi' = -0{\cdot}21$ grade/minute

CHARACTERISTICS OF THE SUPPORTS USED

Azimuth of the perpendicular to the support $\Sigma_0 = 371.16$ grades

CHARACTERISTICS OF THE PENDULUMS P1 AND P2 USED

Mass M = 12 kgs

Period T = 1.85 sec.

Principal moments of inertia with respect to the center of the support ball: $A = 82{\cdot}89\ 10^{6}$, $B = 83{\cdot}11\ 10^{6}$, $C = 0{\cdot}325\ 10^{6}$

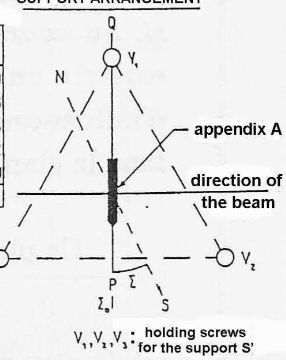
Distance from the center of gravity to the center of the ball: $OG = \ell = 83$ cm

Radius of the support ball: $\rho = 0{\cdot}325$ cm

CORRESPONDENCE OF THE AZIMUTHS Σ AND THE COEFFICIENTS a AND b

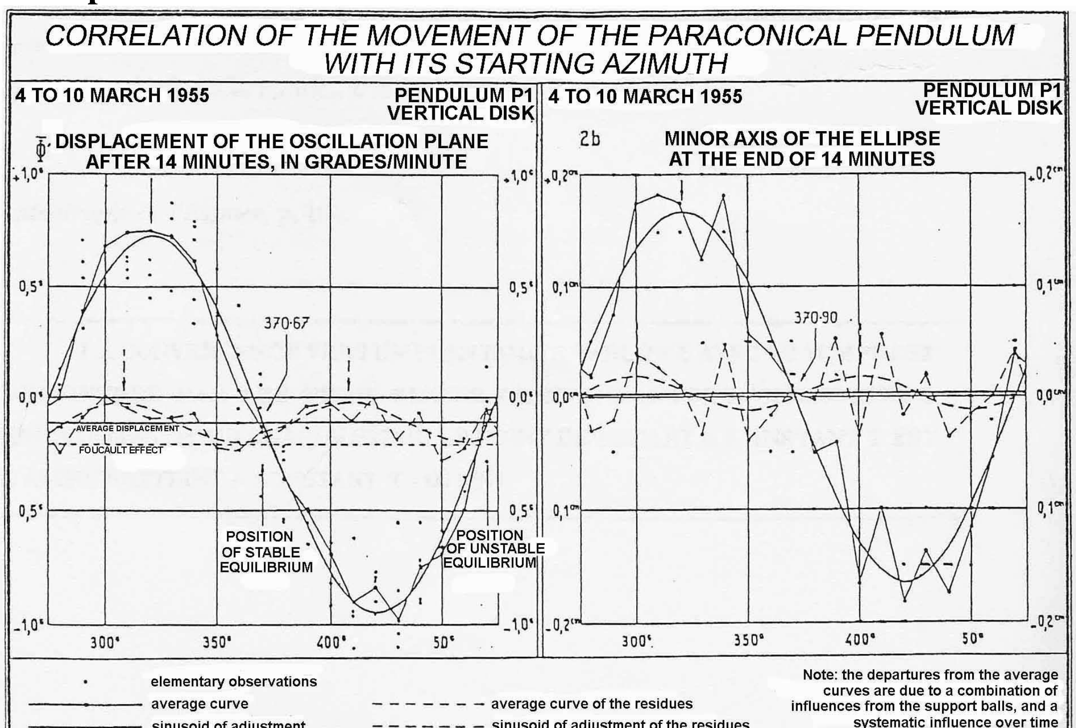
PERIODS OF OBSERVATION	$\Sigma_1 - \Sigma'_1$	$\Sigma_2 - \Sigma'_2$	$\frac{2b_1}{a_1}$	$\frac{2b_2}{a_2}$
1	-0,23	+8,22	+0,198	+0,169
2	-5,37	+6,47	+0,232	+0,528
3	-1,20	+0,03	+0,256	+0,428
4	-6,18	-12,61	+0,322	+0,392
5	+0,05	+1,48	+0,305	+0,540
AVERAGES	-2,59	+0,72	+0,263	+0,411

SUPPORT ARRANGEMENT



Source: Graph IV.B.2 of my Conference of 7 November 1959, and my *Note* of 9 February 1957 to the Academy of Sciences, *Experimental determination of the influence of anisotropy of the support on the movement of the paraconical pendulum.*

Graph XXXIV ANISOTROPY OF THE SUPPORT



Source: Graph IV.B.1 of my Conference of 7 November 1959, and my *Note* of 9 February 1957 to the Academy of Sciences, *Experimental determination of the influence of anisotropy of the support on the movement of the paraconical pendulum.*

***The Anisotropy of Space,* pp. 180-181.**

b – Determination of the anisotropy of the support

The effects of the anisotropy of the support can be determined by releasing the pendulum from different azimuths, and by calculating the correlation of the displacements with the azimuths (pp. 176-182).

The results of observation can be represented by the empirical formulas:

(1) $\varphi' = a_0 + a_1 \sin 2(\varphi - \Sigma_1) + a_2 \sin 4(\varphi - \Sigma_2)$

(2) $2b = 2b_0 + 2b_1 \sin 2(\varphi - \Sigma_1') + 2b_2 \sin 4(\varphi - \Sigma_2')$

where the coefficients are determined by the method of least squares.

φ' represents the *average* variation of the azimuth during a 14 minute experiment, and b the small axis of the ellipse at the end of the 14 minutes.

The sinusoids have periods of 200 and 100 grades respectively.

It is found that the angles Σ_1, Σ_2, Σ_1', and Σ_2' are *very close to the direction of anisotropy of the support*[3].

Over *a very large number of experiments*, the effects of the anisotropy of space on φ' and b are effectively eliminated.

To the first approximation, equations (1) and (2) reduce to the two equations:

(3) $\varphi' = a_0 + a_1 \sin 2(\varphi - \Sigma_1)$

(4) $2b = 2b_0 + 2b_1 \sin 2(\varphi - \Sigma_1')$

---

[3] Equation (1) takes the Airy precession into account.

31L

c – Empirical representation of the movement of the pendulum, for the case of anisotropic support

For the results obtained by analysis of the influence of the anisotropy of the support, it can be validly considered that, *to the first approximation, and during each experiment of 14 minutes*, the following formulas hold:

(5) $\underline{\varphi}' = - \omega \sin L + k \sin 2(\underline{X} - \underline{\varphi}) + K \sin 2(\Sigma - \underline{\varphi}) + \varepsilon$

(6) $2b = k' \sin 2(\underline{X} - \underline{\varphi}) + K' \sin 2(\Sigma - \underline{\varphi}) + \varepsilon'$

In these equations, $- \omega \sin L$ represents the Foucault effect, $\underline{X}$ is the average azimuth of the anisotropy of space corresponding to astronomical influences *during the 14 minute period considered*, and Σ is the direction of anisotropy of the support. The coefficient k is variable over time (pp. 193-195).

Naturally equation (5) considers the global effect $\underline{\varphi}'$, and thus includes the Airy effect.

The direction $\underline{Y}$ of the limit plane is determined by the equation:

(7) $f \sin 2(\underline{Y} - \underline{\varphi}) = k \sin 2(\underline{X} - \underline{\varphi}) + K \sin 2(\underline{\Sigma} - \underline{\varphi})$

The fact that the plane of oscillation φ of the pendulum steadily moves away from the direction Σ of anisotropy of the support shows that the coefficient k is of an order of magnitude comparable to that of the coefficient K.

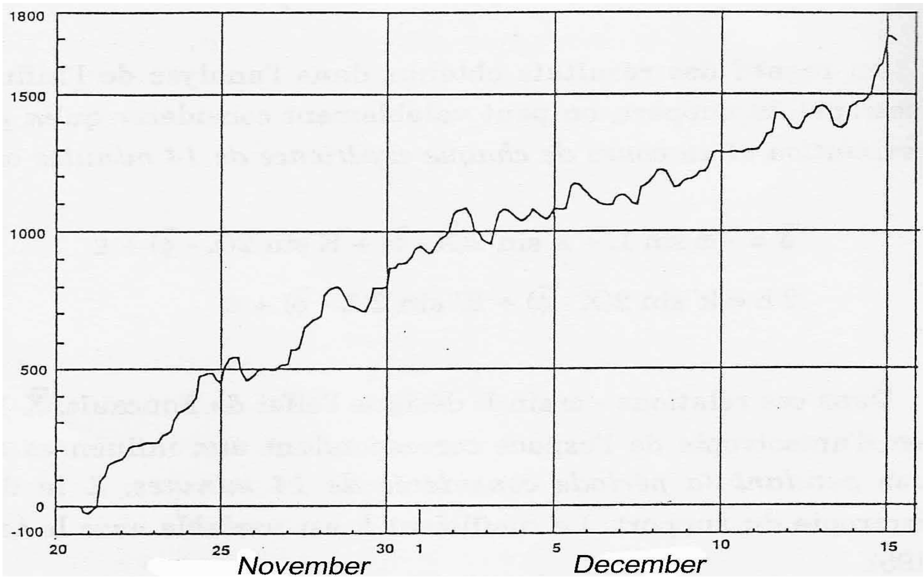
The determination of the direction $\underline{X}$ of the anisotropy of space implies that the coefficient K is negligible, in other words, that the support of the pendulum is isotropic[4].

[4] The Anisotropy of Space, pp. 241-246.

32L

Graph II

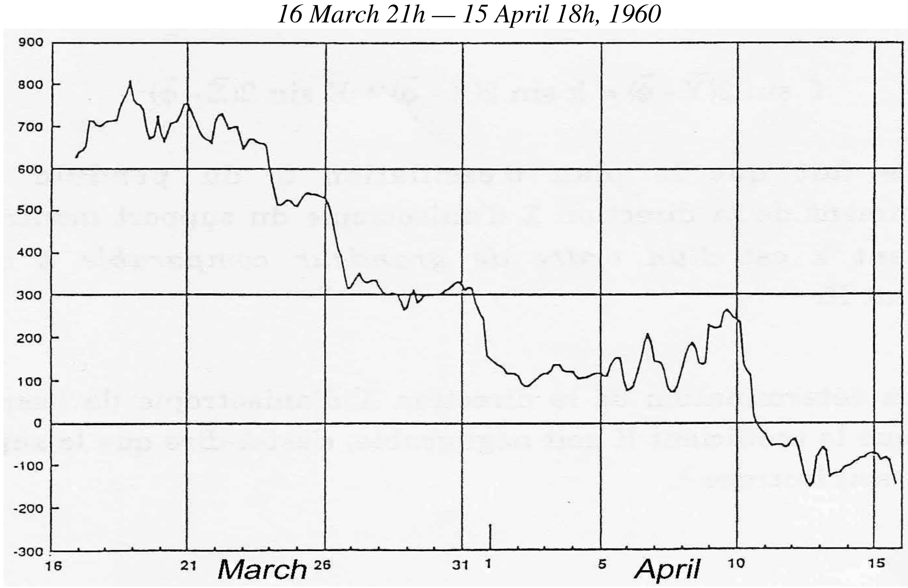
PARACONICAL PENDULUM WITH ISOTROPIC SUPPORT
AZIMUTH OF THE DIRECTION OF ANISOTROPY OF SPACE
determined from the month-long series of observations
20 November 18h — 15 December 6h, 1959



Legend: N = 197 relevant values of the azimuth of anisotropy from 3h to 3h. The azimuths are reckoned in grades from the South, positively in the prograde sense.
Source: Graph 10842 and Table 12708 (18 October 1985)

Graph III

PARACONICAL PENDULUM WITH ISOTROPIC SUPPORT
AZIMUTH OF THE DIRECTION OF ANISOTROPY OF SPACE
determined from the month-long series of observations
16 March 21h — 15 April 18h, 1960



Legend: N = 240 relevant values of the azimuth of anisotropy from 3h to 3h. The azimuths are reckoned in grades from the South, positively in the prograde sense.
Source: Graph 10977 and Table 12705 (19 December 1985)

The Anisotropy of Space, pp. 261-262.

2. – Movement of the paraconical pendulum with isotropic support

a – In the case of an isotropic support, the equations (5) and (6) above reduce to:

(8) $\underline{\varphi}' = - \omega \sin L + k \sin 2(\underline{X} - \underline{\varphi})$

(9) $2b = k' \sin 2(\underline{X} - \underline{\varphi})$

b – The *fundamental importance* of my experiments of 1959-1960 with a paraconical pendulum *on an isotropic support* cannot be sufficiently underlined (pp. 49, 240, 326-330).

These experiments, in fact, *decisively demonstrated the existence of a direction of spatial anisotropy varying over time,* and they also yielded *a great deal of information* which could not be obtained with the experiments with the paraconical pendulum with anisotropic support.

The two graphs opposite represent the directions of spatial anisotropy during the experiments of November – December 1959 and March – April 1960 with the isotropic support (pp. 261-262).

During these two periods, the variations in azimuth of the direction X of anisotropy were considerable: about 1800 grades, i.e. 4.5 full turns, in the prograde direction over 25 days in November – December 1959, and about 900 grades, i.e. 2.25 full turns, in the retrograde direction over 31 days in March – April 1960 (p. 259).

c – Actually at that time, I preferred to wait for the *definitive and complete* proof of the existence of anomalies in the motion of the paraconical pendulum with anisotropic support provided by the two *crucial* experiments of July 1958 at Bougival and Saint-Germain, before constructing an isotropic support (pp. 238-240).

33L

d – In the analysis of the observations of the paraconical pendulum with isotropic support, a *new method* was used for analyzing the data – the *method of mobile correlations* (pp. 247-252) – and this permitted a *large amount of information* of all sorts to be obtained from the two series of experiments of November – December 1959 and March – April 1960 (pp. 255-330)[5].

This method enabled information of exceptional interest to be gathered (pp. 255-330), which could not have been obtained by the method of chained observations. Naturally it *required* releases of the paraconical pendulum every 20 minutes from specific azimuths.

e – The experimental procedure of mobile correlations made it possible to demonstrate an average direction of anisotropy of space quite close to the East-West direction (pp. 256-258).

f – This method involved difficulties in application, due to the perturbing influence of some of the support balls, but this problem was successfully overcome (pp. 253-258).

[5] See in particular *Part B I.2*, above, pp. 25 and 25*.

34L

THE VARIATIONS OVER TIME OF THE ANISOTROPY OF SPACE ARE DETERMINED BY THE MOVEMENTS OF CELESTIAL BODIES, AND IN PARTICULAR BY THE RELATIVE MOVEMENTS OF THE SUN AND THE MOON.

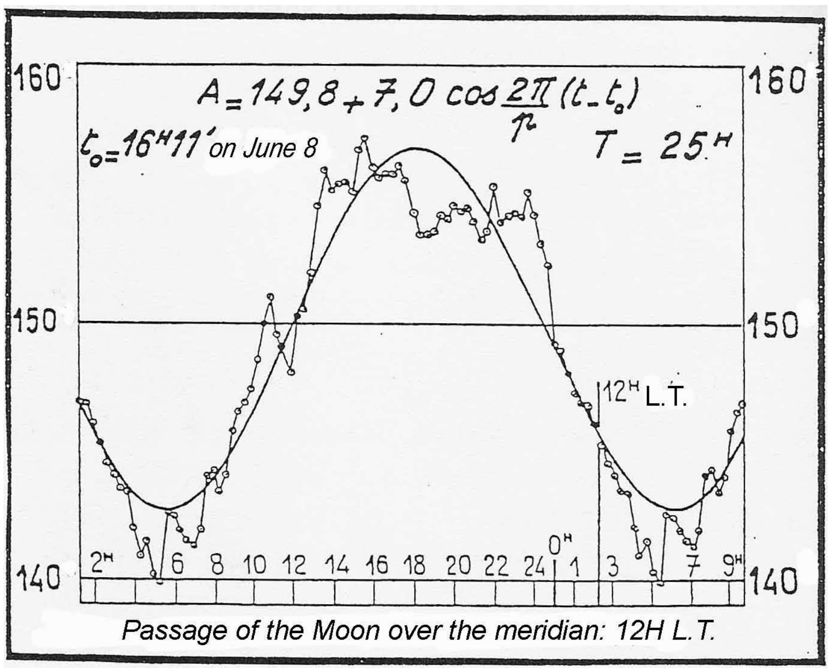
3. – Periodic components of the direction X of spatial anisotropy

The variations over time of the direction of anisotropy of space are linked to the movement of celestial bodies (pp. 184-187).

In particular, the tandem action of the Moon and the Sun on the direction of anisotropy of space causes periodic variations in the azimuth of the plane of oscillation of the pendulum in both anisotropic support and the isotropic support cases (pp. 184-187), as discussed next.

Graph V

AZIMUTH OF THE PARACONICAL PENDULUM
Month-long series of June-July 1955
Adjustment by the Buys-Ballot method
to a wave of 25h



Source: My *Note* of 19 November 1957 to the Academy of Sciences, *Harmonic Analysis of the Movements of the Paraconical Pendulum,* and *Graph IIIA* of my Conference of 22 February 1958.

The Anisotropy of Space, p. 100.

TO AN AMPLITUDE OF 14 GRADES IN 25 HOURS, THERE CORRESPONDS AN AVERAGE PERIODIC COMPONENT

$$\varphi' = \frac{14}{25 \cdot 60 \cdot 60} \cdot \frac{\pi}{200} \text{ rad/sec}$$

$$= 0.244 \cdot 10^{-5} \text{ rad/sec}$$

IV – A VERY REMARKABLE PERIODIC STRUCTURE

The nine month-long series of observations with the anisotropic support and the two month-long series of observations with the isotropic support are characterized by very remarkable periodic structures.

1. – Periodic structure of the month-long series of observations of the asymmetrical paraconical pendulum with anisotropic support

a – The seven month-long series of observations of the asymmetrical paraconical pendulum with anisotropic support are characterized by a very remarkable periodic structure (pp. 96-101, 103-107, 130-141, 144-159, 184-187).

b – Particularly deep analysis was carried out for the luni-solar wave of 24h 50m (pp. 100, 106-112, 144-155).

In order to simplify certain harmonic analysis calculations using the Buys-Ballot method (p. 96, note 1) and in view of the very limited means of calculation which were at my disposal in that era[6], I substituted a period of 25h for the period of 24h 50m, for example on page 100.

As an example, Graph V opposite (p. 100) shows the luni-solar component of 25h calculated by the Buys-Ballot method.

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[6] *Vide* my justification, page 98, note 7.

Table II

AZIMUTH OF THE PARACONICAL PENDULUM AND ATMOSPHERIC PRESSURE

Month-long series of June-July 1955

Adjustment to 13 periods of the theory of tides

Hydrographic Service of Paris and Hydrographic Institute of Hamburg

		Diameter of the wave 2R													
Series	Total observed variation D	K_1 23^h 93	M_1 24^h 84	O_1 25^h 82	Q_1 26^h 87	M_2 12^h 42	S_2 12^h	M_3 8^h 28	S_3 8^h	μ_2 12^h 87	L_2 12^h 19	N_2 12^h 66	M_4 6^h 21	M_{S4} 6^h 10	TOTAL
Azimuth value in grades	83,10	13,00	10,46	4,78	7,78	1,40	3,94	2,54	4,88	3,70	5,30	5,30	1,64	2,32	67,04
Pressure in 1/10 millibar	281,00	11,20	4,24	1,20	3,00	4,40	8,80	1,46	1,96	5,20	1,40	3,40	3,80	3,60	53,66
		Diameter of the wave in % of the total observed variation 2R/D													TOTAL %
Azimuth		15,64	12,59	5,75	9,36	1,69	4,74	3,06	5,87	4,45	6,38	6,38	1,97	2,79	80,67
Pressure		3,99	1,50	0,43	1,07	1,57	3,13	0,52	0,70	1,85	0,50	1,21	1,35	1,28	19,10

Source: My *Note* of 19 November 1957 to the Academy of Sciences, *Harmonic Analysis of the Movements of the Paraconical Pendulum,* and *Table IIIA* of my Conference of 22 February 1958.

The Anisotropy of Space, p. 99.

c – Analysis together with *13 periods from the harmonic analysis used in the theory of tides* was particularly suggestive (in particular, see the Tables on pages 99, 187, 272, and 287).

The same periodicities as in the theory of tides appeared to be significant in the movements of the paraconical pendulum, but their coefficients of amplitude were very different.

As an illustration, the results obtained by the *hydrographic services of Paris and Hamburg* for the series of June-July 1955 are shown opposite (Table II, p. 99).

A comparison with atmospheric pressure is also presented. *The periodic structure of the two series is completely different.*

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Table V

DISPLACEMENTS OF THE PLANE OF OSCILLATION OF THE PARACONICAL PENDULUM
IN HUNDREDTHS OF A GRADE PER MINUTE FROM THE MERIDIAN
DIURNAL AND SEMI-DIURNAL LUNI-SOLAR EFFECTS
Observed amplitudes and coefficients of the luni-solar periodicities

Periodicities	K_1 23 h 93	M_1 24 h 84	O_1 25 h 82	Q_1 26 h 87	S_2 12 h	M_2 12 h 42	N_2 12 h 66	$2N_2$ 12 h 92	Total of the amplitudes
Amplitude of the wave: 2R in hundredths of a grade per minute									
November-December 1959[1]	4,44	4,45	6,41	4,15	4,95	6,95	2,23	8,39	42,0
March-April 1960[1]	1,32	6,51	6,60	1,67	4,41	7,49	6,59	5,09	39,7
November-December 1959[2]	10,6	10,6	15,3	9,88	11,8	16,5	5,31	20,0	100
March-April 1960[2]	3,32	16,4	16,6	4,21	11,1	18,9	16,6	12,8	100
Average of the relative values: a	6,96	13,5	16,0	7,04	11,5	17,7	11,0	16,4	100
Current theory of luni-solar periodicity									
Coefficients[1]	0,706	0,0977	0,377	0,0730	0,563	0,908	0,232	0,0235	2,98
Relative values[2]: b	23,7	3,28	12,6	2,45	18,9	30,5	7,78	0,789	100
Ratios of the relative values									
Ratios a/b	0,294	4,12	1,27	2,87	0,608	0,580	1,41	20,8	1

Legend: (1) Absolute values. The amplitudes in grades per minute corresponding to the paraconical pendulum *are multiplied by 100*.
(2) Relative values = absolute values / total of the amplitudes (or the coefficients)

Source: (1) *Displacements of the azimuth* of the plane of oscillation of the paraconical pendulum in the meridian plane (*Tables* 6629 and 6630 of 1960)
(2) Coefficients of the current theory of luni-solar periodicities: see *Table* IV of § E.1

The Anisotropy of Space, The paraconical pendulum with isotropic support, p. 287.

FOR THE PARACONICAL PENDULUM WITH ISOTROPIC SUPPORT, THE RATIO OF THE COMPONENT OF 24H 50M TO THE COMPONENT OF 24H IS ABOUT 14 TIMES LARGER, THAN WITH THE THEORY OF TIDES (4.12/0.294=14.01)

2. – Periodic structure of the month-long series of observations of the paraconical pendulum with isotropic support

A remarkable periodic structure appeared here as well.

a – For illustration, Table V opposite (p. 287) shows the results of analysis of the series of observations of November-December 1959 and of March-April 1960 together with waves considered in the theory of tides. In both cases the component M_1 of 24h 50m (24.84h) is particularly marked.

As shown by Table V, the coefficients of the different components are very different from those in the theory of tides (pp. 284-287). *Particularly, the* M_1 *component(25h) is much more emphasized than the* K_1 *component (24h).*

b – I cannot recommend enough to the reader referring to the *overall view* of my experiments on the paraconical pendulum with isotropic support (pp. 326-330).

Two facts appear particularly significant:

- First, the directions X of the anisotropy of space in November-December 1959 and March-April 1960 both had the same *sidereal monthly period of 27.322 days*, of a relatively significant amplitude.

  The *periodic components* for November-December 1959 and March-April 1960 are remarkably in phase (at approximately 8 hours), and at about two days they reach their maxima when the declination of the Moon reaches its minimum (p. 308).

38L

This sidereal lunar monthly periodicity is notably present in the cumulative values of deviations Δ North-South and East-West, with a *remarkable agreement of phase* being present as well (Tables VI, VII, and VIII, pp. 308, 311, and 313).

- The azimuths X and the deviations Δ exhibit *very marked* diurnal periodicities, particularly a periodicity of 24h 50m. (Tables IV and V, pp. 272 and 287).

The significant periodicities which appear are *the same as those of the theory of tides*, but *their relative amplitudes are quite different*.

c – One may well ask oneself why, when it occurs, the near alignment of the Moon and the Sun does not generate the same effects as a total eclipse.

In fact, *the importance of the monthly sidereal period of 27.322 days* shows that these effects exist. But they can only really be perceived over a period of several months[7].

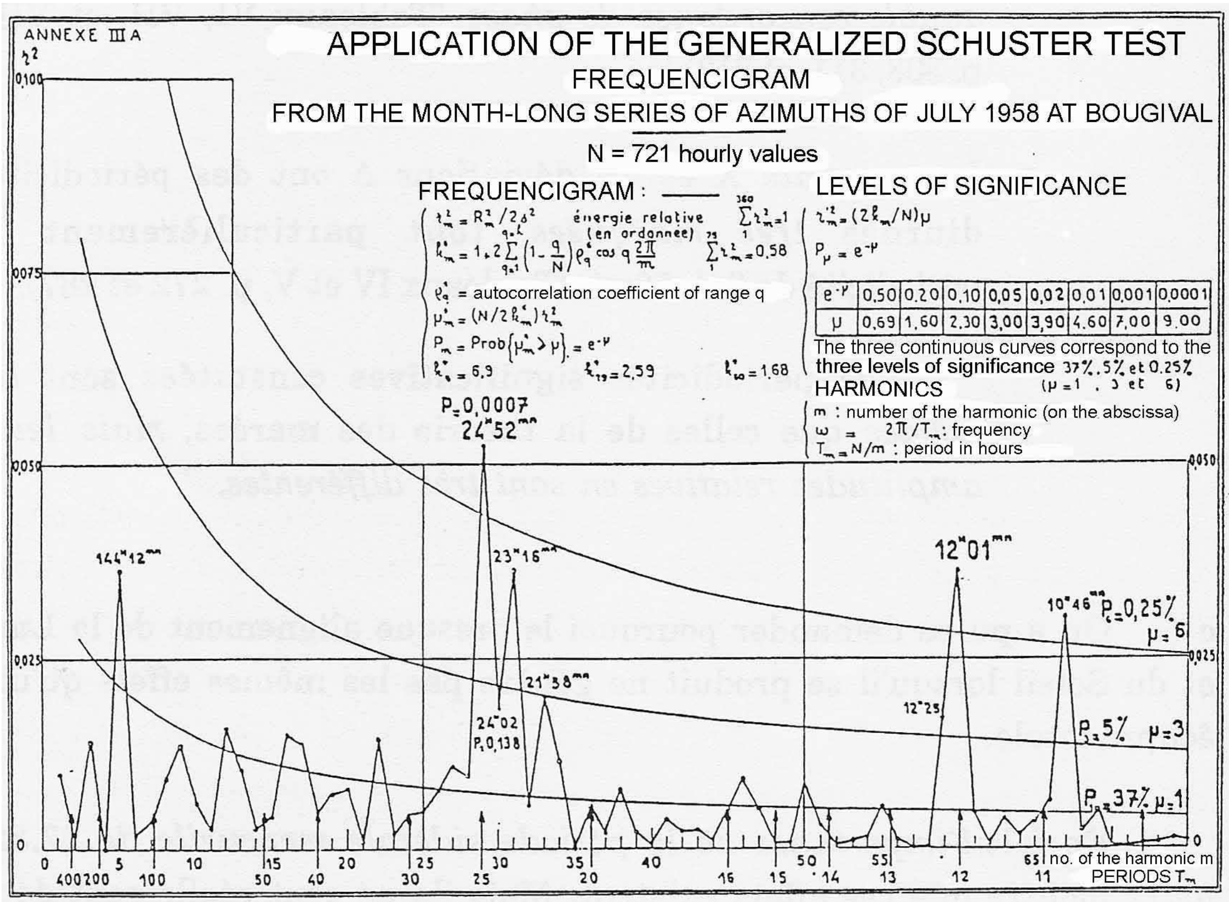
---

7 Moreover, at the moment of a total eclipse, there is undoubtedly an effect of resonance in a system of stationary waves in the ether.

(With regard to the existence of such a system, see *The Anisotropy of Space*, p. 542, note 2, §1).

Graph XXVI

OBSERVATIONS IN JULY 1958 AT BOUGIVAL



Legend: For the formulation of the test, see §B.1.3 above and the *Legend* of *Graph XI.*

Source: Annex IIIA of my Communication of 1961 to the *International Institute of Statistics (*see *Source* of *Graph XXII).*

The Anisotropy of Space, p. 156.

THE PROBABILITY OF OBTAINING THE OBSERVED AMPLITUDE FOR THE LUNI-SOLAR COMPONENT OF 24H 50M BY CHANCE IS ONLY 0.07%

3. – A test of periodicity

In April 1957 I was able to formulate *a test of periodicity* for autocorrelated series. The application of this test allowed me to become *certain* of the existence of the wave of 24h 50m (pp. 55 and 113-117).

- For illustration, I reproduce opposite the application of this test to the month-long series of observations of July 1958 at Bougival. The probability of obtaining by chance the observed amplitude of the luni-solar oscillation of 24h 50m is only 0.07%.

- Overall, it was the harmonic analysis of the various series of observations of the paraconical pendulum with anisotropic support and of the series of observations of the paraconical pendulum with isotropic support which made me absolutely certain of their periodic structure as far as the orders of magnitude of the components of 24h 50m, 24h, 12h 25m, and 12h are concerned, and of the *impossibility* of explaining them by the theory of gravitation, *whether or not completed by the theory of relativity*.

NO PREVIOUS EXPERIMENTER HAS EVER INVESTIGATED, OR ATTEMPTED TO INVESTIGATE, THE PERIODIC STRUCTURE OF THE MOVEMENTS OF A PENDULUM, AND IN PARTICULAR ITS LUNI-SOLAR COMPONENTS.

4. - Overall view

- Seen overall, the harmonic analysis of the month-long series of observations of the paraconical pendulum with anisotropic and isotropic supports disclosed a *very remarkable underlying periodic structure*.

This makes it clear why experiments for a few hours with a Foucault pendulum have always been notable for *inexplicable* anomalies.

- Particularly, my experiments with the paraconical pendulum with isotropic support marked a *fundamental stage* in my researches, and they enabled me to obtain results of *exceptional importance*.

In fact, the periodic structures which were brought to light exhibited *great underlying coherence, particularly as far as their phases were concerned*.

The existence of anomalies in the movement of the paraconical pendulum has become *absolutely certain*.

- *No previous experimenter has ever investigated, or has ever attempted to investigate, the periodic structure of the movements of his pendulum, in particular its luni-solar components.*

The reason is twofold: Firstly, the theoreticians have always considered that the influences of the Sun and the Moon on the movement of a pendulum were *too feeble to be detected experimentally*.

Secondly, all previous experiments have been limited to *durations of only a few hours*.

FOR THE LUNI-SOLAR WAVE OF 24H 50M, IN THE CASE OF THE PARACONICAL PENDULUM WITH ANISOTROPIC SUPPORT, THE EFFECTS OBSERVED ARE ABOUT TWENTY MILLION TIMES GREATER THAN THOSE CALCULATED.

IN THE CASE OF THE PARACONICAL PENDULUM WITH ISOTROPIC SUPPORT, THE RATIO BETWEEN THE OBSERVED EFFECTS AND THE CALCULATED EFFECTS IS ABOUT A HUNDRED MILLION.

THESE DIFFERENCES BETWEEN THE CALCULATED VALUES AND THE OBSERVED VALUES ARE ENORMOUS, AND WITHOUT ANY EQUAL IN THE LITERATURE.

V –TOTALLY INEXPLICABLE OBSERVATIONS IN THE FRAMEWORK OF CURRENT THEORY

1. – Orders of magnitude incompatible with current theory

In both cases, with the experiments with the anisotropic support and with those with the isotropic support, it is found that the amplitudes of the periodic effects are *considerably greater* than those calculated according to the law of gravitation, *whether or not completed by the theory of relativity*.

In the case of the anisotropic support, the amplitude of the luni-solar component of 24h 50m is about *twenty million times* greater than the amplitude calculated by the theory of universal gravitation (pp. 118-129 and Table VII, p. 129)[8].

In the case of the paraconical pendulum with isotropic support, this relation is about a *hundred million* (pp. 285-328).

The discrepancies discovered are enormous, and, as far as I know, unmatched in the literature.

[8] The period of 24h 50m is derived from the period of rotation of the Earth of 24h and from the synodic period of the Moon of 29.53 days (p. 97, note 4 and the tables of pp. 99, 187, 272, and 287).

Table V

FORCES ACTING UPON THE FOUCAULT PENDULUM
DUE TO THE ATTRACTION OF CELESTIAL BODY i
RELATIVE TO AXES FIXED W.R.T. THE EARTH

Notation

M_i : mass of celestial body i
I : center of celestial body i
U_i : attractive potential of celestial body i
T = center of the Earth
μ : coefficient of universal gravitation
$d_i = SI$ $l = SG$ r_T = radius of the Earth
$\vec{N}$ = force exerted by the support on the pendulum

Vector equations[1]

(1) $\vec{F} = M\vec{\gamma}$

(2) $\vec{F} = M\,\mathrm{grad}_G U_T + M\,\mathrm{grad}_G U_i + \vec{N}$

(3) $\vec{\gamma} = \frac{d^2\vec{SG}}{dt^2} + 2\vec{\omega}\wedge\frac{d\vec{SG}}{dt} + \mathrm{grad}_T U_i$

whence:

(4) $\frac{d^2\vec{SG}}{dt^2} = -\vec{g} - 2\vec{\omega}\wedge\frac{d\vec{SG}}{dt} + \mathrm{grad}_G U_i - \mathrm{grad}_T U_i + (\vec{N}/M)$

(5) $\frac{d^2\vec{SG}}{dt^2} = -\vec{g} - 2\vec{\omega}\wedge\frac{d\vec{SG}}{dt} + (\mathrm{grad}_S U_i - \mathrm{grad}_T U_i)$
$+ (\mathrm{grad}_G U_i - \mathrm{grad}_S U_i) + (\vec{N}/M)$

Interpretation

(6) $\mathrm{grad}_S U_i - \mathrm{grad}_T U_i$ = deviation of the vertical
(this term has no effect on the movement of the pendulum)

(7) $\mathrm{grad}_G U_i - \mathrm{grad}_S U_i$ = effective acceleration exerted on the center of gravity G of the pendulum

Order of magnitude of the angular acceleration exerted by body i on the pendulum

(8) $\vec{\gamma}_i / l = (\mathrm{grad}_G U_i - \mathrm{grad}_S U_i)/l = \mu\frac{M_i}{l}\left[\frac{\vec{GI}}{GI^3} - \frac{\vec{SI}}{SI^3}\right]$

(9) $|\vec{\gamma}_i / l| \sim \mu\frac{M_i}{d_i^3}$ $g = \mu\frac{M_T}{r_T^2}$

(10) $|\vec{\gamma}_i / l| \sim C_i = \frac{M_i}{M_T}\frac{r_T^2}{d_i^3}\,g$

Sun : $C_s = 0{,}396.10^{-13}$ Moon : $C_l = 0{,}862.10^{-13}$

-----

(1) For Equations (1), (2), and (3), see the references of note (1) of Table IV.

The Anisotropy of Space, p. 127

Component (6) is of the order of 10^{-8}
Component (7) is of the order of 10^{-13}. This is the one which influences the movement of the pendulum.

2. – An immediate orders-of-magnitude calculation

In the case of the paraconical pendulum with anisotropic support, the order of magnitude of 1 to 20 million can be *immediately* deduced from the theory of universal gravitation and the theory of relative movements.

In this case, effectively, for the 24h 50m component, the order of magnitude *observed* for the variation of the azimuth is $0.186 \cdot 10^{-5}$ radian/sec (average for all the observations) (p. 123).

As for the *calculated* effects, as I wrote in my article of 1958 "*Should the laws of gravitation be reconsidered?"* (Aero-Space Engineering, 1959):

"The extraordinary minuteness of the calculated effects can be easily explained if one keeps in mind that, to obtain the effective gradient $\vec{f}$ *of the luni-solar attraction of a point on the surface of the Sun with respect to the Earth, it is necessary to take the difference between the attractions between that point and to the center of the Earth. The gradient* $\vec{f}$ *is of the order of* 10^{-8}.

"Moreover, the plane of oscillation of the pendulum can only turn under the influence of the luni-solar attraction due to variations of that gradient around the point considered. It is therefore necessary to consider the difference $\Delta\vec{f}$ *between the value of* $\vec{f}$ *at the average position of the pendulum and its value at a neighboring point.* $\Delta\vec{f}$ *is of the order of* 10^{-13}.

"The ratio of the calculated effects of order 10^{-13} *and the observed effects of order* 10^{-5} *is of the order of* 10^{-8}*, i.e. of the order of a hundred million."*

Nobody has yet been able to impugn the validity of this calculation.

(See Table V of page 127, reproduced opposite).

THE AMPLITUDES OF THE LUNI-SOLAR EFFECTS OBSERVED IN THE MOVEMENT OF THE PARACONICAL PENDULUM ARE OF DYNAMIC ORIGIN, NOT STATIC AS FOR DEVIATIONS OF THE VERTICAL OR OF THE INTENSITY OF GRAVITY.

THESE EFFECTS CAN ONLY BE OBSERVED WHEN THE PENDULUM IS MOVING.

On this essential point, see equation (3) of the last paragraph of page 120 and the two first paragraphs of page 121 of *Chapter I of "The Anisotropy of Space".* The movement of the pendulum is determined by the variations of weight *in the field swept by the pendulum*, and these variations correspond to the second term of equation (3) on page 120, which is given by equations (7) and (10) of Table V on page 127, reproduced on page 42* above. This equation results *immediately* from the equations (8) and (9) of that Table.

3. – The dynamic character of the observed effects

The observed effects are only seen when the pendulum is moving.

They are not connected with the intensity of weight (gravimetry) (p. 135, note 6), but with the *variation of weight* (or of inertia) *in the space swept by the pendulum* (pp. 118-119).

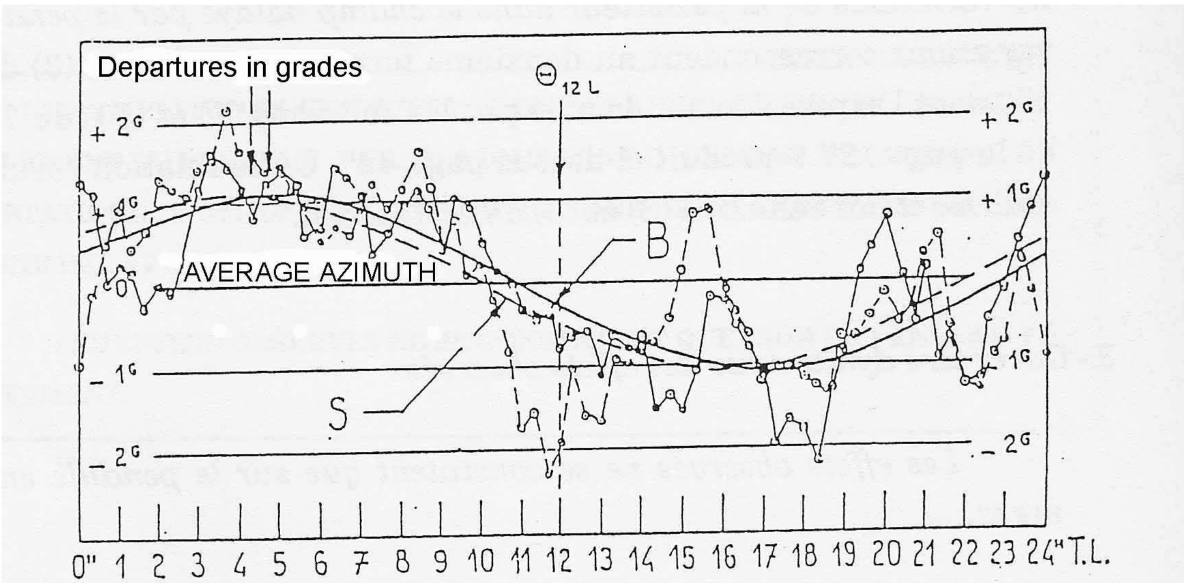
Actually, while the movement of the plane of oscillation of the pendulum is *inexplicable* by the theory of gravitation, the deviations from the vertical are *explained perfectly* by that theory (p. 135, note 6).

The deviations from the vertical correspond to equation (6) of Table V of page 127, page 42* above. They correspond to a *static* phenomenon, while my experiments correspond to a *dynamic* phenomenon.

Graph XVII

EXPERIMENTS OF JULY 1958 AT BOUGIVAL AND AT SAINT-GERMAIN

Results of the Buys-Ballot filter for a 24h 50m filter



Legend

	2 R in grades	$\Theta - \Theta_{12 L}$
BOUGIVAL	2,17	— 7 h. 23 mn.
SAINT-GERMAIN	2,10	— 7 h. 55 mn.

———— : BOUGIVAL — — — — — — — : SAINT-GERMAIN

Fine lines: average cycles Bold lines: sinusoids of adjustment

Source: Allais, 1958, *Should the laws of gravitation be reconsidered?* (Appended complementary Note)

The Anisotropy of Space, p. 146.

THE PERIODIC STRUCTURES OBSERVED AT BOUGIVAL AND AT SAINT-GERMAIN CORRESPONDED IN A VERY REMARKABLE MANNER.

THEY SWEPT AWAY ALL PREVIOUS OBJECTIONS.

VI – TWO CRUCIAL EXPERIMENTS

In July 1958 two crucial experiments were performed simultaneously at Saint-Germain and at Bougival in *identical* conditions (pendulums with anisotropic supports).

The laboratory in Bougival was located in an underground gallery 6.5 km from Saint-Germain, below 57 meters of clay and chalk.

The periodic structures which were observed corresponded in a remarkable manner.

At Saint-Germain and at Bougival the two luni-solar 24h 50m wave components were *practically identical in amplitude and phase*. The same was true for the 12h 25m wave components.

By contrast, while the 24h and 12h components were *practically identical in amplitude, they had opposite phases*[9].

Graph XVII from page 146, reproduced opposite, shows the two 24h 50m components at Bougival and Saint-Germain in July 1958.

These crucial experiments swept away all the objections previously raised against the validity of my experiments.

An electrifying confirmation

In fact, the results of the experiments of July 1958 confirmed *in an electrifying manner* my previous reasoning, leading to the conclusion that, in the movement of the paraconical pendulum with anisotropic support, *there are anomalies of a periodic character which are totally inexplicable in the framework of currently accepted theories*.

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[9] This fact is still not understood.

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Part C

OVERALL VIEW

Several overall conclusions can be drawn from the previous explanation, which is certainly too brief.

I – THE SCIENTIFIC INTEREST OF THE ECLIPSE EFFECT

It seems best for me to quote the commentary which I gave on page 169:

"Whatever the intrinsic scientific importance of the anomalies of the paraconical pendulum corresponding to eclipses may be considered to be – certainly major because these anomalies are totally inexplicable in the light of the currently accepted theory of gravitation – their relative significance is minor, as compared with that of the periodic luni-solar anomalies observed, whose existence is conclusively established by the thousands of observations made and from which they have been deduced."

In fact, continued observation of the movement of a paraconical pendulum can yield much more copious and useful data, than can be deduced simply from eclipse effects.

THE OBSERVATIONS OF THE PARACONICAL PENDULUM WITH ISOTROPIC SUPPORT ENABLE THE PERIODIC STRUCTURE OF THE DIRECTION OF ANISOTROPY OF SPACE TO BE DETERMINED, AND THENCE ENABLE PREDICTION OF THIS DIRECTION OF ANISOTROPY AT A GIVEN PLACE.

II – INFORMATION OBTAINABLE FROM EXPERIMENTS WITH THE PARACONICAL PENDULUM

The essential information which can be deduced from experiments on the paraconical pendulum is the following:

1 – Periodic structure of the movements of the paraconical pendulum

The periodic structure of the movements of the paraconical pendulum can be determined by harmonic analysis of the month-long series of observations of the paraconical pendulum with anisotropic support, *starting from the wave components of the theory of tides*.

2 – Determination of the direction of anisotropy of space

The direction of the anisotropy of space at any given moment, and its periodic components, can be determined from observations of the paraconical pendulum with isotropic support[10].

3 – Prediction of the direction of anisotropy of space

There is an exact similarity between the prediction of the direction of spatial anisotropy and the prediction of the heights of tides at a given place.

The observations made actually allow one to determine the periodic structure of the direction of anisotropy of space, and thence to predict what this direction of anisotropy will be at a given place.

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[10] See pp. 32 and 32* above.

THE LETTER OF MAY 1959 FROM PAUL BERGERON TO WERNER VON BRAUN CONFIRMS THE TOTAL IMPOSSIBILITY OF EXPLAINING THE PERCEIVED ANOMALIES WITHIN THE FRAMEWORK OF CURRENTLY ACCEPTED THEORY.

III – ON THE VALIDITY OF MY EXPERIMENTS

With regard to the validity of my experiments, it seems best to reproduce here the testimony of *General Paul Bergeron*, ex-president of the *Committee for Scientific Activities for National Defense*, in his letter of May 1959 to *Werner von Braun* (p. 231):

> *"Before writing to you, I considered it necessary to visit the two laboratories of Professor Allais (one 60 meters underground), in the company of eminent specialists – including two professors at the Ecole Polytechnique. During several hours of discussion, we could find no source of significant error, nor did any attempt at explanation survive analysis.*
>
> *"I should also tell you that during the last two years, more than ten members of the Academy of Sciences and more than thirty eminent personalities, specialists in various aspects of gravitation, have visited both his laboratory at Saint-Germain, and his underground laboratory at Bougival.*
>
> *"Deep discussions took place, not only on these occasions, but many times in various scientific contexts, notably at the Academy of Sciences and the National Center for Scientific Research. None of these discussions could evolve any explanation within the framework of currently accepted theories."*

This letter confirms clearly the fact that was finally admitted at the time - *the total impossibility of explaining the perceived anomalies within the framework of currently accepted theory.*

In fact, the totality of my experiments established *with absolute certainty* the existence of anomalies in the movement of the paraconical pendulum.

DUE TO THE INCREDIBLE DOGMATISM OF SCIENTIFIC CIRCLES AT THE TIME, SCIENCE HAS LOST AT LEAST FORTY YEARS. NOT ONLY WERE MY EXPERIMENTS NOT FOLLOWED UP, BUT THEY WERE SUCCESSFULLY HIDDEN.

IV – ON THE TERMINATION OF MY EXPERIMENTS WITH THE PARACONICAL PENDULUM

The termination of my experiments on the paraconical pendulum, after the *quite extraordinary success of the two crucial experiments of July 1958 at Bougival and Saint-Germain* (pp. 142-161), was a result of the *incredible dogmatism* of the scientific world in that era.

Over many centuries, no phenomenon had ever before been exhibited whose observed values were from *twenty to a hundred million times* greater than the values obtained by calculation. One might have legitimately thought that the *exceptional chance presented for the deeper investigation of such a phenomenon* would not have been missed – but that is what actually happened.

Science has lost at least forty years. Not only have my experiments not been followed up, but they have been successfully hidden.

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ANNEXES

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ANNEX I

THE THEORETICAL EFFECT OF THE ANISOTROPY OF SPACE

1. – The hypothesis of inertial space anisotropy

1. - Since 1955, and in view of the observational results, I was induced to formulate the *hypothesis* of the anisotropy of inertial space.

I was able to show that, in this manner, it was possible to explain the observed anomalies by supposing a variation of inertial mass from a direction of anisotropy varying over time (pp. 206, 197-212)[11].

The *theoretical* implications of the hypothesis of the anisotropy of inertial space are presented on pages 206-212. See particularly Tables XII and XIII (pp. 211-212) *for the case of an anisotropic support*.

The case of an isotropic support is analyzed on pages 320-325.

This analysis is founded upon two essential results with regard to the magnitude of the effect of the anisotropy of space and the movement of the plane of oscillation of the pendulum.

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[11] Naturally the hypothesis of the anisotropy of inertial space *implies* that the periods of oscillation of a pendulum *will be different* in the direction of anisotropy of inertial space from within the perpendicular direction.

Due to this, the oscillations of the pendulum will somewhat resemble Lissajoux figures; but the present phenomenon is much more complex, because of the predominance of the Airy effect (p. 26 above), and because of the variation over time of the direction and intensity of the anisotropy of space.

THE HYPOTHESIS OF THE ANISOTROPY OF INERTIAL SPACE LEADS TO THE CONCLUSION THAT, THE LONGER IS THE PENDULUM, THE LESS IS THE FOUCAULT EFFECT DISTURBED.

2. – The effect of the anisotropy of space

The effect of the anisotropy of space is proportional to the square of the amplitude of swing of the pendulum and inversely proportional to its length. The effect corresponding to the current theory of gravitation, while likewise proportional to the square of the amplitude of the swing, is independent of the length of the pendulum (p. 209).

This explains why the Foucault effect is disturbed the less the greater the length and the smaller the swing of the pendulum are.

See in particular note 14, p. 209, and the commentaries of A.C. Longden, pp. 174-175, note 4[12].

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[12] See p. 54 below.

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3. – The oscillations of the plane of the pendulum around the direction of the anisotropy of space

There are strong reasons for thinking that in a continuous experiment the plane of the pendulum oscillates around the direction X of anisotropy of space with a period Θ of the order of three hours[13] for a short pendulum of length in the order of one meter (p. 324, note 2, and Table X, p. 325).

a – Movement of the plane of oscillation of the pendulum

The above implies that, after the pendulum has been released, its plane of oscillation first approaches the direction of anisotropy, and then moves away from it.

After having reached a position nearly symmetric and opposite to its initial position with respect to the direction of spatial anisotropy, the plane of oscillation of the pendulum again approaches the anisotropy direction, passes it, continues onward to its initial position, and so on.

Naturally, if the oscillations are damped, the amplitude of oscillation θ of the direction of the major axis of the ellipse with respect to the direction of anisotropy progressively decreases.

Since the direction X of the anisotropy of space and also the period Θ vary over time, the displacement of the plane of oscillation of the pendulum[14] becomes very complex.

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[13] This is only a plausible order of magnitude (p. 324, note 2).
[14] Which also depends upon the Airy effect (p. 26 above).

ANY MECHANICAL ARRANGEMENT FOR KEEPING THE PENDULUM SWINGING AND PREVENTING PROGRESSIVE REDUCTION OF ITS OSCILLATIONS IS COMPLETELY COUNTER-INDICATED.

ONLY A SERIES OF 14 MINUTE LONG OBSERVATIONS OF THE PENDULUM, RELAUNCHING IT EACH 20 MINUTES, IS SUITABLE.

b – Maintenance of the oscillations counter-indicated

This is the reason why a mechanical arrangement to keep the pendulum swinging in order to avoid progressive reduction of its oscillations is *completely counter-indicated* - because in this case it would no longer be possible to determine the direction of anisotropy at each moment.

c – Observational periods of 14 minutes are absolutely appropriate

It is thus seen that periods of observation of 14 minutes are *particularly appropriate*. For a period Θ of the order of three hours, Θ/4 = 45 minutes, which is of an order for which, in an individual 14 minute experiment, the plane of oscillation of the pendulum approaches the plane of anisotropy (which is due to both the anisotropy of space and also the anisotropy of the support) in a effective manner.

This is what the triply chained experimental series demonstrate. As the graph (p. 103-104) for the triply chained experiments shows, the procedure employed allows the plane of anisotropy to be approached with satisfactory rapidity[15].

Moreover, these durations of 14 minutes are sufficiently short for the amplitude of the oscillations to remain adequate, and for the support ball changes at the start of each elementary experiment to be sufficiently numerous for the effects of defective support balls to be statistically compensated.

[15] Pages 29*-29 above

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ANNEX II

LONG AND SHORT PENDULUMS - THE CRITERION l/α^2

1. – An apparent contradiction

1. - In the immense literature on short pendulums, the experiments of Dejean de Fonroque are particularly interesting (p. 185, n. 4; p. 209, n. 14; p. 710). In particular, he took account of luni-solar effects. Unfortunately his analyses are purely qualitative, and he has given us no quantitative data from his observations. Dejean de Fonroque used a short pendulum one meter long, with amplitudes of 45°, i.e. about 0.785 radian. The accounts which he has given of his observations show that the movements of his pendulum had *nothing in common* with those of the Foucault pendulum. (The question of isotropy, or not, of the support of his pendulum was not examined by Dejean de Fonroque).

2. – The experiments of Dejean de Fonroque qualitatively confirm my own experiments. But they are not the only ones to do so.

In his article of 1919, *On the Irregularities of Motion of the Foucault Pendulum*, Longden wrote (pp. 175-176, nn. 4 and 5):

> *"More than a score of well-known physicists and astronomers are on record as affirming that the Foucault Pendulum must be very long and heavy in order to give satisfactory results."*

How then are the quite different behaviors of short pendulums and long pendulums to be explained?

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2. – A possible explanation

In fact, a very simple explanation can be given of this apparent contradiction if the hypothesis of the anisotropy of space is accepted (pp. 206-212 and 320-325)

According to this hypothesis, and in the case of the isotropic suspension (p. 332, Table IX, equations (1) and (2)) (Annex I above, p. 50):

$$(1) \qquad \phi' = -\omega \sin L + (3/8)\, p\, \alpha\, \beta \qquad p = \sqrt{g/l}$$

$$(2) \qquad \beta' = (p/2)\, \alpha\, \varepsilon \sin 2(X - \phi)$$

where X designates the direction of spatial anisotropy. As

$$(3) \qquad \beta = \int_0^t \beta' \, dt$$

we have

$$(4) \qquad \phi'(t) = -\omega \sin L + \frac{\alpha^2}{l} h(t) \qquad \phi' = d\phi/dt$$

where – ω sin L is the Foucault effect, φ is the azimuth of the plane of oscillation at the instant t, *l* is the length of the pendulum, α is its amplitude in radians, and h(t) is a certain function of time which represents the global action of the celestial bodies at the time considered.

Let us denote by $\varphi_m'(t)$ the value of φ'(t) for a short pendulum of length l_m and amplitude α_m as, and by φ_M' the value of φ'(t) for a long pendulum of length l_M and amplitude α_M. Then:

$$(5) \qquad \phi'_m(t) = -\omega \sin L + \frac{\alpha_m^2}{l_m} h(t)$$

$$(6) \qquad \phi'_M(t) = -\omega \sin L + \frac{\alpha_M^2}{l_M} h(t)$$

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If l_m is relatively small, we have

$$(7) \qquad \omega \sin L << \frac{\alpha_m^2}{l_m} h(t)$$

and if l_M is relatively large we have

$$(8) \qquad \omega \sin L >> \frac{\alpha_M^2}{l_M} h(t)$$

We see that, if l_m is sufficiently small, the action of the celestial bodies is dominant, while if l_M is sufficiently large, the Foucault effect is dominant.

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3. – Characteristics of various pendulums

In the case of the long Foucault pendulum set up in the Pantheon in 1852 (p. 174 and p. 209, note 14):

$$l = 67 \text{ m} \qquad \alpha = 0.06 \text{ radian}$$

whence

$$l/\alpha^2 = 67/0.06^2 = 18{,}611$$

For the Allais paraconical pendulum, 1954:

$$l = 0.83 \text{ m} \qquad \alpha = 0.1 \text{ radian}$$

whence

$$l/\alpha^2 = 0.83/0.1^2 = 83$$

For the short pendulum of Dejean de Fonroque, 1879 (p. 50, n8; p. 185, n4; p. 209, n 14; and p. 710):

$$l = 1 \text{ m} \qquad \alpha = 0.785 \text{ radian}$$

whence

$$l/\alpha^2 = 1/0.785^2 = 1.62$$

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The short pendulum of Kamerlingh Onnes, 1880:

The pendulum of Kamerlingh Onnes (which had a Cardan suspension) is a particularly interesting case of a short pendulum. He was the author of the *most remarkable experimental memoir in the literature* concerning the Foucault effect (see Appendix I below).

According to the analysis of this memoir made by J. Stein (1910, pp. 9, 60, and 61):

$$l = 1.2 \text{ m} \qquad \alpha = 0.00436 \text{ radian}$$

(double amplitude 30 minutes of arc), whence

$$l/\alpha^2 = 1.2/0.00436^2 = 63{,}126$$

which is a higher figure than the one for Foucault's long pendulum.

Actually, *on average*, Kamerlingh Onnes demonstrated the Foucault effect almost rigorously; but there were non-negligible discrepancies between the different series of experiments.

The short pendulum of Van der Willingen, 1868:

Another interesting case of a short pendulum is that of Van der Willingen (1868), for which:

$$l = 10.8 \text{ m} \qquad \alpha = 0.014 \text{ radian}$$

whence

$$l/\alpha^2 = 55{,}102$$

The average effect observed only differed from the Foucault effect by 0.5%, but there were considerable discrepancies between the results of the different series of observations.

EVERYTHING TAKES PLACE AS THOUGH THE CRITERION L/α^2 DEDUCED FROM THE HYPOTHESIS OF THE ANISOTROPY OF INERTIAL SPACE IS VALID.

FOLLOWING THIS CRITERION, THE GREATER IS THE RATIO BETWEEN THE LENGTH OF THE PENDULUM AND THE SQUARE OF ITS AMPLITUDE, THE BETTER WILL THE FOUCAULT EFFECT BE VERIFIED.

The coefficient λ

For comparison of pendulums, it is interesting to consider the relation:

$$(1) \qquad \lambda = \frac{l/\alpha^2}{(l/\alpha^2)_a}$$

where $(l/\alpha^2)_a$ denotes the value of l/α^2 for the Allais pendulum, which had

$$l/\alpha^2 = 83$$

Table I below is derived using this relation.

The criterion l/α^2

If the criterion l/α^2, *which is deduced from the hypothesis of the anisotropy of inertial space*, is valid, then it should be found that the greater is the value of l/α^2, i.e. the greater is the coefficient λ, the better is the Foucault effect verified.

In fact, this is what is found.

Overall, it certainly seems that the results of observation confirm the validity of the criterion l/α^2, which is deduced from the hypothesis of the anisotropy of inertial space.

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COMPARISON OF THE VALUES OF l/α^2 FOR FIVE REFERENCE EXPERIMENTS

	l (meters)	α (radian)	l/α^2	λ $(l/\alpha^2)/(l/\alpha^2)_a$
Paraconical Allais pendulum 1954	**0.83**	**0.100**	**83**	**1**
Pendulum of Foucault (Pantheon) 1852	**67.00**	**0.060**	**18,611**	**224**
Pendulum of Van der Willingen 1868	**10.80**	**0.014**	**55,102**	**664**
Pendulum of Dejean de Fonroque 1879	**1.00**	**0.785**	**1.62**	**0.0195**
Pendulum of Kamerlingh Onnes 1880	**1.20**	**0.0044**	**63,100**	**760**

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4. – Order of magnitude of the function h(t) - Illustration

From the relation (1) of §2 above, we have

$$(1) \qquad \phi'(t) = -\omega \sin L + \frac{\alpha^2}{l} h(t)$$

We can get an idea of the order of magnitude of the function h(t) by considering Graph XXIII which represents the azimuths of 28 September to 4 October 1959 with the isotropic suspension (p. 318)[16]. On its right hand side, the azimuth varied in the prograde direction by 200 grades in 24h, whence

$$(2) \qquad \phi' = +200 \frac{2\pi}{400} \frac{1}{24 \,.\, 3600} = +\ 0{,}36.10^{-4} \text{ rad. / sec.}$$

At Saint-Germain, in CGS units, this result was obtained (p. 93, note 1):

$$(3) \qquad -\omega \sin L = -\,0{,}55.10^{-4} \text{ rad. / sec.} \qquad l/\alpha^2 = 8\,300$$

From (1), we thus have, in CGS units:

$$(4) \qquad 0{,}36.10^{-4} = -\,0{,}55.10^{-4} + \frac{h(t)}{8\,300}$$

i.e.

$$(5) \qquad h(t) = 8\,300 \times 0{,}91.10^{-4} = 0{,}75$$

Equation (1) accordingly becomes:

$$(6) \qquad \phi' = -\,0{,}55.10^{-4} + \frac{0{,}75}{l/\alpha^2}$$

i.e., in the case of the Foucault pendulum in the Pantheon, in CGS units:

$$(7) \qquad \phi' = -\,0{,}55.10^{-4} + \frac{0{,}75}{1{,}86\ 10^{6}} = -\,0{,}55.10^{-4} + 0{,}40.10^{-6}$$

It is thus verified that in this case the second term is effectively negligible, and that φ' reduces in practice to the Foucault effect.

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[16] See above, p. 19*.

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ANNEX III

OBSERVATIONS OF THE MOVEMENTS OF FOUCAULT PENDULUMS DURING THE ECLIPSE OF 11 AUGUST 1999

1. – Characteristics of the pendulums

From the data given by David Noever on the characteristics of the Foucault pendulums utilized for the observations of 11 August 1999 (23 September 1999 comments – To Eclipse Network Collaborators), the lengths of the pendulums, the amplitudes of their oscillations, the magnitude of the eclipse, and the durations of observation are presented in Table II.

The length of the pendulums used varied from 15 m to 61 m, and, where any indication is given, the amplitude in radians varied from 0.02 to 0.22 radians.

For three of the experiments, the magnitude of the eclipse effect was nil.

I remind the reader that, for the Allais pendulum, $l = 83$ cm, $\alpha = 0.10$ radians, while for the Foucault pendulum in the Pantheon, $l = 67$ m, $\alpha = 0.06$ radians.

2. – Duration of the observations

For observations 1, 3, 4, 5, 6, and 7, the period of observation was of the order of 4 to 6 hours. In light of Graphs XXIX, XXXI, and XXIII (pp. 165, 167, and 318) relating to my observations of 1954 and 1959[17], *this is much too short a period to detect anomalies properly.*

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[17] Pages 16*, 17*, and 19* above.

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3. – The criterion l/α^2

To the extent that the criterion l/α^2 is valid, *the smaller l/α^2 is, the more chance there is for observing an effect during an eclipse*.

From this point of view, and with regard to the observations for which sufficient data is available, it would have been the laboratory of Huntsville (no. 5 in Table II), for which the value of l/α^2 is the smallest, equal to 459, which had the greatest chance of detecting an anomaly during the eclipse. But the magnitude of the eclipse there was nil.

By contrast, it would have been the observatory in Austria (no. 1 in Table II) which had the greatest chance of observing the Foucault effect.

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TABLE II

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OBSERVATIONS OF FOUCAULT PENDULUMS DURING THE ECLIPSE OF 11 AUGUST 1999 - CRITERION l/α^2

		l (meters)	α (radians)	l/α^2	magnitude of eclipse	duration of observations
1	Austria (Observatory)	53	1/53=0.019	146,800	1.028	11 August: 7h42-13h42
2	Germany (Observatory)	15	1/18.8=0.053	5,340	0.881	?
3	Austria (Museum)	17	?	?	0.99	9-12 August: 7h40-13h20
4	Trento (Italy)	?	?	?	0.82	11 August: 7h40-13h20
5	Huntsville (US)	22.2	1/4.6=0.22	459	0.0	11 August: 7h40-13h20
6	Louisville (US)	22	?	?	0.008	11 August: 7h40-13h20
7	Boulder (US)	55	?	?	0.0	11 August: 7h40-13h20
8	Paris (France)	61	?	?	0.944	?

Notes: See Table I, p. 60.
For the Foucault pendulum of 1852, l=67m, α=0.06 radian, l/α^2 = 18,611
For the Allais paraconical pendulum, l=0.83m, α=0.10 radian, l/α^2 = 83

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APPENDICES

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APPENDIX I

BIBLIOGRAPHY CONCERNING THE FOUCAULT PENDULUM AND RELATED EXPERIMENTS

The bibliography relating to the Foucault pendulum and related experiments is *immense*. I have personally consulted more than 1,500 works and memoirs. (Allais, 1958, *Should the Laws of Gravitation be Reconsidered? Conclusions*).

1. – Bibliography on Pendulums, 1629-1885

A very extended Bibliography on Pendulums was produced in 1889 by the French Physical Society (Collection of Memoirs related to Physics, Vol. IV, Gauthier Villars, 1889, pp. B1-B216).

The references relating to the Foucault pendulum and related experiments are given from p. B125 to p. B216. For the period 1851 to 1885, they include several hundred titles.

2. – The rotation of the Earth: its mechanical proofs ancient and new, J.C. Hagen, 1911

1-: This work edited by J.C. Hagen (and translated into French by P. de Vregille) was published in 1911 by the "*Specola Astronomica Vaticana*" (Vatican Observatory) (189 pages in 22 x 32 quarto, with six plates).

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This volume is accompanied by two Appendices:

1 – *The experiments of Kamerlingh Onnes*, 1910, edited by J. Stein, (72 pages in quarto, with four plates).

2 – *Analysis of two experiments of J.C. Hagen upon isotomeography, and upon the application of a fixed pulley to measurement of the deviation of a body in free fall,* 1912, 53 pages, with three plates.

2-: *The main volume contains an analysis by J.C. Hagen of the Foucault pendulum and of related experiments, pp. 42-65.*

This text offers an analysis of experiments on the Foucault pendulum from 1851-1911 which is of *considerable interest*.

Many pertinent comments are made on the main reruns of Foucault's experiment from 1851 to 1911, in particular with regard to the Airy precession (see pp. 12 and 26 above).

From these analyses it is clear that *anomalies have never ceased to appear in the reruns of Foucault's experiment*.

Anybody interested in the Foucault pendulum should read this analysis attentively in order to be in a position to understand all the difficulties of the subject.

3. – The experiments of Kamerlingh Onnes, J. Stein, 1910

Stein's memoir on the experiments of Kamerlingh Onnes in 1879 constitutes Appendix I of the above work of Hagen.

The first memoir by Kamerlingh Onnes in 1879 was his doctoral thesis at the Faculty of Sciences in Groningen University. It includes both an analysis of the theory of the pendulum and his own experiments.

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Professor Van Geir sums up his commentary upon the thesis of Kamerlingh Onnes with this judgment (Stein, 1910, p. 5):

> *"Of all the theoretical and experimental works whose goal has been to prove the rotation of the Earth by pendulum experiments, it is, without doubt, the most elaborate and the most profound in all its aspects."*

As far as I know, this memoir remains today "*the most elaborate and the most profound*" of all experimental attempts with a pendulum to demonstrate the Foucault effect.

Kamerlingh Onnes (1853-1926) received the Nobel Prize in Physics in 1913 for his experiments upon the properties of matter at low temperature.

This thesis of Kamerlingh Onnes, of 290 pages with four plates, was written in Dutch (*Nieuwe bewijzen voor de aswenteling der Aarde*, New demonstrations of the axial rotation of the Earth). It has never been translated into English or French, which is a rather strange circumstance for a doctoral thesis of a winner of the Nobel Prize in Physics.

The very profound commentaries of J. Stein appear to me to be *very pertinent*, although the theory of Kamerlingh Onnes's apparatus with a "*Cardan*" type suspension is *relatively complex*.

The experimental results are presented on pp. 60-69 of Stein's memoir. The *average* of the experimental values of $\omega \sin \lambda$ only differs by about 0.5% from the theoretical value, but deviations of the order of 6% were present between the different series of observations.

(For a short analysis, see *Bibliography on Pendulums 1629-1885*, pp. B.193 and B.194).

ALL PREVIOUS EXPERIMENTS ON THE FOUCAULT PENDULUM HAVE PRESENTED ANOMALIES WHICH HAVE NEVER BEEN EXPLAINED.

BY APPROACHING EXPERIMENTS ON THE PENDULUM IN A DIFFERENT MANNER, I.E. VIA CONTINUOUS OBSERVATIONS OVER PERIODS OF A MONTH AND HARMONIC ANALYSIS OF THEIR PERIODIC STRUCTURE, MY OWN EXPERIMENTS HAVE MADE IT POSSIBLE TO SURMOUNT THE INCESSANT DIFFICULTIES ENCOUNTERED BY THE 19TH AND 20TH CENTURIES OBSERVERS.

4. – Overall View

From these analyses taken as a whole, it is seen that *all the experiments on the Foucault pendulum present inexplicable anomalies.*

Little by little the experimentalists became discouraged by having no theory on such, and turned to other lines of research.

In 1866 Van der Willingen could already write (pp. 53 and 712):

> *"In experiments on the Foucault pendulum, at least in the experimental sphere, people always stop precisely at the point that the real difficulties start."*

This judgment is as valid as ever. (See my commentaries, p. 53, note 17).

I think that by approaching experiments on the pendulum in a different manner, i.e. via continuous observations over periods of a month and harmonic analysis of their periodic structure, my own experiments have made it possible to surmount the incessant difficulties encountered by the observers of the 19th and 20th centuries. This new level of analysis has achieved considerable progress.

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APPENDIX II

RERUNNING MY 1954-1960 PARACONICAL PENDULUM EXPERIMENTS

A

RERUNNING THE EXPERIMENTS

1. – Continuing the investigation of the eclipse effect

In view of the great interest shown by David Noever in the "*Allais Effect*" observed during eclipses, and bearing in mind the fact that the eclipse effect *is only a particular case of a much more general phenomenon* brought to light by my experiments in 1954-1960 with the paraconical pendulum, I consider it to be *very desirable* for NASA to rerun my experiments of *continuous observation over periods of at least a month* of an asymmetrical paraconical pendulum (consisting of a disk suspended via a support ball), both with anisotropic and isotropic supports.

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ABOVE ALL, EFFECTIVE RERUN OF MY EXPERIMENTS REQUIRES IMPLEMENTATION OF IDENTICAL EXPERIMENTAL CONDITIONS.

2. – Experimental conditions identical to those of the 1954-1960 experiments

Before anything else, it is imperative to rediscover the regularities already observed with the equipment used previously, even if at first sight this does not appear to be optimal.

If one bears in mind that the object is to demonstrate anew the anomalies observed in the past, it will be understood that it is absolutely necessary to keep to the same experimental conditions[1].

3. – A highly motivated experimental team

The second condition necessary for success is to build up a team of experimenters who not only are highly motivated, but also have extended professional experience in research.

It will not be enough to set up suitable experimental equipment; it must also be operated continuously, while exploiting the observed data in an appropriate manner.

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[1] Here the example of Esclangon's experiments is full of lessons. *A priori* modifications without real significance were enough to make the observed effects disappear – see *The Anisotropy of Space*, Chapter IV, §B.2, note 6, p. 379.

IF EXPERIMENTAL CONDITIONS ARE SET UP WHICH ARE IDENTICAL TO THOSE I EMPLOYED WITH THE PARACONICAL PENDULUMS WITH ANISOTROPIC SUPPORT AND WITH ISOTROPIC SUPPORT, IT IS CERTAIN THAT THE EXISTENCE OF ALL THE OBSERVED ANOMALIES, AND ALSO THEIR MUTUAL INTER-RELATIONS, WILL BE CONFIRMED.

4. – Certain success

If experimental conditions are set up which are *identical* to those I employed with the paraconical pendulums with anisotropic and isotropic supports, it is *absolutely certain* that *the existence of all the observed anomalies, and also their mutual inter-relations, will be confirmed.*

This certitude is founded:

— upon analysis of the *seven one-month-long series* of observations of the paraconical pendulum *with anisotropic support* performed at IRSID and at Bougival from 1954 to 1960, and upon analysis of the *two one-month-long series* of observations of the paraconical pendulum *with isotropic support* performed at IRSID in November-December 1959 and in March-April 1960[2];

— *and in particular upon analysis of the extremely remarkable, even decisive, mutual agreement* observed in the periodic structures of the two sets of observations of the movement of the paraconical pendulum with anisotropic support, performed in identical conditions *during the crucial experiments of July 1958 at Bougival and at Saint-Germain*[3].

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[2] See above, pages 23-24.
[3] See above, page 44.

THE SUGGESTED EXPERIMENTS WOULD MAKE IT POSSIBLE TO DETERMINE THE DIRECTION OF SPATIAL ANISOTROPY AND TO PREDICT THIS ANISOTROPY DIRECTION AT ANY GIVEN POINT, AS IS THE CASE WITH TIDES TODAY.

5. – A set of experiments of exceptional scientific interest

Repetition of my experiments with the paraconical pendulum with anisotropic and isotropic supports would be, *according to all the evidence, of exceptional scientific interest*.

These experiments would in fact be able to confirm *the existence of an anisotropy of space*, which manifests itself as a privileged direction varying over time as a result of astronomical influences.

They would also make it possible *to determine* the direction of this spatial anisotropy and its periodic structure, and *to predict* the direction of this anisotropy at any given point, as is the case with tides today.

IMPLEMENTATION OF 14-MINUTE EXPERIMENTS WITH RELEASES EVERY 20 MINUTES IS AN INDISPENSABLE CONDITION, WHETHER THE PROCESS OF CHAINED SERIES OR THE PROCESS OF MOBILE CORRELATIONS IS CONSIDERED.

ANY ARRANGEMENT FOR MAINTAINING THE AMPLITUDE AUTOMATICALLY SHOULD BE COMPLETELY EXCLUDED.

B

GENERAL PRINCIPLES

1. – Experimental conditions

The equipment and procedures for the experiments are *very simple* (pp. 81-86): experiments over fourteen minutes each, with releases being performed every 20 minutes, while changing the support ball between each experiment.

In any case, it is preferable to use an asymmetric pendulum, like the disk I utilized, *because in this case the plane of the disk tends to coincide with the plane of oscillation (pp. 93 and 657, note 3), which makes it easier to determine that plane*.

In the same way, the implementation of experiments over 14 minutes with releases every 20 minutes is an *absolutely necessary condition*. This condition is a *sine qua non, whether the process of chained series*[4] *or the process of mobile correlations*[5] *is considered.*

Continuous experiments using some means to maintain the amplitude of the pendulum must be *completely excluded*[6].

It would be *perfectly useless* to operate the equipment in a vacuum.

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[4] See pp. 23-24 above.
[5] See p. 25 above.
[6] See Annex I, Section 3b, pp. 52-53 above.

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The construction of a pendulum and supports as similar as possible to those I utilized (pp. 81-86 and 241) should not present any difficulties.

It might be advantageous to use a circular support (p. 241), even in the case of an anisotropic support.

It would be desirable to select an experimental location close to a mechanical workshop.

2. – Personnel

What is essential is to perform continuous observations, day and night, with a team of 8 to 10 trained operators, *re-launching the pendulum every 20 minutes*.

Once again, any automatic means to maintain the oscillations should be avoided, because, inherently, it engenders perverse effects.

The team should be entirely dedicated to the task at hand. It should include at least a trained statistician and a physicist who is competent in physics and in astronomy. (Knowledge of the French language on the part of at least one participant would be very desirable.)

3. – Month-long series of observations

a – Preliminary observations

Each month-long series of observations should be preceded by preliminary observations like those I have described (pp. 94-95), *with photographic recording if possible*.

It is particularly necessary to determine the anisotropy of the support (pp. 176-182).

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b – Logged observations

The azimuths and amplitudes *at the end of* each 14 minute experiment should be measured by the observers.

If possible, a *continuous photographic record of the trajectories* should be maintained in parallel.

At Saint-Germain there were about 450 oscillations of the pendulum during each period of 14 minutes, i.e. 840 seconds (840/1.85=454).

Graphs of the observed azimuths and of the minor axes of the elliptical trajectories at the end of each experiment of 14 minutes should be produced each day.

c – Harmonic analysis of the observations

Each series of observations from 20mn to 20mn with 721 values (31 days) should be immediately followed by their harmonic analysis:

- First, harmonics of 24h 50m and 24h (perfectly separated over a series of 721 hours) should be searched for.
- Next, the observations should be adjusted with respect to the 13 principal periods utilized in the theory of tides.

For this, the programs of the hydrographic service of the US should be used (pp. 96-101; see particularly p. 97, note 5, and Table II, p. 99).

Also, the remarkable work of Paul Schureman, *Manual of Harmonic Analysis and Prediction of Tides*, US Department of Commerce, 1941 (*The Anisotropy of Space*, pp. 115, 135, 185, 187, 272-273, 287, 480, and 707) should be employed.

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- A comparison should be made with the theoretical amplitudes as predicted by the theory of tides.

- A frequencygram of the observations should be calculated, and *my test of periodicity* should be applied (pp. 115-116)[7].

[7] See pages 39 and 39* above.

THE ANTICIPATED COST FOR IMPLEMENTING A MONTH-LONG SERIES OF OBSERVATIONS OF THE PARACONICAL PENDULUM WITH ANISOTROPIC SUPPORT WOULD BE MUCH LESS THAN THE COST ATTRIBUTABLE TO ALL THE OBSERVATIONS OF THE TOTAL ECLIPSE OF 11 AUGUST 1999.

SUCH A MONTH-LONG SERIES OF OBSERVATIONS WOULD YIELD MUCH MORE COPIOUS AND VALUABLE DATA THAN ALL THE OBSERVATIONS OF THE TOTAL ECLIPSE OF 11 AUGUST 1999.

C

EXPERIMENTAL PROGRAM

1. – Three successive phases

The rerunning of my experiments should be broken into three phases:

- The first relating to the paraconical pendulum with anisotropic support,

- The second relating to the paraconical pendulum with isotropic support,

both above in conditions *identical* to those I used, and

- The third with other types of pendulum and other systems of observation.

A FIRST MONTH-LONG SERIES OF CHAINED OBSERVATIONS WITH A PARACONICAL PENDULUM WITH ANISOTROPIC SUPPORT WOULD CONFIRM THE EXISTENCE OF THE PERIODIC LUNI-SOLAR COMPONENTS DISCOVERED BY ME IN 1954-1960.

IT WOULD THUS BE POSSIBLE TO DECIDE UPON FURTHER EXPERIMENTS WITH FULL KNOWLEDGE OF THE FACTS.

2. – Experiments with the paraconical pendulum with anisotropic support

The *easiest experiments to implement* are those with the paraconical pendulum with anisotropic support.

a – Anisotropy of the support

The desirable order of magnitude for the anisotropy of the support is that which I have already contemplated (pp. 176-182)[8].

b – Month-long series of observations

It is desirable, above all, to perform successively:

- a month-long series of chained observations;
- a month-long series of triply chained observations[9];
- two month-long series of chained observations in two different places with identical apparatus[10].

The first month-long series will confirm the existence of the periodic components which I discovered.

c – Probable total time required for these experiments

A period of the order of 6 to 8 months should be allowed for training the operators and performing the above three series of observations.

Then the decision can be made to start the second phase of observations, that of the paraconical pendulum with isotropic support.

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[8] See pp. 30 and 30* above.
[9] See pp. 29 and 29* above.
[10] This entails repeating my two crucial experiments of July 1958 at Bourgival and at Saint-Germain (pp. 142-161).

WITH THE ISOTROPIC SUPPORT, TWO EXPERIMENTAL PROCEDURES WILL ENABLE THE DIRECTION OF ANISOTROPY OF SPACE TO BE DETERMINED:

- THE PROCESS OF MOBILE CORRELATIONS;

- THE PROCESS OF CHAINED EXPERIMENTS.

THESE TWO PROCESSES ARE INDEPENDENT AND COMPLEMENTARY.

3. – Experiments with the paraconical pendulum with isotropic support

a – The advantages of the isotropic support

The advantages of an isotropic support are outstanding with regard to information yield, but actual implementation of an isotropic support, and making the observations and interpreting them, involve special difficulties which can only be easily coped with by a team of observers previously trained with a paraconical pendulum with anisotropic support.

b – The observations

It seems to be eminently desirable, indeed necessary, to perform two series of *simultaneous observations with identical pendulums and suspensions at the same site*:

- the first using the process of mobile correlations (pp. 247-254);

- the second using the process of chained experiments, as with the pendulum with anisotropic support.

The two methods, which are *entirely different*, will no doubt result in *slightly different* determinations of the anisotropy of space.

These two procedures are accordingly *independent and complementary*[11].

[11] The procedure of chained experiments is able to overcome all the difficulties encountered with the application of the procedure of mobile correlations (pp. 253-254).

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c – Exploitation of the observations

Exploitation of the chained series for the isotropic support will be the same as that proposed for the anisotropic support.

The method of mobile correlations makes it possible to obtain a large amount of supplementary information (pp. 247-372).

These two mutually associated experiments will make it possible to determine, at each instant, *the direction of the anisotropy of space and its periodic structure* (pp. 238-254).

In the case of mobile correlations, the various applications are those which I have utilized (pp. 255-234).

d – Experiments at different locations

Subsequently, it would be useful to perform the double series of observations specified above at two different locations and with four identical pendulums and four identical isotropic supports (§3b)[12].

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[12] See page 80 above.

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TRYING NEW EXPERIMENTAL CONDITIONS, IN PARTICULAR USING VERY SHORT PENDULUMS WITH LARGE AMPLITUDES, SHOULD NOT BE CONSIDERED BEFORE REPEATING MY EXPERIMENTS WITH THE PARACONICAL PENDULUM WITH THE ANISOTROPIC AND THE ISOTROPIC SUPPORT.

4. – Experiments with different experimental conditions

a – Third phase

Subsequently, in a third phase, other types of pendulum and other procedures for observation may be considered, *but only after rerunning the two first sets of experiments and confirming the periodic effects which I have discovered.*

In this type of experiment one must make haste slowly. That is the essential key for success.

b – Short pendulums with large amplitudes

After the two initial phases above it would, in particular, be possible to consider experiments *with short pendulums about 20 cm long, and with large amplitudes of the order of 45°*. The effects observed would doubtless be *considerably enhanced*.

But setting up such arrangements would take a considerable time, and they could only be exploited by a highly trained team.

In my opinion, for the moment, such tests should be totally excluded.

In any case, any quest for a means of maintaining the amplitude of the oscillations steady in order to enable continuous observation should be totally excluded, at least for the first few months[13].

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[13] See Annex I above, page 53.

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APPENDIX III

SUPPLEMENTARY REFERENCES

I now list for David Noever a number of my works which may be useful for the rerun of my experiments on the paraconical pendulum:

1957 – *Periodic structure of the movements of the paraconical pendulum with anisotropic suspension, and of the luni-solar influence; Experimental results and anomalies* - Volume I (in French)
C.R.A.S., Vol. 244/245, Sessions of May 13, November 4, 13, 18, and 25, and December 4, 1957.

1958 – *Should the laws of gravitation be reconsidered*? (in French)
Perspectives X (Polytechnic School), pp. 90-104, with a Supplementary Note of two pages (intercalated and not paginated).

1958 – *Should the laws of gravitation be reconsidered*? (in English)
Aero-Space Engineering, September 1959, No. 9, pp. 46-52; October 1959, No. 10, pp. 51-55; and November 1959, No. 11, p. 55. English translation of the *Perspectives X* memoir above.

1959 – *Periodic structure of the movements of the paraconical pendulum with anisotropic suspension, and of the luni-solar influence; Experimental results and anomalies* - Volume II (in French)
C.R.A.S., Vol. 247/248, Sessions of November 3, December 22, 1958, and 19 January, 9 February, 1959.

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1961 – *Generalization of the Schuster Test in the Case of Autocorrelated Temporal Series, under the Hypothesis of Random Perturbations of a Stable System* (in French)
Bulletin of the International Institute of Statistics, 1962, Vol. 39, second issue, pp. 143-194.

1982 – *Frequency, Probability, and Chance* (in English)
In the work *Foundations of Utility and Risk Theory with Applications,* edited by Bernt F. Stigum and Fred Wenstop, D. Reidel Publishing Company, Dordrecht, 1983, pp. 35-84.

1983 – *Frequency, Probability, and Chance* (in French)
Journal of the Statistical Society of Paris, second and third trimesters of 1983, pp. 70-102 and 144-221.

1983 – *On The Normal Distribution of Values of a Sum of Sines at Regularly Spaced Instants*,
C.R.A.S., Vol. 296, series I, 30 May 1983, pp. 829-830.

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