Anisosphere analysis of the equivalence between a precessing Foucault pendulum and a torsion pendulum

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Historical context

From 1953 to 1960, the French engineer Maurice Allais conducted physics experiments with an anisotropic Foucault pendulum of his invention, which he named paraconical pendulum, and with which he observed fluctuations in precession rate showing soli-lunar periodicities.

After 6 years of publication in the *Comptes-Rendus de l'Académie des Sciences* about an instrument whose functioning was apparently understood only by him, his instrument was declared inappropriate and untrusty by his contemporary academicians. His papers were refused and his annual funding over 100000 of today's euros was denied. The fine instrument that was then dismantled has never been surpassed in 60 years since.

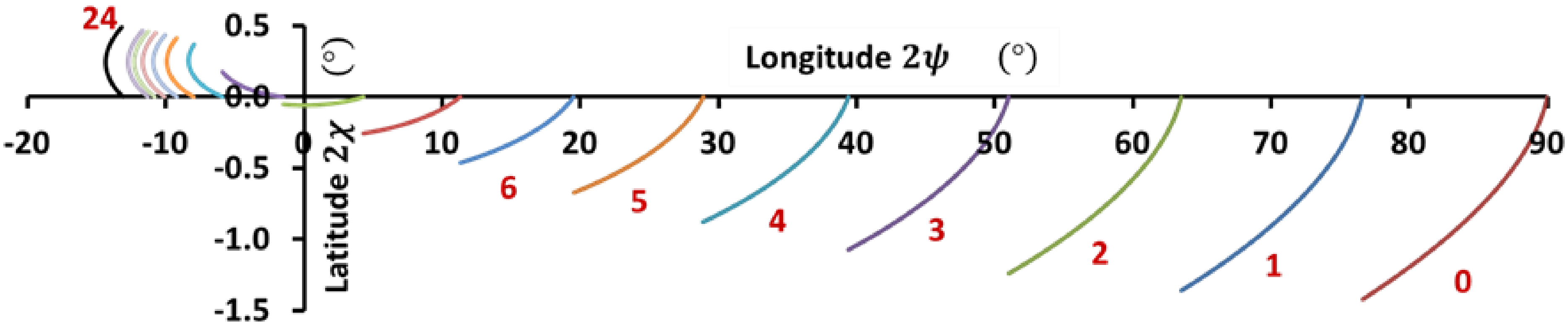
Allais then abandoned physics and became an economist. He won the Nobel Prize of economics in 1988 and he died in 2010 at the age of 99.

Aim of the talk

Thanks to an anisosphere analysis of Allais pendulum and measuring procedure in retrospect, it is proposed to show

- **that Allais' paraconical pendulum was indeed a very high performance instrument;**
- **that the soli-lunar periodicities detected by Allais were by all means no esotheric results.**

Allais' procedure of enchained runs during week- or month-long continuous experiments

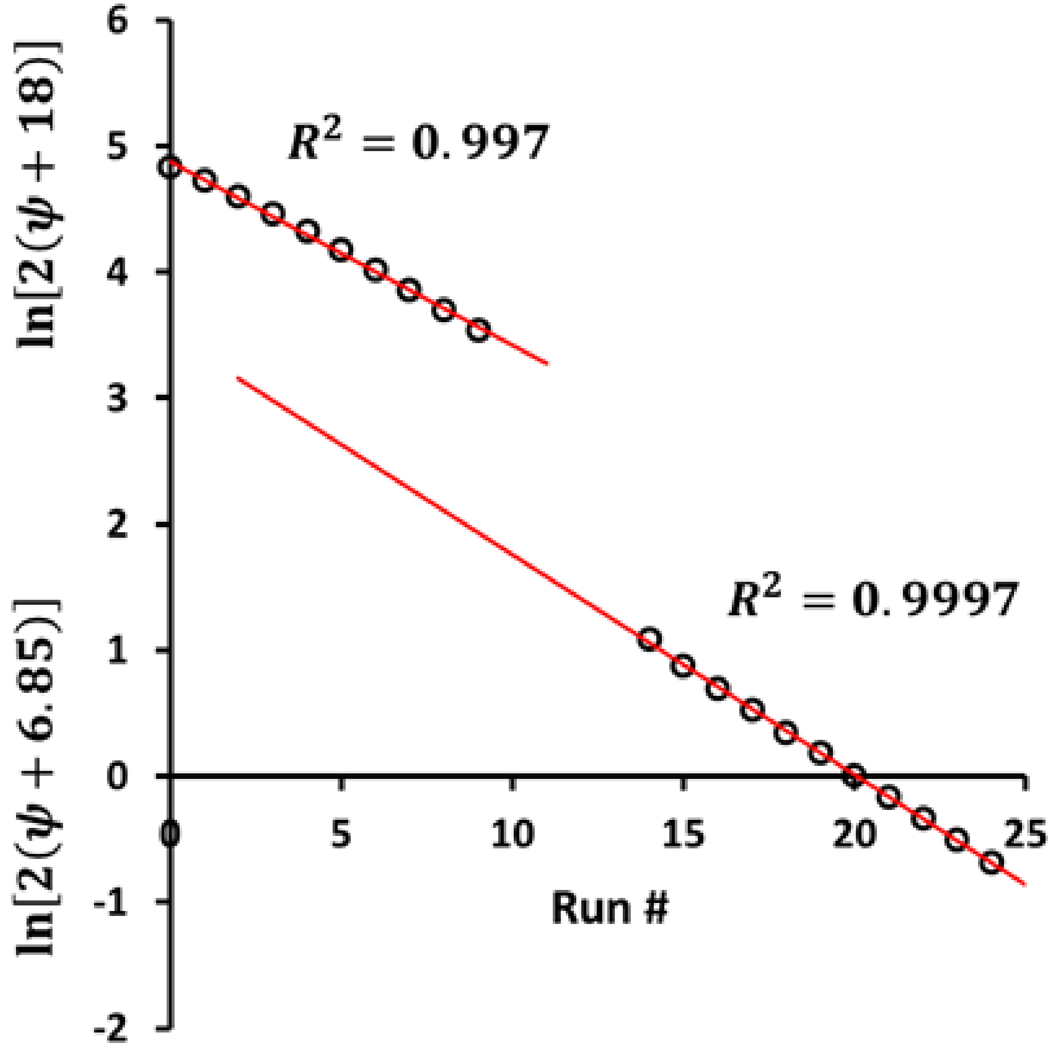


Simulation of the enchained-runs procedure on the anisosphere. A selection of phase curves of the 25 runs of this simulated experiment is shown. The experiment is started at an azimuth 45° higher than the slow axis azimuth due to suspension anisotropy, here taken as the origin of longitudes on the anisosphere. As a result of the important Airy effect, the quasi totality of the phase curves are squeezed within a ±1° range about the anisosphere equator. Note that for the sake of graph clarity, the latitude scale has been exaggerated by a factor 10. The last phase curves, not shown, pile up on the asymptotic curve exemplified by run 24, where the final and initial azimuths coincide.

Damping characteristics of the enchained-runs procedure.

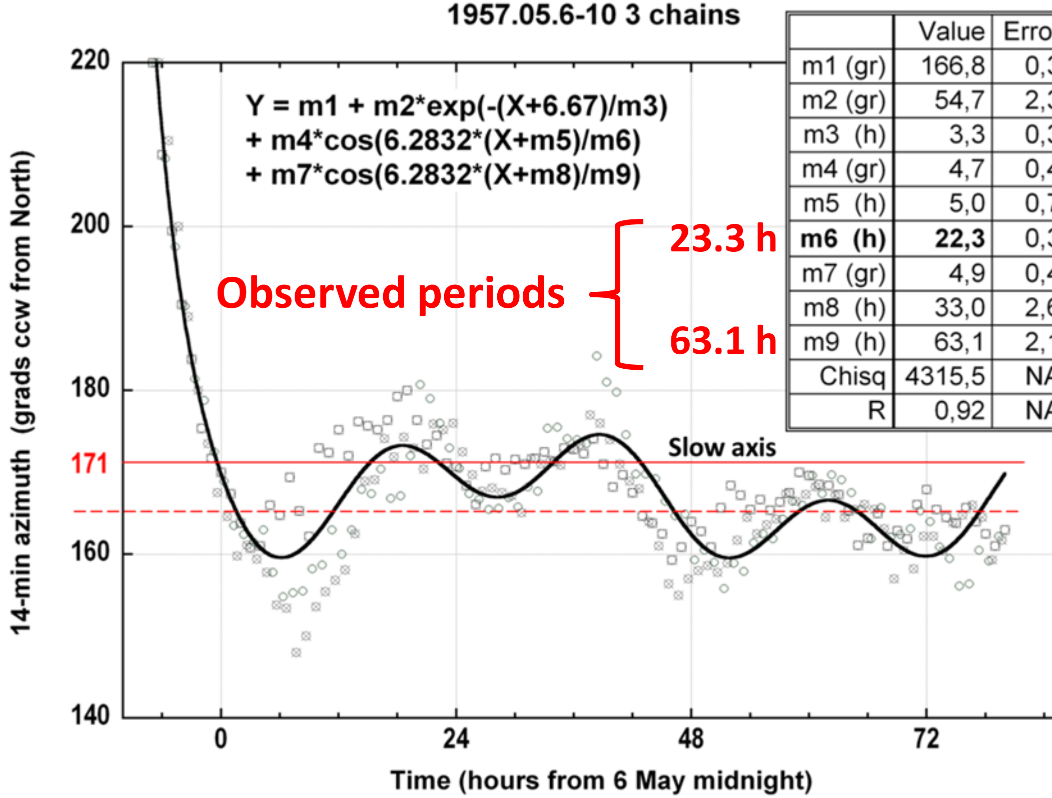
For a pendulum launch at a higher azimuth than the slow eigenazimuth, the consecutive launch azimuths undergo exponential decay toward the asymptotic azimuth $\psi_{\infty+} = -18°$ with a time constant of 6.85 runs.

Once the eigenazimuth has been crossed (from run 9 on in the preceding slide), a new asymptote $\psi_{\infty-} = -6.85°$ prevails, with a time constant of 5.73 runs.



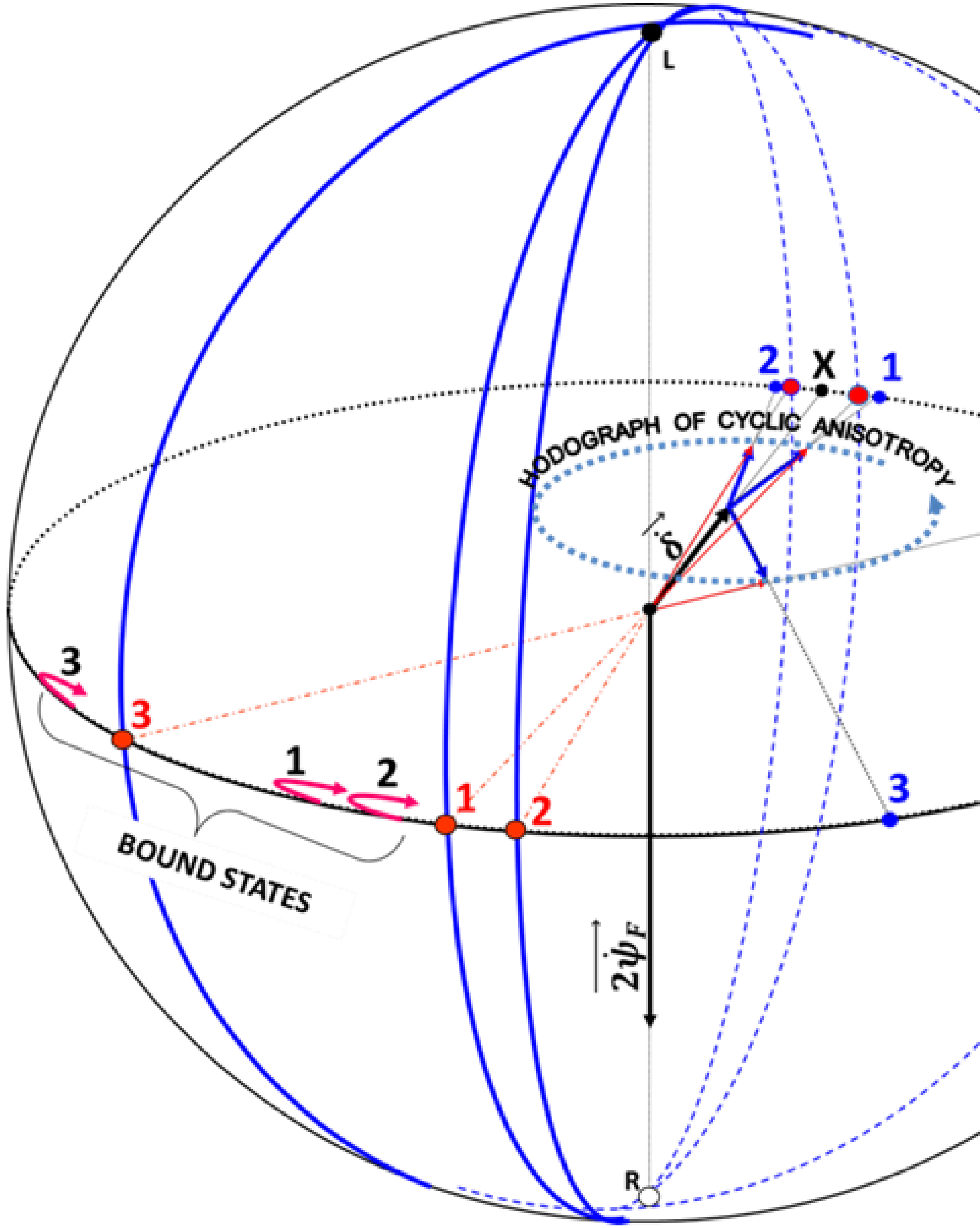
Spectral analysis of a triply-enchained-run experiment over 3.5 days

The individual dots represent all the stop-start azimuths connecting the 14-min enchained runs. Note that the azimuth units are grads counted positive in the ccw sense. A theoretical function (equation in inset) in the form of the sum of a decreasing exponential and of two sinusoidal components is fitted to the data. The known slow eigenaxis from suspension anisotropy is at 171 grads. The steady state equilibrium azimuth (red dotted line) falls 5.7 grads (5.13°) below the slow eigenazimuth. Considering 1 run/h in each chain, the damping time constant (m3 in the inset table) is 3.3 runs.



	Value	Error
m1 (gr)	166,8	0,3
m2 (gr)	54,7	2,3
m3 (h)	3,3	0,3
m4 (gr)	4,7	0,4
m5 (h)	5,0	0,7
m6 (h)	**22,3**	0,3
m7 (gr)	4,9	0,4
m8 (h)	33,0	2,6
m9 (h)	63,1	2,1
Chisq	4315,5	NA
R	0,92	NA

Anisosphere analysis of the influence of a perturbing slowly varying cyclic linear anisotropy contribution. The result is a cyclic wandering of the linear anisotropy slow eigenaxis. The **phase curve** of a 14-min run always starts and stops at about 4° to 6° on the low-azimuth side of the slow eigenaxis. It **tracks the wandering of the slow eigenaxis** with a constant offset but with very little lag, occupying a set of **bound states linked to the slow eigenaxis**.

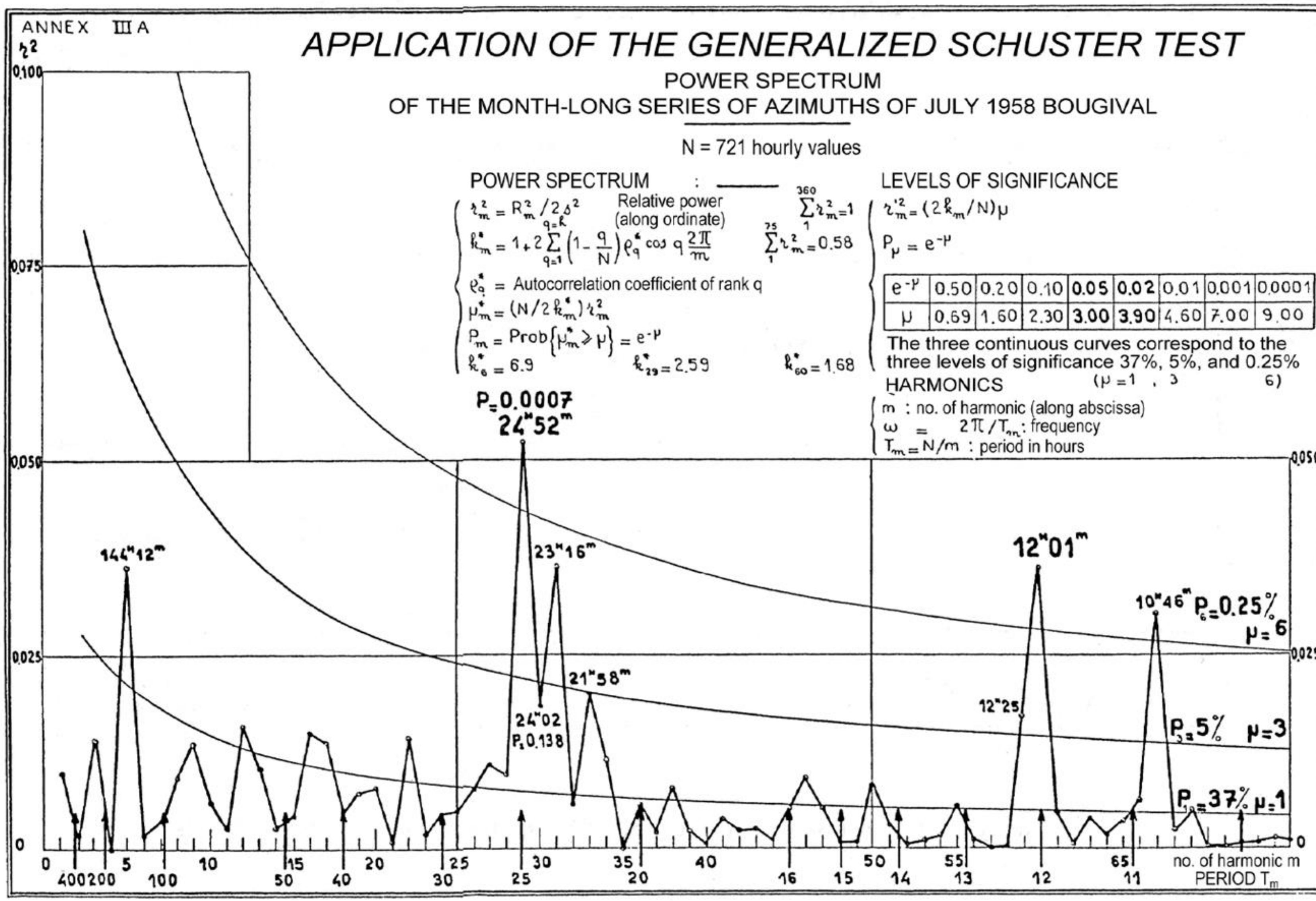


The fact that the precessing pendulum tends to stabilize at an asymptotic bound state azimuth with an exponential damping process involving a very long time constant
$(\mathbf{3.3runs} \times \mathbf{14min} = \mathbf{46min}\ or\ \mathbf{0.77h})$
makes it equivalent to torsional pendulum with almost critical damping , making it a fine measuring instrument responding to periodicities of 10h and more.

The oscillations in the final azimuth of each 14-min run of the precessing pendulum suggest a cyclic contribution of linear anisotropy that enters a vector sum with the fixed linear anisotropy of suspension. The amplitude of about 4.5° in each individual cyclic component with the respective periods of 22.3 h and 63.1 h means that the variable anisotropy amounts to approximately 10% of the fixed suspension anisotropy.

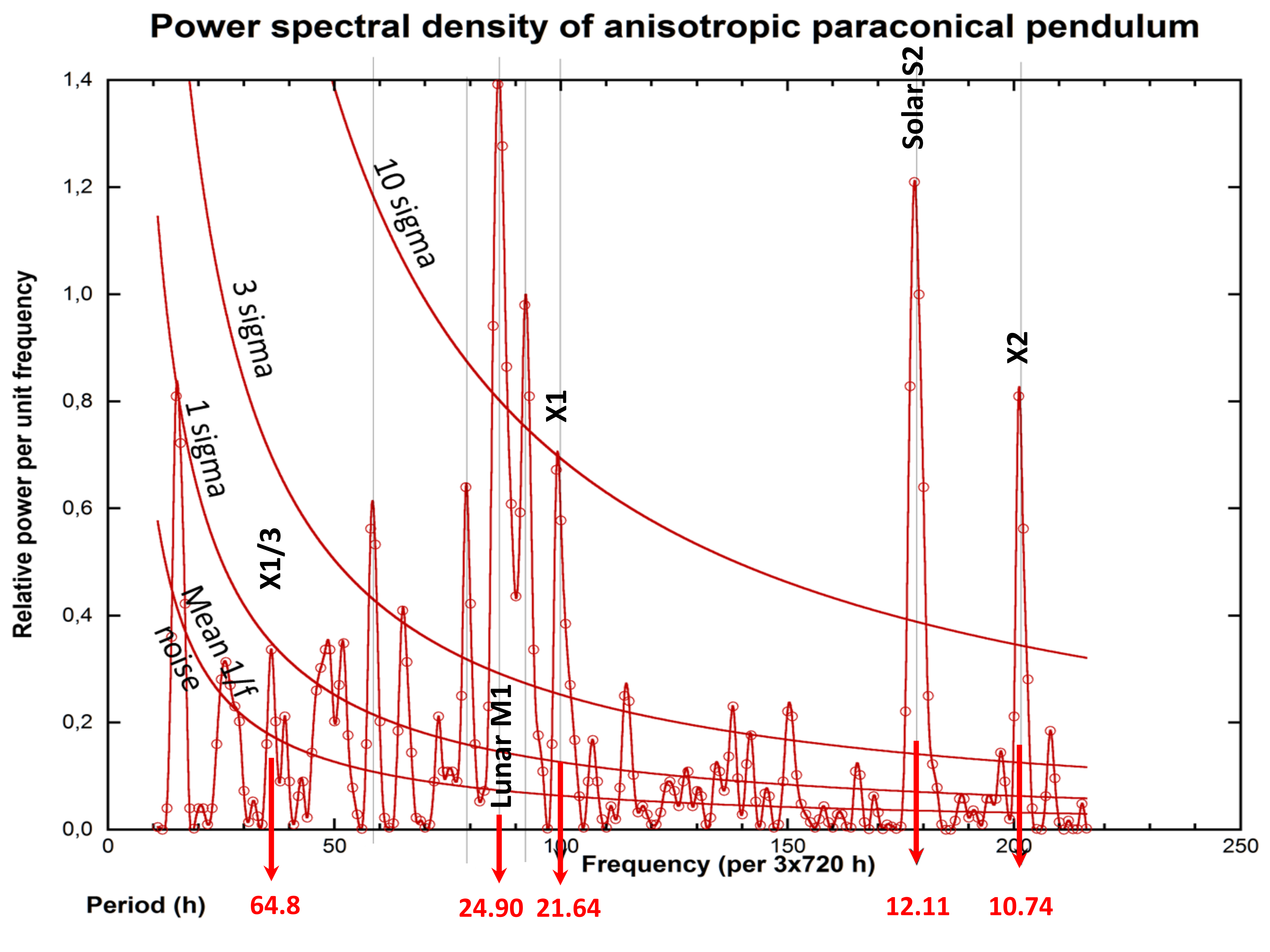
GRAPH XXVI

OBSERVATIONS OF JULY 1958 AT BOUGIVAL

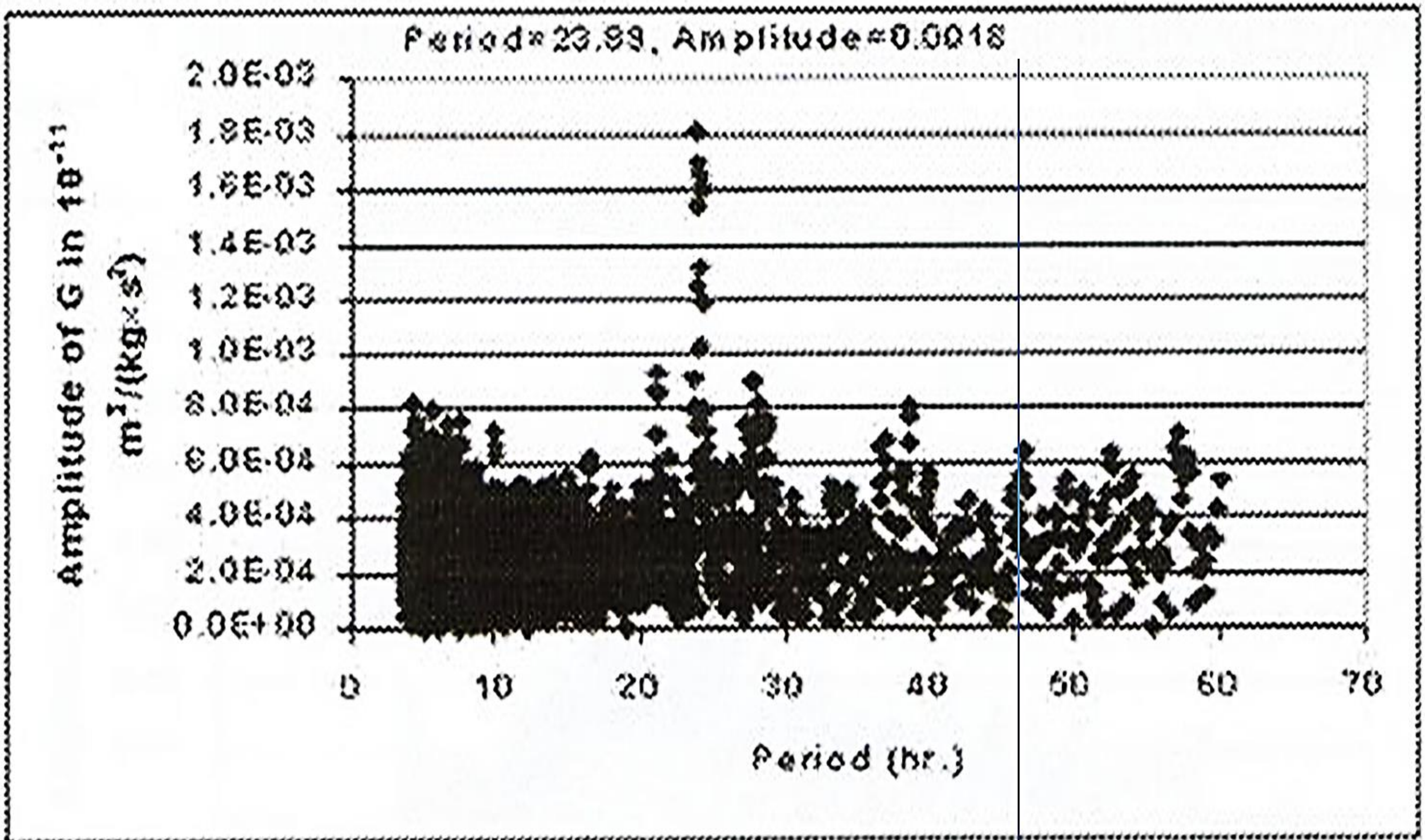


Legend: On the formulation of the test, see §B.1.3 above and the *Legend* of *Graph XI*.

Source: Annex III A of my Communication of 1961 to the *International Statistical Institute* (see *Source* of *Graph XXII*).



Power spectral density of anisotropic paraconical pendulum
Relative power per unit frequency
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0,0
0
50
100
150
200
250
Frequency (per 3x720 h)
10 sigma
3 sigma
1 sigma
Mean 1/f noise
X1/3
Lunar M1
X1
Solar S2
X2
Period (h)
64.8
24.90
21.64
12.11
10.74



Period=23.99, Amplitude=0.0018
Amplitude of G in 10^-11 m^3/(kg×s^2)
2.0E-03
1.8E-03
1.6E-03
1.4E-03
1.2E-03
1.0E-03
8.0E-04
6.0E-04
4.0E-04
2.0E-04
0.0E+00
0
10
20
30
40
50
60
70
Period (hr.)

Saguenay pendularium (August 2017)
Slow axis vs time