

NOTES ON IC REPORT G33 AS A RESULT
OF WORK SUBSEQUENT TO 24/1/1985.

By: R. Latham MA, PhD, FInstP
Emeritus Reader
Imperial College
University of London
London, SW7

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- 1) Further work has led to no modifications of the report up to page 55, with the conclusions in sections 7 and 8 remaining as stated. Bougival data supplied for the month prior to July and August 1950 by Professor Allais, while not so consistent, bears out the periodicity obtained.
- 2) Section 9, the St. Germain data and its interpretation is now known to require extensive modification. This is because the fluctuations in the data are large enough to render invalid the positioning of the maxima and minima. At the time of the original work, the choice was made with the idea that the St Germain and Bougival data was essentially the same, apart from fluctuations; though it was realised that some of the choices were subjective.

The difficulty is well shown up if the two sets of data are compared by a phase sensitive detection technique. One uses the Bougival data for which the days of maxima and minima at mid-day and mid-night are quite unambiguous to specify the phase of the periodicity (in this case the change-over days for the square wave modulation). The St. Germain value is just read at mid-day and placed into one or other set, depending on whether the Bougival value is max. or min. for that particular day. The two sets are then averaged separately and differenced to give the value of the St. Germain effect at the Bougival periodicity.

The Bougival data itself can be treated using its own periodicity by taking just the values at mid-day rather than using the value of the maximum or minimum when it actually occurs. This may be considered as more comparable to the St. Germain figures.

The values obtained are:-

Difference (Max. - Min.)	Bougival	29.04	+	4.99	Units
	St. Germain	1.68	±	10.48	Units

The unit here is 0.1 grade or 0.09 degrees of azimuth. This is rather a devastating result as the Bougival value, which is six standard deviations above its own noise, is still three standard deviations above the St. Germain noise.

The Bougival difference obtained in this way is not very different from the value given in page 44 of the report, namely 21.04 ± 2.42 units. The data mentioned above for the previous month was included in an overall total, giving:-

Difference (Max. - Min.)	Bougival	28.28	+	4.11	Units
	St. Germain	-10.31	±	8.09	Units

Again the Bougival data agrees, but the St. Germain figure is even negative. The St. Germain data, however, shows some

systematic differences and in this case the data in the original report may well be more reliable.

At its face value, then, one could well now argue that whatever effect is present at Bougival is not present at St. Germain. It is believed that this conclusion is not correct, however, for several reasons. If the effect is still present at the ground level site at St. Germain, then some phase correlated error must cancel it out. This explanation is suggested for the following reasons, which are stated here and amplified later in these notes.

- a) The theoretical model shows how such an error can arise due to the anomalous Allais forces or couples leading to air circulation in the room.
- b) Some measurements at Imperial College showed quite conclusively that small air circulation affected the pendulum in just the correct way - leading to the growth of the minor axis.
- c) The fact that the eclipse effect does occur at ground level. This, taken in conjunction with the long time constant for the damping of air movements, means that the real effect is normally balanced by the long time constant error effect, of roughly equal value. The sudden withdrawal of the real effect then shows up clearly.

The lack of direct comparison between the Bougival and St Germain data in section 10 arises because the latter has only a very small nett value with a large statistical error. It unfortunately follows that the agreement in phase and amplitude noted by Allais in the 24 hour 50 minute periodicity between the St. Germain and Bougival data must be fortuitous.

The dissimilarities between the full Fourier analyses of figs. 15 and 16 and the rather weak evidence for the square wave sidebands in fig. 15 for the St. Germain data also stem from the same cause.

- 3) The further work suggested on page 75 of the report, namely to delineate the Fourier spectrum better by varying the length of the run to shift the points along the time axis, has been done and is quite successful. For the Bougival data, the succession of sidebands comes up well and their exact positions and amplitudes are much more clearly shown. However, a difficulty arises in that the upper and lower sidebands can now be seen to have different amplitudes, all the upper ones being consistently lower than all the lower ones, exactly as is roughly shown for the sidebands of order 1 in fig. 16. At the time it was thought that this was just because of the arbitrary positioning of the points of

observation affecting the accuracy but now it is shown to be real. No explanation for this has been suggested.

As would be expected from what has been said in (2) above, the St. Germain detailed spectrum shows little correlation with the Bougival one.

- 4) Part 2 of the report, which was partly written when Part 1 was issued, ran into a severe problem in the mathematics of the pendulum motion. This has only recently been solved and the ideas require to be tested out experimentally first and then should be included in the mathematical framework before Part 2 can be completed.

The problem is as follows:-

Briefly, it can be seen from the detailed Allais data that the azimuth change increases more or less exponentially during the run, suggesting that the minor axis behaves similarly. On the other hand, the longitudinal and transverse frequencies of oscillation, as found from the moments of inertia, differ appreciably from each other and it can be shown that the difference is a little more than one complete period during the 14 minute run. Thus, the value of the minor axis should not rise steadily but should go through more than a complete cycle and the precession should rise to a maximum, return to zero and start off again upwards before the run ends.

In no experiment has any of this been seen, though there is a little evidence of the exponential rise getting marginally faster and slower at times when the frequency difference suggests that it should.

It is almost certain that the explanation of this is that some amplification is taking place in the oscillation along the minor axis, driven by the main swing along the major axis. Many possibilities have been considered as to what could be the cause of this amplification (if present). Aerodynamic effects are not likely to be the cause since Allais has obtained similar effects with disc bobs of various kinds and also with a cylindrical bob; though it will be seen later that aerodynamic effects are not to be neglected.

Rotation of the pendulum about its vertical axis during the swing can cause the ball rolling on a plane to shift the point of suspension transversely, leading to possible amplification. Such rotation does occur, as can be shown mathematically, though it is small and very difficult to see experimentally. It was eventually concluded that any amplification due to this mechanism, while in theory possible, would be a rather small effect.

Parametric amplification was also considered, since the ball and plane support does not have infinite vertical rigidity and will be raised and lowered at the correct double frequency by the centrifugal force of the pendulum swing. However, the mathematics of this as given by McLachlan (1) requires a vertical movement of about a centimetre to give enough amplification to outweigh the difference of periodicities along the major and minor axes. The vertical movement of the Allais mount must be three or four orders less than this. However, it was noticed that the actual movement of the bob, due to the rather large amplitudes of swing used by Allais, was of the correct order. The pendulum equations are so complicated that it has not yet been clearly shown whether the vertical motion of the bob is or is not relevant in causing amplification.

If it is, then McLachlan page 102 gives for the Allais case a total gain $e^{\mu z}$ of about 70 during the run and the author's college pendula, with their slightly smaller amplitudes of swing, a gain of about 12 during the run. In the Allais case, such a gain would probably conceal the effect of the differing frequencies of oscillation and in the college pendulum, the frequencies are substantially equal; so that in each case the minor axis might rise more or less exponentially during the run, as observed.

It is an interesting possibility that parametric cross-amplification should occur for a Foucault or conical pendulum with a large amplitude of swing and one which has not previously, to the author's knowledge, been suggested. Mathematically, it should be possible to see if the equations suggest it. However, in view of their complexity with a wide angle of swing and a small transverse amplitude, it may be easier to test it experimentally, using the statistical release azimuth technique as given by Allais to eliminate any of the anomalous effects shown in his work. Alternatively, if the ideas in this note are correct, one could choose a time when there is no acceleration of the bob along the radius vector to the sun.

In spite of several attempts, it has not been possible yet for the author to incorporate the parametric amplification suggested above into the equation of motion for pendula with differing longitudinal and transverse frequencies; to obtain a curve of minor axis or precession with time during the run for comparison with the experimentally observed curves. It is believed, however, that parametric amplification of sizeable amount is indeed the way to reconcile the expected behaviour of the Allais pendula with the experimental observations.

(1) N. McLachlan, Theory and Application of Mathieu Functions, Oxford University Press, 1947, Pl9, 102, 285.

- 5) Once having solved the problem of the shape of the minor axis growth curve, the rest of Part 2 was to provide a model for how the anomalous force could arise in practice and most of this has been done.

It is obvious that a varying transverse force, proportional to the longitudinal displacement of the bob, could be at the root of the anomalous minor axis growth and area precession. This would have the same effect as a variation of the anisotropy of the support rigidity; which was postulated by Allais as a fixed anisotropy to give his fixed azimuth. However, this would have other unobserved and undesirable effects. A force proportional to the velocity should not affect the minor axis but one proportional to the acceleration could do so.

Next, it is necessary to differentiate between a force and a couple, either of which would have an effect on the pendulum bob. Here the author's gyroscope work, mentioned as forming Part 3, becomes relevant. A transverse force perpendicular to the acceleration of the matter of the gyroscope rotor gives a large gyroscope couple since the acceleration inverts, and so the anomalous force inverts, about the centre of the gyroscope wheel. For the enormous gyroscope wheel accelerations, the effect is very large and a large anomalous gyroscope couple should be generated; if the wheel is suitably oriented with respect to the radius vector to the sun. This is not found experimentally. If the anomaly were a couple rather than a force, the couples would balance out and the result would only be a slight internal strain within the gyroscope wheel and no net external couple. It is therefore concluded that the anomaly is the production of a couple whose axis lies in the direction to the sun and whose value is proportional to the radial acceleration of the mass in this direction.

As a model one imagines a very tenuous fluid, emerging from the sun radially, probably mainly in or near the solar equatorial plane. When this meets any matter (by this one means the nuclear material in which the mass mainly resides) it finds the nuclei impenetrable and has to flow round the nucleus. In so doing, the flow has a slight twist round the obstacle and it imparts a slight couple, proportional to the mass and to its acceleration along the direction of flow. Once every 13 days the sense of the couple changes sign.

The whole is very similar to the force in the direction of flow which would be generated by streamline flow of a frictionless fluid round a spherical pendulum bob, if the bob is being accelerated. This is a normal correction to the motion of the bob through the air and gives a force equal to half the mass of the displaced fluid multiplied by the acceleration of the bob. The only differences are that it is due to an aether motion as the fluid, rather than a material

fluid and it involves a rotational twist and a couple rather than streamline flow and a linear force.

- 6) The next concern is what happens with other accelerations due, say, to the motion of the earth, its rotation or to lunar effects. It is immediately obvious that small couples must similarly arise and should be detectable. This particularly applies for fluids carried around with the earth and subjected to various accelerations involved in the earth's motion. Since the 10FG gyroscopes used by the author had the gyroscope unit enclosed by and supported by a fluid, this fluid should show small effects due to the position of the solar radius vector and these effects should give a very small gyroscope anomaly. These may well have been the cause of the small effects observed. In Part 3, a similar phase sensitive technique has been used with the 26 day solar periodicity suspected in an attempt to display correlations. The results have not so far been very satisfactory but in this case, there are probably many other disturbing effects and while the measurements cover a long time, there are many gaps.

A more important fluid effect should occur in an ordinary room. The air is at rest at the boundaries but, within the body of the room, some circulation should be generated. This will have a daily periodicity and will change over every 13 days to the opposite sign, exactly as the Bougival Allais data predicts. It forms an ideal basis for the phase connected error suspected in the St. Germain data. The author, using one of his pendula at Imperial College, obtained perfect correlation with the switching on and off of a small set of cooling fans on a PDP 8 computer in the same room but some distance away. The minor axis of the pendulum was recorded and showed a change of value whenever the fans were on. The amount of air circulation was not large enough to be noticed as a draught (probably of the order of roughly fractions of a mm per second and almost certainly about a vertical axis). At that time, the importance of the observations was not realised and no detailed flow measurements were made. The phenomenon was duly eliminated by enclosing the corner of the room, including the pendulum, by a thin polythene sheet which prevented the air circulation.

If one considers time constants of air flow in a room of moderate size, ie. 3m x 3m x 3m, one comes up with times of 2 to 3 hours. It may well be that at St. Germain, where the room size was large, the effect was also large and the time constant perhaps 4 to 6 hours or more. Any eclipse effect would show because of a change in the direct solar effect on the pendulum, while the air circulation with its longer time constant would not alter much during the hour or so of the lunar obscuration.

In many ways, this suggested air circulation in a closed room with good thermal lagging would be a better test of the Allais phenomenon than the very difficult and time consuming pendulum measurements. A very thin mylar sheet or strip of gold leaf, observed microscopically, would form a good instrument for observing small air velocities and a 26 day square wave periodicity would not be readily confused with other effects, particularly if circulation about a vertical axis were measured.

Such a test needs to be made urgently.

In summary, therefore, the following program of work requires to be done:-

- a) Test whether cross amplification is observed with a conical pendulum of large amplitude in one direction, due to vertical motion of the bob rather than the support.
 - b) If so, include the above in the Allais pendulum equations of motion to see if the observed minor axis and area precession curves can be properly matched.
 - c) Check in detail the rotation of air about a vertical axis on the minor axis growth rate of an Allais pendulum ie. repeat the author's observations using controlled and measured flows.
 - d) Measure the air circulation in a room caused by the solar interaction and check it numerically with the Allais effect at St. Germain.
 - e) Examine by dimensional analysis, or experimentally, the effects on other fluids with a view to explaining gyroscope effects, possible atmospheric circulation effects and also possible direct effects on planetary motion.
- 7) A problem which has not yet been seriously considered is the situation concerning 12 and 24 hour periodicities. Some of the resolved components of pendulum bob acceleration give daily and others semi-diurnal periodicities.

Since the Allais pendulum has an equilibrium azimuth of 160 - 200 grades, starting from zero at the N/S direction, it has components of N/S as well as E/W motion. Also, since the latitude of Paris is roughly 45° , there are components along the earth's polar axis as well as in the equatorial plane. Even if this were not complicated enough, the inclination of the earth's axis of 21° is quite enough for 45° latitude to give a noticeable difference between mid-summer and mid-winter. Even for a 12 hour periodicity, the difference between the angles to the radius vector to the sun, between

day and night, would give a 24 hour effect. The mode of display chosen by Allais as well as the author, uses Rn^2 which confuses the issue as the sign of Rn is lost.

At the present time, it is thought that the main, direct Bougival effect is a 12 hour one, with the 24 hour periodicity manufactured because the results were taken in mid-summer only. If one only had Bougival measurements in mid-winter, one could begin experimentally to differentiate between the possibilities. It is also thought that the air circulation effect, leading to the St. Germain 24 hour periodicity, is a direct 24 hour one. It will be noticed that the 12 hour peak at St. Germain on fig. 15, while probably present, is much smaller than the large 12 hour peak at Bougival on fig. 16, which is a dominant feature in the spectrum. The square wave modulation of the 12 hour peak does not, however, show up much, if at all; which is rather surprising.

R. Latham.