

1959

3.59

Incomplete

NEW THEORETICAL AND EXPERIMENTAL
RESEARCH WORK ON GRAVITY

Allais

MEMOIR WRITTEN TO COMPETE FOR
THE YEARLY PRIZE
OF THE "GRAVITY RESEARCH FOUNDATION"

FOREWORD

The present memoir has been written in order to compete for the yearly prize of the "Gravity Research Foundation".

This memoir ~~sums up~~ the results of numerous pieces of research work ^{the} which ^{of which} reference is given in the "bibliography" and ^{the} which ^{of which} french text is attached as an appendix to the present file.

SUMMARY

Research work on gravity will effectively and rapidly make progress only under the condition that one undertakes a thorough reinvestigation of the gravity theory and keeps on systematically carrying out new experimental research work.

In relationship with the above the present memoir ^{gives} ~~is giving~~ :

- a) a generalization of the law of newtonian potentials taking into account propagation speed and an absorption rate of gravific disturbances variable with considered point and direction
- b) ^a the report about a remarkable gravific disturbance observed during the total eclipse sun of June 30th 1954.
- c) the report of the gravific anomalies found ~~out~~ in the movement of the paraconical pendulum with anisotropic support under the form of periodical lunarsolar components that cannot be explained at all within the frame of the present gravity theory (observed effects about hundred million times greater than those actually computed).
- d) an indication of the experimental anomalies already found ~~out~~ in other experiments as well as the estimate at a few millibars or the order of magnitude of the relations between v and v_0 when the laws of mechanics have been verified at the surface of the earth as well in astronomy as well

NEW THEORETICAL AND EXPERIMENTAL
RESEARCH WORK ON GRAVITY

No decisive progress in the field of gravity can be accomplished as long as the present theory will not be carefully reexamined and new experimental re-researches will not be carried out in view of determining on the one hand/^{determining} if the present theory can be considered as satisfactory, and this up to which approximation and on the other hand if new complementary terms should be taken into consideration.

The present memoir intends to briefly account for :

- a) research work on the gravity theory in view of taking into account on the one hand the propagation waves and on the other hand an absorption effect depending on distance.
- b) Observations made on the movement of the paraconical pendulum borne by an anisotropic support during the total sun eclipse of June 30th 1954, which tends to suggest the existence of a screening effect of the sun by the moon, which screening effect would justify the suggested change to the gravity theory.
- c) experimental anomalies experimentally found in the movement of the paraconical pendulum.
- d) research work carried out on the experimental anomalies previously found in the field of gravity on the one hand and on the degree of approximation with which gravity laws have been actually verified on the surface of the earth and in the field of astronomy as well on the other hand. As a result of the theoretical and experimental research work carried out under consideration of a) b) c) d) above, it follows that in the present state of things the

/s/

present theory of gravity cannot be considered what soever as fully accounting for observed experimental facts, that new research work of both theoretical and experimental nature should be undertaken and that said research work do condition any decisive progress in the field of the gravity theory.

I - GENERALIZATION TO THE PRESENT GRAVITY THEORY
 TO TAKE INTO ACCOUNT TIMES OF PROPAGATION
 AND OF AN ABSORPTION EFFECT DEPENDING UPON
 DISTANCE

1) One knows how the indefinite equation of newtonian potentials

$$(1) \quad \Delta \varphi - 4\pi k \delta = 0$$

(where φ designates the newtonian potential, δ the density and k the constant of universal gravity) has been generalized in two ways, by Lorenz on the one hand in order to take into account times of propagation and by Yukawa on the other hand in order to take into account a damping effect during propagation. A synthesis of these two standpoints has been made by Mr. Hély who has indicated that the indefinite equation

$$(2) \quad \Delta \varphi - \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t^2} - \frac{2k_0}{r} \frac{\partial \varphi}{\partial t} - k_0^2 \varphi + 4\pi k \delta = 0$$

in which coefficients c and k_0 are considered as constants admits as a solution the expression

$$(3) \quad \varphi(x_1, x_2, x_3) = \int k \delta(\xi_1, \xi_2, \xi_3, t - \frac{r}{c}) \frac{e^{-k_0 r}}{r} dt$$

the integral being extended to the whole space and r being the distance between points $M(x_1, x_2, x_3)$ and $m(\xi_1, \xi_2, \xi_3)$. Space E_3 considered is euclidian.

this
 In said space the propagation of disturbances takes place along a straight line at a constant speed c and with a constant rate of damping k_0 .

This conception is very interesting and quite natural but unfortunately is valid only in the case of c and k_0 being constant.

2) One can easily show⁽¹⁾ that with the usual tensorial notations the equation which generalizes equation (2) in case of variable coefficients can be written

$$(4) \quad \frac{1}{\sqrt{|g|}} \partial_i (\sqrt{|g|} g^{ij} \partial_j \varphi) - \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t^2} - \frac{2k_0}{c} \frac{\partial \varphi}{\partial t} - k_0^2 \varphi + 4\pi K \delta = 0$$

and that this equation admits as a solution the expression

$$(5) \quad \varphi(y_1, y_2, y_3) = \int \sqrt{|g|} K(\eta_1, \eta_2, \eta_3) \delta(\eta_1, \eta_2, \eta_3, t - \frac{r}{c}) \frac{e^{-k_0 r}}{r} d\tau'$$

with

$$(6) \quad r = \int_M^m ds$$

this integral being calculated along the line joining M and m and minimizing said integral, together with

$$(7) \quad ds^2 = g_{ij} dy^i dy^j$$

Whereas the disturbances represented by equation (1) are propagating along a straight line with an infinite speed and that the disturbances represented by equation (2) are propagating along a straight line with a constant speed c and a damping rate k_0 , the disturbances represented by equation (4) propagate along curved trajectories and with a speed and a damping rate depending upon the considered point and direction.

3) Equation (4) generalises equation (1) and can particularly explain on the one hand an effect of gravity absorption established in the experiments of Majorana (9) and on the other hand suggested by the observations made on the movement of the parabolical movement during the total sun eclipse of June 30th 1954 (3) (4). It can also very simply explain anomalies of gravity of which a pseudo-explanation has been given up to now by the theory of isotropy (2).

II - DISTURBANCE OF THE MOVEMENT OF THE
PARACONICAL PENDULUM WITH ANISOTROPIC SUPPORT
ESTABLISHED DURING THE TOTAL SUN ECLIPSE OF
JUNE 30 th. 1954

Experimental arrangement.

During the years 1954 up to 1958 a series of systematic experiments have been carried out with a paraconical pendulum (pendulum suspended by a ball) with anisotropic support (support ⁱⁿ which elasticity and inertia are different in two ^{perpendicular} rectangular planes) in an underground laboratory at Saint-Germain.

The weight of the pendulum made up of a disc is of about 12 kgs. and the length of the equivalent simple pendulum is of about 83 cms. The pendulum is entirely made of bronze. The observed data is the azimuth of the oscillating plane of the pendulum. Observations are taking place day and night during a period of time of about one month.

Observed Effect.

During the series of continuous observations of June - July 1954, a very remarkable disturbance of the movement of the paraconical pendulum with anisotropic movement was established during the total sun eclipse of June 30 th. 1954. *David*

The phenomenon should be considered as being given way to forces which order of magnitude is those of the Foucault effect and nothing in the present theory does allow for the interference of said forces neither as to their order of magnitude nor to the screening effect apparently performed by the moon with respect to the sun.

The phenomenon appears to result from forces of order of magnitude of the order of magnitude of those which cause the Foucault effect. Nothing in the present theory permits the explanation of ~~these~~ these forces, either as to their order of magnitude nor as to the screening effect apparently performed by the moon with respect to the sun (5)

III - PERIODICAL ANOMALIES
OF THE MOVEMENT OF THE PARACONICAL PENDULUM
WITH ANISOTROPIC SUPPORT

1) Experiments made in St-Germain from 1954 up to 1958.

The statistical analysis of several monthly series of observations carried out day and night of the azimuth of the paraconical pendulum here-above described in my Laboratory at Saint-Germain located underground during the years 1954-1955, has made evident the existence of periodical components, the periods of which are close to 24 hours 50 minutes (wave of diurnal lunar type), 24 h. and 12 h. (waves of diurnal solar type and semi-diurnal solar type), and the amplitudes of which are statistically significant (4) (7).

Discussion of results.

The thorough theoretical and experimental analysis of the experiments carried out have led me to the following conclusions (8) (9) (12) (13)

- 1°) that the established periodical effects do really exist and are not due to accidental causes.
- 2°) that said effects cannot be identified with the periodical luni-solar effects foreseen by the ^{present} admitted theory of gravity, as the observed effects are about hundred million times greater than theoretical effects.
- 3°) that these effects cannot be assigned to the indirect influence of anyone of the following phenomena earth tides, temperature, atmospheric pressure, earth magnetism, microseismic agitation, cosmic rays, periodical character of human activity.

The whole of this analysis has been presented in my memoir of May 1958 about the anomalies of the paraconical pendulum.

3) Simultaneous experiments of Saint-Germain and Bougival of July 1958.

Repeated
These experiments have been carried out again day and night in two laboratories at the same time, the first one being the one already used at Saint-Germain, and the second one being a new laboratory located at Bougival, at 6.5 kms from the first one, in an underground gallery of a chalk deposit, recovered by 57 m. of clay and chalk, protected against any external disturbance and particularly any thermal variation. Pendulums used and suspensions as well were the same *identical*

Wave again
The anomalies previously ascertained ~~kept on being~~ *present* observed. In the attached graph I am ~~accounting for~~ *present* the harmonical analysis results obtained by the Buys Ballot filter method for a filter which period is of 24 h. 50 min., from the observations simultaneously made in the two laboratories during one month.

This graph enables one to compare the results obtained in the two laboratories. The two waves have very slightly different amplitudes and are almost perfectly in phases (10).

Waves of 24 h. and 12 h. ~~do~~ correspond also to each other but are 180° out of phase.

From one series of observations to the other one finds out important differences in amplitude, in the observed periodical effects. The standard deviation Σ of series of observations has been respectively of about 18,2 - 17,8 - 19,9 and 5,4 grades in June-July 1954, November-December 1954, June-July 1955 and July 1958 at St-Germain, and of about 4 grades at Bougival in July 1958. For these five series the ratio $2R/\Sigma$ of the amplitude of the wave of 24h. 50min. to the standard deviation has been about 0,18 - 0,72 - 0,70 and 0,52 (9) (10) (11).

4) State of discussion.

The main elements of discussion are the following ones (9).

./.

- a) The practical identity of the periodical effects of 24 h. 50 min. simultaneously found out in the two laboratories alone allows one to eliminate any explanation of the effect through a fortuitous cause.
- b) The conditions of temperature practically invariable as they are established in Bougival allow to eliminate any thermal effect.
- c) The practical identity of periodical effects of 24 h. 50 min. found out at Bougival and Saint-Germain allows elimination of any influence exclusively based on the influence of the Saint-Germain building or of any other cause such as wind.
- d) ~~Along~~ the comparatively great variability of the amplitudes of periodical found-out effects in a relationship with the period of time allows to eliminate any explanation based upon the presently admitted laws of gravity.
- e) The observed phenomenon is the only one of the presently known geophysical phenomena for which the amplitude of the wave of lunar-diurnal type is of the same order of magnitude as the amplitude of the wave of solar-diurnal type and very much bigger than the amplitudes of the waves of semi-diurnal solar and lunar types : This very particular periodical structure alone allows ~~to eliminate as~~ as a possible cause any one of the geophysical phenomena presently known.

In the present state of things one must infer the existence of a new phenomenon involving the existence in the laws of gravity of complementary terms which up to the present time have remained unnoticed.

5) Order of magnitude of found out effects.

For average speeds of the pendulum of about 15 cm. per second, the order of magnitude of found-out effects is of $5 \cdot 10^{-6}$ of gravity (9).

Obward

. / .

that is to say very small, but experimental results seem to suggest that said effects do increase with the amplitude that is to say with the speed.

Under this assumption the revealed effects would have a considerable importance for earth missiles and for space rockets. ~~It's still up to experiment to decide upon.~~ But naturally this effect has not yet been experimentally checked

o o

**IV - ANOMALIES ALREADY FOUND OUT IN EXPERIMENTS ON
GRAVITY AND DEGREE OF APPROXIMATION OF THE
VERIFICATION OF FUNDAMENTAL PRINCIPLES OF
MECHANICS.**

1) Anomalies found out in mechanical phenomena

Anomalies that have been found out in the movement of the paraconical pendulum seem to me to be ^{closely} in close connection with the difficulties and anomalies met with in the explanation of numerous dynamic phenomena and which have remained up to now unexplained (9) :

- 1) Anomalies of the theory of tides
- 2) Movements of the top of the Eiffel tower
- 3) Importance of the deviations toward the South observed in the fall of bodies
- 4) Variations in the amplitude of deviations toward the East in the fall of bodies
- 5) Anomalies found out in the action of terrestrial revolution upon the flow of liquids (experiment of Tumlitz)
- 6) Anomalies found out in the movement of the horizontal gyroscope of Föppl.
- 7) Anomalies found out in the experiments carried out with the isotomeograph
- 8) Anomalies found out in the experiments carried out with the suspended pulley

./...

- 9) Various anomalies found out in geophysical measures and imputed up to now to experimental errors
- 10) Results apparently inexplicable obtained by General Doctor Louis Pasteur in his experiments upon the oscillation of pendulums (1954)
- 11) Remarkable features of the solar system up to now remaining without any explanation.

To these anomalies bound to movement are to be added some anomalies of static nature :

- 1) anomalies of gravity : there is an excess of gravity above oceans and deficiency above continents. The isostasy theory has given of these anomalies according to me only a pseudo-explanation.
in my opinion
- 2) anomalies in the experiments upon the newtonian attraction : on the one hand there exists an absorption of gravity (experiments of MAJORANA) and above all a variation of the newtonian force depending upon the medium where it exercises itself (experiments of CREMIEU)

2) Accuracy of verification of gravity laws.

Therefore ~~it is not without any interest that one can put to~~ himself the question with what accuracy gravity laws are verified in the field of astronomy as well as on the earth surface. ~~As~~ Astonishing as it might appear, all treaties of Mechanics and Astronomy are remarkably mute on this fundamental question. This is an essential gap and an evident deficiency from the point of view of scientific discipline. Any law has in fact no meaning whatsoever if one does not know the degree of accuracy with which it has been verified.

The consideration of residuum of adjustments by the least square ^{method} which served to establish the tables now used in Astronomy ^{does} show in fact that the order of ~~M~~ magnitude of the relative deviations ^{discovered} found out for angular displacements between observation and theory is at least of about $3 \cdot 10^{-6}$ during the revolution period of a heavenly body.

./...

Moreover the comparison of measures of g obtained either by observation of the oscillations of the pendulum, or by the fall of invar rulers, shows that the order of magnitude of the relative accuracy with which laws of mechanics are verified on the earth surface is about 10^{-5} .

As a result the anomalies which I think I have ^{discovered} ~~rendered evident~~ are not at all contradictory with the previous data of experience neither on the earth surface nor even in the field of astronomy (9).

3) Meaning of the anomalies that have been found.

From the scrutiny of the anomalies I have hereabove ^{As called} recalled and from the discussion of the accuracy with which the principles of mechanics have been established, it ^{appears} results quite evidently that these principles do not have at all the absolute value which a too common opinion seems to attach to them. These principles have presently acquired some kind of metaphysical quality beyond any discussion. In reality mechanics is not at all a perfect science - a pure science in which nothing else is to be found any more. It is and remains an experimental science which can and must be improved.

It is time to face to think over these phenomena again. This additional scrutiny appears obviously to be of a capital interest for building up a new theory which can synthetize in a single theory, theories of gravity, of electrodynamics and of quantum. It is not at all the same thing to state that...

(a) $\Delta \varphi = \dots$

or to state we have

(b) $\Delta \varphi = \dots$

with

(5) $\leq \dots$

for equation (c)

Anyone who has worked out these difficult matters knows that equation (a) could not be substituted without great danger to equation (b), because in the integration process of partial differential equations corrective terms have a very great importance.

./...

Thus

This at a moment when the building up of a coherent unitarian theory of physics appears perhaps to present a greater difficulty than ever before, the exhaustive scrutiny, both in the experimental and theoretical fields, of all the hereabove anomalies appears to me to be of the highest interest, because it seems to me liable to entail the revision of certain postulates whose rigid validity has been accepted without an effective support of experimentation.

Only facts must guide us and not mummified principles, however useful they might be in first approximation. The only source of our knowledge is experience and any thought which locks up itself in abstract principles precisely by doing so condemns to ~~sterility~~ itself (9) .

to sterility.



Conclusions

If we wish make effective progress in the knowledge of the gravitic laws in order possibly to control them for terrestrial or astronomical appliances, it seems to me that the result of the previous discussion is, firstly, to rethink thoroughly the gravity theory, and secondly to follow up the experimental researches here above analysed or referred to

Experiment is the single origin of our knowledge - only in the experimental field are we able to make effective and quick progress - The experimental results I have obtained are alone sufficient ground for cheer - Effectively they show that Mechanics is not an achieved science, there are complementary terms which are able, in certain circumstances, to play a very important part. It is desirable as quickly as possible to determine the general properties of these complementary terms and to make up their shortcomings

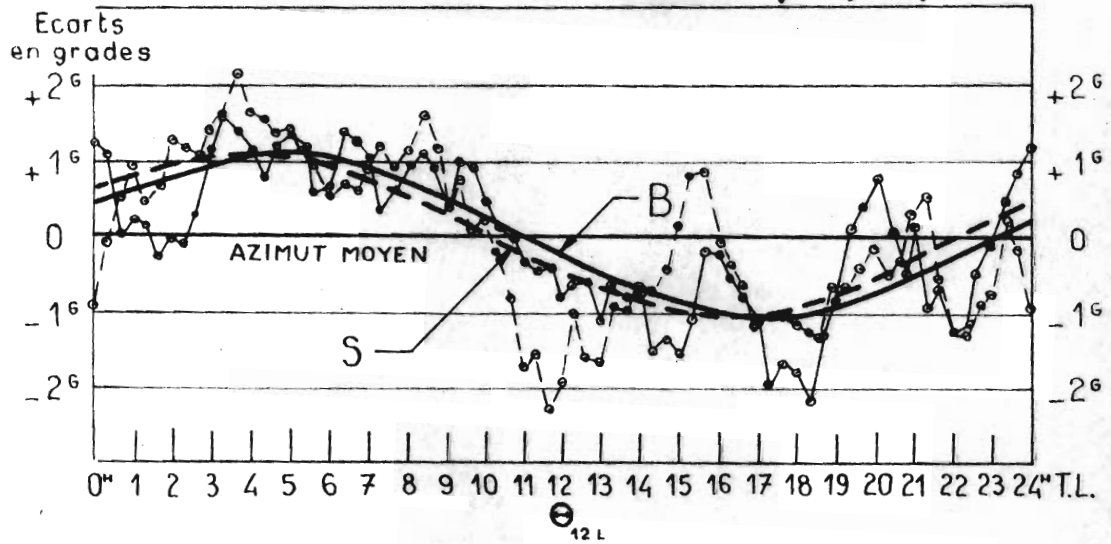
RESULTATS DU FILTRE DE BUYS-BALLOT

ANNEXE I

BOUGIVAL et SAINT GERMAIN

FILTRE DE 24^h50^{mn}

MOIS (1+2+3+4)



	Cycle moyen	Sinusoïde d'ajustement	2R en grades	$\Theta - \Theta_{12L}$ heure du sommet
BOUGIVAL	—●—	————	2,174	-7 ^h 23 ^{mn}
S ^t -GERMAIN	- - -●- - -	- - - - -	2,106	-7 ^h 55 ^{mn}