Allais effect again

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Abstract

The Allais effect was first reported by Maurice Allais in 1954. It involves an abrupt change in the azimuth of a paraconical pendulum's oscillation plane during the solar eclipse, totaling up to 13.5 degrees. There is also a reduction of the oscillation frequency several orders of magnitude larger than the Newtonian prediction. The amplitude of the oscillation fluctuates in the transition to the solar eclipse.

In this article, the earlier model for the effect based on the replacement of the oscillator with its quantum counterpart with very large gravitational Planck constant is discussed. For $\hbar_{gr}$ the oscillator corresponds to a small oscillation quantum number limit, and this can give rise to large quantum fluctuations of the amplitude as transitions which change this quantum number so that the reason would not be gravitation but TGD based quantum theory.

There is evidence that Allais effect is not mere screening. This leads to a proposal that a diffractive effect is involved. The most promising model relies on quantum diffraction in the "world of classical worlds" (WCW) consisting of space-time surfaces obeying holography = holomorphy principle and having interpretation as Bohr orbits. Monopole flux tubes can be also interpreted as analogs for flowlines of an incompressible hydrodynamic flow past an obstacle. They can be regarded as quantum particles meaning analogy with quantum diffraction for Schrödinger equation.

A possible explanation for the maximal value for the reduction of frequency $\Delta f/f \simeq \beta_0$, where $\beta_0 = v/c \leq 1$ is the velocity parameter appearing in the expression of gravitational Planck constant, is discussed. Also possible alternative causes of the Allais effect are considered.

To sum up, the Allais effect would not reflect so much gravitational interaction as the basic ontology of TGD involving WCW, hierarchy of Planck constants, and zero energy ontology as quantum ontology.

1 Introduction

The Allais effect [E1, E8] (see this and this) was first reported by Maurice Allais in 1954. It involves an abrupt change in the azimuth of a paraconical pendulum's oscillation plane during the solar eclipse, totaling up to 13.5 degrees.

1.1 Empirical findings

Consider first a brief summary of the findings of Allais and others [E8].

1. Paraconical pendulum consists of a rigid rod of ~ 1 meter and a metal ball. The bob, that is the weight at the bottom, has lense like shape. Paraconical pendulum differs from the conical pendulum in that the suspension point of the pendulum is not fixed but is a metal sphere able to roll without sliding in plane. Therefore it has 2 degrees of freedom rather than only one: both swinging and rotation around the vertical axis are possible.

2. In the absence of any other forces than the gravitation of Earth) paraconical pendulum can behave much like a conical or Foucault pendulum. The oscillation plane of the paraconical pendulum turned by 13,5 degrees during 14 minutes (see https://plus.maths.org/mathematical-mysteries-foucaults-pendulum-and-eclipse). It is difficult to see how the gravitational fields of the Sun and Moon could explain this behaviour by changing the effective value of the Earth's gravitational acceleration.

3. Allais concludes from his experimental studies that the orbital plane approach always asymptotically to a limiting plane and the effect is only particularly spectacular during the eclipse. During solar eclipse the limiting plane contains the line connecting Earth, Moon, and Sun. Allais explains this in terms of what he calls the anisotropy of space.

4. Some experiments carried out during eclipse have reproduced the findings of Allais, some experiments not. In the experiment carried out by Jeverdan and collaborators in Romania it was found that the period of oscillation of the pendulum decreases by $\Delta f/f \simeq 5 \times 10^{-4}$ [E1, E7] which happens to correspond to the constant $\beta_0 = 2^{-11}$ appearing in the formula of the gravitational Planck constant for the Sun. It must be however emphasized that the overall magnitude of $\Delta f/f$ varies by five orders of magnitude. Even the sign of $\Delta f/f$ varies from experiment to experiment.

5. There is also the finding by Popescu and Olenici, which they interpret as a quantization of the plane of oscillation of paraconical pendulum during solar eclipse [E9].

6. There is also evidence that the effect is present also before and after the full eclipse. The time scale is 1 hour. Allais emphasized that the effect is a dynamic, not static, phenomenon, connected to the variation of weight or inertia in the space swept by the pendulum during the eclipse. The 10% excessive bending of light is reported during some eclipses (the "residual arc") is also reported.

While many attempts to confirm it have met with varied or ambiguous results, several observations indicated anomalous behavior that cannot be easily explained by general relativity (GR) or standard Newtonian mechanics.

1.2 The TGD view of Allais effect briefly

The TGD view of Allais effect involves quantum physics based on TGD based quantum ontology. One can consider several different levels for how quantum physics appears in the description.

1. One can start from a harmonic oscillator model for the gravitational pendulum and perform a quantization using the gravitational Planck constants of the Sun or the Earth. The huge values of these Planck constants imply that small values of the harmonic oscillator quantum number are involved. The changes of this quantum number could explain the fluctuations at quantum criticality assignable to the transition to the eclipse. The effect would not be gravitational but quantum mechanical and due to the large value of $\hbar_{gr}$.

2. During a full eclipse, the screening of the solar gravitational field might explain the Allais effect. There is however evidence that the Allais effect appears also outside the regions of full eclipse and therefore in the scale of the Earth. This suggests that a description involving interference and diffraction effects besides screening is needed.

   In the TGD framework, models involving classical long range gravitational or Z^0/Kähler fields cannot be excluded. These models do not however look promising: the standard physics based expectation is that the effects are quite too small.

3. The description in terms of wave functions identified as spinor fields of the "world of classical worlds" (WCW) is more promising. The argument of the WCW spinor field would be the space-time surface as analog of Bohr orbit for a particle as 3-surface. One would have essentially wave mechanics in WCW. Instead of a Bohr orbit one would have a wave in the space of Bohr orbits (WCW).

   The Moon would act as an obstacle giving rise to quantum diffraction, which reduces to screening immediately behind the Moon. The diffraction would not be caused by the classical gravitational interaction but would be analogous to the diffraction of electrons in a double screen and a genuine quantum effect.

4. The observed reduction $\Delta f/f \simeq 2^{-11}$ of the oscillation frequency of the pendulum is several orders of magnitude larger than the prediction and happens to be equal the velocity parameter appearing in the solar gravitational Planck constant. Quantum criticality for the transition to eclipse and zero energy ontology (ZEO) [L2, L1, L7, L8] [K2] suggest a possible explanation for this finding. In particular, the notion of causal diamond (CD) as a geometric counterpart for the perceptive field [L4] would be involved and the reduction of the frequency would be mathematically analogous to that occurring is cosmological redshift.

The cautious conclusion would be that the Allais effect does not tell so much about new gravitational physics than about the new quantum ontology predicting the notion of WCW realizing holography = holomorphy vision, the hierarchy of Planck constants, and ZEO.

2 The TGD view of the Allais effect

Appendix gives a brief summary of the basic assumptions and implications of TGD necessary for the understanding of the TGD view of the Allais effect. The view of TGD as it was 2024 can be found in [L5, L6].

2.1 A TGD inspired quantum model for gravitational pendulum

It is natural to simplify the situation by considering a conical pendulum, that is gravitational pendulum for which the oscillation plane is free, instead of the paraconical pendulum.

To build a qualitative view, one can model the gravitational pendulum idealized as a harmonic oscillator. If h_{gr} is important then one must build a quantum model for the oscillator. One could first consider the simplest gravitational pendulum with one angle as a degree of freedom so that no attempt is made to explain the change in the oscillation plane. A more realistic case would be as a conical pendulum with two degrees of freedom corresponding to swinging and rotation.

The conservative option is that the Allais effect can be understood in terms of clasical forces. Second option is that the effect is purely quantum mechanical. Consider first the forces involved.

1. Newtonian gravity of the Earth, Moon and Sun is characterized by gravitational potentials. Each of these produces a gradient force. During an eclipse of the longitudinal effect, the Sun's gravitational force could weaken and disappear during a total eclipse if screening occurs. If the classical Z^0 force of Kähler force is involved, it could interfere with the gravitational force and contribute to the effect.

   The change of the gravitational force in vertical direction is reported to be consistent Newtonian predictions. One should understand why the effect is large in the transversal directions. The Sun-Moon pair and the Earth's vertical are in different directions. What is the direction of the Sun relative to the Earth's gravitational field in the studied cases? The shadowing effect depends on this direction.

2. Could the gravitomagnetism predicted by general relativity play a role?In the Maxwellian approximation, the gravitomagnetic field of the Sun is extremely weak: there are however anomalies, which challenge this assumption [E12, E3, E4] but might have different explanation in the TGD framework.

3. In the TGD framework, electroweak magnetism associated with induced classical Z^0 or Kähler field could be involved. For $\hbar_{gr}$ these fields could be important, at least in the scale $\Lambda_{gr} = GM/\beta_0 = r_S/2\beta_0$, which for the Sun is about $R_E/2$ and for the Earth about 5 mm. In the TGD picture, monopole flux tubes carrying Kähler monopole fluxes could give rise to a Lorentz force. Could this relate to the transversality of the Allais effect?

   What do the flux tubes related to electroweak magnetism or gravito-magnetism look like? The proposal is that gravitational interaction is mediated by narrow square-like radial monopole loops with a magnetic field parallel to the flux tube.

4. Could the large value of h_{gr} characterizing large scale quantum coherence amplify the effect? Could the effect be proportional to square N^2 of the number of flux tubes meeting the pendulum rather than N in the quantum coherence region? Or are the energies of the gravitons (say) as $E = h_{gr}f$ much larger than for the ordinary Planck constant and therefore amplify the effect? A possible interpretation for the large value of h_{gr} is as the replacement of a single flux tube with a bundle of $n = h_{gr}/h$ flux tubes defining an analog of Bose-Einstein condensate. For this interpretation the two alternatives might be equivalent.

Two standard physics views can be considered.

1. In the first case, there is no shadowing of gravitation by the Moon and the effects of the Sun and the Moon are additive. It is difficult to see how this picture could explain the Allais effect.

2. In the second case, the Moon partially shadows the Sun and only the Moon would contribute to the gravitational force during complete shadowing. This does not conform with the belief that gravitational interaction is not screened.

TGD allows two options.

1. In TGD inspired phenomenology, gravitational interactions would be mediated by the monopole flux tubes which are 3-D generalizations of strings but can have an astrophysical length scale.

The gravitational flux proportional to the monopole flux would be analogous to an incompressible fluid flow and the Moon could act as an obstacle. The gravitational flux would not be lost but would go past the Moon.

Contact between the pendulum and the flux tubes would occur. Wormhole contacts define contacts and also the 2-D string world sheets as intersections of the space-time sheets are involved.

2. TGD also allows the purely quantal view based on quantum diffraction in WCW. Monopole flux tubes would be analogous to quantum particles and the Moon would serve as an obstacle inducing quantum diffraction in the same way as in double slit experiment. The absence of screening would correspond to unitarity and probability conservations.

2.2 Could the quantum harmonic oscillator model predict genuine quantum effects caused by the large values of $\hbar_{gr}$?

One can start from a harmonic oscillator model for the conical pendulum.

1. For a harmonic oscillator, the frequency is independent of the amplitude of the oscillation and one has $E = n\hbar\omega$ in the standard quantum mechanics. At the limit of large values of oscillator number n, the system behaves classically. The replacement $\hbar \rightarrow \hbar_{gr}$ implies $E = n\hbar_{gr}\omega$. This can lead to a situation in which the value of n_{gr} is small. This can lead to large effects as the value of n_{gr} changes.

2. What is the situation for a non-linear oscillator such as a gravitational pendulum? In this case the frequency depends on amplitude classically. In the quantum case the frequency could be identified in terms of the eigenvalues of energy as $\omega = E/\hbar$. The energy eigenvalues are however expected to depend on $\hbar$. Hydrogen atoms are a good example: in this case the energy eigenvalues are proportional to α_{em}^2 and therefore to $1/\hbar^2$.

3. Can one imagine that the scaling $\hbar \rightarrow \hbar_{gr}$ could lead during the eclipse to a reduction of f, which is by 3 orders of magnitude larger than predicted by the classical model? For the classical oscillator the reduction of frequency is at maximum about 14 per cent. The classical amplitude of the oscillator relates by quantum-classical correspondence to the oscillator number n as $A \propto \sqrt{n}$.

   Very large value of $\hbar_{eff}$ reduces the value of n to $n_{gr} = (\hbar/\hbar_{gr})n$ and it can become small. Amplitude would be by $(\hbar/\hbar_{gr})^{1/2}$. Does this mean that the harmonic oscillator approximation should improve? If so, even the non-linear quantum model is unable to explain the large reduction of f.

   Oscillator quantum number as an analog for the number of quanta and oscillator amplitudes are canonically conjugate variables and Uncertainty Principle states that if the amplitude is precisely defined, the value of n is uncertain.

Could the large value of $\hbar_{gr}$ make the oscillator genuinely quantal?

1. It is good to take the values of $\hbar_{gr}$ for proton as a standard example. For the general mass $m = Nm_p$ one has $\hbar_{gr}(M,m) = N\hbar_{gr}(M,m_p)$. For $N = 1$ one has $\hbar_{gr}(M_E,m_p) = GM_Em_p/\beta_0 = r_s/2L_p \simeq 2.377 \times 10^{13}$. For the Sun one has $\hbar_{gr}(M_S,m_p) = GM_Sm_p/2\beta_0 = r_S 2^{11}/2L_p \simeq 1.426 \times 10^{22}$.

2. The energy of the classical oscillator is $E_{cl} = m\omega^2A^2/2$. Quantum-classical correspondence $E_{cl} = E_{qu} = n\hbar\omega$ gives the estimate $n = mAR^1\omega/2\hbar$, with $\hbar = 1.054 \times 10^{-34}$ J. One can consider a simple numerical example. Assume $\omega = 2\pi$ s^{-1}, mass $m = 1$ kg and amplitude $A = 1$ m. In this case one obtains $n \simeq .47 \times 10^{34}$.

3. Assume that the oscillator has a size of quantum coherence region with radius $\Lambda_{gr}(E) = r_S(E)/2 \simeq .5$ cm for $\beta_0(E) \simeq 1$. Suppose that a cube sized region with this size has the density of water $\rho \sim 10^{30}m_p/\text{m}^3$. In this case one would have $N \sim 1.25 \times 10^{23}$.

This gives $n/n_{gr}(E) = 2.3 \times 10^{36}$. Using the estimate for n this gives $n_{gr}(E) = n/2.31 \times 10^{36} \sim .21 \times 10^{-2}$. This does not make sense since $n_{gr}(E)$ should be larger than 1. The volume should be larger by at least by a factor of about 500. The size of the quantum coherence regions should be at least 5 cm, 10 times larger.

4. Assume that the oscillator has a mass of 1 kg and has in the case of water density a volume of 10^{-3} m^3. One can argue that $\Lambda_{gr}(E)$ gives only a lower bound to the size of the quantum coherence region. If the scale up volume corresponds to a gravitational quantum coherence region, the size would be 10 cm so that n_{gr} would be equal to 17.6 and larger than 1.

5. In the case of the Sun the estimate gives $n/n_{gr} = 7.7 \times 10^{44}$. This is by factor $(3.3 \times 10^8$ larger than for the Earth and the problem becomes even worse. The scaling of about factor 10^3 for the size of the quantum coherence region to about 100 m would be required.

   The size scale of the quantum coherence region in the solar gravitational field is $R_E/2$ and in this case one would have the limit with a large value of n_{gr}: this situation cannot of course correspond to the recent case.

2.3 Geometric optics is not enough: is diffraction is needed

The Allais effect occurs during the entire period that it takes for a full shadow to travel over the Earth and also in the region where the full shadow is not present and the effects measured at different loci correlate [E10]. Therefore the effect of the screening by the Moon is not local like in the geometric optics picture and diffractive effects are suggestive.

1. A hole in the screen generates a characteristic diffraction pattern (see) expressible in terms of a Bessel function, whose argument is proportional to the ratio R/λ of the radius R hole and and the wavelength λ of the incoming light.

2. Assuming linearity of the underlying field equations, the Moon could be formally regarded as an "antihole". If a wave falls on a screen, a diffraction pattern is created. When a hole in the screen is replaced with an obstacle such as Moon, this pattern must be subtracted from the pattern in the absence of the hole.

What is diffracted?

1. Could classical waves be gravitational waves or possibly classical Z^0 waves generated by the Sun? In the general relativity framework, gravitational waves from the Sun are predicted to be extremely weak. Could the diffracting waves correspond to Z^0 cyclotron radiation generated at the flux tubes carrying dark electrons?

   Since the classical Z^0 field must be weaker than the gravitational field, also this option looks implausible unless constructive interference due to the long range quantum coherence is in question. The large value of h_{gr} would give them a large amount of energy in the energy scale of visible light. However, the very idea of large h_{eff} is that lowest order contribution given as a classical contribution having no dependence on h_{eff} dominates.

2. Could a diffraction analogous to the diffraction of quantum particles identified as flux tubes emanating from the Sun be in question? The flux tubes as analogs of strings would be analogs of quantum particles and would be described by an analog of Schrödinger amplitude identifiable as a spinor field in the "world of classical worlds" (WCW) consisting of space-time surfaces satisfying holography= holomorphy principle.

   The flux tubes arriving from the Sun would be like a beam of particles described by a wave function and interference and diffraction for wave functions would take place. Moon could act as an obstacle producing the opposite of the effect produced by a hole in the screen. The effect has little do with classical or quantum gravitational fields.

Diffraction is characterized by two scales: the radius R of the hole in the screen (the radius of the obstacle in the dual situation) and the wavelength λ of the diffracting wave.

1. The natural identification for R is as the radius of the Moon.

2. What about the wavelength λ? In the [E10] it is proposed that the Sun is emitting particles with 44 m spatial periodicity. This scale could correspond to the wavelength λ and to the frequency $f = 6.9$ MHz if the waves are associated with a massless field.

   Electron has a cyclotron frequency of .56 MHz in the endogenous magnetic field of .2 Gauss assigned with magnetic monopole flux tubes in the TGD inspired model of living matter. There is a difference of order of magnitude. However, the TGD inspired model for music harmony suggests also the octaves of this field strength.

The parameters R and λ should have meaning at the level of both space-time surface and WCW.

2.4 Monopole flux tubes as mediators of the gravitational and other interactions

TGD suggests that monopole flux tubes serve as mediators of gravitational and also other interactions.

1. Magnetic monopole flux tubes are thickened strings but their lengths can be astrophysical and they carry a conserved monopole flux. This means a connection with string models. The difference is however that the flux tubes as string like objects could have astrophysical length scales. Could one regard flux tubes as particles and assign to them wave function as WCW spinor field so that one would have quantum diffraction at the level of WCW?

2. Interesting questions relate to the possible role of reconnections possible for the flux tubes returning to the Sun. The conservation of monopole flux allows U-shaped flux tubes turning back at the Moon and returning to the Sun. This would be an analog of reflection. But doesn't this mean that these flux tubes cause no long range gravitational effect in this case? Also reconnections creating closed flux tubes propagating past the Moon are possible but can they contribute to the static part of the gravitational force?

Can one make any guesses about the dimensions of the monopole flux tubes? The proposal of [E10] is that the Sun is emitting particles with $\lambda \sim 44$ m spatial periodicity. Could these particles correspond to monopole flux tubes? Could one think that flux tubes from the are emitted as flux tube bundles of radius which corresponds to the quantum gravitational coherence scale $\Lambda_{gr}(S) \simeq 3000$ km $\sim R_E/2$ of the Sun. Could the separation between these flux tubes be $\lambda \sim 44$ m? If so, a single flux tube bundle would contain $N \sim (\Lambda_{gr}/\lambda)^2 \simeq .68 \times 10^{10}$ flux tubes.

2.5 How to describe the effects of the Moon?

One can consider several models for the effects of the Moon.

1. The first option is screening so that the Moon would absorb the gravitational flux tubes or force them to turn backwards. This does not conform with the Newtonian view of gravitation and with the conservation of gravitational flux which would correspond to the monopole flux. Also the findings about the presence of Allais effect also outside the eclipse region are in conflict with this idea.

2. The situation could be also seen as an incompressible hydrodynamic flow past an obstacle. The gravitational flux tubes would be analogous to hydrodynamical flow lines. The incompressibility of the flow would correspond to the conservation of the magnetic and gravitational flux. This would give screening behind the Moon but conservation of flux would force the flux past the Moon.

3. One could try to describe the situation as diffraction of classical gravitational and Z^0 fields. In this case the Moon would serve as an "anti-source" generating the negative of the diffraction pattern generated by a hole in the screen. If the fields are identified as magnetic fields quantized to flux tubes in TGD, the flux conservation is obtained and there is an analogy with hydrodynamics of incompressible fluid.

4. A further, and perhaps the most realistic, view is in terms of quantum diffraction at the level of the WCW for the monopole flux tubes as basic objects as 3-surfaces generalizing the point-like particles. The WCW spinor field would correspond to the analog of Schrödinger amplitude."

What happens during an eclipse if the interference and diffraction play a role? One must distinguish between short and long wavelengths.

1. Concerning short wavelengths, it could be imagined that the contribution from the Sun is shaded during the eclipse and only the lunar contribution is received. For short wavelengths there would be no diffraction during the total eclipse and geometric optics would work.
2. The large value of the gravitational Planck constants h_{gr} implies a long gravitational Compton wavelength of order $R_E/2$ for $\beta_0(Sun) \simeq 2^{-11}$ and would indicate that diffraction and interference are important for long wavelengths. An analogy is, for example, the interference pattern that occurs around a boat dock in waves.
3. Screening occurs also in diffraction by an obstacle immediately behind the obstacle. One should clarify what happens at the level of geometry in the screening. Could the flux tube turn back and return to its source in the screening, say by the Moon? Could the flux tube reconnect and give rise to flux tube loops. Also the Earth causes similar screening and the Allais effect would occur in the Moon when shadowed by the Earth.

2.6 Could the induced Z^0 and Kähler fields have a role in the Allais effect?

The interpretation of Allais effect in terms of diffraction in WCW is rather attractive but one can also consider the possibility that the diffraction of gravitational and Z^0 fields is involved and perhaps even provide an alternative description. This also relates to the fundamental description of quantum gravitation. Quantization of metric does not work in general relativity: could the description of quantum gravitation be in terms of WCW spinor fields having as arguments Bohr orbit like space-time surfaces rather than of the second quantized metric tensor.

1. TGD predicts the possibility of long range Z^0/Kähler forces and I have also considered classical Z^0 force as a source of the Allais effect [K1]. Both electromagnetic and Z^0 field involve Kähler field as a part and the latter could be the long range field which is not subject to the weak screening.
2. Could Z^0 eclipse give a non-gravitational contribution to the Allais effect?. Z^0 field and maybe also classical W fields would be massless below Λ_{gr} due to the large value of h_{gr}. Z^0 Coulombic force directed along the flux tubes would be screened and also a Z_0 magnetic torque would be present. One could say that besides em radiation also Z^0 readiation represented as waves from the Sun is screened.

2.7 The reduction of the frequency of the pendulum as evidence for ZEO?

The reduction of the oscillator frequency is 3 orders of magnitude too large. It corresponds also to the parameter $\beta_0(S)$ appearing in $\hbar_{gr}(S)$. Suppose that $\Delta f/f \simeq \beta_0(S) \simeq 2^{-11}$ is not an accident. Could β_0 correspond to a real velocity?

1. Intriguingly, the formula for redshift for this velocity gives in $\Delta f/f = \sqrt{(1-\beta_0)/(1+\beta_0)} \simeq -\beta_0$. Could it be that the oscillation frequency is in some sense redshifted during the eclipse.

   The magnitude of $v_0 = c\beta_0 \simeq 150$ km/s is huge as compared to the velocity of the oscillator having order of magnitude 1 m/s. Therefore the redshift cannot be caused by a real motion of the pendulum relative to the observer.
2. Could one imagine any physical interpretation for $\beta_0(S)$? The solar system rotates around the galactic center with a velocity of 200–230 km/s. Could $\beta_0(S)$ relate to this velocity? Note that Earth moves relative to the Sun with velocity 29.78 km/s.

What comes to mind as an explanation for $\Delta f/f$ in the TGD framework is zero energy ontology (ZEO) already briefly summarized.

1. Could the screening of the solar gravitational field by the Moon mean that cd(S), the solar CD as a candidate for the cd of the observer, separate from the cd(P), the CD of the pendulum as sub-CD of cd(S)? The splitting of the U-shaped monopole flux tube contacts coming from the Sun by a reconnection as a correlate for the screening by the Moon could correspond to this splitting at the space-time level.

2. Quantum criticality is expected to prevail in the beginning of the solar eclipse. Large length scale fluctuations should take place. Could the large fluctuations observed in the beginning and end of the eclipse correspond to fluctuations of $\hbar_{gr}$ and thus in the values of the velocity parameter β_0 as a moduli parameter for CD?

   The causal diamond cd(P), associated with the quantum coherence region U of the pendulum, is a sub-cd of cd(Sun). Could the velocity parameter β_0 appearing in $\hbar_{gr}$ parameterize a Lorentz boost for cd relating it to a standard cd. A possible problem with this interpretation and the $\beta_0 \leq 1$ as a good approximation in the case of the Earth and cosmology [L9] would correspond to a boost with light velocity.

3. Before SSFR a delocalization in the moduli space $M(P)$ of cd(P):s takes place and generates a quantum superposition in $M(P)$ involving different size scales of CD, different values of $\beta_0(P)$ and possibly also different directions of the Lorentz boost.

   In the SSFR a localization in the moduli space for cd(P) occurs: in particular, the size of the cd(P) and the value $\beta_0(P)$ are fixed. The size of the cd is bound to increase in a statistical sense and this corresponds to the increase of the geometric identifiable as the temporal distance between the tips of cd.

   The new value of $\beta_0(P)$ serves as a moduli parameter for cd. cd(Sun) and cd(P) (or rather their active boundaries) are related by Lorentz boost but it is not clear whether one can say that they move relative to each other. This analog for relative motion of CDs would occur with a maximal velocity $\beta_0 = \beta_0(Sun)$ in which case $\beta_0(P) = 0$ would be true.

4. The analog of cosmic redshift would take place. The observed frequencies of all periodic processes for P are reshifted by $\beta_0 \leq \beta_0(Sun) \simeq 2^{-11}$. The Allais effect could be seen as evidence for the prediction that at the fundamental level the space-time is not connected but consists of separate space-times sheets within CDs forming a scale hierarchy.

3 Questions by Esa-Juhani Ruoho

Esa-Juhani Ruoho made some questions related to the TGD view of Allais, which inspired the considerations of this article as an attempt to uddate the earlier model by bringing in the rather dramatic developments that have occurred during last years.

3.1 Allais effect as interference or diffraction effect and transversality

[ER1] In your TGD model, the Allais effect is an interference effect involving gravitational Planck constant h_{gr} having a very large value. The key finding from the analysis of Duif (2004) [E2] and Goodey et al. (2022) [E6]) is that the anomaly is primarily horizontal - instruments sensitive to horizontal forces detect signals 10^3–10^5 times larger than vertical gravimeters. Allais's own anisotropy coefficient is $\sim 10^{-6}$, while classical tidal prediction gives $\sim 10^{-13}$. Does TGD predict this horizontal dominance, or is the amplification at large h_{gr} isotropic?

[MP1] I have considered a TGD based explanation as interference of classical dark gravitons/gravitational waves arriving from the Sun and Moon [K1]. In the recent view of TGD, one can consider classical hydrodynamic model and quantum diffraction model, which also involves interference.

1. Perhaps the most convincing TGD based classical view is that the gravitational force of the Sun can be modelled in terms of a gravitational flux as analogous to an incompressible

hydrodynamical flow. The monopole flux tubes arriving from the Sun would be analogs of flow lines and idealizable as strings so that a connection with string model emerges. The Moon is modellable as an obstacle for this flow. The gravitational flux would be conserved but there would be no diffraction yet.

2. Quantum version of this picture would be analogous to quantum diffraction of particles as 3-surfaces identified as monopole flux tubes connecting Sun or Earth and idealizable as strings so that a connection with string model description of gravitation would emerge. Moon would define the obstacle and the scattering would involve quantum diffraction as in double slit experiment. This would give a stringy variant of quantum diffraction in a reasonable approximation.

3. The gravitational Compton wavelength $\Lambda_{gr} = r_s(Sun)/2\beta_0$, $\beta_0 \simeq 2^{-11}$ of the Sun is on the order of $R_E/2$, where R_E is the Earth's radius. Therefore interference and diffraction on these scales could occur. For the Earth $\Lambda_{gr} = r_s(Earth)/2\beta_0$ with $\beta_0 \simeq 1$ is about .5 cm. The Moon should have the same value of $Lambda_{gr}$ in the solar gravitational field.

4. This would make a precise prediction for the diffraction pattern in terms of Bessel function. The large value of the gravitational Planck constant would be essential for the effect. The findings of [E10] suggest a wavelength of 44 m. To my view the quantum diffraction for the flux ubs inducing modification of g represents a transversal effect in the scale of the Earth.

3.2 Anomalies in geometric transitions

[ER2] The C1/C4 pattern — anomalies in geometric transitions (first and fourth contact), absence during totality — is the strongest observational result, confirmed for instance by Wang and Kuusela (1992) [E5, E11]. Does the TGD interference mechanism produce transient phenomena at the beginning/end of the alignment and not a continuous effect during the maximum coverage time?

[MP2] One must model the interaction of gravitational flux tubes with the conical pendulum. One can start from a harmonic oscillator model for the conical pendulum and perform a quantization using the gravitational Planck constants of the Sun or the Earth.

The huge values of gravitational Planck constants imply that small values of the harmonic oscillator quantum number are involved. The changes of this quantum number at criticalilty could explain the large fluctuations as quantum critical fluctuations assignable to the transition to the eclipse. The effect would not be gravitational but quantum mechanical and due to the large value of $\hbar_{gr}$ predicted by TGD based quantum ontology.

3.3 Indications for continuous background isotropy

[ER3] Goodey et al [E6](see this) confirmed Allais's 24h 50min lunar periodicity with a statistical significance of $p \leq 7.8\times\ 10^{-6}$. Pugach & Olenici (2012) [E10] (see this) observed anomalies during the eclipse that was not visible from their observation sites (440 km apart, the eclipse visible only in the Indian Ocean). Both point to a continuous, non-local anisotropy of space that is only amplified by the eclipse.

The observed effects from different observation sites were correlated and lasted the time about 12 hours the lunar shadow was passing the Earth. Therefore effects appear also outside the shadow, which has radius slightly larger than the diameter of the Moon, which roughly one half of the Earth radius. The picture provided by geometric optics does not explain this.

[MP3] Both the classical hydrodynamical and quantum diffraction model for the gravitational interaction between the pendulum and gravitational fields of the Sun and Moon would predict that the effects appear in the scale of the entire Earth. The presence of wavelength 44 m supports the quantum diffraction model.

4 Appendix: Some TGD background and questions

In the following I represent the general TGD background and questions.

4.1 General description of scattering

In the TGD, scattering events can be divided, in analogy with QCD, into transitions from the initial state (hadronic state) to the interaction state (formation of quark gluon-plasma) and then to the final state (hadronization).

1. Gravitons and various other bosons and fermions appear in the description of the initial and final states, which is in terms of the modes of the spinor fields of $H = M^4 \times CP_2$. The spacetime surface is not involved at this level. Color multiplets are associated with both quarks and leptons and an infinite hierarchy of scaled copies of the standard model is predicted.

2. In the interacting intermediate state, embedding space-coordinates define primary degrees of freedom. By general coordinate invariance there are only 4 of them. The classical theory obeying holography = holomorphy principle is an exact part of quantum TGD. This strongly suggests that classical description of interactions at space-time level is necessary. Electroweak degrees of freedom can be regarded as color degrees of freedom associated with the CP_2 spin degrees of freedom. Also gravitational waves are induced and not primary. This strongly suggests a dramatic simplification of the description of gravitational and gauge interactions.

3. In TGD, fermionic vertices are basically analogous to standard model vertices represented as 3-D singular surfaces at which imbedding space coordinates have discontinuous derivative modulated by the presence of the induced metric. The gravitational contribution to the fermionic vertices would be a part of electroweak due to the contribution of the CP_2 metric to the induced metric: intuitively it is clear that this should be related to gravitations.

   It would seen fermionic electroweak vertices and the possibility of very large values of h_{gr} making possible long range quantum coherence for electroweak fields, are enough in the description of the fermionic degrees of freedom based on the TGD counterpart of quark-gluon plasma phase. There would be no need to include gravitons at this level. Various final state particles, including gravitons would appear only in the transition to the final states analogous to hadronization. This forces us to ask whether it is possible to talk about something analogous to graviton propagator?

4. In the recent view only the propagators for fundamental fermions are needed in the fermionic sector and the N-point functions for the spinor fields of "world of classical worlds" in the geometric degrees of freedom would emerge from the functional integral over WCW.

4.2 Some zero energy ontology

To understand the proposed model for the large value of $\Delta f/f$ some zero energy ontology (ZEO) forming the basis of the TGD inspired quantum measurement theory is needed.

1. The basic entity in ZEO is causal diamond CD= cd$\times CP_2$, where *cd* is causal diamond of M^4 defined as an intersection of future and past directed light-cones. cd is analogous to an empty cosmology with a big bang followed by a big crunch. CD has interpretation as the analog of the perceptive field of a conscious observer containing space-time surfaces or their restrictions.

   The Lorentz invariant light-cone proper time a analogous to cosmic time defines a natural time coordinate so that the cd projections of 3-surfaces are intersections of the space-time surface with $a = constant$ 3-D hyperboloids of the second half-cone of the cd.

2. In TGD inspired cosmology energy and momentum are conserved, and the cosmic redshift could be seen as a problem. In TGD, the cosmic redshift is not caused by the tiring of light but is almost completely a kinematical effect due to the different orientations of 3-D tangent spaces of the 3-surfaces associated with the observer and source. The different orientations of tangent spaces are caused by the cosmic expansion which in TGD framework is mostly to the cosmic expansion associated with the $a = constant$ hyperboloid of the cd associated with cosmology.

Could the unexpectedly large reduction of the frequency in Allais effect be due to the different orientations of cds of the observer and pendulum characterized by a relative velocity parameter β_0 distinguishing between cds defining the perceptive fields of the observer and pendulum?

3. The moduli space M of cds includes besides scalings also Poincare transformations mapping the passive boundary of cd (PB) to itself but acting non-trivially on cd as whole. Small state function reductions (SSFRs), identifiable as the TGD counterparts of repeated quantum measurements in standard QM, leave PB and the 3-D fermion states at it invariant (Zeno effect) but affect the active boundary of cd (AP) and states at it. The sequence of SSFRs defines self as a conscious entity.

   A given SSFR is preceded by a unitary evolution implying delocalization in the moduli space M of cds and SSFR induces a localization in M. SSFRs induce only a scaling of the PB leaving by the generalized conformal invariance the 3-D fermionic quantum states at it invariant. Lorentz transformations of the cd leaving PB invariant are possible but act non-trivially in M since they do not leave AP invariant.

4.3 Questions

4.3.1 Questions about gravitational interactions

There are questions related to the TGD description of gravitational interactions.

1. Both color interactions and gravitation couple to conserved isometry charges. This suggests that the situation is completely symmetric between gravitation and color interaction. Are also the gravitational interactions are induced by the presence of the induced metric in the couplings of the induced spinor fields to the electroweak gauge potentials? Somehow the space-time description of gravitational interactions should allow to distinguish them from gauge interactions. Does the distinctition emerge only when the free quarks and leptons in the interacting sate organized to final state particle giving rise also to gravitons?

2. Gravitational interactions cannot reduce to electroweak gauge forces. Gravitons and actually all elementary particle do emerge from fundamental fermions.

   Also gravitational interaction should emerge somehow. Hadrons and also quarks and leptons emerge as geometric objects identifiable as closed monopole flux tube structures behaving like string like objects. Could gravitational interactions at the fundamental level emerge in the same way and be mediated by gravitational monopole flux tubes.

3. Einsteinian gravitation approximately reduces to a $U(1)$ force and one can speak of Newtonian gravitation as the analog of electric force and also of gravimagnetism. The genuine reduction of gravitation to electroweak forces is not possible. One would have repulsion instead of attraction whereas matter and antimatter have repulsive gravitational force. It is now known and that antihydrogen falls down in the gravitational field of the Earth.

4. Hamilton-Jacobi (H-J) structure as a generalization of the Kähler structure for the causal diamond (cd) of M^4 and consistent with M^4 metric is degenerate in the sense that Kähler form is non-trivial only in the transversal degrees of freedom parametrized by a complex coordinate and trivial in the longitudinal degrees of freedom. What is the role of M^4 H-J structure concerning gravitational interaction? Does also M^4 Kähler form contribute to gravitation? Also the cd Kähler Kähler form is also of monopole type in the sense that it has non-trivial homology. Now it is due to the fact that cd has hole along the axis connecting its tips.

4.3.2 A more precise identification of basic objects

A precise identification of the basic objects such as flux tubes and massless extremals is needed.

1. What is the precise identification of the closed monopole flux tubes? One can consider single-sheeted closed monopole flux tubes whereas elementary particles and hadrons correspond to

two-sheeted monopole flux tubes involving two wormhole contacts between them. Could also gravitational monopole flux tubes and "massless" extremals mediating interactions be such 2-sheeted structures.

2. What are the TGD counterparts of virtual particles are? Is it possible to construct them from the solutions of classical field equations satisfying holography= holomorphy correspondence? Could the light-like momenta associated with the sheets of a pair of parallel MEs be different so that they could be responsible for a transfer of momentum and could serve as TGD counterparts of virtual momenta transferred in interactions.

   How does the attractive character of gravitation concretely emerge? Graviton is a spin 2 particle, formally a pair of spin 1 bosons. Could one see gravitons as pairs of $U(1)$ bosons? Could gravitons be described in terms of MEs consisting of a pair of parallel space-time sheets carrying massless modes? Could the MEs of virtual gravitons carry light-like momenta which are not parallel? This brings in mind the proposal that gravitation could be seen as a square of a gauge theory.

4.3.3 Questions related to the notion of effective Planck constant

There are also questions related to the effective Planck constant.

1. The increase of h_{eff} to a large enough value guarantees that perturbation theory applies ("Mother Nature loves her theoreticians" [L3]). If this is indeed the case, the lowest order contribution to the scattering amplitude is independent of the Planck constant.

   Therefore the large size of the Allais effect could reflect the large value of gravitational Compton length: there would be a large scale constructive interference impossible in standard model. Although a very large value of the gravitational Planck constant could be involved, the induced electroweak gauge fields or their screening could contribute to the Allais effect.

2. The increase of h_{eff} increases the size of quantum coherence region for all gauge interactions and quantum gravitation. In particular, this should be the case at the gravitational monopole flux tubes.

   The notion of induced gauge field makes possible also the presence of color interactions in very long scales, even astrophysical scales since color interactions at the level of induced spinor fields reduce to electroweak interactions since the electroweak group $SU(2)_w$ is a subgroup of the color group.

4.3.4 Questions related to the identification of fundamental interactions as contact interactions

The proposal is that fundamental interactions are contact interactions. Holography = holomorphy principle implies that the interactions betweeen space-time sheets analogous to Bohr orbits are associated with their intersection giving rise to string world sheets. The magnetic monopole flux tubes are candidates for the mediators of long range interactions.

1. Could gravitational mass as Newtonian gravitational flux, using Planck mass or CP_2 mass as a unit, be identifiable as Kähler magnetic monopole flux? If so, the gravitational mass would be a multiple of the basic unit of monopole flux. In the case of quarks, the Kähler charge is not integer. Does color quantum relate to this somehow.

2. Could gravitational coupling strength GMm reduce as a coupling between Kähler magnetic monopole fluxes associated with the 2-D intersections of the flux tubes consisting of string world sheets? Is this true for all couplings? Does $\hbar/G_N$ or $1/R^2$ correspond to string tension and is therefore much smaller for non-gravitational strings, which are much thicker if their radius correspond to p-adic length scale.

3. The TGD view about the cosmic evolution relies the p-adic variants of function fields allowing to understand the p-adic length scale hypothesis. Holography = holomorphy vision allows an exact solution of field equations. Evolution is essentally increase of algebraic complexity.

One must distinguish between hierarchies of p-adic length scales and Planck constants. This means two closely related evolutions. Why G appears in gravitational interactions instead of R^2 and string tension in hadronic interactions? Could the flux tubes in the case of gravitational interactions be cosmic strings with a minimal p-adic length scale associated with $p = 2$?

4. Is the real CP_2 radius equal to Planck length l_G for the minimal value of $h = h_0$ and is the radius R equal to its scaled version with $h = (7!)^2 h_0$?

5. Are also the gauge couplings associated with the electric gauge fluxes assignable with the intersections of monopole flux tubes? What about the exponents of the electric type fluxes associated with the string world sheets defining non-integrable phase factors, bringing to mind gauge theory formulation of the scattering amplitudes in terms of the string world sheets.

6. How to understand the notions of electric and gravitational Planck constant at the deeper level? Here I have proposed that Yangian algebras as involving polylocal generators might allow to understand them.

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