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Interplanetary external driven quasidynamo as the origin of geomagnetic jerks correlated with length of day and gravity anomaly

[The origin of 5.9-years and 11-years and semi-annual periodic geophysical signals and Jovian planets alignments as the origin of the abrupt geomagnetic jerks]

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Abstract: We report phenomenological inevitable correlation between the Sun's magnetic field oscillation through the Earth and the Jupiter, with sinusoidal geomagnetic jerks observed at the Earth, additionally aligned with the gravity and length of day sinusoidal variations and we observe too that the Sun and Jovian planets alignments with Jupiter are origin of the observable abrupt geomagnetic jerks whether historical or new, and experimental results demonstrate a possible explanation on the base of the planetary induced currents upon the metallic liquid cores of the planets upon the varying external magnetic fields as the source of heat flows continued by frictional turbulent and convectional fluid fluxes, amplified and expanding by the Earth magnetic field and observations are showing too that it should be an electric coupling effect between metallic cores of the planets, under the magnetic field oscillation so that Jupiter conductive metallic region interacts with Earth metallic core while the Sun's magnetic field is oscillating through the Jupiter and we see a relation between secular variation of the Earth's magnetic field and long term trend of 5.9-years signals as a new method to measure geomagnetic secular variation by LOD signals.

Key words: geological and geophysical evidences of deep processes, core dynamics, heat flow, magnetic and electrical methods, gravity variations, dynamo theory, geomagnetic field variations, solar-terrestrial interaction, planets alignment, geomagnetic jerks, LOD variations

1. Introduction

A geomagnetic jerk or secular geomagnetic variation impulse is a relatively sudden change in the second derivative of the Earth's magnetic field with respect to time. These events were noted initially by *Courtillot et al. (1978),*

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Malin and Hodder (1982), Courtillot and Le Mouël (1984). The clearest ones, observed all over the world, happened in 1969, 1978, 1991, and 1999. Data before 1969 is scarce, but there is evidence of other global jerks in 1901, 1913, and 1925. Other events at 1932, 1949, 1958, 1986 and 2003 were detected only in some parts of the world and new analyzing has detected some next jerks. We do not want to introduce here a technical version of the geomagnetic jerk features in detail for example the exact geographical map of the magnetic field variations or exact inverse engineering of the secular variations to shape the core flows dynamics because that our paper is not on the detection of the geomagnetic jerks. But we want to explain here the origin of the detected geomagnetic jerks in addition with detection of the LOD variations and relevant gravity changes all on the base of experimental results and solar system phenomenology and Maxwell equations and hydrodynamics, and in reality we want to show here that the reported geomagnetic jerks aligned with LOD variations and relevant gravity changes are not appeared randomly suppose originated externally out of the Earth's atmosphere. But the introduction of geomagnetic jerks features in detail is visible at multitude of the papers published before and for an excellent general definition of the geomagnetic jerk features we may refer to the paper *Tozzi et al. (2009)* and many next papers are included to the relevant introductions not needed to repeat here.

By the way, measurements are showing the abrupt changes of the secular magnetic field in some dates (*De Michelis et al., 2005; Brown et al., 2013; Alexandrescu et al., 1996*) assumed to be connected to the core flows (*Bloxham and Jackson, 1991; Mandea et al., 2010; Holme, 2007*) and at the paper "The origin of the geomagnetic jerks" (*Bloxham et al., 2002*), we see a general explanation of process as noted that:
"The fact that they represent a reorganization of the secular variation implies that they are of internal origin, and their short timescale implies that they are due to a change in the fluid flow at the surface of the Earth's core (as has also been established through mapping the time-varying flow at the core surface). However, little is understood of their physical origin. Here we show that geomagnetic jerks can be explained by the combination of a steady flow and a simple time-varying, axisymmetric, equatorially symmetric, toroidal zonal flow. Such a flow is consistent with torsional oscillations in the Earth's core, which are simple oscillatory flows in the core that are

expected on theoretical grounds, and observed in both core flow models and numerical dynamo models."

An analysis on the measurements data is showing a background oscillating geomagnetic jerk as 5.9 years' periodic oscillation of the geomagnetic jerks (*Silva et al., 2012; Brown et al., 2013*) and as noted at *Silva et al. (2012)* paper:
"The first time derivative of residual length-of-day observations is known to contain a distinctive 6-year periodic oscillation. Here we theorize that through the flow accelerations at the top of the core the same periodicity should arise in the geomagnetic secular acceleration. We use the secular acceleration of the CHAOS-3 and CM4 geomagnetic field models to recover frequency spectra through both a traditional Fourier analysis and empirical mode decomposition. We identify the 6-year periodic signal in the geomagnetic secular acceleration and characterize its spatial behaviour."

The analysis by scientists on the LOD observations show that the length of day is changing periodically almost 5.9 years (*Vondrák and Burša, 1977; Liao and Greiner-Mai, 1999; Abarca del Rio et al., 2000; Mound and Buffett, 2003; 2006; Olsen and Mandea, 2007; Holme and de Viron, 2013*) as a verification for oscillation of the Earth's rotation aligned with geomagnetic jerk 5.9 years oscillation and not only the 5.9 years periodic signals are confirmed for times above 1960 suppose as noted at *Holme and de Viron (2013)*, the 5.9 years signals have been confirmed for times before 1960 as:
"Also plotted (vertically shifted for clarity) are the decadal varying signal alone and the data with the 5.9-year oscillation subtracted, demonstrating the separation of the oscillation from the background trend. Inference from spectral studies suggests that the 5.9-year oscillation is also present prior to 1960."

We have shown here phenomenological evidences for link of the interplanetary external sources and internal core flows, and new reported geomagnetic jerks and historical geomagnetic jerks (*Korte et al., 2009; Qamili et al., 2013; Matzka et al., 2010*) are being detected all in agreement with Jovian planets alignments and observations show the 11-year periodic signals too and strongly this is correlated to the solar activity and we have shown here the origin of the planetary semi-annual signals too. On the other hand, recently it was published an article by *Anderson et al. (2015)* on the gravitational constant G measurements data, reported in these decades and their

analysis in the data shows the Earth's gravity is oscillating at the same period the Earth rotation is oscillating and *Mandea et al. (2012)* has analyzed the data from continuous satellite measurements made from 1999 to 2010 so that oscillation of the Earth's magnetic jerk aligns with Earth's gravity oscillation and for exact analysis on data we may refer to *Schlamminger et al. (2015)*.

We need to notice that the main reason of jerks is outside of the Earth. In the paper it is considered as the interplanetary driven partial quasidynamo which, of course, is not the self consistent hydromagnetic dynamo, mechanism operating in the Earth‘s outer core. This partial quasidynamo is an of external origin perturbation of flows and magnetic fields on the CMB.

In the section 1 – in the introduction we have described the annals of the Geomagnetic jerks and LOD variations and gravity anomalies in relevant together and we have shown some examples of the occurrences and a simple definition of the parameters and data and in the section 2. We have discussed purely the possible mechanism and probable methods and we have resulted the equations and formulas on the base of the Maxwell equations and hydrodynamics and in section 3. We have shown the observational data and experimental results referenced to the published papers and reported data by scientists to set with pure results aligned with description of the compatibles included to the relevant figures and tables and this section, we have referred to the solar system simulators to evaluate the parameters and ultimately in the conclusions it has been described the most important motes of the paper in simplest and shortest sentences.

2. Method and theory

For explanation of the observations and experimental reports we put forward a logical mechanism on the base of the Maxwell equations and hydrodynamics, in addition with some experimental results, actually accepted and we refer to the scientific references and we have verified the mechanism in result by reported data and observed phenomena. Generally, the proposed mechanism is a quasidynamo, initiated externally by the Sun and Jovian planets affecting at the Earth's conductive outer core. But it should be noticed

that this quasidynamo is not the self consistent hydromagnetic dynamo in dynamo region of the cosmic body. But in the Earth‘s core it is a partial dynamo as a perturbation on the CMB.

2.1. Interplanetary induced currents as the origin of the partial core flows

The geomagnetic jerks reveal presence of the core flows (*Bullard, 1948*) as quoted by Bullard that:
“It may be subject to turbulent currents due to thermal convection or to the shearing forces associated with the secular deceleration of the Earth. Such motions would cause the conducting material of the core to move across the Earth’s magnetic field and would produce electric currents. These electric currents would produce a further magnetic field, and it is the purpose of this paper to consider the hypothesis that the changes in this field constitute the secular change. We do not consider the origin of the main field itself, but merely use the observed fact of its existence as part of the mechanism required to produce the secular change.”

It has been theorized to exist secular change of the magnetic field, relevant to the chaotic occurrences of the core flows as mentioned in some papers, for example *Qamili et al. (2013)*. But observations are showing that partial geomagnetic jerks over time scale of a year or more, almost all are not random suppose random processes probably are atmospheric (ionosphere and magnetosphere) tiny effects and some long time secular variations might dependent too to convectional heat processes in the mantle (*Biggin et al., 2012*) and then based on the Bullard suggested mechanism, it remains turbulent currents due to the thermal convection as a possible internal origin of the geomagnetic jerks whereas that we may refer to newer papers, for example *Bloxham et al. (2002), Dumberry and Bloxham (2006)*. For geomagnetic jerk extraction from core flows and dynamo driven core currents, we may refer to a scientific technical report (*Wardinski, 2004*) “Core Surface Flow Models from Decadal and Sub decadal Secular Variation of the Main Geomagnetic Field”.

At all papers the geomagnetic jerks are completely on the Maxwell equations and hydrodynamics related to the core fluxes and the fluid fluxes cause to oscillate the gravity and Earth’s spin because of asymmetric change in the

moment of inertia for change of gravity (*Dumberry, 2010*) and the exchange of angular momentum between the outer core and solid mantle (*Mound and Buffett, 2006*). For Earth's spin change and in addition to periodic geomagnetic jerks we observe, abrupt geomagnetic jerks, reported in some dates, and these abrupt geomagnetic jerks are aligned with gravity and LOD anomalies too (*Holme and de Viron, 2005; Nakada, 2009*).

The cores of the planets are liquid conductors and then a possible explanation is on the base of the eddy currents or generally geomagnetic induced currents (GIC) (*Fink and Christiansen, 1989*). Eddy currents are loops of the electric currents, induced within conductors by a changing magnetic field in the conductor due to the Faraday law of induction.

A conductor object in a varying magnetic field or upon an AC voltage will experience dissipation of kinetic energy and braking effect. This mechanism does generate an external driven fluid fluxes as a partial quasidynamo which might be defined as a perturbation in the whole Earth's dynamo and versus a theory published newly on the whole generation of the Earth's dynamo by lunar tidal effect (*Andrault et al., 2016*) which is so far to accept, the mechanism of interplanetary external driven dynamo here is a secondary partial dynamo and ultimately, the drag forces are created by induced currents and electrical resistance within conductors cause a dragging effect analogous to friction which dissipates the kinetic energy as a source for convectional hydrodynamic flows. In both externally driven and internally driven secular variations of the magnetic field, the cause are induced currents and relevant heat convection and core fluid fluxes, based on the Maxwell electromagnetism and hydrodynamics. However, the braking effect of the eddy currents too may result, the variation in the length of day.

We should notice that the Earth has internal driven fluid fluxes too and some of the core flows which they cause to appear secular variation of the geomagnetic field are relevant to the internal sources as the secondary dynamos. But external driven partial dynamos have own relevant induced currents, penetrative in the Earth's metallic core and some partial induced currents are generated by external sources and continued by relevant core flows. Motion of these external driven core flows through the Earth's magnetic field will generate again, secondary induced currents by dynamo shape mechanism. The Earth's magnetic field will expand and amplify the externally driven heat processes. Thus, the Earth's magnetic field is reason to

continue and expand occurrences of the fluid fluxes and then the retardation of the visible events, and ultimately neutralized in an equilibrium point by Magnetohydrodynamics as a mechanism initially developed by *Alfvén (1942)* which causes to set fluids along the magnetic field lines or returning to ever stable motions in equilibrium points with those relevant secular change.

On the other hand against the internally driven core flows which moving at whole inside of the core, on the base of the externally driven quasidynamo we understand that the external driven core flows will be generated near the core mantle boundary (CMB) for that, in a perfect conductor with no resistance, the surface eddy currents, exactly cancel the field inside the conductor, so no external magnetic field penetrates inside the conductor and then, eddy currents will be generated on the core mantle boundary. Recent investigations of the secular acceleration pulses in the Earth's magnetic field have concluded that these events, observed at the Earth's surface, are resulted at the core mantle boundary (*Bloxham, 1988; Buffett et al., 2016; Chulliat et al., 2010; Mandea et al., 2000; Gire et al., 1986*) or, (*Voorhies, 1986, 1993, 1995, 2004*). Then the core mantle boundary (CMB) is dominant area for external driven fluxes originated by induced currents with hundreds kilometer diameter to generate geomagnetic jerks as reported and mentioned by scientists in references. Of course penetration of the externally driven quasidynamo to the core inside concerns to conductivity of the metallic core and by decrease of the conductivity, the penetration depth of external driven quasidynamo will increase proportionally.

In reality, the core flows models are scientific predictions from observations of the geomagnetic secular variations (with jerks included), accompanied with LOD variations and gravity anomalies, as an inverse engineering of the geomagnetic jerks' observations and for a mathematical analysis on the inverse theory, schematically we may refer in some sections to the paper *Aubert (2013)*.

Fluid fluxes are not ended after end of the initial generation of induced currents, but continued by the Earth's magnetic field. Because of the absorption and generation of the heat, they do not occur simultaneously and not in a constant position. They can't neutralize themselves suppose continued in the core as the hydrodynamic flows to develop induced currents upon the Earth's magnetic field. While it exits several number of the fluid

fluxes, the event is visible as global. But since there is alone one fluid flux it seems local event (*Bloxham et al., 2002; De Michelis et al., 2005; Duka et al., 2012*).

Mathematical solutions on the base of the Maxwell equations and hydrodynamics have been developed for such an inverse theory and the problem of electromagnetic induction in thin sheets was first formulated by *Price (1949)* in terms of the scalar magnetic potentials of the inducing and induced magnetic fields and developed by *Ashour (1950)* to investigate the problem of induction of electric currents in a uniformly conducting circular disk.

But we have a schematic comparable similarity between planetary driven induced currents and ionosphere induced currents by geomagnetic field oscillations (*Ashour and Price, 1948*). Strong reason of this schematic correlation is conductivity of both ionosphere and liquid cores and the reality that the penetration of the Solar magnetic fields into the planetary interiors is possible and similar to this penetration into their ionospheres.

It has long been known that the compass needle daily executes small regular oscillations and *Stewart (1882)* concluded that the daily magnetic variations were due to electric currents in the upper atmosphere and Stewart also suggested that convective currents established by the Sun's heating influence are to be regarded as "conductors moving across lines of magnetic force, and are thus the vehicle of electric currents which act upon the magnet". It is convenient to call this hypothesis of Stewart's the "dynamo theory".

The theory received early support from *Schuster (1889)*, who proved that the greater part of the field of the Geomagnetic variations has its origin outside the Earth, and that the remainder may reasonably be attributed to the Earth's currents induced by the varying external field and *Schuster (1908)* developed a dynamo theory for such an external effect. Improved the theory further, giving special attention to the magnetic variations due to tides caused by Moon, which are more amenable to theoretical treatment of externally driven induced currents. *Martyn (1949)* showed that the oscillation of the ionospheric E region was likely to be due to the electrodynamic forces associated with the currents responsible for the lunar magnetic variations.

The current induction in an anisotropic ionosphere by external fields has been studied by *Ashour and Ferraro (1962; 1964)* so that certain distribu-

tions of freely decaying currents in a spherical shell model of the ionosphere of non-isotropic electric conductivity would rotate about the geomagnetic axis. We may refer to the paper *Ferris and Price (1965)* as the currents induced by periodic and aperiodic magnetic fields in a uniformly ionized spherical shell rendered anisotropic by a permanent dipole field. Schematically here we consider spherical shell of the Earth's core, rendered anisotropic by the permanent dipole field of the Earth, situated to generate induced currents by initial effect of interplanetary external magnetic fields and the generation of the eddy currents in the ionosphere by oscillation of the geomagnetic field, mechanically is the same generation of the eddy currents in the core of the Earth by oscillation of the external magnetic fields and for motion of the induced currents in the core of the planets by external magnetic fields, we may refer to the paper *Price and Ferris (1962).* We can generalize mathematical equations of the electromagnetic induction in an infinite plane sheet with a circular hole by an external magnetic field (*Ferris, 1973*), with a spherical conductor with a hole in the centre to show the mathematical equations for induced currents in the conductive cores of the planets and it needs no to repeat equations again here.

2.2. Jupiter intermediate electric coupling effect upon terrestrial planets metallic cores

The flows at the top of the core, affect to generate LOD variations as noted by *Holme and Buffett (2015)* that:
"We also consider the implications for the connection between core-surface flow and length-of day variation – a stably stratified layer has implications for interpretation of core flow and the Earth's angular momentum budget."

And we may refer to *Holme and de Viron (2013)* as noted that:
"Interdecadal periods have been less clear, and have been characterised by signals with a wide range of periods and varying amplitudes, including a peak at around 6 years. Here, by working in the time domain, rather than the frequency domain, we demonstrate a clear partition of non-atmospheric component into only three components: a decadally varying trend, 5.9-year period oscillation and jumps at times contemporaneous with geomagnetic jerks."

The observations of 5.9 years periodic signals are showing we have geo-

magnetic jerks in the Earth by varying the Sun's magnetic field through the Jupiter and this phenomenology shows that the Jupiter with big metallic region has an intermediate effect electromagnetically on the Earth's conductive core and thus, we have the Jupiter driven partial core flows on the terrestrial planets conductive cores and Jupiter effect is much larger than that of other Jovian planets for its giant metallic region and nearness to the Sun and nearness to the terrestrial planets and then mainly we detect Jupiter-driven core flows at the Earth by the Sun's magnetic field oscillation through the Jupiter.

The Jovian magnetic field amplitude at the Earth's position is very smaller than that of the Sun and this means that the Jupiter's magnetic field is not directly affecting to generate eddy currents at the core of the Earth and in reality, the period of signals in LOD variations and geomagnetic jerks, don't verify such a direct effect suppose the periodicities are showing that the Jupiter has an intermediate effect on the Earth's core to generate geomagnetic jerks and relevant LOD variations and probable gravity anomalies.

Observations are showing that the Sun should be affecting on the Jupiter electrically conducting region and this Jupiter metallic Hydrogen region is influencing on the Earth's metallic core as an indirect intermediate effect. But what is the mechanism of this interaction between metallic electrically conducting regions?

It is almost impossible for such an interacting effect of the metallic cores under the magnetic field variations by Hall effect and then we may refer to Nipher experiments as a possible explanation. In the Nipher experiments (*Nipher, 1916; 1917; 1918*) two metallic spheres were used so that a small metallic core was in the Faraday cage and a next big metallic core was outstanding and when Nipher used a AC voltage into the outstanding big metallic core, it was observed a difference in the atomic level electric field as a reason to generate electric interaction between these metallic spheres.

As noted in the *New York Times* (19 September 1917):

"It will be shown that gravitational attraction between masses of matter not only has been diminished into zero, but has been converted into repulsion which is more than twice as great as normal attraction."

In further experiments (1918), Nipher decided to check his results. To do this he replaced the large solid lead spheres with two metal boxes, each filled

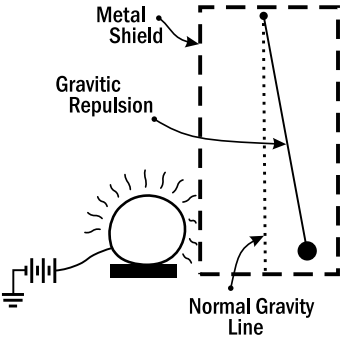

Fig. 1. Gravitational repulsion caused between large & small masses. Current on.

with loose cotton batting. These hollow boxes (having practically no mass) rested upon insulators. They were separated from the protective screen by sheets of glass and were grounded to it by heavy copper wires. The metal boxes were then charged in every way that the solid lead spheres had been, but not the slightest change in the position of the lead balls could be detected. This would seem to prove conclusively that the "repulsion" and "gravitational nullification" effects that he had produced when the solid balls were electrically charged were genuine and based undoubtedly on a true inter-atomic electrical reaction, and not upon any form of electrostatic or electromagnetic effects between the large and small masses. In Nipher experiments (*Nipher, 1920*) it was noted that:

"Results obtained on December 12 last are alone sufficient to establish the fact that enormous local changes in the earth's potential are constantly occurring and these changes produce variations in gravitational attraction between large masses and suspended masses."

In addition, it was noted by *Very (1919)* that:

"Nipher has shown that electric charges slowly penetrate into the substance of the leaden spheres of the Cavendish apparatus, producing a repulsion which is of the same order as their gravitational attraction, and this is no matter whether the electricity be positive or negative. After equilibrium is attained, and exhibition of the opposite sort of electricity penetrates most rapidly into the substance of the smaller spheres and reverses their electric sign first, when, for a time, there may be electric attraction, or at least a progressively diminishing repulsion between the large and small spheres; but

when saturation is reached, the spheres repel each other as before... It is a misnomer, however, to call the effect as Nipher does, a "gravitational" repulsion."

Then we can generalize such a phenomenon to the solar system and if we consider the Jupiter's metallic core as the same big outstanding metallic sphere in the Nipher experiments and Earth's metallic core as the same small metallic sphere in the Nipher experiments, then schematically we can wait for a very small electric interaction between Jupiter's and Earth's metallic cores, while the Sun's magnetic field is oscillating through the Jupiter as the same that Nipher used AC voltage into big outstanding metallic sphere.

From Nipher experiments, the metallic atoms show infinitesimal small electric interaction under the influence of the vibrational magnetic field and then, when the Sun's magnetic field is oscillating through the Jupiter metallic region, it appears an infinitesimal small electric interaction as an electric coupling effect between Jupiter metallic region and other planets electrically conducting regions.

The electric coupling effect of planets electrically conducting regions however, is infinitesimal small but in the planetary scales we may see for Jupiter very big metallic Hydrogen region, a small measurable effect reasoning to vary the atomic potential energy of other planets metallic regions and too an electric force between metallic regions to appear braking effect and too shearing forces between metallic region and surrounding shell (e.g. mantle in the Earth).

Such a similar mechanism has been revealed newly for super conductors and we may refer to the famous experiments by Eugene Podkletnov (*Podkletnov and Nieminen, 1992; Podkletnov and Vuorinen, 1996; Podkletnov, 1997*), known for his claims made in the 1990 of designing devices consisting of rotating discs constructed from ceramic superconducting materials. Podkletnov used a superconducting ceramic disc by rotating it above powerful electromagnets and he noticed something extremely strange. Small objects above the disc seemed to lose weight.

By the way, strongly the metallic bodies on the influence of the magnetic field variation will generate an electric interaction, however not easy to detect in small scales but we may observe a very small size of electric interaction between the large scale metallic bodies, for example the cores of the planets and it has been false idea to consider just the pure gravity

between planets and we may accept ultimately that there is a partial electric interaction while the planets are upon the Sun's magnetic field oscillation.

Then Sun's magnetic field oscillation through the Jupiter will generate shearing forces at the CMB as a turbulent flows generated by frictional forces between solid mantle and molten core, and mechanism of this frictional core flows is the same initially proposed by *Bullard (1948)* and the change of atomic level potential energy is creating too, convectional heat flows.

The primordial heat generation of the planets may be too relevant to the change of the atomic level potential energy in the metallic cores and this change of the potential energy possibly may reason to generate heat flows in the core and their relevant convectional flows and then all geomagnetic jerks may not be relevant to the shearing forces but directly may be relevant to convectional flows.

The interaction of the planets cores is visible in the phenomena and here, we will see that LOD variations and geomagnetic jerk reports and relevant gravity anomalies are verifying external driven quasidynamo included systematically to the metallic cores electric coupling effect and this is a proposed mechanism here as a theory on the base of the phenomenological reports and physical sciences. But scientists may refer to their theories however experimental reports show that the Jupiter metallic region has an influence on the Earth's core as a coupling effect and Jovian planets alignments with Jupiter are verifying such a process and this is verified by analysis of the data here.

2.3. Jovian planets alignments as the amplifier effect

It was understood above that the Jupiter metallic region is active to interact on the terrestrial planets metallic cores, of course since it be upon the Sun's magnetic field oscillation. But at the alignment dates which the Jupiter is aligned with other Jovian planets or the Sun is in the middle of Jovian alignment, the empirical results are showing that the Sun and Jovian planets alignments with Jupiter are reason to enhance the electric activity of the Jupiter to interact upon the terrestrial planets metallic cores. The mechanism of this amplification phenomenon is not exactly clear yet but as we will show it in the next sections, the reported data of geomagnetic jerks

are verifying completely it and we will see that analysis of the scientific reported data shows exactly that the alignment effect is not a direct magnetic effect suppose it works as an amplification for electric coupling effect and the size of the planetary magnetic fields is tiny to generate such a direct effect.

At the alignments, the Jupiter metallic region has the more tendency to interact with terrestrial planets metallic cores means that the alignment of active conductive cores cause the electric coupling effect between metallic cores to be amplified as an electric resonance and such a phenomenon requires to be followed by scientists in detail whereas here on the base of the jerks data and LOD variations, it is visible that the alignment effect amplifies the electric coupling effect between metallic cores of planets means that the Sun's magnetic field oscillation upon the electrically conducting regions of planets activates the planets electric interaction and Jovian planets alignments enhances it.

It was noted above that there exist a schematic similarity between the ionosphere induced currents by external magnetic field variations and interplanetary externally driven quasidynamo and then it is probable to observe the enhancement effect of geomagnetic variations in the ionosphere too. In a theoretical discussion of the solar atmosphere, *Cowling (1932)* considered the consequences, for the electron conductivity, of the inhibition of the Hall current by polarization of the medium; he found this conductivity thereby increased from the Pedersen value to that which obtained in the absence of a magnetic field. *Martyn (1948)* suggested that this effect might be responsible for the high conductivity necessary in the ionosphere to meet the requirements of the dynamo theory.

As noted *Egedal (1947)*, the daily magnetic variations are considerably enhanced in a narrow zone near the magnetic equators. *Martyn (1949)* examined the data accumulating regarding this equatorial enhancement, with a view to testing the applicability of the enhanced conductivity to this region. He found evidence consistent with the existence of a narrow belt of high conductivity encircling the Earth in a region lying near the equators and for Hall current polarization on ionosphere at all latitudes we may refer to *Baker and Martyn (1953)*.

Then it is very probable that Jovian planetary alignments which cause to enhance the Jovian driven quasidynamo, to be dependent to the induced

current polarization at Jupiter by Jovian planets alignments with Jupiter and such a mechanism may be discussed by scientists in detail for that here, inverse engineering of phenomena shows existence of enhancing effect by Jovian planets alignments.

3. Results

3.1. Solar magnetic field oscillation and planetary core flows

Schematically referring to the paper *Ferris and Price (1965)*, the idea that the ionosphere shields the Earth from magnetic field fluctuation outside it is not entirely valid and then, for induced current driven by variation of the external magnetic field and the reality that the magnitude of the current in a given loop is proportional to the strength of the magnetic field, it is resulted that the magnetic jerks O_M in each planet M, it corresponds to the first time derivative of the external magnetic fields B_{iM} through the planet which $i$is *i-th* magnetic field and M is *M-th* planet which the magnetic field passes through in so that:

$$O_M = k_M \left|\partial B_{iM}/\partial t\right|. \tag{1}$$

The influence of the external magnetic fields to the conductive core of the planets is not equal for different planets suppose coefficient k_M seems to be small for terrestrial planets, probably for those with solid mantle and thus we should wait for record of the geomagnetic jerks in the Jovian planets highly, directly by the Sun's magnetic field variation through them however this realization is very hard and in this time some scientists are analyzing large scale variations in Jupiter (*Ridley and Holme, 2016*). For the Earth by consideration of the Sun's inverse cube force of magnetic field and Earth's equation of its elliptical orbit we deduce the Sun's effect on the Earth's core by Eq. (1) that:

$$O_3 = K_{30}\, r_{30}^{-4} \times \left|\sin\left(\frac{2\pi}{T_3}t + \theta_3\right)\right|. \tag{2}$$

So that K_{30} is a coefficient for penetration of the Sun's magnetic field into the Earth's core and r_{30} is Sun-Earth distance and T_3 is the Earth orbital period and t is date and θ_3 is time phase relevant to the considered

date however θ_3 is almost near to zero for Earth because that year beginning is at the date that the Earth is almost at the major axis however θ is not zero for other planets clearly.

By equation (2) we expect relevant geomagnetic jerk and LOD variations and this equation is showing semi-annual signal for geomagnetic jerk and LOD variation in the planets relevant to oscillation of the θ's magnetic field through the planets, of course actually included to those relevant retardations. By Eq. (2) we should expect minimum amplitudes for signals when the Earth is on the major axis because, the sinus function at Eq. (2) is zero at major axis and for points of the orbit that first time derivative of the Sun's magnetic field through the Earth is maximum we should expect peaks for geomagnetic jerk and LOD variation diagrams and, for orbits near to circle, these maximum values of the magnetic field time derivative should lie on the minor axis.

This semi-annual oscillation is just match with first time derivative of the Sun's magnetic field through the planets because that the Sun's features similar to the solar wind and heat and radiation are not oscillating at the planets position in such a oscillation phase which peaks be happened just at the major axis and minor axis of the orbits and then if the measurements at the Earth are verifying semi-annual signals which the peaks be happened at the major and minor axes then such an experimental results will verify completely the reality that the Sun's magnetic field oscillation at the planets does generate relevant semi-annual signals.

Now question is that is visible such a sinusoidal semi-annual signals at the LOD variation and geomagnetic jerk and gravity anomalies?

For such a semi-annual signals we may refer to many papers for example *Le Mouël et al. (2010)* or in the paper *Höpfner (1998)* we observe clear semi-annual oscillations of the LOD, relevant to reality that the core flows are dependent on the Sun as a complete phenomenological evidence for externally driven quasidynamo and we observe in the Fig. 2, complete agreement of LOD variation semi-annual signals with Sun's magnetic field sinusoidal oscillation at the Earth position as a wonderful inevitable paradigm.

As it is visible the sinusoidal functions are completely in agreement and such a symmetry is impossible to be occurred accidentally and similar semi-annual variations should be appeared in the other planets too, of course planetary semi-annual sinusoids in that planets.

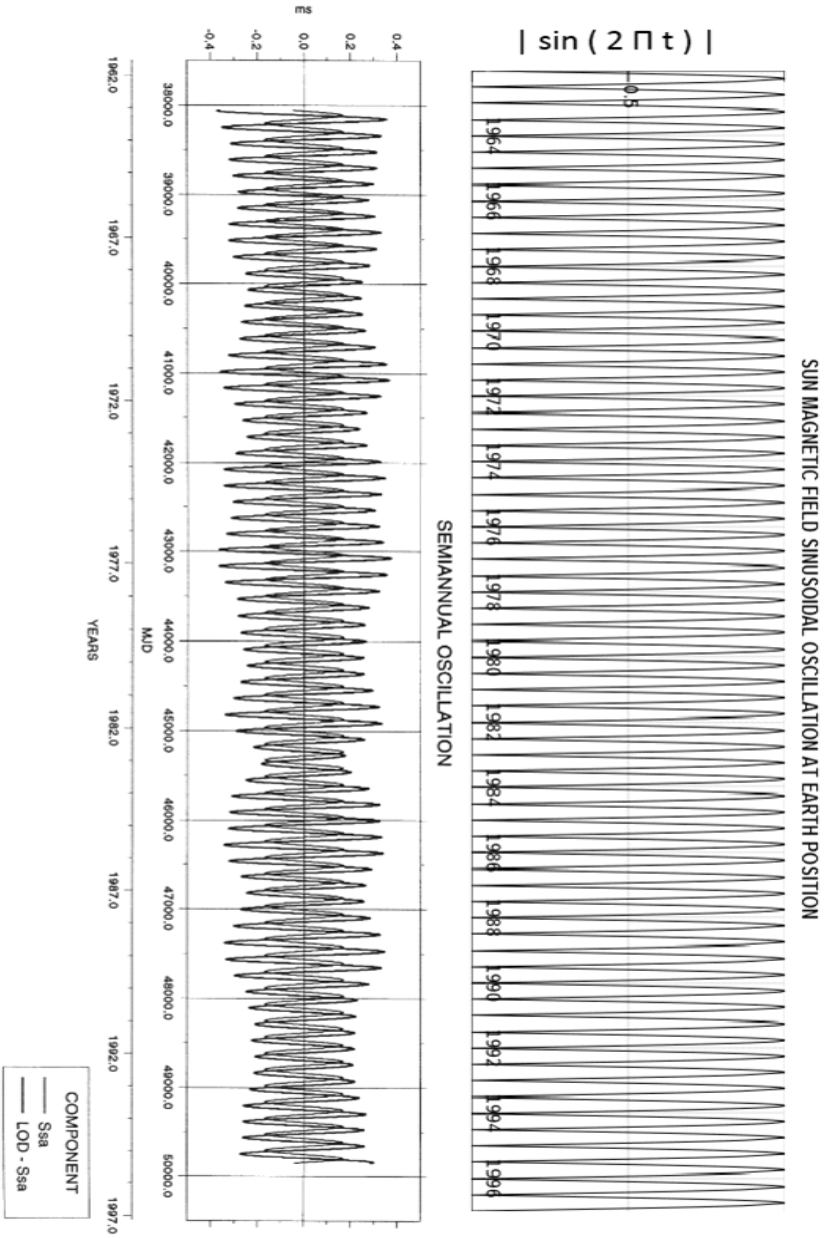

Fig. 2. The comparison of semi-annual LOD signals (*Höpfner, 1998*) versus the Sun's magnetic field oscillation through the Earth's orbit.

3.2. The 5.9-years geophysical signals

Jupiter metallic region is able not only to induct flows to the core of the terrestrial planets suppose even, the induction is being amplified and expanded by planets magnetic field and for Earth we have below equation so that u_{53} is showing Jupiter penetration coefficient as the fifth planet on the Earth as the third planet in the solar system and i is *i-th* external magnetic field indices so that:

$$O_3 = \sum_{i=0}^{N} u_{53} \left| \partial B_{i5} / \partial t \right| . \tag{3}$$

Of course the Sun's magnetic field B_{05} through the Jupiter is much greater than that of the other external magnetic fields at the Jupiter position and then this equation is transferred to a simpler equation that:

$$O_3 = u_{53} \left| \partial B_{05} / \partial t \right| . \tag{4}$$

Then geomagnetic jerks in terrestrial planets are mainly relevant to the first time derivative of the external magnetic fields through the Jupiter with partial effect dependent to the Jupiter distance from the Earth so that by inverse cube force of magnetic field and the equation of Jupiter elliptical orbit we deduce for Sun's effect on Jupiter and Jupiter secondary interaction effect on Earth that:

$$O_3 = K_{50} r_{50}^{-4} \times \left| \sin\left(\frac{2\pi}{T_5} t - 0.9 \right) \right| . \tag{5}$$

And K is additional coefficient different for each planet and r_{50} is distance of the Sun from the Jupiter and geomagnetic jerk O_3 is relevant just to the value of the external magnetic fields allowing us to compare the Sun and planets in their effect to the Jupiter and -0.9 is phase of the Jupiter in its orbit around the Sun relevant to the considered date. The Eq. (5) has period as half of the Jupiter orbital period means $T_5/2 = 5.93\, yr$ for that, the magnetic field changing through the Jupiter is relevant to radial distance varying.

Observations confirm tightly both the period and phase of the signals with partially Jovian driven quasidynamo and such a complete agreement never could be appeared randomly and for geomagnetic jerk confirmation

with Eq. (5), we may refer to paper *Silva et al. (2012)* and as noted by (*Brown et al., 2013*), the jerk amplitudes suggest possible periodic trends which may related to the 6-year periods detected independently in the geomagnetic secular variation and length-of-day. Length of day and secular variation of the magnetic field are dependent on the core flows (*Holme and de Viron, 2005*) as noted in this paper for a time-series that:
"By subtracting computed atmospheric angular momentum from a time-series for length-of-day variations, we obtain a high-resolution time-series that is useful for studying the effects of core on length-of-day variations. Features in time-series are closely correlated with time at which geomagnetic jerks have been observed, suggesting a role for core in angular momentum exchange within Earth system on timescales as short as one year, and that jerks are directly related to processes responsible for changes in core angular momentum."

At Fig. 3 we observe correlation between sinusoid of LOD variations and Jupiter driven geomagnetic sinusoid at Eq. (5) so that the left side diagram contributes to the analysis at *Duan (2015)* and we may refer to other databases too.

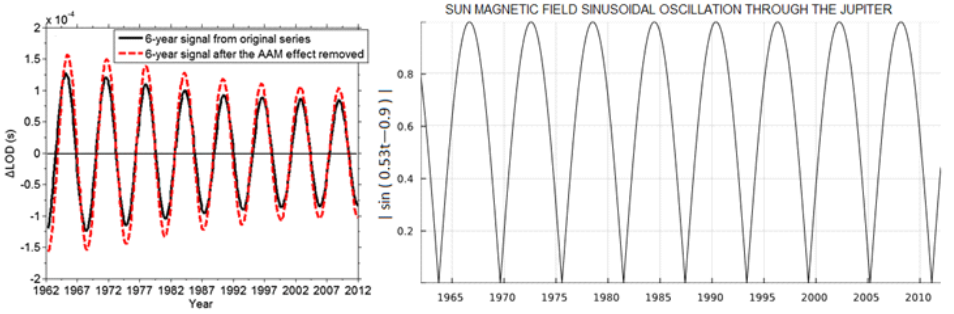

Fig. 3. Comparison of the LOD variations signals and the Sun's magnetic field sinusoid through the Jupiter.

For gravity changes, referring to *Schlamminger et al. (2015)* as noted by *Anderson et al. (2015)*, fit shows the period is almost 5.91 years and agreement of oscillation of the Sun's magnetic field through the Jupiter and gravity oscillation is visible at Fig. 4.

Coefficient u_{53} in Eq. (3) corresponds to Jupiter-Earth distance because that the electric coupling effect of the cores is relevant partially to the

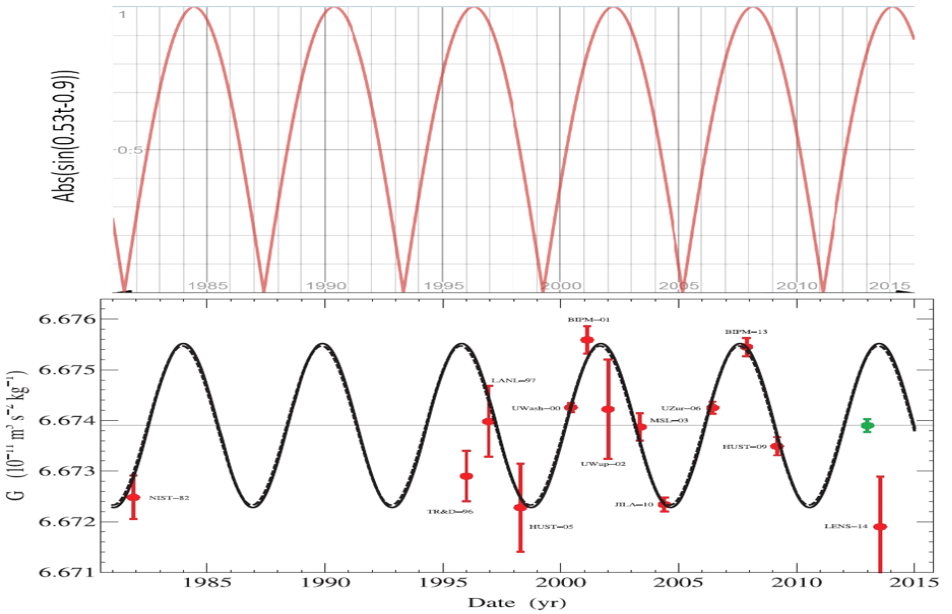

Fig. 4. A set of 13 measurements of G exhibit a 5.9-year periodic oscillation (solid curve) (Credit: *Anderson et al. (2015)* EPLA) that closely matches the 5.9-year oscillation in the Sun's magnetic field through the Jupiter.

Jupiter-Earth distance. but we should notice that the sinusoid of geomagnetic jerk is not dependent on the parameter u_{53} for that, peaks are relevant to the first time derivative of the Sun's magnetic field through the Jupiter. Coefficient u_{53} is almost constant for small changes of distance like the Jupiter-Earth distance as a factor between 1–1.5 however probably detectable in very accurate analysis and it was detected a near period 1.023 yr in revised G measurement (*Schlamminger et al., 2015*) as noted in *Anderson et al. (2015)*.

3.3 Jovian planets alignments as the source of abrupt geomagnetic jerks

Then the Jovian planets alignments with Jupiter is reason to amplify the electromagnetic activity of the Jupiter which is the source of 5.93 years periodic signal. This amplification is a source to generate abrupt geomag-

netic jerks visible at the Earth surface. It means that the Jovian planets alignments with Jupiter are reason to enhance the Jupiter metallic region electromagnetic activity to influence on the Earth's core so that Jovian driven geomagnetic jerk is enhanced by an alignment amplifier factor λ as:

$$O_3^* = \lambda O_3 \,. \tag{6}$$

So that $O_3$is geomagnetic jerk at Eq. (4) and O^* is relevant total geomagnetic jerk amplified by jovian planets alignments.

We show here in the tables, the correlation of the alignments with observed geomagnetic jerks O^*. The line arc is the angle between Jupiter's major axis and Sun-Jupiter line and the geomagnetic jerks are proportional with sinusoid of line arc of the Jupiter according to the Eq. (5) and correlation of Jovian planets alignments with amplification of the geomagnetic jerks is an inevitable confirmation.

The geomagnetic jerks are not simultaneous because spatial distribution of the core flows occur with retardation and usually the event begins from northern hemisphere and ends to the south (*De Michelis et al., 2005*). This may concern to the migration of the flows, and the alignment date should be almost the beginning time of occurrence. This is an evidence that the core flows are expanding by Earth's magnetic field after generation at alignment epoch. The research of all alignments between 1890 to 2020 is presented in the next Tables 1–9.

In these tables for alignments dates we have referred to NASA's solar system simulator (NASA'S EYES: Jet Propulsion Laboratory). Line arc is angle between Jupiter's major axis and Sun-Jupiter line in that orbit around the Sun and L as the length of the alignment defined as the distance between left and right planets in the alignment and reports are data for occurrences of the geomagnetic jerks referring to the published papers and each mentioned amplitude for an especial geomagnetic jerk in the tables it is relevant to the detected amplitude referenced in the relevant report in that table.

Saturn-Jupiter-Uranus is very strong alignment so that it is visible the reports in the fewer line arcs too and we observe agreement between the alignments line arcs and amplitudes of the reported geomagnetic jerks as a verification for Eqs. (5, 6).

For Jupiter-Saturn-Uranus in comparison with Saturn-Jupiter-Uranus we

Table 1. Saturn-Jupiter-Uranus

Line date	Reported jerks epoch	Line arc	L (AU)	Reports
1915.08.30	for event 1915	∼ 25	∼ 29	*Brown et al., 2013; Qamili et al., 2013*
1922.08.02	Less marked event	∼ 8	∼ 28	–
1925.02.04	for event 1925	∼ 77	∼ 27	*Alexandrescu et al., 1996*
1958.03.16–1959.08.12	Tangential event 1958	∼ 9 – 45	∼ 28	*Golovkov et al., 1989*
1968.07.09	Related to 1969 event	∼ 37	∼ 29	*Le Mouël et al., 1982; Malin et al., 1983*
2010.07.10	For event 2011	∼ 25	∼ 30	*Chulliat and Maus, 2014*

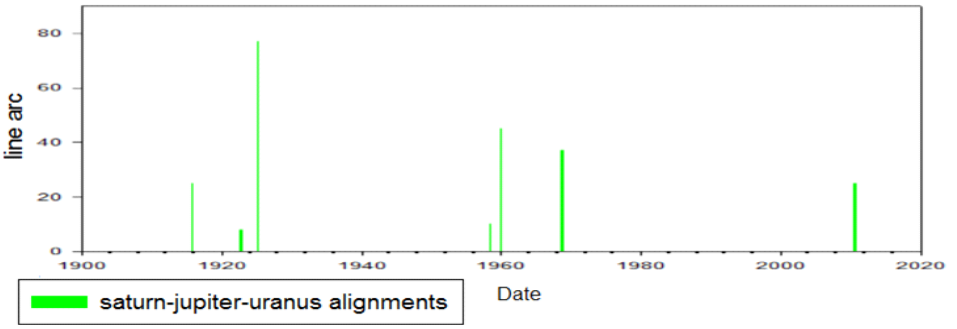

Fig. 5. The Saturn-Jupiter-Uranus alignments and relevant line arcs.

see that when Jupiter is between the Jovian planets, the generated effect is almost two times stronger and it is wonder that recorded jerk at 1896 is exactly for lining up at 1895.08.11.

Again we see that the alignments of Saturn-Jupiter-Neptune with much less line arcs, have no any jerk reports and generally all relevant geomagnetic jerks are less marked as a relation between alignment arm length and amplitude of the geomagnetic jerk.

Jupiter-Saturn-Neptune average arm length is almost equal to Saturn-Jupiter-Neptune arm length but Jupiter is not in the middle and then the amplitude is almost half and there is no any reported geomagnetic jerks relevant to these alignments else a less marked event for 1989.11.11 if it be possible to discriminate between other geomagnetic jerks occurred almost simultaneously.

It is visible that the relevant geomagnetic jerks are less marked and this is completely in agreement with size of the alignments arm length and value

Table 2. Jupiter-Saturn-Uranus

Line date	Reported jerks epoch	Line arc	L (AU)	Reports
1895.08.11	Observed at 1896–1898	∼ 86	∼ 24.5	*Balasis et al., 2016*
1944.05.15	From 1945, a strong field spreads until 1949	∼ 51	∼ 19.5	*Duka et al., 2012*
1989.02.04	for a group of events centred at 1990.1	∼ 49	∼ 24.5	*Cafarella and Meloni, 1995; Macmillian, 1996; De Michelis et al., 2005*

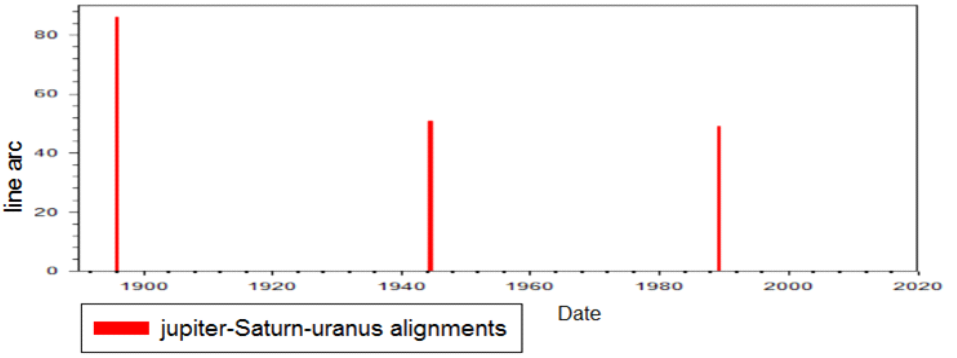

Fig. 6. The Jupiter-Saturn-Uranus alignments and relevant line arcs.

of the line arcs in the Uranus-Jupiter-Neptune alignment.

Jupiter-Uranus-Neptune alignment is once happened in considered interval and in this alignment, the Jupiter is not in the middle but alignment length is lesser than that of Uranus-Jupiter-Neptune and then probably less marked report at 1992 is caused by this alignment.

At the date 1998.06.20, the Jupiter has no any alignment but Saturn is almost in MOID (Minimum Orbit Intersection Distance) with Jupiter and Saturn plays the role of Jupiter here so that we have an alignment Neptune-Uranus-Saturn to activate highly the Saturn, and Saturn influence on the Jupiter is in the same manner that Jupiter is influencing Earth and thus, consequently the Jupiter is influencing on the Earth by Saturn alignment effect and Saturn should be in its active zone of influence and solar system simulators are verifying this and the report of geomagnetic jerk at epoch 1999 (*Brown et al., 2013; Mandea et al., 2000*) is revealing this. Such an event is being occurred at the date 1936.06.15 for alignment Saturn-

Table 3. Saturn-Jupiter-Neptune.

Line date	Description	Line arc	L (AU)	Report
1896.01.05	Less marked event	∼ 73	∼ 39	*Balasis et al., 2016*
1902.10.26	Less marked event 1902–1903 1902–1903	∼ 58	∼ 39	*Alexandrescu et al., 1996; Duka et al., 2012*
1904.05.01	–	∼ 6	∼ 39	–
1933.11.30	–	∼ 10	∼ 39	–
1971.07.10	For event 1972.1	∼ 47	∼ 40	*Chambodut et al., 2007; Duka et al., 2012*
2008.11.11	for 2009 (–18.6 nT/yr^2)	∼ 80	∼ 40	*Chulliat and Maus, 2014; Kotzé and Korte, 2016*

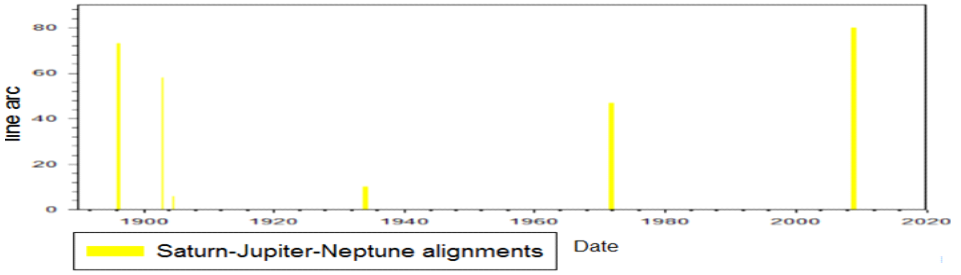

Fig. 7. The Saturn-Jupiter-Neptune alignments and relevant line arcs.

Table 4. Jupiter-Saturn-Neptune.

Line date	Reported jerks epoch	Line angle	L (AU)	Report
1915.12.18	–	∼ 15	∼ 34	–
1952.08.06	–	∼ 19	∼ 35	–
1989.11.11	For event centred at 1990.1	∼ 74	∼ 35	*Cafarella and Meloni, 1995; De Michelis et al., 2000)*

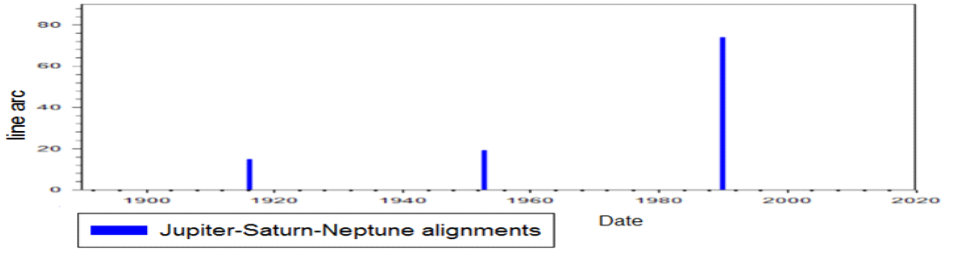

Fig. 8. The Jupiter-Saturn-Neptune alignments and relevant line arcs.

Table 5. Uranus-Jupiter-Neptune

Line date	Reported jerks epoch	Line arc	L (AU)	Jerk reports
1896.06.17	CLF and NGK Y-component	~ 61	~ 49	*Balasis et al., 2016*
1899.04.10	Much less marked event	~ 45	~ 49	–
1907.05.04	Less marked event observed 1908 observed 1908	~ 87	~ 50	*Qamili et al., 2013; Balasis et al., 2016*
1915.03.14	Less marked event at 1915	~ 43	~ 49	*Balasis et al., 2016*
1918.06.08	Less marked observed event 1919	~ 66	~ 49	*Alexandrescu et al., 1996*

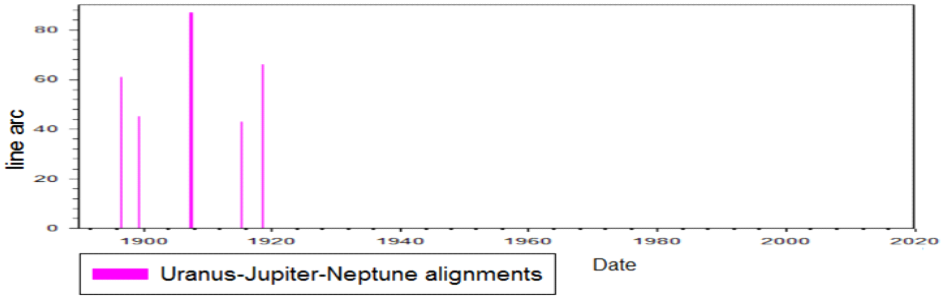

Fig. 9. The Uranus-Jupiter-Neptune alignments and relevant line arcs.

Table 6. Jupiter-Uranus-Neptune

Line date	Description	Line arc	L (AU)	Jerk reports
1991.09.05	Report around 1992	~ 52	~ 34	*Le Huy et al., 1998; Brown et al., 2013*

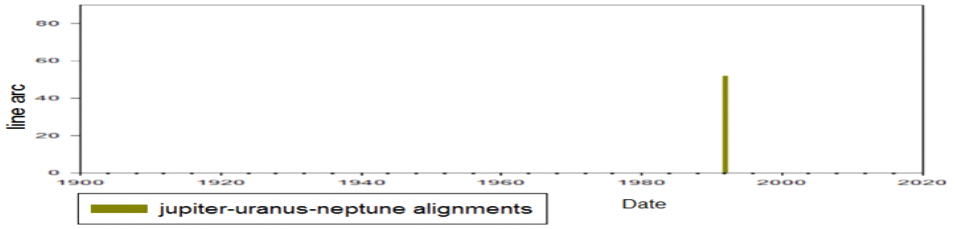

Fig. 10. The Jupiter-Uranus-Neptune alignments and relevant line arcs.

Sun-Neptune which the Saturn is almost in minimum distance with Jupiter and it is observable a less marked geomagnetic jerk for that at epoch 1937 (*Golovkov et al., 1989*).

Table 7. Jupiter-Sun-Saturn

Line date	Reported jerks epoch	Line arc (deg)	Jerk reports
1892.01.16	observed event at 1983	∼ 22	*Nevanlinna, 2004; Balasis et al., 2016*
1911.05.14	observed event at 1912–1913	∼ 25	*Alexandrescu et al., 1996; Ducruix et al., 1983*
1930.12.23	observed event at 1932	∼ 87	*Alexandrescu et al., 1996*
1951.08.04	observed event at 1952	∼ 14	*Duka et al., 2012*
1971.01.12	observed event at 1972	∼ 36	*Chambodut and Mandea, 2005; Qamili et al., 2013*
1990.07.22	observed event at 1991	∼ 84	*De Michelis et al., 2005*
2011.02.18	–	∼ 2	–

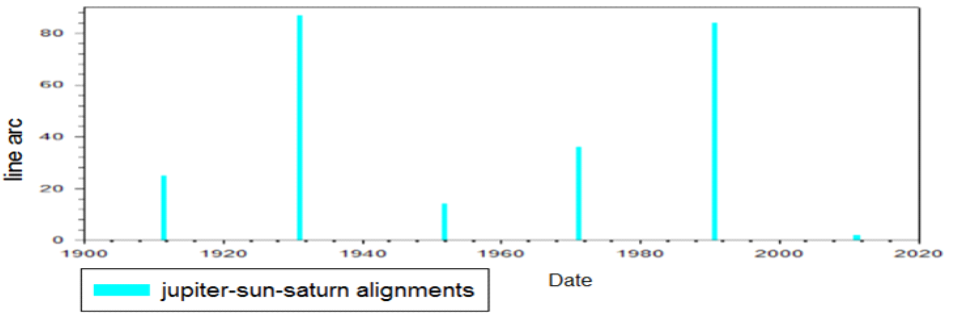

Fig. 11. The Jupiter-Sun-Saturn alignments and relevant line arcs.

By the way, the Jovian alignments generate geomagnetic jerks proportional with sinus of the line arcs and some very strong alignments are possible to occur in much less line arcs and null results are in weak influence zone of the Jupiter and this phenomenology is verifying that Jupiter alignments with Jovian planets enhance the Jupiter activity on the Earth's core and Jupiter-Sun-Jove alignments are affecting on the Jupiter activity and while the Sun is not in the middle of alignment we have no noticeable effect whereas that while the Sun is in the middle of the alignment, the effect is strong and for Jupiter-Sun-Jove alignments we refer to the below tables and those relevant figures.

It is manifest that null result is relevant to the much less line arc and all alignments are relevant to the reported geomagnetic jerks and we see that jerks of 1913 and 1991 and 1932, are iteration of a unit event.

Table 8. Jupiter-Sun-Uranus

Date	Reported jerks epoch	Line arc	Jerk reports
1893.05.10	observed event at epoch 1894	∼ 21	*Nevanlinna, 2004; Balasis et al., 2016*
1907.02.15	observed event at epoch 1908	∼ 85	*Qamili et al., 2013; Balasis et al., 2016*
1920.10.20	observed event at epoch 1921	∼ 43	*Duka et al., 2012; Pinheiro and Travassos, 2010*
1934.08.24	–	∼ 12	–
1948.07.11	Jerk observed in pacific area and American regions at epoch 1949	∼ 71	*Alexandrescu et al., 1996*
1962.06.04	this event is similar to 1920.11.02 event and observed at epoch 1963	∼ 48	*Duka et al., 2012; Qamili et al., 2013*
1976.03.30	observed event in the field 1978	∼ 17	*Alexandrescu et al., 1996*
1989.12.10	observed event at epoch 1990	∼ 76	*De Michelis et al., 2005; Balasis et al., 2016*
2003.09.06	Much less marked jerk	∼ 49	–
2017.07.07	–	∼ 12	–

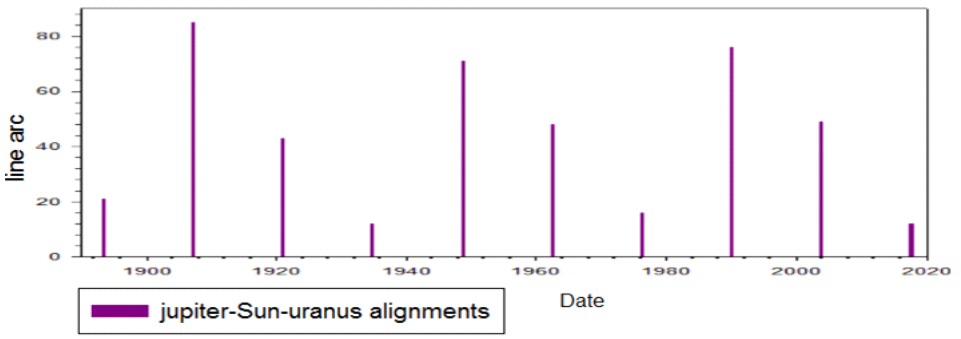

Fig. 12. The Jupiter-Sun-Uranus alignments and relevant line arcs.

Reports amplitudes fit with inverse square of the arm length and this is possible to observe for other Jovian planets alignments with Jupiter too as a verification for such a correlation between arm length of the alignments and geomagnetic jerks amplitudes.

The average arm length of the Jupiter-Sun-Neptune alignment is 1.4 times longer than that of Jupiter-Sun-Uranus and then, relevant alignments to the Jupiter-Sun-Neptune should be almost 2 times weaker and then, all

Table 9. Jupiter-Sun-Neptune.

Line date	Reported jerks epoch	Line arc	Jerk reports
1901.02.27	Saturn-Jupiter-Sun-Neptune Event at epoch 1901–1902	∼ 71	*Alexandrescu et al., 1996*
1913.12.18	Less marked event reported 1913–1914	∼ 80	*Balasis et al., 2016; Alexandrescu et al., 1996*
1926.09.15	–	∼ 52	–
1939.05.12	–	∼ 26	–
1952.02.01	–	∼ 0	–
1964.10.13	Revealed by Moscow observatory	∼ 30	–
1977.06.18	Observable in the field 1978	∼ 57	*Alexandrescu et al., 1996*
1990.04.19	Much less marked event between next events	∼ 85	–
2002.12.15	Less marked event observed at epoch 2003 detected by a new high resolution technique	∼ 65	*Olsen and Mandea, 2007; Balasis et al., 2016; Silva and Hulot, 2012*
2015.11.03	–	∼ 39	–

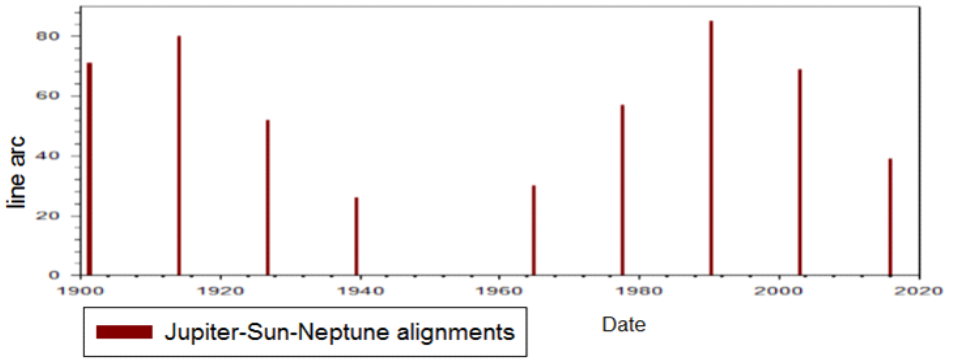

Fig. 13. The Jupiter-Sun-Neptune alignments and relevant line arcs.

alignments of Jupiter-Sun-Neptune should be less marked events and this is agreement else at 1901 that the alignment is enhanced by Saturn near lining with Jupiter-Sun-Neptune.

Ultimately we observe that all reported geomagnetic jerks occur at the alignment dates and too, inversely while we have a Jovian alignment, it exist a relevant geomagnetic jerk in reports as a very strong confirmation for one by one correlation between geomagnetic jerks and Jovian alignments. Solar system simulators are verifying exactly all the correlations between reports

and alignments, but for shortening the paper we show at Fig. 14, some of the famous geomagnetic jerks relevant to their Jovian planets alignments.

Of course when the Sun is not in the middle of the Jovian planets alignments it is visible that the amplitude of the effect is weak as the same manner for Jupiter when Jupiter is not in the middle. But for alignments of Sun-Jupiter-Saturn it seems to exist some relevant Much less marked events in reports for example for epochs 1901, 1981, 2000 (*Balasis et al., 2016*) and 1921, 1941 (*Duka, 2012; Pinheiro and Travassos, 2010*) and 1961 because of the reality that arm length of Sun-Jupiter-Saturn is short proportionally and Sun-Jupiter-Saturn effect might be relevant to the Saturn which the Sun's magnetic field is rapidly varying at alignment time through the Saturn and this is in agreement with quick succession of geomagnetic jerks at these epochs.

We observe that there are several consequanet noticeable events as Jupiter-Saturn-Uranus at epoch 1989.02.04, Jupiter-Sun-Uranus at epoch 1989.

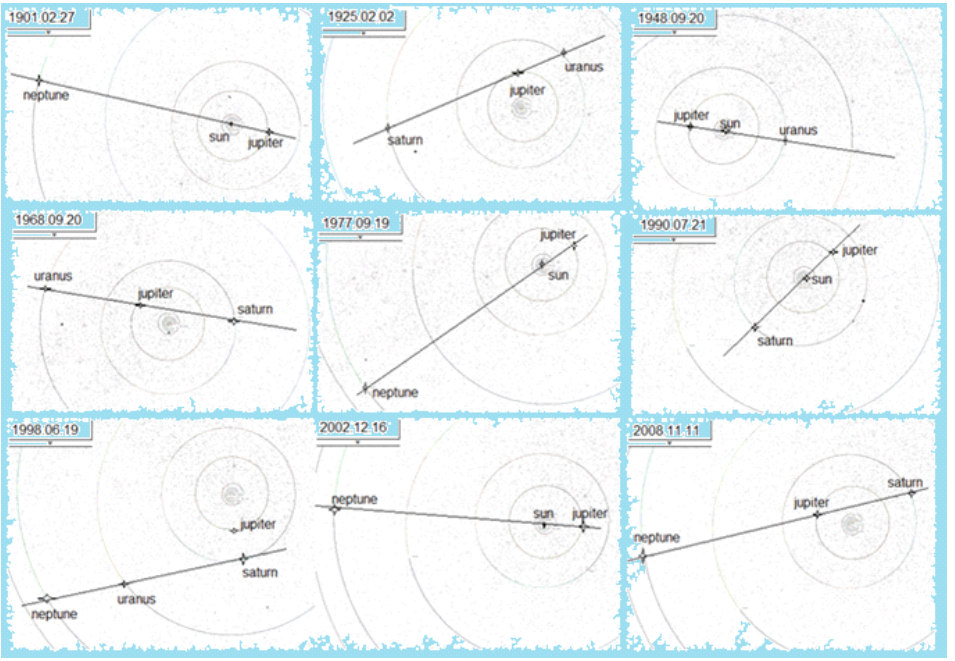

Fig. 14. Several alignments concern to relevant geomagnetic jerk dates.

12.10, Jupiter-Sun-Saturn at epoch 1990.07.22 and these alignments are very near in time, visible as a unified event centered at 1990.1 (*De Michelis et al., 1998; 2000*) and as noted at *Chambodut and Mandea (2005)* that: *"For the so-called 1969 event a first group of dates is centered on 1969.5 ±0.5 and another one 1972.1 ±0.5; their merging date being around 1971."*

Whereas, here we observe that the reported jerk about 1972 is different from reported jerk at 1969. Suppose we have a clear event at 1972. We should notice that the Saturn and Uranus and Neptune metallic cores have almost equal sizes and then the amplitude of the geomagnetic jerks generated at Jovian alignment ideally should be proportional with inverse square of arm lengths and too according to the Eq. (5), the amplitude of the geomagnetic jerks in the alignments should be proportional with sinus of the line arcs and too we should consider a coefficient for realization between different alignments structurally and then, almost we have a simple formula for ideal geomagnetic jerks generated by Jovian planets alignments that:

$$O_3 \propto \frac{1}{L^2}\beta \sin(\alpha). \tag{7}$$

So that β is structure coefficient of the alignments and α is line arc and L is arm length.

We can't find an accurate formula for geomagnetic jerks for that the geomagnetic jerks are relevant to the planets interiors and probably declined by number of the core flows so that we observe greater amplitudes in quasi-local events and probably there is a conservation law of geomagnetic jerk's amplitudes in an event divided to several number of the events in a global event.

New exact analysis (*Kotzé and Korte, 2016*) shows for epoch 2009 we have a jerk with mean amplitude $18.6\,\mathrm{nT/yr^2}$ and we can consider Saturn-Jupiter-Neptune alignment occurred at epoch 2009 as a standard reference for other occurences and line arc in this alignment is 80 degree and arm length is 40 AU and by Eq. (7) for pure Jovian planets alignment we have:

$$O_3^*[J - Jup - J]/18.6 = \sin(\alpha)/\sin(80) \times 1600/L^2, \tag{8}$$

$$O_3^*[J - Jup - J] \approx 30000 \sin(\alpha)/L^2. \tag{9}$$

Now referring to the reported geomagnetic jerk at epoch 2003 with amplitude $25\,\mathrm{nT/yr^2}$ we can calculate structures' coefficient β. At epoch 2003 we

have Jupiter-Sun-Neptune with line arc 65 degree and arm length, 35 AU. But 2003 event is almost at middle of the solar maximum activity and then by consideration of calculations in the next section we find that the Sun's alignment effect while the Sun is in the middle, is 1.2 times stronger than Jovian planets alignments while Jupiter is middle and so, structure coefficient is deduced as:

$$\beta_{Jup-Sun-J} = 1.2\beta_{J-Jup-J} = 2.4\beta_{Jup-J-J}. \tag{10}$$

Then not only here we can show the correlation of geomagnetic jerks with Jovian planets alignments suppose we have an almost simple approximate formula for ideal amplitude of the geomagnetic jerks and by this formula we get amplitudes for jerks at Fig. 15. For existing alignments in the considered interval 1980–2020 which confirms again the agreement of the correlations included to the arm length inverse square and, correlation of the geomagnetic jerk's amplitudes to the sinus of the line arcs as the angle between the Jupiter's major axis and Jupiter-Sun line and ultimately, inevitable verification for essential relation of the Sun's magnetic field oscillation through the Jupiter and Earth's CMB core flows as the sources for the reported geomagnetic jerks in these decades. It is wonder that there is a complete one by one correlation between geomagnetic jerks and Jovian planets alignments means that for each observable Jovian alignment in the solar system we have a report for geomagnetic jerk at that time and inversely for each reported geomagnetic jerk in the data, we have a relevant Jovian alignment and this confirmation is arguing inevitable correlation of the Jovian planets alignments and geomagnetic jerks and at Fig. 15. It is visible correlation of equations with observations carefully.

We need to notice that however the Jovian planets alignments with Jupiter are to some extent strong that it is possible to measure their relevant geomagnetic jerks at the Earth. But it is possible to observe such a phenomenon about the Saturn instead Jupiter by improvement of the precise of the measurements and data analysis. For example, we may detect a much less marked event for Saturn-Uranus-Neptun, when the Saturn is at the active zone of its line arc and probably it is possible to detect a very weak periodic 14.5-years signals, half of the Saturn orbital period. However, detection of the Saturn dependent effect is easier at its alignment dates.

We see strong agreement between amplitudes of the observed geomag-

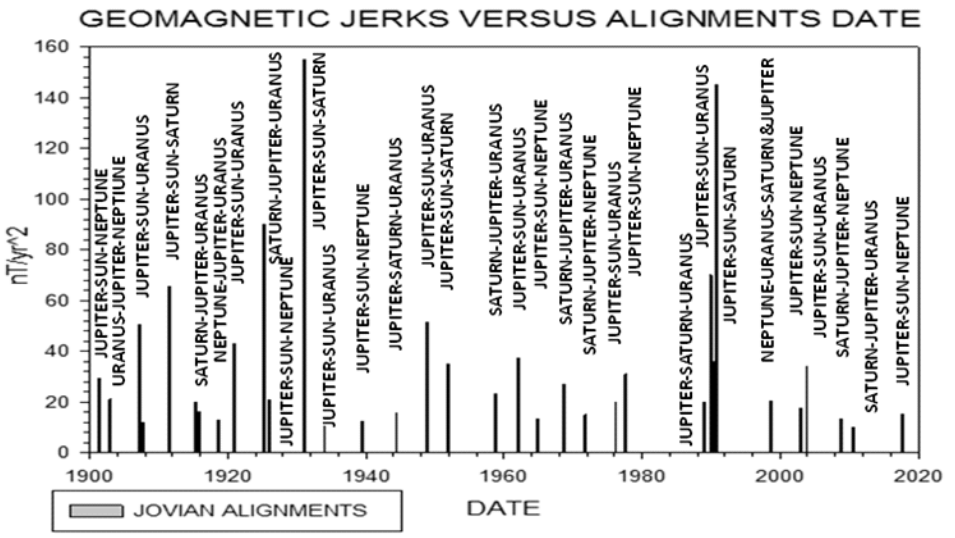

Fig. 15. Geomagnetic jerks reported dates correlated to the Jovian planets alignments.

netic jerks and ideal formula at Eq. (7) above and for alignment at 2017.07.07, the ideal formula shows $11\,\mathrm{nT/yr^2}$ and because that this is a much less marked event, the visibility of such an event is rare for distribution of geomagnetic jerk's power and because of entopic reasons.

3.4. Historical jerks reports and inevitable agreement with Jupiter alignments

We refer here to historical reports however unfortunately analysed dates have been approximate for that there is no magnetic three components time series of data and we have listed alignments accordance to NASA's solar system simulator versus the dates of geomagnetic jerk's reports (*Korte et al., 2009*) and everybody may refer to every accurate solar system simulator arbitrary.

In the Fig. 16, we see the Table 10 in a diagram to easy visibility of the correlations between the historical alignments and reported jerks date for amplitudes of these historical geomagnetic jerks we refr to the ideal formula at Eq. (7) above.

And for another data base of historical geomagnetic jerks, reported in the

Table 10. Geomagnetic jerks from 1410 to 1990 in comparison with alignments.

Line date	Alignments	Arm (AU)	Line arc	Report date
1409.10.07	JUP-SUN-URA	∼ 25	∼ 72	1410
1447.01.01	JUP-SAT-URA	∼ 17	∼ 60	1448
1506.07.02	JUP-SUN-URA	∼ 25	∼ 53	1508
1597.05.01	SAT-JUP-URA	∼ 27	∼ 40	1598
1603.02.10	JUP-SUN-URA	∼ 25	∼ 40	1603
1658.11.15	JUP-SUN-NEP	∼ 35	∼ 73	1661
1692.10.01	JUP-SUN-SAT	∼ 15	∼ 55	1693
1706.02.19	JUP-SAT-NEP	∼ 32	∼ 79	1708
1741.05.05	JUP-SUN-URA	∼ 25	∼ 90	1741
1764.07.01	JUP-SAT-URA	∼ 19	∼ 74	1763
1860.10.17	SAT-JUP-NEP	∼ 37	∼ 65	1861
1888.04.14	JUP-SUN-NEP	∼ 35	∼ 43	1889

Source: (*Korte et al., 2009*).

measurements (*Qamili et al., 2013; Matzka et al., 2010*), we see strong confirmations between dates of Jovian planets alignments and reported dates for geomagnetic jerk as visible at Table 11.

However, the measurements have not generated precise dates but again correlations are very strong between assumed parameters and we observe,

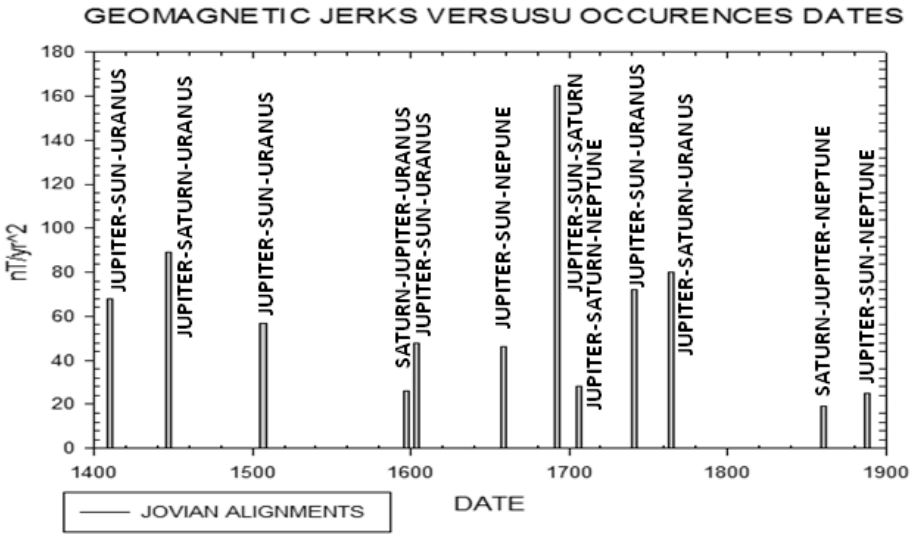

Fig. 16. The alignments in agreement with reported geomagnetic jerks.

Table 11. Geomagnetic jerks reported in the interval 1600–1900.

Line date	Alignments	Arm (AU)	Line arc	Report date
1603.12.10	JUP-SUN-URA	∼ 25	∼ 40	1603
1633.10.07	JUP-SUN-SAT	∼ 15	∼ 64	1635
1659.02.09	JUP-SUN-URA	∼ 25	∼ 65	1663
1672.09.01	JUP-SUN-SAT	∼ 15	∼ 21	1672
1700.01.05	JUP-SUN-URA	∼ 25	∼ 79	1703
1718.01.14	SAT-JUP-NEP	∼ 38	∼ 90	1719
1733.10.08	JUP-SUN-SAT	∼ 15	∼ 39	1733
1752.10.16	JUP-SUN-SAT	∼ 15	∼ 83	1751
1762.12.09	JUP-SAT-URA	∼ 15	∼ 24	1763
1769.06.05	JUP-SUN-URA	∼ 25	∼ 37	1770
1778.01.03	SAT-JUP-URA	∼ 28	∼ 70	1779
1788.09.27	SAT-JUP-URA	∼ 29	∼ 80	1789
1808.09.09	JUP-SAT-URA	∼ 20	∼ 33	1810
1824.09.01	JUP-SUN-URA	∼ 25	∼ 90	1826
1838.02.28	JUP-SUN-URA	∼ 25	∼ 35	1838
	UNKOWN			1844
1852.03.07	JUP-SUN-SAT	∼ 15	∼ 25	1853
1866 (1868)	JUP-SUN-URA (SAT-JUP-NEP)	∼ 25(38)	∼ 87(30)	1868–1870
1879.11.10	JUP-SUN-URA	∼ 25	∼ 40	1882
1888.05.13	JUP-SUN-NEP	∼ 35	∼ 43	1888

Source: (*Qamili et al., 2013; Matzka et al., 2010*).

the data as a diagram at Fig. 17 to see easier the correlations between events dates and Jovian planets alignments.

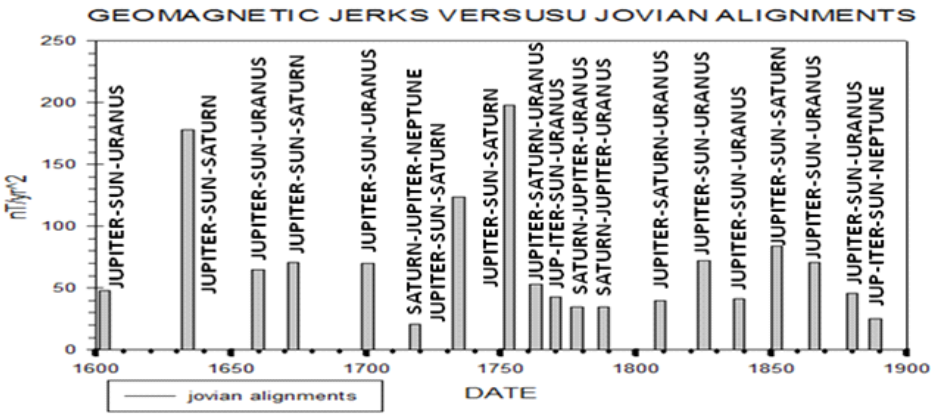

Fig. 17. The alignments in agreement with reported geomagnetic jerks.

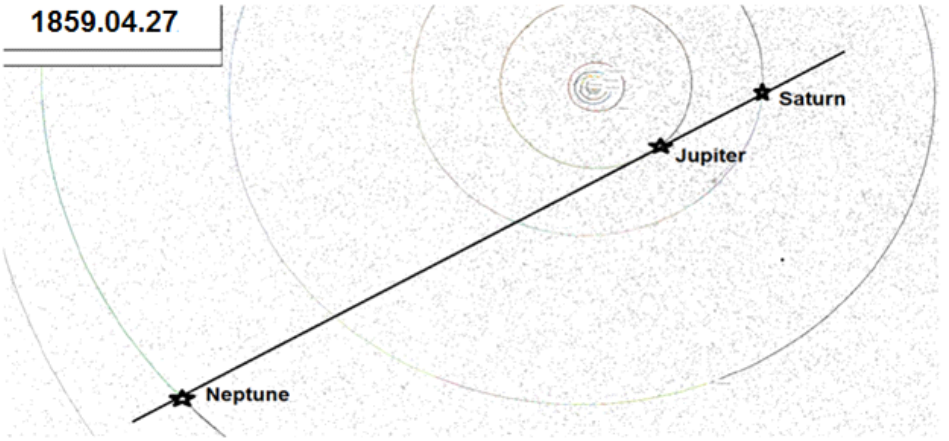

Fig. 18. The alignment completely in agreement with reported geomagnetic jerk at epoch 1860 (*Newitt and Dawson, 1984*).

The iteration of an alignment is iteration of the jerk as a strong confirmation and we see the similar events with event at epoch 1901.

It is wonder that all the alignments are a bit occurred before of reports dates as a verification for ever existing retardation and a verification for Jovian driven quasidynamo at the Earth because that Jovian driven quasidynamo is in agreement ever with the reality that the alignments should be prior to the reports date. For example, there is evidence of a jerk around 1860 (*Newitt and Dawson, 1984*) and when we refer to the solar system simulators we observe that we have an alignment Saturn-Jupiter-Neptune at 1859.04.27 with almost 37 AU arm length which is proportionally short and too, Jupiter is at the middle of the alignment as a feature of stronger effect.

3.5. Solar activity effect on the geomagnetic jerks and LOD variations

In addition to semi-annual signals generated by oscillation of the Sun's magnetic field at the Earth orbiting around the Sun, clearly we should wait for 11 years' periodic oscillation of the geomagnetic jerk and LOD, relevant to the solar cyclical activity which concerns to the absolute oscillation of the Sun's magnetic field as noted at *Vukcevic (2014)* that:

"Sunspots are associated with rise and fall of the soar toroidal magnetic field, and normally appear in pairs. Direction of the magnetic field vector $\boldsymbol{B}$ *in the northern hemisphere coincides with the direction of solar rotation (positive orientation,* $B > 0$*) during even-numbered cycles, it is opposite for the southern hemisphere. Relationship between direction of rotation and the magnetic field vector orientation is reversed during odd-numbered cycles (for the northern hemisphere* $B < 0$*)."*

Then solar cyclical activity will result two shapes of the 11-years periodic signals in the LOD and geomagnetic jerks as:

1. Direct effect by the Sun's magnetic field absolute oscillation through the Earth,
2. Jupiter driven external effect dependent on the absolute variation of the Sun's magnetic field through the Jupiter.

Both direct absolute effect and Jupiter driven absolute effect of the solar cyclical activity will clearly imply 11-years periodic signals on the LOD and geomagnetic jerks and probably on the gravity too.

This 11 years' periodic signals have been detected before in several analyzings (for example *Gu, 1990; Abarca del Rio et al., 2003; Wardinski and Holme, 2003; Alexandrescu et al., 1995*) and as noted at *Le Mouël et al. (2010)*:
"We study the evolution of the amplitude A of the semi-annual variation of the length-of-day (lod) from 1962 to 2009. We show that A is strongly modulated (up to 30%) by the 11-yr cycle monitored by the Sunspot number WN."

Dependency to the solar activity has been detected well in the LOD variation as mentioned by *Ma (2007)* that:
"In this present paper, wavelet technique is applied to analyse the time series of the Earth's length-of-day series during 1832–1997 and the Sunspot relative numbers during 1700–2006, with emphasis on investigating external excitation source of the Earth's variable rotation. The results show modulation action from solar activity plays an important role in decadal change of the Earth rotation, and this strengthens the conclusion that the Earth's rotation is modulated by the solar activity."

Or we may refer to work "Possible influence of the 11-year solar cycle on length-of-day change" (*Ma, 2015*).

Up to here in this paper, we have considered constant, the Sun's absolute magnetic field but solar activity indexes are showing that the solar magnetic field is changing by time cyclical as the famous 11 years' oscillation of the solar activity and then not only, the Jupiter orbiting causes, the change of the Sun's magnetic field through the Jupiter relatively suppose absolutely, the Sun's magnetic field is too changing through the Jupiter and through the other planets too. Then, the change of the Sun's magnetic field through the Jupiter is divided to the two realizable origins so that by generalization of the Eq. (1) we have:

$$O_3 = k_{53} \left| \left(\partial B_{05}/\partial t\right)_{orbital} + \left(\partial B_{05}/\partial t\right)_{absolute} \right| \tag{11}$$

In some dates for example at epochs 1948.07.11 and 1958 and 1968.07.09 we observe that the reported amplitudes of the geomagnetic jerks are stronger than that of calculated by ideal Eqs. (7, 10) for geomagnetic jerk. According to Eq. (11), the geomagnetic jerks relevant to these three dates are amplified by solar activity because that these events are in maximum solar activity occurred at solar active cycle period, referring to the NASA reports for solar activity as visible at Fig. 19. These three events have been compared together before by *Golovkov et al. (1989)* titled as "Common features and differences between jerks of 1949, 1958 and 1969".

Ultimately we see a total equation for external driven interplanetary signals at the Earth so that:

$$\begin{aligned} O_3 = {} & k_{53} \left| \left(\partial B_{05}/\partial t\right)_{orbit} + \left(\partial B_{05}/\partial t\right)_{absolute} \right| + \\ & + k_{03} \left| \left(\partial B_{03}/\partial t\right)_{orbit} + \left(\partial B_{03}/\partial t\right)_{absolute} \right| . \end{aligned} \tag{12}$$

This equation results four kinds of the signal at the Earth as:

1. Direct absolute effect of the Sun at the Earth interior resulting 11-years signal,
2. Direct orbital effect of the Sun at the Earth interior resulting semi-annual signal,
3. Indirect absolute effect of the Sun's magnetic field through the Jupiter resulting 11-years signal,
4. Indirect orbital effect of the Sun's magnetic field through the Jupiter resulting 5.9-years signal.

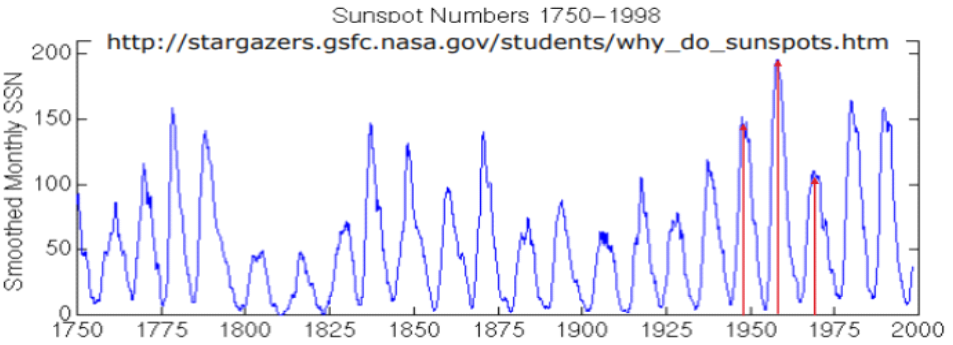

Fig. 19. Strengthening of geomagnetic jerks while those are in maximum activities of solar.

Such a mix of signals with different origins can generate apparent phase shift in tiny intervals and such a phase shift at the 11-years and 5.9-years signals is visible some times in the measurements. However, ultimately the signals return to the pure 11-years and pure 5.9-years signals and now by understanding of the real sources of the signals it is easier to discriminate signals at observed data.

The 5.9-years period of LOD signal has been detected accurately in experiments for example at *Duan (2015)* as quantitatively the 6-years signal, from $1962 \sim 2012$, using normal Morlet wavelet (NMWT) method combining wavelet packet and Fourier analysis technique, for the first time in both time and frequency domains. But in some experiments it is possible to appear phase shift in some time intervals as a deviation in the signals, however the signals trend return to full strength in the next cycles.

While solar activity peak is adequately large, the absolute variation of the Sun's magnetic field is prevailing factor and apparently may be reason to cancel 5.9-years signal as noted by *Duan (2015)* that:
"Gorshkov (2010) indicated that the $6 \sim 7$-year oscillation signals decreased abruptly in the 1990s and speculates it is due to the stronger signals in a $2 \sim 3$-year band cancelling out the $6 \sim 7$-year signals; while, Holme and de Viron (2013) further indicated that the "6-year oscillation" shows an apparent drop in amplitude in the 1990s (but this amplitude returns to full strength in the next cycle), and they interpreted it as the consequence."

And at epoch 1990, the solar activity is in its maximum and then the

solar activity is possible to cancel apparently the six-year signal. However, this phenomenon is possible too to be appeared by occurrence of the abrupt geomagnetic jerks related to Jovian planets alignments to cancel apparently 6-year signal from measurements and it is wonder that we observe Jupiter-Sun-Saturn lining up at epoch 1990.07.02 as the same 2–3 years stronger signal band covering smaller six years signal.

We have an increase in the additional activity of the Sun between 1830 and 1900 and in this interval we may discriminate easier the geomagnetic jerks dependent to the solar activity.

Nevanlinna (2004) shows secular variation of the Earth magnetic field in the interval 1830–1900 dependent to the solar activity oscillation and we see correlation between the solar activity and reported geomagnetic jerks in the considered interval in Fig. 20.

The alignment effect can't amplify direct absolute effect of the Sun's magnetic field oscillation through the Earth whereas that indirect absolute effect through the Jupiter can be amplified by Jovian alignment and then, such a difference is allowing us to discriminate between indirect absolute effect and direct absolute effect of the Sun's magnetic field which both have 11-years signals. On the other hand, observations verify that the indirect absolute and indirect orbital effect of the Sun's magnetic field are near together in size at the Earth measurements because that they are prevailing each other by small changes. For example, by equality of the indirect absolute and indirect orbital effects at epoch 1969, the reported geomagnetic jerk at epoch 1969 based on the Eq. (11) is almost 2 times stronger than our

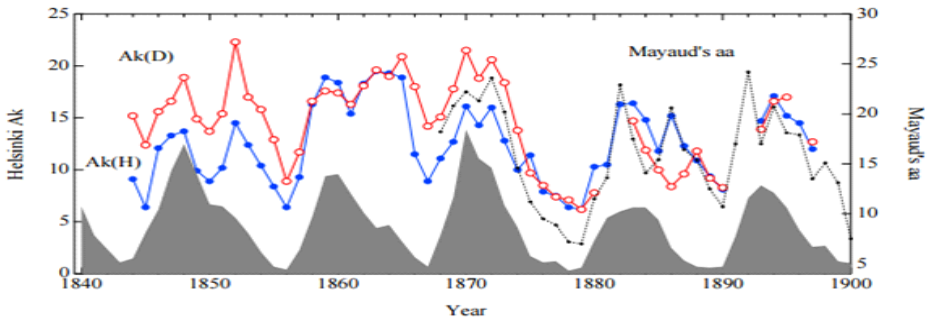

Fig. 20. Annual values of activity indices. Ak(H) (blue) and Ak(D) (red) are derived from the H- and D-components, respectively, using the Helsinki data reported by H. Nevanlinna.

calculated amplitude by Eqs. (7, 10) and then by Eq. (11) at epoch 1969 we have almost that:

$$(\partial B_{sun}/\partial t)_{orbit} \simeq (\partial B_{sun}/\partial t)_{absolute} \ . \tag{13}$$

And then every theory claiming to explain the solar cyclical activity is limited to this condition at Eq. (13) that averagely, the first time derivative of the Sun's absolute magnetic field through the Jupiter is near to its orbital variation at Jupiter position and this equality at Eq. (13) is showing that Sun's magnetic field absolute variation is a noticeable effect, not a partial change. For example, according to the Eq. (13) on the base of the orbital variation of the Sun's magnetic field at Jupiter position we deduce that the Sun's absolute magnetic field could to vary 25% at three years, when Jupiter moves from perihelion to the aphelion. By this noticeable variation of the Sun's absolute magnetic field we find that solar cyclical activity should be a large scale phenomenon at the Sun and such a great change in the magnetic field amplitude is almost impossible by planetary sources. Of course yet, the partial effect of the external sources is possible to influence on the generation of some sunspots at the Sun surface (*Ferris, 1969*). It is arresting that the Ferris is who he has discussed the electric current induction in the ionosphere and metallic sheets (*Ferris and Price, 1965; Ferris, 1973*).

On the other hand, when we see that the yearly change of the Sun's magnetic field is noticeable, then we can deduce a direct relation between the solar cyclical activity and cosmic radiation. Of course, the correlation of the solar activity and cosmic ray has been revealed by scientists before and we may refer to the *Balasubrahmanyan (1969)* and a newly analysis by *Barlyaeva et al. (2014)*. Strongly, emissions of the matter and electromagnetic fields from the Sun increase during high solar activity, making it harder for Galactic cosmic rays to reach Earth. Cosmic ray intensity is lower when the solar activity is high.

By the way, we have revealed here again that the Sun activity relevant to Sunspots number, approximately is proportional with first time derivative of the Sun's absolute magnetic field. But we can consider an accurate factor for solar activity with Aso that with assuming a constant C we have:

$$A = C\partial B_{sun}/\partial t. \tag{14}$$

We should notice that A is a pure factor for the solar activity value on the base of the solar magnetic field absolute variation and this parameter A

is in relation with the sunspots number approximately, because that *SSN* is not a regular parameter. The generation of the sunspots under the change of the Sun's magnetic field is an approximate phenomenon might be relevant to many conditions. It seems that when sunspots number is not small, the correlation of the *SSN* to the solar activity factor A is linear too. However, the scientist can calculate a phenomenological formula as a good approximation for such a correlation between parameter A and *SSN*.

Then on the base of the observations ("Extreme Space Weather Events". National Geophysical Data Center) we see that the solar activity oscillation peaks are conformal with peaks of the cosmic ray entrance amplitude. This phenomenon is showing us that solar activity may be reasonable by cosmic ray because that cosmic ray is relevant to the Sun's magnetic field amplitude, not its first time derivative. If Sun's magnetic field variation was reason of the oscillation of the cosmic ray, then cosmic ray oscillation phase should be conformal with Sun's magnetic field amplitude, not its time derivative.

The cosmic ray entrance oscillation phase is conformal with first time derivative of the Sun's magnetic field leading us to the side that the cosmic ray may be a wave with its wave period as the same period of solar activity and this is remembering us the theory of the sea of the electrons (*Dirac, 1930*) as a theoretical model of the vacuum as an infinite sea of particles with negative charges.

Such a correlation is so far possible to accept. But if the cosmic ray is not naturally a wave shape radiation then why the cosmic ray and solar activity are conformal in both period and phase?

The phase shift is possible to be tiny accidentally, but about the period of cosmic ray entrance and solar activity, conformal period is not accidental suppose if we consider Sun's magnetic field as a mathematical function then unity of the period means that the solar activity is not a partial change in the Sun's magnetic field suppose it should be the change of the whole Sun's magnetic field as a strong verification again for Eq. (14). In this shape the correlation of the solar activity to the cosmic ray amplitude is not a direct relation suppose direct relation is between the Sun's magnetic field and cosmic ray. But solar activity is conformal with magnetic field and magnetic field is conformal with cosmic way. Then solar activity is conformal with cosmic ray as a charming correlation. Then solar activity is whole change of the Sun's magnetic field and this shows that the Sun's magnetic field

reversal is a real phenomenon and Sun's magnetic field is really changing totally and it is not far to see that such a mechanism is impossible else by self consistent dynamo, in agreement with the Sun.

3.6. Long term decreasing trend of lod signals and geomagnetic secular variation

On the other hand, referring to the paper *Duan (2015)* we see the long term decreasing trend of LOD signals about 0.05 ms during the past 50 years and this decreasing trend should be relevant to the Earth magnetic field strength's decreasing trend during past 50 years and reason is that LOD signals are relevant to turbulent frictional CMB flows which their development amplitude is affected by the Earth's magnetic field amplitude. Inverse mechanism too is possible to do so that core flows are reason to explain the variation of the axial dipole as noted by *Holme and Buffett (2015)* that:
"Buffett (2014) has recently provided a model in which zonal toroidal motions are associated with the excitation of a zonal poloidal instability. This model is able to explain the broad variation of the axial dipole over the past 100 years, and also to explain feature of geomagnetic jerks that cannot be explained by purely torsional motions."

By comparison of the two different measurements for LOD signals and secular variation of the geomagnetic field we obtain a relation between secular variation of 5.9 years periodic LOD signal and geomagnetic field secular variation as visible at Fig. 21.

We see that the total intensity at Toronto has decreased 14%, from approximately 64 000 nT to 55 000 nT, during the last 160 years and long term trend amplitude of LOD signals decreases 0.05 ms during past 50 years which is near to 14% and too, we may refer to the axial dipole measurement of geomagnetic field in comparison with 5.9 years LOD signals secular variation visible at Fig. 22.

Schematically we see that it should be a relation between LOD variation and geomantic field and at (*Whaler and Holme, 2011*) it has been discussed before correlation between the axial dipole strength and flows in the outer core.

The geomagnetic field is an amplifier of external driven 5.9-years signal and this concerns to the reality that the currents are amplified and expanded

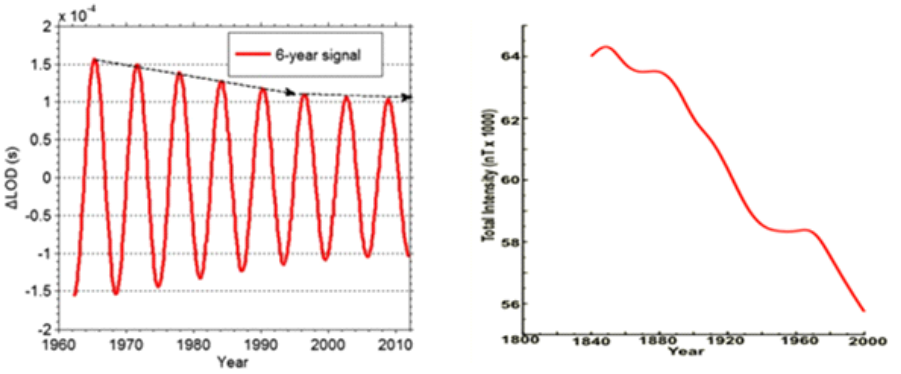

Fig. 21. Long term trend variation of the LOD signals versus Earth secular variation of magnetic field in Toronto.

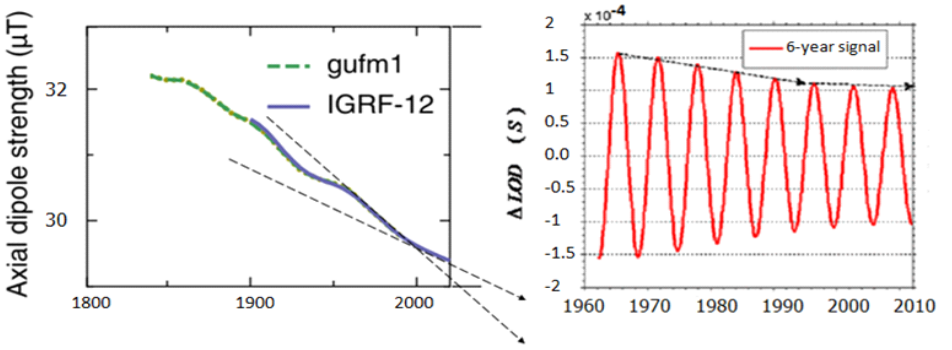

Fig. 22. Long-term damping trend of LOD signals versus strength of the axial dipole component of Earth's magnetic field from 1600 to 2020 (*McElhinny and McFadden, 1998*).

by Earth's magnetic field as a dynamo and similar to the alignments amplification effect at Eq. (6), here the geomagnetic field is too amplifier of the external driven LOD variation to generate observed amplified LOD variation as:

$$\Delta^* LOD = \eta B_{earth} \times \Delta LOD\,. \tag{15}$$

So that observed LOD variation is total amplitude of LOD variation, possible to observe and η is scale coefficient and now in a limited interval of time, possible to consider constant, the peak of external driven LOD variation, we result:

$$\Delta^* LOD = \mu B_{earth} \,. \tag{16}$$

So that μ is assumed as a constant and by this relation we obtain that:

$$\mu \frac{\partial B_{earth}}{\partial t} = \frac{\Delta^* LOD}{\Delta t} \,. \tag{17}$$

And this is visible at Fig. 22 and it is wonderful that LOD variation gradient is changed at the epoch 1992, exactly at the same date that geomagnetic field gradient is changed and in reality, the long term trend variation of 5.9-years LOD signal is unrelated to the AAM effect (*Duan, 2015*), Atmospheric Angular Momentum effect. Then it should exist an internal effect as a variation in generation of LOD signals by core flows.

In addition, at *Wilson et al. (2008)*, we see a spin-orbit coupling between the Sun and the Jovian planets to generate solar cycle and it seems that we are now near to resolve the question of the solar cyclical activity and ultimately we should remember the correlation between geomagnetic jerks and increase of the earthquakes number detected by *Gokhberg et al. (2016)* as a correlation between liquid motion of the Earth and earthquakes and variations in the Earth's length of day as a verification for core flows effecting on the Earth's spin.

4. Conclusions

It is visible that some of the Earth's interior partial core flows are external origin phenomena as the interplanetary driven partial quasidynamo. We have verified it on the base of the physics and experimental reports and we see that the oscillation of the external magnetic fields affect the planets interior too to generate partial effects similar to the geomagnetic jerks and LOD variations and gravity anomalies. We are seeing inevitably that the Jovian planets alignments are affecting on the amplification of these effects and effects are dependent too to the solar activity. The quasidynamo is not the self consistent hydromagnetic dynamo in dynamo region of the cosmic body. In the Earth‘s core it is a partial dynamo as a perturbation on the CMB. The Geodynamo in the Earth ‘s outer core is not of an external origin, but some variations, for example jerks, have external causes.

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