Solar Magnetic Field and the Dynamo Process

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Abstract

To understand how solar magnetic field is generated and maintained, new prototype model for solar dynamo process is considered, in which the model is based on the concept of Mass-Charge interaction. The differential rotation of the Sun, solar magnetic activity cycle, and the variations of sunspot numbers can be explained with the PVN charge interactions of solar planets on the hot plasma in the Sun, not with their gravitational interactions, of which the tidal effect, however, has been wondered whether the planetary alignment in the solar system has a correlation to the solar cycle or not.

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Introduction

The origin of the Earth's magnetic field is explained with the model introducing the Mass-Charge interaction in the Earth's interior, in which the Earth's magnetic field is generated by the Earth rotation with negative charges (mainly electrons) accumulated or relatively highly concentrated between the Earth's crust and its mantle, so called Mohorovicic discontinuity. (Kim 2008) Therefore, it is natural to suppose the electric or electromagnetic connection of the Earth's interior from outer space, especially from the Sun; thus, solar activity could affect on natural phenomena on the Earth. In fact, the correlation of solar activity to the seismic and volcanic phenomena on the Earth has been inquired for a long time although it is still in debate. (Tavares and Azevedo 2011, Harriet Jarlett 2013, Love and Thomas 2013, Young, Rozsa 2020, Marchitelli 2020) By the way, there is a story, which has been going around through internet and social media for some time, saying that High-frequency Active Auroral Research Program (HAARP), which was initiated as an ionospheric research program (UAF), can modify weather, activate volcanoes, induce earthquakes, etc. It can be ascribed simply to a conspiracy theory because any acceptable or even plausible explanation cannot be found in the domain of science at present. At this point, however, it is not clear whether those natural phenomena were accompanied by accident or had causal relationships with the experiments in HAARP. If the experiments caused the natural phenomena, still it is not clear whether the natural phenomena were planned in advance or unintended but accompanied. Anyhow, if the cause-and-effect relationship is true especially for earthquakes, people might wonder how it is possible.

For solar magnetic field, if the same mechanism is considered with the model as in the Earth's magnetic field, we can find a comprehensive explanation for the differential rotations of the Sun -- rotating faster close to the equator than near the poles of the Sun, which has been observed for a long time; solar magnetic activity cycle (solar cycle) – the Sun's polar field has been flipped almost every 11 years; and sunspot cycle – variations of sunspot numbers that also has been observed for a long time and known to be related to the solar magnetic activity.

First of all, we need to wonder why and how the Sun's magnetic field has been flipped periodically, which means there should be an electromagnetic interaction involved. Although gravitational tidal force effect appears negligibly small on the Sun, if there is a similar effect but through an electric interaction, it can make a huge different result.

If the strength of electric interaction is compared with gravitational interaction in general and the mass-to-charge ratio of electron (or proton) is considered, the interaction strength in Mass-Charge interaction can be significant, particularly in the Sun that is a giant ball of hot plasma. For an electron in the sun, for instance, the strength of Mass-Charge interaction F_e with a planet in the solar system is compared with gravitational interaction F_G as

$$\frac{F_e}{F_G} = \frac{k_e |C|}{G} \cdot \left| \frac{q_e}{m_e} \right| \approx \frac{8.9 \times 10^9 \cdot 10^{-19}}{6.67 \times 10^{-11}} \cdot 1.76 \times 10^{11} \approx 2.35 \times 10^{12},$$

in which k_e is Coulomb's constant; G, Gravitational constant; q_e/m_e, mass-to-charge ratio of electron; the coefficient $C \approx -10^{-19}$ C·kg^{-1} is used for the PVN (primitive virtual negative) charge corresponding to the planet mass. (Kim 2008) In general, the ratio of interaction strength for plasma in the Sun is still significant because the mass ratio of proton to electron $m_p/m_e \approx 1836$; however, we should consider a screen effect from the interplanetary charge distribution that is induced for the PVN charges of planets in the solar system.

The Sun has inner layers (major parts); core, radiative zone, and convective zone and outer layers; photosphere, chromosphere, and corona. The core has about 0.2 to 0.25 of solar radius and 34% of the Sun's mass, generating nuclear fusion power of the Sun. The radiative zone extends to 3 quarters of the Sun's radius from the core, in which energy transfers through radiation. Above the radiative zone, convective heat transfer is happening in the convective zone.

Approximately every 11 years the Sun's magnetic field has flipped, which is the half of solar cycle. There is a solar activity accompanied with the solar cycle, which is the variation of sunspot numbers. Sunspots are relatively dark areas appeared on the Sun's surface (photosphere) when a bundle of strong magnetic fields is pushed out of convective zone to photosphere; usually they appears as a pair with opposite polarity; the dark area is cooler than surrounding. After the beginning of solar cycle, sunspots appear at latitude around 25 to 30 degree north and south of the Sun's equator; then, the number of sunspots increases and they appear at lower latitudes; sunspots at both side latitudes get close to the equator, around latitude ~15 degree north and south, until the solar cycle ends, in which the pattern of sunspots looks like the wings of a butterfly. (STCE)

Solar Magnetic Field

Although it has been known that solar magnetic field is originated in turbulent convective fluid in convective zone and differential rotation of the Sun (NWRA 2000, NASA, Wikipedia Solar_dynamo 2020) and there has been another way of thinking to explain the solar magnetic field besides the so-called standard theory (Akasofu 2007, Bowler 1990), the detail mechanism is still absent.

Now, let's think new solar dynamo process as following: If an astronomical mass object is rotating on its axis, at least, it has primordial magnetic field, considering of a magnetic dipole moment generated with the PVN charge distribution for mass of the astronomical object and the rotation, although the magnetic field is not significant in its intensity. If the astronomical object has its core and hot plasma inside energized through nuclear reactions, the magnetic field increases through the electric charge separation process in the hot plasma; positive charges are being attracted to the core, negative charges are being pushed out. However, in the Sun if the radiative zone is considered as like a perfect conductor although it is not, the negative charges should be near the radiative zone with a negative charge distribution to make sure that the electric field disappears in the radiative zone, which also supply a minimized electric potential to the negative charges. Then, it should be the boundary of radiative zone or the bottom of convective zone.

From which two magnetic dipole moments are built up; one is by the positive charge distribution inside; the other, by the negative charge distribution outside; however, the magnetic dipole moment by the negative charge distribution is much bigger than the other.

Fig. (1) shows the schematic drawing representing the charge separation inside the Sun -- positive charge distribution in radiative zone and negative charge distribution in convective zone if there is no electric interaction involved from outside the Sun. With the rotation of the Sun, the magnetic dipole moments are generated in the Sun; one is from the positive charge distribution inside and the other, from the negative charge distribution outside radiative zone. Therefore, between the core and the convective zone, the direction of magnetic field is pointing downward to the south and following the geometry of charge distributions in the magnetic dipoles inside and outside. In the convective zone and outside the sun, the magnetic field is coming out of the south and going into the north although the Sun's magnetic field is diverted by solar wind and pervaded throughout the solar system.
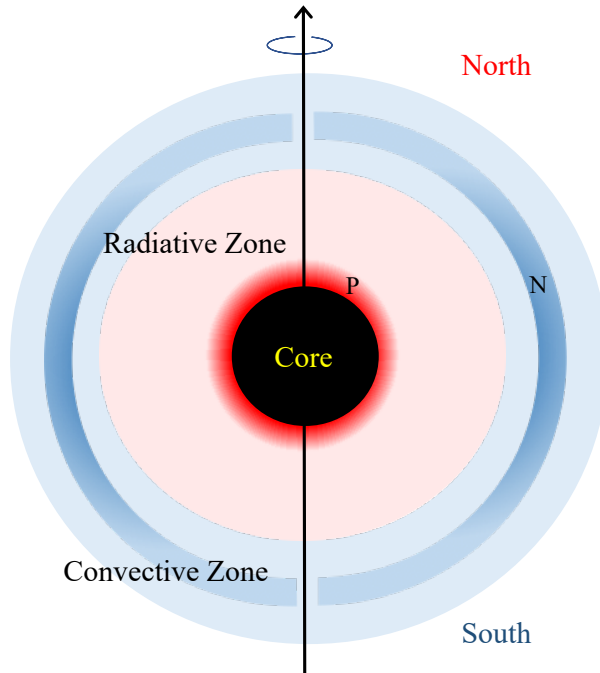

Fig. 1: Electric charge distribution for solar magnetic field

Differential Rotation

The Sun is not a rigid body but a huge ball of hot plasma; hence, the Sun rotates differently depending on its latitudes, axial distances, etc., for example, the rotation period is 25.05 days at equator and 34.3 days at poles, which has been ascribed to a pure mechanical reason with mass

convection and the conservation of angular momentum; however, the detail mechanism is not known yet. (Zell 2017, Wikipedia Differential_rotation)

If the differential rotation of the Sun is originated by merely mechanical process (mass convection), the rotation speed at the equator should be slower than at nearby the poles because the direction of mass convection should be outward in radial direction from the core in which nuclear fusion process is taking place. However, according to observations the rotational rate is 34.3 days at the poles and 20.05 days at the equator of the Sun; the closer to the equator, the faster the rotation is. What kind of mechanical process dose it make possible?

Now, what if an electromagnetic interaction is involved during the mass convection process for charged particles moving outward in convective zone due to high temperature gradient? In the model of solar dynamo process based on Mass-Charge interaction and the charge separation process inside the Sun, two magnetic dipole moments are built up for the Sun's magnetic field.
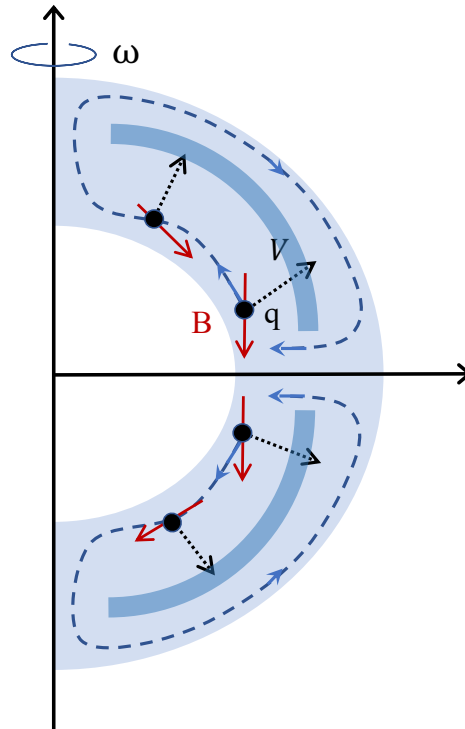

Fig. 2: Convetion of charged particles in convective zone

Fig. (2) is a schematic drawing: a charge q is in motion in convective zone of the Sun with velocity V, which should be in radial direction because the source of convective energy transfer is from the nuclear fusion process at the core, interacting with magnetic field (B), which is swirling around magnetic field lines, going high latitudes (away from the equator) and following

a path, for example, as shown in Fig. (2), in which the dotted lines with arrows indicate not for a specific charged particle but for the pattern of convective plasma motions in general; the convective flow is cooled down, back to low latitudes nearby the equator of the Sun, and the flow sinks to the bottom of the convective zone; then, it makes the rotational speed increased nearby the equator due to the angular momentum conservation for the flow of plasma in which each charged particle has physical mass, which can explain the differential rotation of the sun, in general. Anyhow, even if the charge polarity in the convective zone in Fig. (2) is changed to positive, the general mechanism of the differential rotation as above is still effective.

Tidal Effects of Planets in the Solar System

The correlation of solar activities, such as solar cycle and variations of the sunspot numbers, and the positions of solar planets have been observed in the statistical data for last 1000 years. (Rabie 2019, Stefani 2016, Solheim 2013, J. A. Abreu 2012, WOOD 1972, Ferris 1969, Bigg 1967) Although the gravitational tidal effect of planets in the solar system is negligibly small (NASA SCIENCE 2000), it was enough to have a reasonable suspicion for the correlation.

Now, we can find a plausible explanation for the correlation with the concept of Mass-Charge interaction. (Kim 2008) In making a disturbance of mass (or charge) distribution in the Sun, the PVN charge interactions of solar planets on the plasma (electric charges) in the Sun, let's call that *E-tidal force*, is similar to the gravitational tidal force on the Sun. However, the gravitational tidal force is due to the difference of intensity between gravitational attractive force and the centrifugal force, which appears in a rotating system, at a local point in an extended body, which is so small to be considered in the Sun; however, the E-tidal force makes positive charges attractive and negative charges repulsive due to the PVN charges of solar planets, which results in a disturbance of electric charge distribution in the convective zone of the Sun.

Naturally, the E-tidal force effect should be dependent on the planetary alignment of the solar system. For example, the E-tidal force effect on the Sun from two planets, let's say, Earth and Jupiter gets greater when the two planets are close to the positions of opposition and gets smaller when the planets are close to the positions of conjunction if the estimation is made at the center of the Sun; however, the effect is not so simple because the Sun is a huge extended body.

In fact, the electric charge distribution in the Sun keeps being disturbed by planets in the solar system, and the disturbances can be scattered (or distributed around the Sun) or focused on a specific side or both sides in the alignment of solar planets with the Sun, from which there are two extreme cases; one case is when all planets get close together in a line but apart from the Sun and the other case is when all planets are lined up but equally distributed across the Sun in a line. It is supposed that with the planetary motions of solar planets and the rotation of the Sun, the electric charge distribution in convective zone of the Sun is changed periodically and the change of electric charge distribution is triggered by those two extreme cases.

The E-tidal force effect makes the electric charge distribution changed inside the Sun as shown in Fig. (3), in which the convective zone is being taken by positive charge distribution while the negative charge distribution is being pushed out. The intensity of magnetic fields at north and

south poles get smaller; the other polarities will appear at each poles; this process keeps going on until the E-tidal force effect reaches to a maximum limit; then, positive charge distribution takes over the region.

It has been observed that at the beginning of new solar cycle, sunspots appear at around latitude 25-30 degree north and south of the sun's equator. (STCE) Now, we can find a clue why the sunspots appear at the latitudes at the beginning of new solar cycle.
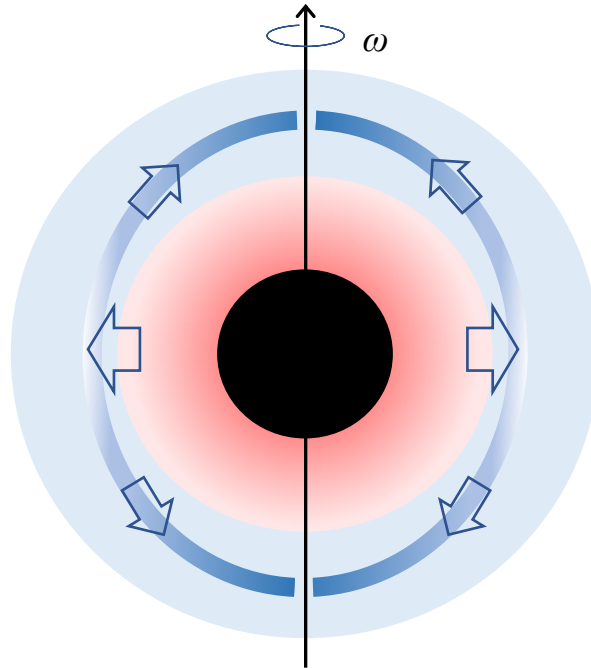

Fig. 3: Postive charge distribution is taking over the convective zone (E-tidal force effect).

The E-tidal force effect for negative charges is repulsive; thus, negative charge distribution is being pushed to higher latitudes north and south from the sun's equator as shown in Fig. (3), which makes a sudden increase of negative charge density at some latitude above the equator, let's say, latitude 25-30 degree north and south; then, magnetic pressure increases and outmost magnetic field lines are pushed out to the photosphere. The magnetic pressure keeps being increased when positive charge distribution get close to the convective zone; the number of sunspots increases and appear at lower latitudes until the positive charge distribution takes over the convective zone; then, the Sun's magnetic field flips. With the effect of differential rotation of the Sun, which is called *omega-effect* (NASA), the pattern of sunspots is made like the wings of a butterfly – butterfly diagram of sunspots.

Now, another solar cycle starts. In Fig. (4), the E-tidal force effect is getting smaller; the positive charge distribution in the convective zone is being moved away from the equator, and new

negative charge distribution starts to fill the convective zone; the positive charge distribution in the radiative zone is shrunk. At around latitude 25-30 degree north and south, sunspots should appear as before, but their magnetic polarities are opposite to the polarities in the previous cycle.
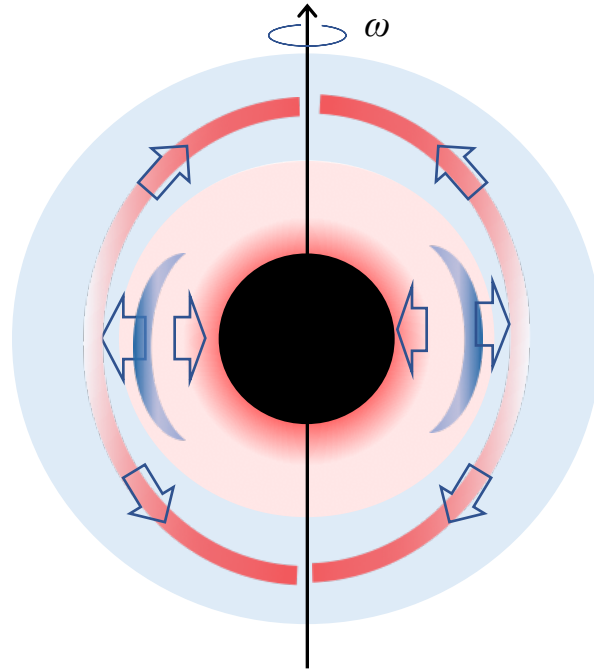

Fig. 4: Negative charge distribution is taking back.

With the prototype model of solar dynamo process described as above, let's investigate the solar magnetic field in which the magnetic poles have flipped periodically.

Solar Cycles and the PVN charge interactions of Solar Planets

Since the planets of solar system, actually their PVN charges, are supposed to keep interacting on the plasma (electric charges) in the Sun and making the Sun's magnetic field flipped periodically, first of all, it is desirable to know the interaction strength of each planet to the Sun. Then, it is interesting to examine how the interaction strength keeps being changed with planetary motions of the solar system.

The interaction strength is given as $F_p \propto m_p r_p^{-2}$ since the PVN charge is proportional to planet mass m_p, in which r_p is the distance from the planet to the Sun. Hence, the ratio of interaction

strength is estimated as $I_J : I_V : I_S : I_E \approx 11.7 : 1.56 : 1.04 : 1.0$ for planets such as Jupiter, Venus, Saturn, and Earth.
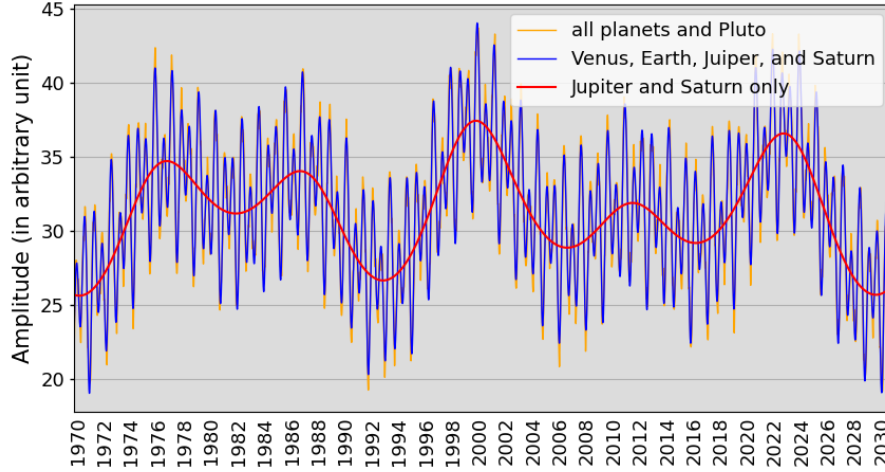

Fig. 5: Interaction strengths of solar planets on the Sun

However, only Jupiter and Saturn make a long-time periodic pattern as shown in Fig. (5), in which each data point, made on a daily basis, represents the magnitude of a vector sum with interaction strengths of planets in the planetary orbit surface (2D) with the Sun at the center. In the Fig. (5), the red line shows the effect of interaction from only Jupiter and Saturn; the blue line indicates the effect added from planets Venus and Earth; the small effects of interaction with orange color at the tips come from the other planets in the solar system and the Pluto. Since all solar planets are periodic in their planetary motions, it is natural to expect that the interaction strength in Fig. (5) should be periodic too.

In the calculation for data in Fig. (5), however, it is assumed that all the planets in the solar system are on 2D flat surface with the Sun at the center of their orbits, which means that their orbital inclinations and barycenters are ignored, especially for the Jupiter; to synchronize planet positions at present time, their orbit-phases, actually relative phases to the Earth ($\phi_E = 0$)[2], are measured manually (Walker, TheSkyLive 2020) and included in the calculation; because their eccentricities are so small, their elliptical motions are ignored except Jupiter and Saturn since both planets make the major variation of interactions on the Sun (hereafter, *grand variation*) as shown in Fig. (5); for planets Jupiter and Saturn, the orientations of their elliptic orbits are adjusted with the information of their perihelion dates. The eccentricity of Jupiter makes a significant difference in the grand variation as shown in Fig. (6), in which the blue line indicates the interaction strength when both planets are in circular motions ($e = 0$) with their average

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[2] $\phi_{Me} = -112°$; $\phi_V = 65°$; $\phi_E = 0°$; $\phi_{Ma} = 15°$; $\phi_J = -47°$; $\phi_S = -44°$; $\phi_U = 54°$; $\phi_N = 6°$; $\phi_P = -50°$ (09/08/2020)

9

distances from the Sun; however, the red line shows the difference when the eccentricities of both planets[3] are considered.
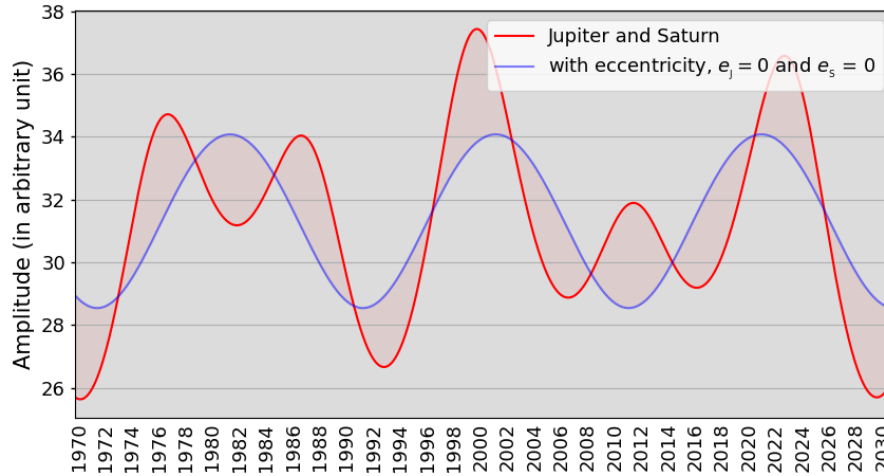

Fig. 6: Grand variation with the eccentricity of Jupiter

With two planets, Jupiter and Saturn, in Fig. (6) we can interpret the grand variation of interaction strength on the Sun. If both planets are approaching to each other, the interaction strength is increased; if they are receding from each other, the interaction strength is decreased. In other words, when both planets are in a line with the Sun, if the Sun is between the planets, the interaction strength is the minimum; if the both planets are one side of the Sun, the interaction strength is the maximum. However, as mentioned before, we'd better say that these are two extreme cases instead of the maximum and minimum because the Sun is not a point object but a huge extended body, and we can assume that the extreme cases of interactions are expected when planets in the solar system are lined up in a straight line or close to the line, in general.

For instance, at around year 1981 in Fig. (6), the blue line indicates the maximum of interaction strength, which means both planets are in a straight line but the Sun is aside in the line, which can be called as *Jupiter-Saturn's Opposition*[4]. On the other hand, at around year 1991, the blue line shows the minimum, which means both planets are in a straight line but across the Sun, which can be called as *Jupiter-Saturn's Conjunction*[5]. However, the red line shows the effect of Jupiter's elliptical motion. For example, the width of graph with red line including the peak at around year 2023 is smaller than the blue one nearby because Jupiter is passing through its

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3 $e_J = 0.0489$; $e_S = 0.0565$

4 maximum angle between Sun-Jupiter-Saturn (180° viewing from Jupiter)

5 minimum angle between Sun-Jupiter-Saturn (0° viewing from Jupiter)

perihelion, and thus, the peak of the graph is higher than the peak of blue one. For another example, the peak of graph with red line at around year 2011 is also made when Jupiter is passing the perihelion. On the other hand, the downward peak in the graph with red line at around year 1980 – 1982 is made when Jupiter is passing through its aphelion. In general, the downward peaks made by the red line indicate when Jupiter is passing its aphelion, and the upward peaks indicate when Jupiter is passing its perihelion. The pattern of the grand variation of interaction strength, which is made by Jupiter and Saturn, seems to be repeated with the period of about 60 years; however, the exact period cannot be estimated clearly in this calculation because the planetary motion of the solar system is simplified as mentioned before.

Through the planetary motion in the solar system, all the planets keep making interferences in the electric charge distribution of the Sun from all directions depending on their planetary positions. If some planets are lined up with the Sun, the effect of interference is boosted on a specific direction toward the Sun; then, the enhanced interaction effect, supposedly, can initiate the change of the electric charge distribution especially in the convective zone of the Sun.

If there is no external interference disturbing the charge distribution in the Sun or not strong enough to disturb, the negative charge distribution is expected in the convective zone, which generates the magnetic field making the Sun's south pole appear to be its magnetic north. On the other hand, if the external interference is big enough to change the negative charge distribution to positive charge distribution in the convective zone, then, the positive charge distribution generates the magnetic field making Sun's north pole appear to be its magnetic north.

Because the planetary motion is periodic and also the solar cycle and the variations of sunspot numbers are known to be periodic, which means the variation of solar planets interactions also should be periodic, it can be interpreted as following: from the average value for a period[6] in Fig. (5) or Fig. (6), the half above is the interaction to make the positive charge distribution and the half below is the interaction to make the negative charge distribution in the convective zone of the Sun or *vice versa* if the case of planets aligned across the Sun, which is the *Jupiter-Saturn's Conjunction*, is more effective to make the positive charge distribution in the convective zone than the other case, which is the *Jupiter-Saturn's Opposition*.

Now, one step further, if the interaction of solar planets on the Sun is supposed to be the main source to make the solar cycle, the accumulation of interactions over time, which should be proportional to the energy (work) supplied by planets in the solar system through their PVN charge interactions, should be correlated to the solar cycle because the Sun's magnetic field is the outcome by the electric charge distribution in the convective zone and the rotation of the Sun.

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[6] In fact, the exact period is not defined clearly; however, the solar cycles in past can be used, or the average value for a long time is another way to get a close one.
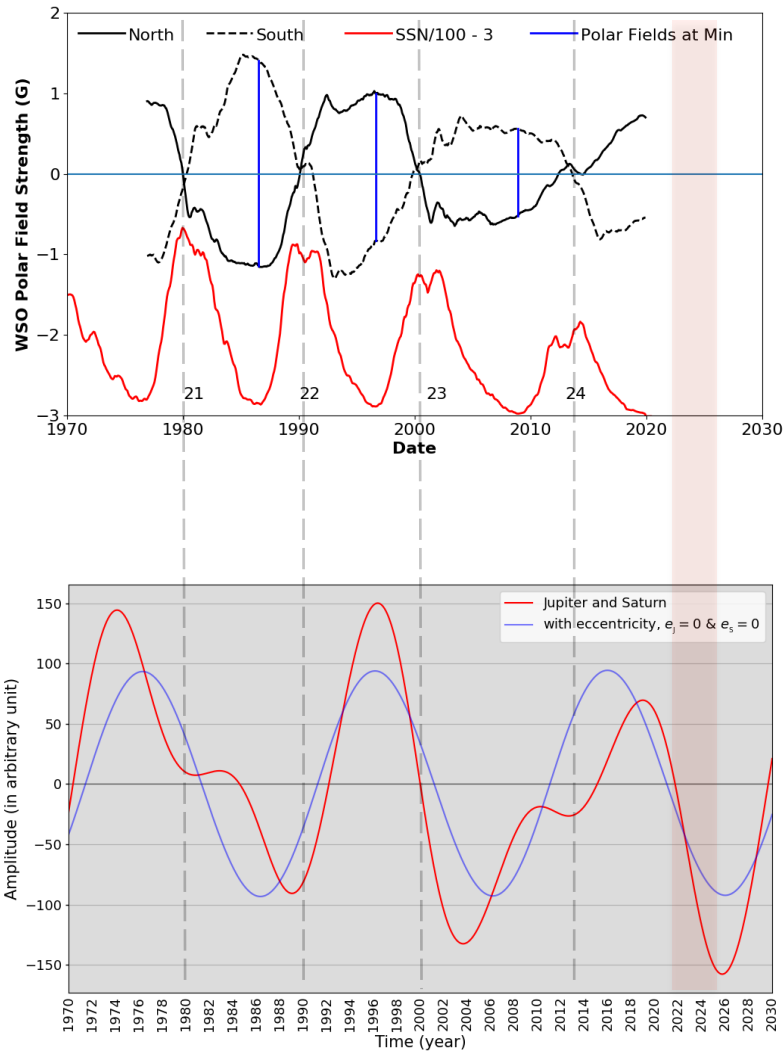
Fig. 7: E-tidal force effect by the PVN charges of Planets, Jupiter and Saturn

The data of interaction strength in Fig. (6) is subtracted with the average value; then, another form of data, which represents the PVN charge interaction energy from planets Jupiter and Saturn (E-tidal force effect), is made with the process of accumulated summation; and it is subtracted with its own average value and multiplied with the negative sign to compare with the corresponding physical variable in the Sun -- the intensity of magnetic field in which the magnetic field is supposed to be generated by the positive charge distribution in the convective zone of the Sun.

Finally, the data is shown at the bottom in Fig. (7) to compare with the above one. As shown in Fig. (7), the correlation of solar cycle to the variations of sunspot numbers has been known for a long time. (Solar Cycle Science 2017) Now, we can investigate another correlation of solar cycle to the E-tidal force effect of planets in the solar system.

In Fig. (7) whenever the Sun's magnetic field flips, it crosses the zero field line on the upper figure; in the figure below, both graphs pass the zero line closely, especially the graph with blue line. It seems that the flip of sun's magnetic field is more dependent on the phase than the distance from the Sun in planetary motions of planets. On the other hand, the intensity and the variation of magnetic field seem to be dependent on the graph with red line. The solar activity is estimated by measuring the sunspot numbers viewing from Earth, and it has been known that the Sun's magnetic field flips at nearby the solar maximum and the magnetic field maximum occurs at near the solar minimum. To compare the timing correspondence of solar maximum and solar minimum, Fig. (8) shows the correspondences with the graph showing the variations of sunspot numbers from 1950 to 2020 (SILSO 2020).

In Fig. (7) and Fig. (8), we can find the planetary positions of Jupiter and Saturn on solar maximums, on which the Sun's magnetic field have flipped in the year 1960, 1970, 1980, 1990, and 2000, those of which are closely corresponding to the *Jupiter-Saturn's Opposition* and the *Jupiter-Saturn's Conjunction*, alternatively. (TheSkyLive 2020) In addition, the peaks of the Sun's magnetic fields should be expected between the two extreme cases, of which the time period $P \sim 10$ years [7]; during the first half of the period after passing an extreme case, their Opposition or Conjunction, the intensity of Sun's magnetic field increases and the number of sunspots get smaller; during the other half of the period, the intensity of Sun's magnetic field decreases and the number of sunspots get bigger.

The two extreme cases are corresponded clearly to the graph with blue line whenever it passes the zero line although it doesn't represent the exact positions of Jupiter and Saturn since their elliptic planetary motions are ignored in the graph with blue line. Therefore, it seems that the irregular shapes in the graph with red line makes the variation of solar cycle although it is more realistic than the other with blue line. (Wikipedia List_of_solar_cycles)

In Fig. (7) or Fig. (8), for example, after passing the first half of the period between the two extremes, if the amount of energy supplied by solar planets, which is represented by the size of graph with red line, is not big enough to change the polarity of the Sun's magnetic field until the end of the other half of the period, the change of the Sun's magnetic polarity is delayed. On the other hand, if the energy supplied is big enough to change the polarity of the Sun's magnetic field, the change of polarity precedes before the end of the other half of the period.

Besides the size of the graph with red line in Fig. (7) or Fig. (8), which should be proportional to the magnetic field intensity at north pole of the Sun, the number of sunspots on the Sun and the variation of the numbers have been used for a long time to estimate the Sun's magnetic activity.

In fact, the prediction of solar cycle has been made not by a direct calculation but with a model made from comparing the pattern and investigating the trend of present data with scientific data collected in past. Especially, the variations of the sunspot numbers, the data of which has been collected for about 400 years, shows a variation over the period of time (QRZNOW, Solheim 2013), and some people have concerns about the time-variation whether it affects on next solar cycle or not. Therefore, not all people speak with one voice; there are some exceptional

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[7] $2P = T_S T_J / (T_S - T_J)$, in which the orbital period of Saturn $T_S = 29.47$ yr and the period of Jupiter $T_J = 11.87$ yr.

predictions mentioning "extended solar minimum" or " mini ice age". (SWPC 2020, Space Weather 2020, Allon 2020, Alexander 2020, Phillips 2019)
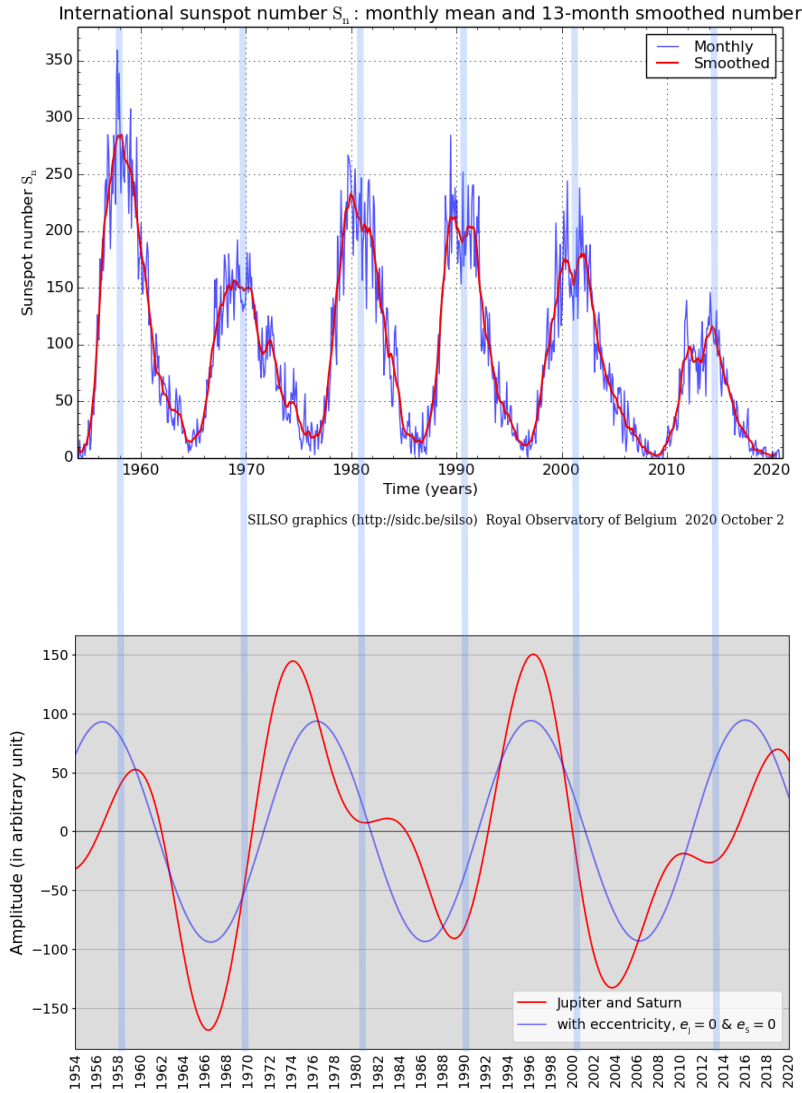

Fig. 8: Correspondences to solar maximum and solar minimum

Fig. (9) shows the group sunspot number (GSN) vs. time (year), in which the year represents in the middle of year, not the beginning of year. To know a long-term trend of the group sunspot number, the data smoothing functionality in computer software, moving averages, was used in Fig. (9) with the solid green and red lines. Except the time period called Maunder Minimum (1645 − 1715), the periodic variation (17th century - present) is shown clearly with the solid red line. Then, this brings up the question of what made the time-variation of solar activity over the period of time.

14

Since the driving force behind the solar cycle (solar magnetic activity cycle) is supposed to be the E-tidal force effect, which is the PVN charge interactions of solar planets on the hot plasma (electric charges) in the Sun, the cause of the variation should be related with the PVN charge interactions of solar planets in which the strength of interaction and the effect on the solar activity depends on the planetary alignment of the solar system, especially Jupiter and Saturn, which has a period of about 60 years as shown in Fig. (6); however, the variation of the interaction strength is not big enough to contribute for a long-term trend. Beside the cause from the planetary alignment, there is a screen effect for the PVN charge interaction due to the charged particles induced between solar planets and the Sun in interplanetary space. Therefore, the plasma density in interplanetary medium (Wikipedia Interplanetary_Medium 2020) is another critical factor for the strength of PVN charge interaction, which affects on solar activity. Now, the question arises as to whether the plasma density in interplanetary medium is changing or not.
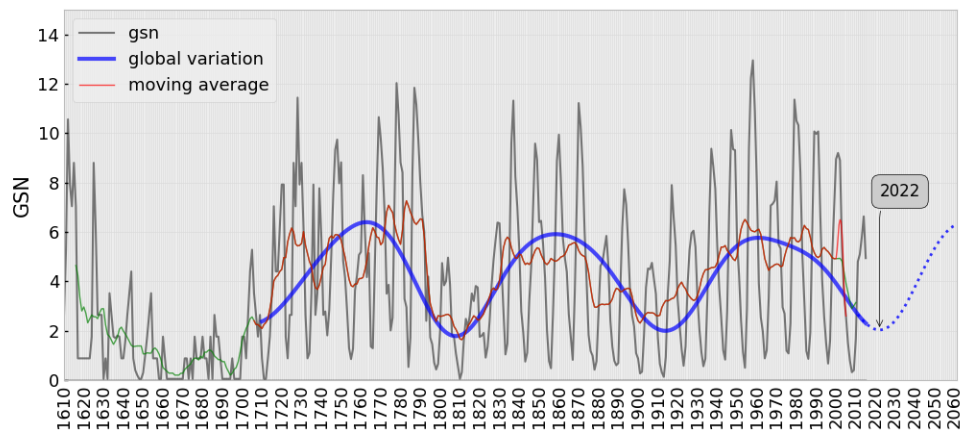

Fig. 9: group sunspot numbers over last 400 years[8] and global variation

Like the magnetosphere of the Earth, there is the heliosphere of the Sun, which is made with the Sun's magnetic field and solar wind, protecting planets in the solar system from cosmic radiations. The interplanetary charged particles, mainly protons and electrons in solar wind, are not easy to move out from the heliosphere of the solar system to the interstellar space as galactic cosmic rays coming into the solar system are blocked at the edge of the heliosphere. (Specktor 2019, NMDB 2017, Feimer 2010)

Therefore, it can be expected that the plasma density in interplanetary medium should be increased up to some point; then, it can make an equilibrium at the boundary of the heliosphere; however, the screen effect created from the interplanetary plasma makes the strength of PVN charge interaction decreased; then, it makes solar activity gets weak and the plasma density get smaller, and vice versa.

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[8] Sunspot data from the World Data Center SILSO, Royal Observatory of Belgium, Brussels.

Hence, at least, the plasma density in interplanetary medium should be fluctuating. If the planetary medium is maintained solely by the Sun, the density of the medium should have a periodic variation, which can be called a self-sustaining ability of the Sun; however, the source of the planetary medium can be outside the solar system, and the galactic environmental condition also affect on the density of planetary medium.
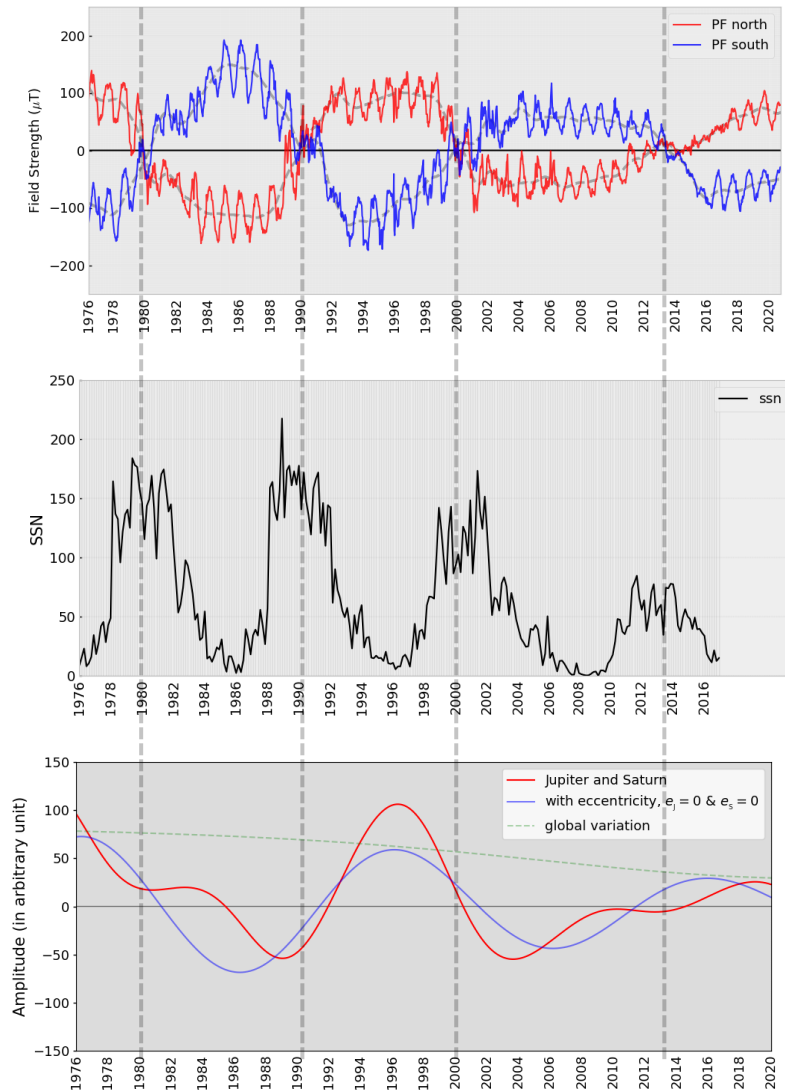

Fig. 10: Sun's polar fields, sunspot numbers, E-tidal force effect on the Sun

It is trial-and-error method to estimate a global variation of group sunspot numbers (GSN); still a best-fit is made as shown with the solid blue line in Fig. (9) and the GSN variation for the near future is expected as shown with the dotted line, in which a minimum of GSN is expected in 2022 or so.

16

Including the plasma density effect in planetary space, the E-tidal force effect is compared with the solar polar magnetic fields of the Sun in Fig (10). (WSO 2020, SILSO) In Fig. (10); the upper graph represents the solar magnetic fields at the north pole and south pole with red and blue lines, respectively[9], the middle one shows the corresponding the variation of sunspot numbers, and the last graph shows the energy supplied through the PVN charge interaction on the Sun. Not only the time correspondences of solar maximum and the minimum (SSN graph in the middle) to the sun's magnetic field flips and its maximum and the minimum strengths (graph at the top), those of which can be compared with the graph at the bottom, but also a couple of features are distinguished:
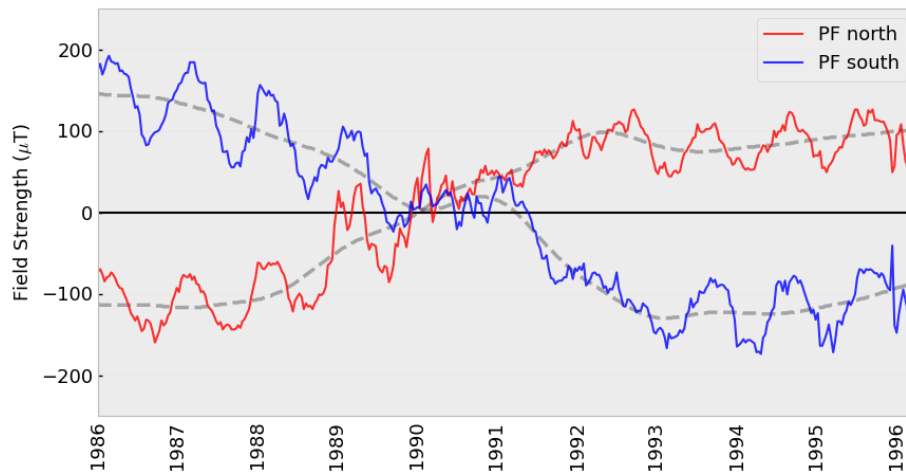

Fig. 11: the variation of solar polar fields (1986 – 1996)

Firstly, the strength of polar field at each solar cycle gets weaker; the peaks of sunspot numbers get smaller; and the size of graph with the red line also gets smaller. The other one is about the variation of the solar polar fields as shown in Fig. (11) more in detail for the variation of polar fields from 1986 to 1996, which is a part of the upper graph in Fig. (10). Both fields at the north pole and the south pole, which looks like a yearly variation going up and down, move simultaneously in the same direction with noticeably similar amount of amplitude. In addition, before and after Sun's magnetic poles flipped in 1990-1991, the phase of variations is also reversed for the same periodic planetary motions as before. (Venus, Earth, etc.) Anyhow, for the peculiar variations of both polar fields as above, a possible explanation in the prototype model of solar dynamo can be as following:

The peculiar variation of both polar fields is coming from the combined planetary motions of Venus and Earth in general, and the noise-like small variation is from Mercury, though. Before and after the flip of the Sun's magnetic field, the phase reversal of the variations is due to the

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[9] Wilcox Solar Observatory data used in this study was obtained via the web site http://wso.stanford.edu courtesy of J.T. Hoeksema.

polarity of dominant electric charges in the convective zone of the Sun, in which the charge polarity should be negative before and positive after the flip of the Sun's magnetic field, and the orbital inclinations of Earth and Venus to the Sun's equator, with which the location of charge distribution, not amount of charges, in the convective zone is changed to above and below across the Sun's equator periodically.
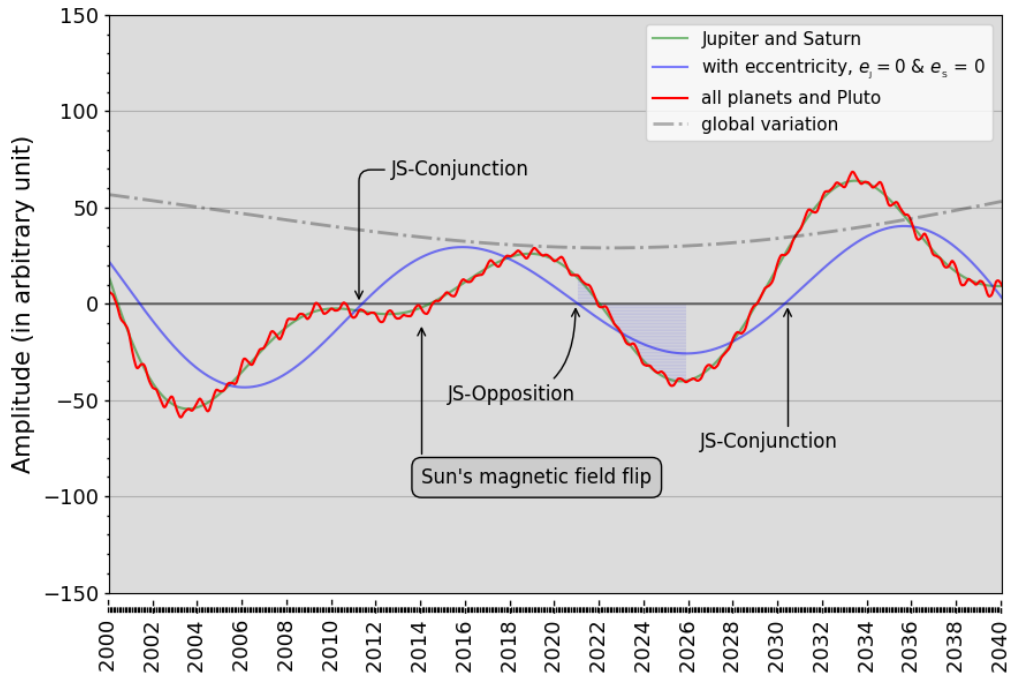

Fig. 12: Expectation of solar cycle 25

Although it is not a conclusive systematic way but the trial-and-error method to find the global variation of GSN that affects on the PVN charge interactions of solar planets, including the global variation effect let's talk about the present status of solar cycle (solar cycle 25) and make some expectations for the future. Since the solar minimum passed, for which many researchers mentioned in 2019 or so (SPACE WEATHER PREDICTION CENTER 2019) and also it can be confirmed in Fig. (12) if the variation of graph is compared with the Sun's magnetic field at the north pole, we can expect next solar maximum; however, the question is whether it is in the near or distant future.

According to a report, the solar maximum last time was in the middle of 2014, which had been already delayed because it was supposed to be in 2011 or so (for the period of 11 years); the solar minimum (the peak of Sun's polar magnetic field) passed with the relatively small size of the magnetic field intensity of the Sun in Fig. (12) if it is compared with other cases; then, the next solar maximum should be delayed once again. However, it should appear during the first

half of the period after passing the *Jupiter-Saturn's Opposition* in Fig. (12), which is before 2025-2026. Also, the size of maximum should be smaller than the size of solar cycle 24.

Anyhow, for any reason, if the solar maximum doesn't show up even after the first half of the period, we should expect a period of extended solar minimum and wait for the next solar maximum, at least, until next *Jupiter-Saturn's Opposition*, which means that the extended period of solar minimum can be more or less ~25 years.

Discussion

For physical fields such as gravitational, electric, magnetic, and electromagnetic fields, ontological interpretations provide a fundamental basis to understand physics comprehensively. (Kim 2008) (Kim 2017) For example, to understand how Faraday's law of induction is working when a conducting disk rotating simultaneously with a permanent magnet that is the source of magnetic field - Faraday Paradox, we need to know more than the physical concept given to the magnetic field in physical laws; that is what the magnetic field is in ontological point of view. By the same token, the source of Earth's magnetic field was supposed to be two magnetic dipole moments made by charge distributions inside the Earth and the rotation of the Earth. Similarly, the Sun's magnetic field is supposed to be generated by magnetic dipole moments; however, since the Sun is in hot plasma state, the charge distributions in the convective zone and the radiative zone keep being changed through the external primitive virtual negative (PVN) charge interactions, which depends on the motions of planets in the solar system. Hence, the charge distributions in the convective zone and the radiative zone should be periodic because the motions of solar planets are periodic, and thus, the variation of solar magnetic field also should be periodic, which is, known to be, about 22 years.

Although it seems to be crude, this prototype model of solar dynamo that is based on the physical concept of Mass-Charge interaction, which is fundamentally different from contemporary model of solar dynamo, is providing qualitative explanations, as never before, yet consistently, for the origin of solar magnetic field, differential rotation of the sun, and solar activities such as solar cycle and sunspot cycle.

Furthermore, if the hot plasma gas convection from the bottom of convective zone of the Sun up to the corona is possible alternatively, which might be connected to the way of convection shown in Fig. (2), we can find a clue for the puzzling question in solar physics for a long time: that is, why the corona, outmost layer of solar atmosphere, is so hotter than inner layers, chromosphere and photosphere, which is up to 300 times hotter than the photosphere. (Pevtsov 2020, Crockett 2019, Sharp 2017) Then, the energy source for the high temperature of corona region doesn't have to be in the solar atmosphere, photosphere or chromosphere.

The author of this short essay is not an expert in solar physics; nevertheless, he introduces the prototype model of solar dynamo as above, hoping that researchers in the field might find answers for long-stand questions about the sun.

By the way, in addition to the correlation of solar cycle (and sunspot cycle) to the planetary alignments in the solar system, there have been numerous inquiries into the correlations of solar activity to natural phenomena on the Earth, such as volcanoes, earthquakes, etc. (Marchitelli 2020, The Sun Today, Johnson-Groh) If it is true, that means the planetary alignments in the solar system should be linked to some natural phenomena on the Earth. Although it is not direct but rather through the effect on the Sun, it can be said that the planetary alignments in the solar system could affect on human life on the Earth in the end. It reminds us of Astrology, to which any scientific connection still seems to be far away, though.

However, there is an interesting fact that the variation of E-tidal force, which is the PVN charge interactions of solar planets with their planetary motions, has a period of about 60 years as shown in Fig. (6), and surprisingly, there is the same 60-year cycle in "Four Pillars of Destiny". (Kim 2019) Is this a coincidence? Otherwise, how that is possible? We need to consider what is the demarcation of science and whether the principle of fairness (justice) in scientific research has not been ruined by majority in the name of "general agreement" or scientific consensus.

Works Cited

Akasofu, Syun-Ichi. "Long-Standing Unsolved Problems in Solar-Terrestrial Physics." *IEEE Transactions on Plasma Science* 35, no. 4 (Aug. 2007): 751-758.

Alexander, Ralph B. "Upcoming Grand Solar Minimum Could Wipe Out Global Warming for Decades." *Science Under Attack.* October 05, 2020. https://www.scienceunderattack.com/.

Allon, Cap. "Professor Valentina Zharkova: "We Entered the 'Modern' Grand Solar Minimum on June 8, 2020"." *ELECTROVERSE.* August 30, 2020. https://electroverse.net/we-entered-the-modern-grand-solar-minimum-on-june-8-2020/.

Bigg, Edward. "Influence of the planet Mercury on sunspots." *The Astronomical Journal* 72 (1967): 463.

Bowler, Sue. "Science: A simple model for planets' magnetic fields?" *NewScientist.* June 16, 1990. https://www.newscientist.com/article/mg12617213-300-science-a-simple-model-for-planets-magnetic-fields/ (accessed 08 22, 2020).

Crockett, Christopher. "Hotter than the sun:The mysterious solar corona." *Knowable MAGAZINE.* 2020 Annual Reviews, Inc. September 23, 2019. https://www.knowablemagazine.org/article/physical-world/2019/solar-corona-temperature (accessed August 23, 2020).

Feimer, Walt. *Cosmic Rays and the Heliopause.* October 1, 2010. https://svs.gsfc.nasa.gov/20186.

Ferris, G. A. J. "Planetary influences on sunspots." *Journal of the British Astronomical Association* 79 (1969): 385-388.

Harriet Jarlett. "No link between solar activity and earthquakes." *phys.org.* April 11, 2013. https://phys.org/news/2013-04-link-solar-earthquakes.html.

J. A. Abreu, et al. "Is there a planetary influence on solar activity?" *Astronomy and Astrophysics* A88, no. 548 (11 2012).

Johnson-Groh, Mara. "Powerful eruptions on the Sun might trigger earthquakes." *Astronomy.* July 13, 2020. https://astronomy.com/2020/07/powerful-eruptions-on-the-sun-might-trigger-earthquakes.

Kim, Kiyoung. "Metaphysics and Human Life." *viXra e-prints.* vixra.org. 2019. http://vixra.org/pdf/1911.0314v2.pdf.

—. "Paradigm Shift in Physics." *viXra e-prints.* vixra.org. 02 2017. http://vixra.org/pdf/1702.0179v1.pdf.

—. "Primitive Virtual Negative Charge." *arXiv e-print.* 11 2008. www.arxiv.org/pdf/0811.0522.pdf.

Love, Jeffrey J., and Jeremy N. Thomas. "Insignificant solar-terrestrial triggering of earthquakes." *Geophysical Research Letters*, March 16, 2013: 1165-1170.

Marchitelli, V., Harabaglia, P., Troise, C. et al. "On the correlation between solar activity and large earthquakes worldwide." *Sci Rep* 10 (2020): 11485.

NASA SCIENCE. "Interplanetary Low Tide." *NASA SCIENCE.* May 3, 2000. https://science.nasa.gov/science-news/science-at-nasa/2000/ast04may_1m/.

NASA. "The Solar Dynamo." *Solar Physics.* https://solarscience.msfc.nasa.gov/dynamo.shtml (accessed 11 6, 2020).

NMDB. *Solar Wind, Heliosphere, and Cosmic Ray Propagation.* Neutron Monitor Database. September 27, 2017. http://www01.nmdb.eu/public_outreach/en/02/#solarmodulationofgalacticcosmicrays.

NWRA. "The Solar Dynamo." *North Western Research Associates.* 2000. https://www.cora.nwra.com/~werne/eos/text/dynamo.html.

Pevtsov, Alex. "Explain the Coronal Heating Problem, Please." *Stanford SOLAR Center.* 2020. http://solar-center.stanford.edu/FAQ/Qcorona.html.

Phillips, TONY. "Experts Predict a Long, Deep Solar Minimum." April 10, 2019. https://spaceweatherarchive.com/2019/04/10/experts-predict-the-solar-cycle/.

QRZNOW. *Solar Cycle Trends and Gleissberg Cycle.* QRZNOW.COM. https://qrznow.com/solar-cycle-trends-and-the-gleissberg-cycle/.

Rabie, Passant. "Planetary Orbits May Explain Mystery of Sun's 11-Year Cycle." *SPACE.com.* 06 18, 2019. https://www.space.com/planets-affect-solar-cycle.html.

Rozsa, Matthew. "A study that links solar activity to earthquakes is sending shockwaves through the science world." *salon.com.* July 21, 2020. https://www.salon.com/2020/07/21/a-study-that-links-solar-activity-to-earthquakes-is-sending-shockwaves-through-the-science-world/.

Sharp, Tim. "Atmosphere of the sun:Photosphere, Chromosphere & Corona." *SPACE.com.* Future US, Inc. November 02, 2017. https://www.space.com/17160-sun-atmosphere.html.

SILSO. *Monthly smoothed total sunspot number.* http://www.sidc.be/silso/infosnmstot.

—. *Sunspot Number graphics.* October 2, 2020. http://sidc.be/silso/ssngraphics.

Solar Cycle Science. *Discover the Polar Field!* SolarCycleScience.com. 2017. http://solarcyclescience.com/polarfields.html.

Solheim, J. E. "The sunspot cycle length - Modulated by planets?" *Pattern Recognition in Physics* 1 (12 2013): 159-164.

SPACE WEATHER PREDICTION CENTER. *SOLAR CYCLE 25 FORECAST UPDATE.* December 09, 2019. https://www.swpc.noaa.gov/news/solar-cycle-25-forecast-update.

Space Weather. *Solar Cycle 25 Is Here. NASA, NOAA Scientists Explain What That Means.* September 15, 2020. https://www.nasa.gov/press-release/solar-cycle-25-is-here-nasa-noaa-scientists-explain-what-that-means/.

Specktor, Brandon. *There's a violent Battle Between Solar Wind and Cosmic Rays, and Voyager 2 Just Passed Through it.* November 22, 2019. https://www.livescience.com/voyager-2-detects-heliopause-plasma-shield.html.

STCE. "A sunspot oddity." *Solar-Terrestrial Centre of Excellence.* 01 09, 2018. http://www.stce.be/news/414/welcome.html.

Stefani, F., Giesecke, A., Weber, N. et al. "Synchronized Helicity Oscillations: A Link Between Planetary Tides and the Solar Cycle?" *Sol Phys* 291 (2016): 2197-2212.

SWPC. *SOLAR PREDICTION SCIENTISTS ANNOUNCE SOLAR CYCLE 25.* SPACE WEATHER PREDICTION CENTER. September 15, 2020. https://www.swpc.noaa.gov/news/solar-prediction-scientists-announce-solar-cycle-25.

Tavares, Marilia, and Anibal Azevedo. "Influence of Solar Cycles on Earthquakes." *Natural Science* 3, no. 6 (April 2011): 436-443.

The Sun Today. "Do Solar Flares Cause Earthquakes?" *The Sun Today.* https://www.thesuntoday.org/solar-facts/flares-and-earthquakes/.

TheSkyLive. *3D Solar System Simulator.* TheSkyLive.com. 2020. https://theskylive.com/3dsolarsystem.

UAF. "HAARP." *University of Alaska Fairbank.* https://haarp.gi.alaska.edu/.

Walker, John. *The Sky LIVE.* https://www.fourmilab.ch/cgi-bin/Solar/action?sys=Sf.

Wikipedia Differential_rotation. "Differential rotation." *Wikipedia The Free Encyclopedia.* https://en.wikipedia.org/wiki/Differential_rotation.

Wikipedia Interplanetary_Medium. *Inteplanetary Medium.* October 07, 2020. https://en.wikipwdia.org/wiki/interplanetary_medium.

Wikipedia List_of_solar_cycles. *List of solar cycles.* https://en.wikipedia.org/wiki/List_of_solar_cycles.

Wikipedia Solar_dynamo. "Solar dynamo." *Wikipedia, The Free Encyclopedia.* June 17, 2020. https://en.wikipedia.org/w/index.php?title=Solar_dynamo&oilid=963046429 (accessed August 3, 2020).

WOOD, K. "Physical Science:Sunspots and Planets." *Nature* 240 (1972): 91-93.

WSO. *Wilcox Solar Observatory Polar Field Observations.* October 14, 2020. http://wso.stanford.edu/Polar.html (accessed October 19, 2010).

Young, C. Alex. "Do Solar Flares Cause Earthquakes?" *The Sun Today.*
https://www.thesuntoday.org/solar-facts/flares-and-earthquakes/.

Zell, Holly. "Solar Rotation Varies by Latitude." *NASA.* Aug. 7, 2017.
https://www.nasa.gov/mission_pages/sunearth/science/solar-rotation.html.