Part VII
Metric Quantization And Stellar Dynamics

Recall equation 13a and 100km/sec metric quantization, 1km/sec metric quantization and 20m/sec metric quantization speeds of part 6. Here we show that the 1km/sec metric quantization plays an especially important role in the sun. For example there is a jump in speed at the tachocline of 1km/sec.

Tachocline Metric Quantization

The same metric quantized speed of 100km/sec, 10^6K=T also applies to the tachocline temperature, the bottom of the solar convection zone (S=W+U, P/T=ρ, PdV=W; So T,U held. Given ρ drops with greater radius r, then P drops, so added convective change in volume dV, etc., at the larger r since S constant). There is a super high temperature next to a much lower temperature at the tachocline and the tachocline is at 1km/sec metric quantization motion also with the overlying layer slower implying that at the tachocline the Reynolds number must be high because of the two different velocities next to each other at that radius. These large temperature and velocity gradients right next to each other explain why there is a convection zone.

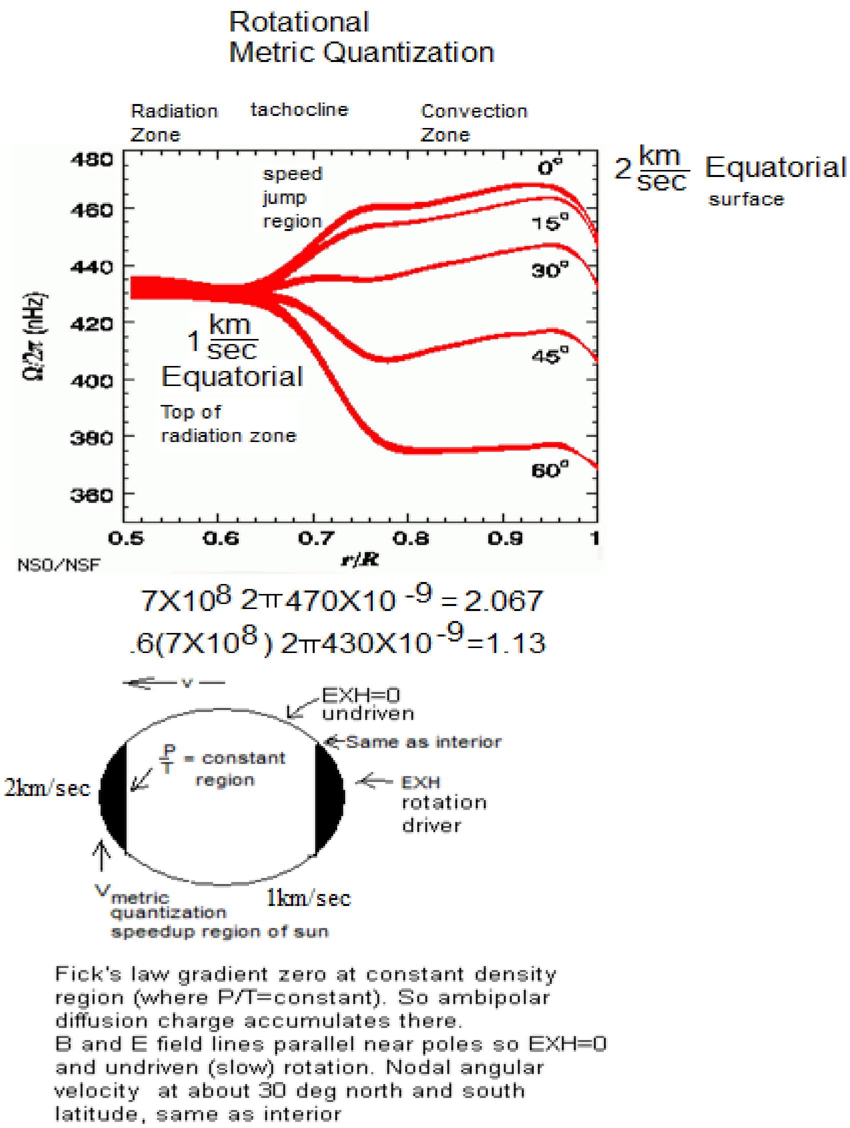

Figure 1

Note that the Tachocline exists between 0.68 and 0.72 r/R. Note that in .7R-.8R region that $E_{radial}XB_{dipole}=0$ at the poles so there is no differential rotation there. $E_{radial}XB_{dipole}$ is maximum at the equator. Below we use the values of Ω above the top of the tachocline at about 0.8R. From the above graph we have 460nHz rotation at 0deg equator and 430nHz at 30deg at 0.8R. Note that 30 deg is the latitude of 0 differential rotation. What if we increased the angular velocity at 30 deg to 460nHz, what would the speed be? The difference in these speeds we define as differential rotation.

$$7X10^8X2\pi430X10^{-9}\cos30=1638m/sec$$
$$7X10^8X2\pi460X10^{-9}\cos30=1752m/sec$$
$$1752-1638=114m/sec.$$

Recall also that metric quantization requires that there exist a grand canonical ensemble (thus a chemical potential exchange of energy between physical systems) at some point in the formation of the system for the conservation of energy to also hold.

Stellar Equatorial Speed Metric Quantization And The Instability Gap

Recall metric quantization results in stability, here for O, B A and G K M stars. This implies that the intermediate classes of stars should be unstable. This is the instability region of the HR diagram, see below.

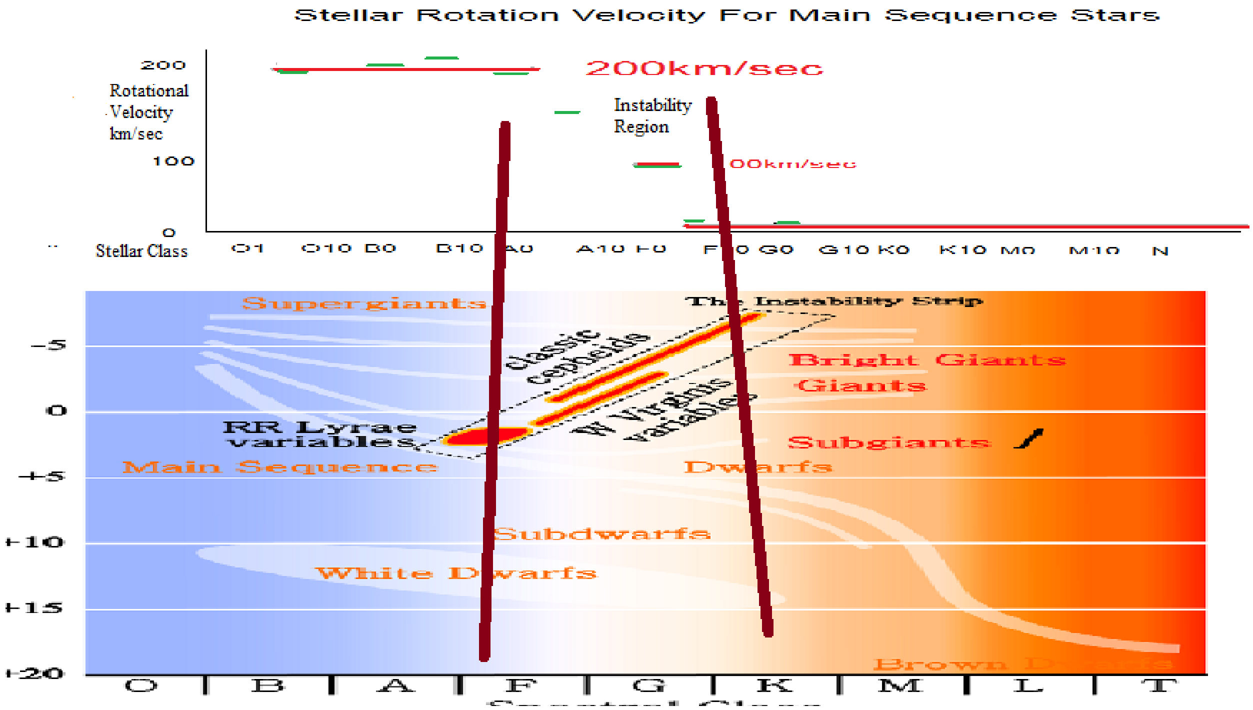

Figure 2

Figure 2 is a compilation of average stellar equatorial velocities for main sequence stars also showing an unambiguous metric quantization at 200km/sec.

Hand waving arguments about the opacity of HeII (using the κ mechanism) are the usual explanation for this instability gap. But note how the metric quantization jump region(first graph in figure 2), where instability is to be expected, overlaps the instability gap in the spectral classes on the HR diagram. Metric quantization is clearly the reason for the instability as we see above, not the opacity of HeII. The brighter Cepheids for example are nearer the right edge of the instability strip so are more stable and so at a lower frequency.

There is a lower velocity metric quantization, and so stellar stability, for main sequence stars K→M at about 2km/sec on the right side of the figure A2 which is what actually starts out the Δv=1km/sec differential rotation of the sun relative to the 1km tachocline rotation. The B field component we stated was responsible for the differential rotation is instead actually then *derived* from this metric quantization effect. The motion relative to that ambipolar diffusion charge layer already must exist for the B field to effect the co-moving convection zone plasma.

Placed one on top of the other we see that the instability strip.

Neutron Stars

Neutron stars are created in supernovas. The neutron stars initially rotate at about 100km/sec in the outer layers and end up rotating, after many years, at 1km/sec in the inner layer.

The core temperature is about 2,000X the surface temperature in a mature neutron star that has slowed down to the limiting rate of rotation thereby implying it has the highest interior pressure and energy density of its life cycle. There then has to be those six P states derived in part I since we have reached the highest possible (P state) energy density inside. There are then 6 distinct fundamental particle layers with 6 distinct angular momentums with the inner most layer rotating at 1 km/sec and so the outermost (given the 6 consecutive P state layers) layer rotates at 6km/sec in consecutive 1km/sec increments implying a 11sec rotation period for a 12km radius neutron star. These particular range of rates of rotation are due to limitations on the angular velocity increase in a supernova and hence due to the initial angular momentum..

Note then that the bottom layer 1km/sec rotation rate and those 6 layers limit the final rate of rotation rate to 6km/sec which corresponds for a 12km radius star to a rotational period of about 11 seconds. There is then a limiting rotation rate of neutron stars of about 11 seconds per rotation which they attain after many years.

By the way the outer layer would have the usual neutron drip radius, etc..

Note that metric quantization dominates the physics of neutron stars!

So what has actually been observed? Well, the limiting rotation rate of neutron stars is 1 revolution per 11seconds and their initial equatorial speed is 100km/sec.

100km/sec drop To 1km/sec Just Above The Chromosphere

The 1km/sec $\rightarrow$100km/sec plays an especially important role in corona heating as well.

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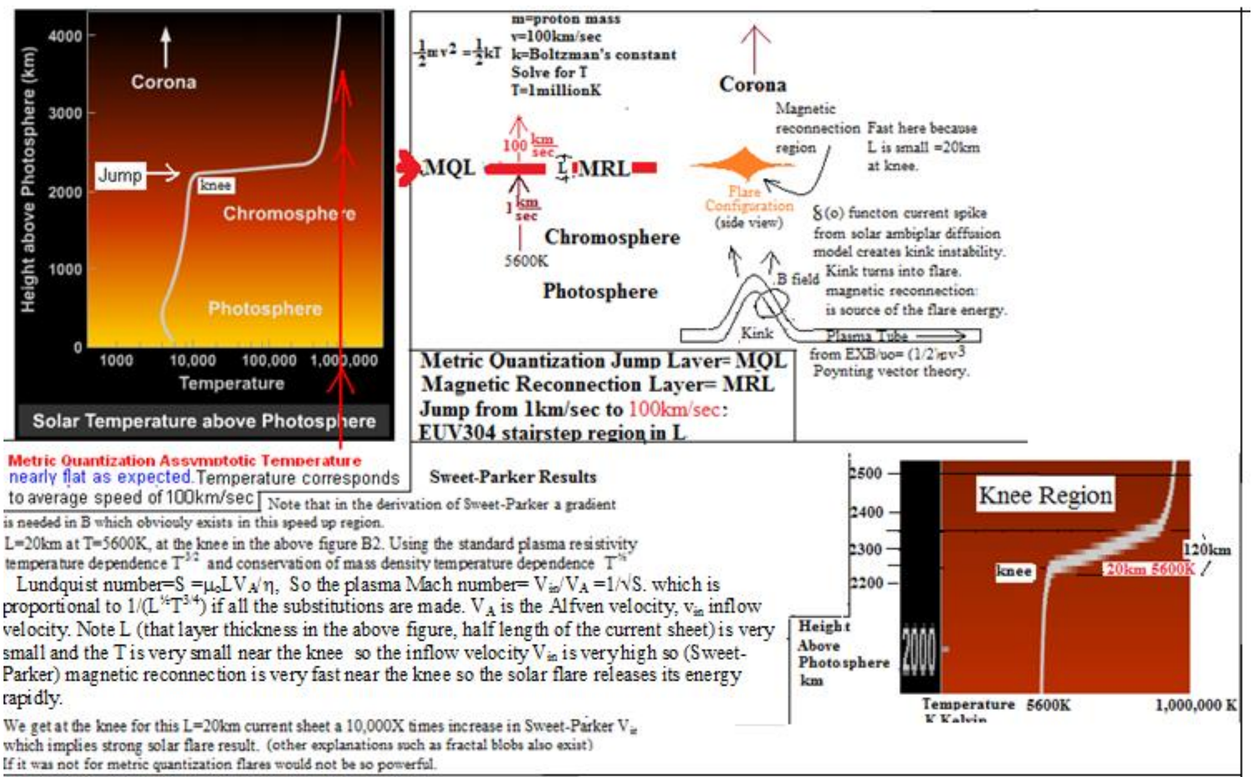


Figure 3

T=1,200,000K, k=Boltzman's constant, m_p =electron mass, solve $(1/2)m_pv^2=(1/2)kT$ for v and get 100km/sec. V=n100km/sec comes from object B metric quantization in the new pde.

that same metric quantized speed of 100km/sec, 1MK=T also applies to the tachocline, the bottom of the solar convection zone (S=W+U, P/T=ρ, PdV=W; So T,U held. Given ρ drops with greater radius r, then P drops, so added convective change in volume dV etc., at the larger r since

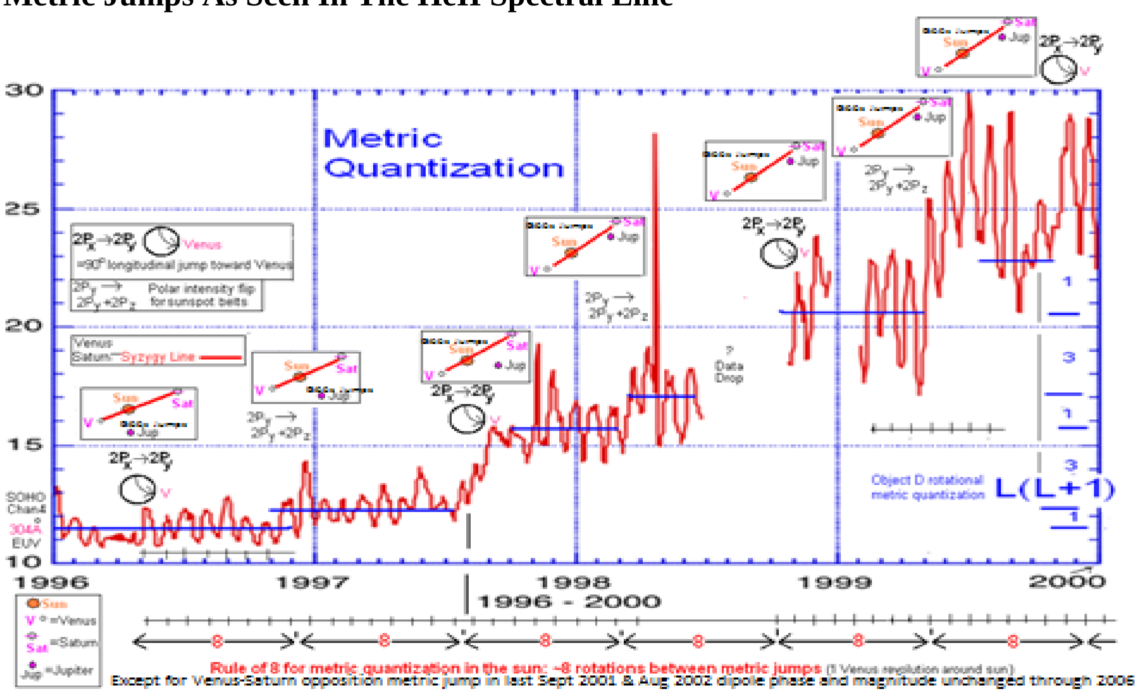
S constant) thereby explaining why there is a convection zone just as we explained above (again using the metric quantization 100km/sec, 1MK) the origin of the hot corona.

Sweet-Parker Theory Application

Note in Sweet-Parker theory that a gradient in the magnetic field is needed which obviously exists in that speed up region of length L=20km at T=5600K, at the knee in the above figure B2. Using the standard plasma resistivity temperature dependence $T^{-3/2}$ and conservation of mass density temperature dependence $T^{-1/2}$. We get at the knee for this L=20km current sheet a 10,000X times increase in Sweet-Parker V_{in} which implies strong solar flare result.

Lundquist number=$S = \mu_o L V_A/\eta$, So the plasma Mach number= $V_{in}/V_A = 1/\sqrt{S}$. which is proportional to $1/(L^{1/2}T^{3/4})$ if all the substitutions are made. V_A is the Alfven velocity, v_{in} inflow velocity. Note L (that layer thickness in the above figure, half length of the current sheet) is very small and the T is very small near the knee so the inflow velocity V_{in} is very high so (Sweet-Parker) magnetic reconnection is very fast near the knee so the solar flare releases its energy rapidly. Large L s, farther away from the knee, don't give as high probability of flares since they are at high temperatures T. Thus metric quantization is responsible for the high flare intensities.

Metric Jumps As Seen In The HeII Spectral Line



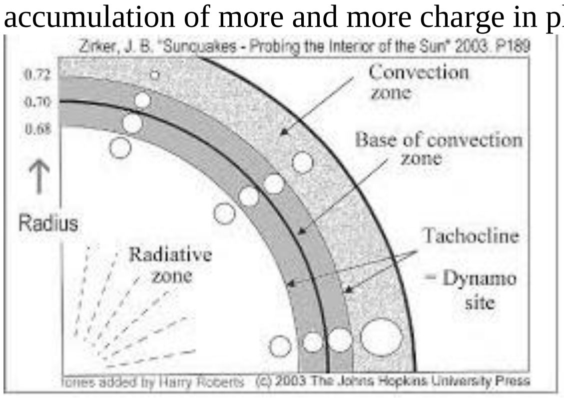
Appendix

Implications Of Metric Quantization In the Sun Concerning Tidal Sensitivity

Recall Biermann's battery component $d\mathbf{B}/dt = kbc\nabla n_e X \nabla T/(n_e e)$ Also the equatorial tachocline transition from 1km/sec to 2km/sec has a high Reynolds number given the hot radiation zone transition there. Thus there is higher convection and so higher temperature gradient∇T north and south of the equator since convection is a more efficient method of heat transfer than conduction or radiation. This effect is also responsible for the multiple plasma "conveyer belts" beneath the

photosphere. n_e is the same density as the protons at the tachocline (because of complete ionization at the tachocline) and so∇n_e merely points out along the radius, the usual density gradient direction. So ∇n_e is radial and∇T has a large component that points north and south of the equator so that $k_b c \nabla n_e X \nabla T/(n_e e)$ is not zero just north and south of the equator. Note also that the cross product of $\nabla n_e X \nabla T$ is clockwise in the northern hemisphere (looking down from the north pole) and vice versa for the southern hemisphere so a current loop is effeciently created. Note that Faraday's law implies that tidal forces changing the area of this current loop increase this current half the time and suppress it half the time. Hence the origin of the solar cycle given a ~11 year Jupiter- tidal syzygy interaction . So there is a Biermann's battery initial current plus a later more long lasting Faraday's law induced current. At around 30° the feedback mechanism (see below) helps form the resulting current loop plasma tubes and the associated magnetic fields giving that feedback effect. At 45° however there can be no feedback mechanism since the 1km/sec metric quantized speed region is at the sun's surface implying low Reynolds number implying no latitudinal motion to create these currents and magnetic fields.
Given this circumferential plasma tube current we can then use the motion of the sun about the solar system COM to explain the solar cycle and we will use the rate of change of the solar tides in conjunction with Faraday's law to derive the cause of solar flares using this model.
The multiple rates of change of these electrical currents give current spikes at certain times effecting the dP/dr MHD equation term allowing the derivation of a large Suydam kink instability in these plasma tubes and therefore deriving the times of solar flares.

A feedback loop with the resulting magnetic field allows these currents to be concentrated into plasma tubes. Since the top of the tachocline is moving relative to the radiation zone this charge creates a current and so a magnetic field feedback mechanism, that along with the conveyer belt effect and high conductivity for the radiation zone (applied to mid latitudes here) allows the accumulation of more and more charge in plasma tubes.



Feedback Mechanism
Feedback Mechanism

Note with infinite conductivity no electric field and hence no charge accumulation is allowed in a conductor, (eg., a plasma) and so you obtain trivial ambipolar diffusion drift at the ion speed of sound. That is because the standard theory of Fick's Law diffusion assumes *no rotation* for the electrons on the outer part of the plasma and no large change in temperature and so in that theory the electrons and protons both end up moving at the speed of sound of the ions $v_s=\sqrt{(kT/m_p)}$.
The metric quantization jump from 1km/sec to 2km/sec near the solar equator tachocline creates a higher Reynolds number and so higher convection (which is more efficient at heat transfer) and so a higher temperature near the solar equator. So there is a latitudinal temperature gradient

along with the usual radial pressure decrease. This then implies a Bierman battery electrical current since a Bierman battery current is created when, as in this case, plasma temperatures and pressure gradients point in different directions. But the Biermann battery provides a temporary pchange in B field and electrical currernt and we do have a differential rotation of the equatorial convection zone and a large temperature increase in the radiation zone. That allows nontrivial charge diffusion. See below.

1) This Biermann battery current creates at first a relatively small moving charge at the tachocline Q_i and so an associated current I_1 given the 1km/sec metric quantization increase in speed of the convection zone relative to the tachocline motion. In that regard recall that the amount of charge moving above the tachocline depends on the Biermann battery efficiency but also on plasma conductivity in nonhomogenous ambipolar diffusion: the lower this conductivity the higher the charge accumulation (Using $E\sigma=j$, $E=Q/dC$, $C=4\pi\varepsilon_o/[1/a-1/b]$, a inner, b outer radius respectively, b-a=d].

2) Biermann battery current I_1 thereby creates a yet larger magnetic field B_1 according to Amperes law. Thus this feedback mechanism favors the formation of locally large magnetic field regions, *hence it is the reason why the equatorial plasma tubes exist*. In that case recall that the magnetic field falls off with $B=\mu_o I/2\pi r$ (not with $1/r^2$) around a long plasma tube so it is still very powerful even at a long distance away from the tube making this tube-feedback effect very powerful

4) Also recall that a magnetic field perpendicular to the direction of charge flow acts as a source of (magnetic) Ohmic resistance through the q(vXB) =force, thus lowering the conductivity of a plasma in the direction of charge flow.

5) This charge adds even more current, creating a larger magnetic field, ad infinitum in what constitutes a Feed Back Mechanism because there is a nontrivial relative motion and temperature differential here. So there is a feedback mechanism that in contrast does create a equatorial tachocline current in the sun. The H^2 dependence makes this a diverging process that can only quit when the current is the same as the Faraday's law plus Biermann currents

Because of the direct dependence of the B field on the current and the added change in the charge magnitude on the B field squared this is not a converging (to zero), die off, feedback mechanism. It will only level off when the diffusion charge flow rate equals the circumferential rate of flow of charge.

6) Given this circumferential plasma tube current we will then use the motion of the sun about the solar system COM to explain the solar cycle and we will use the rate of change of the solar tides to derive the cause of solar flares using this model with the solar cycle (Figure 1) component of this derivation.

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Battery Analogy

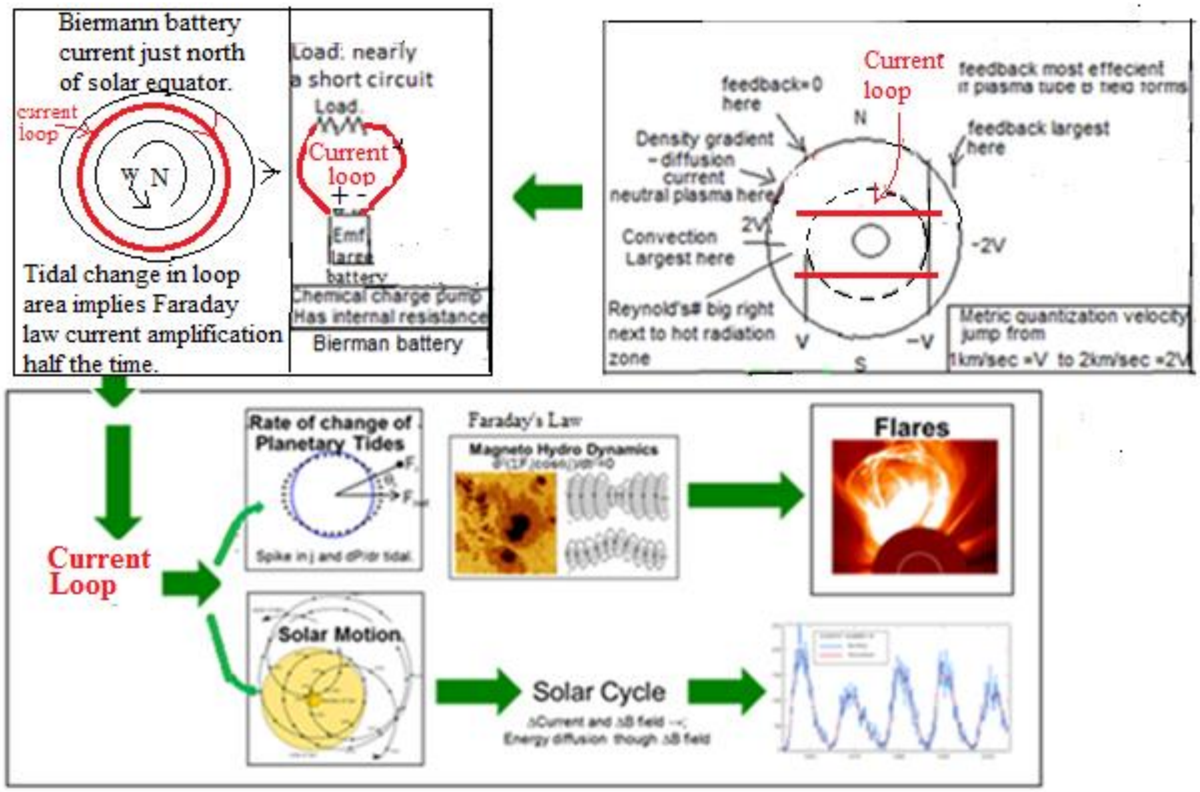


Figure 1. Dependence of Solar Cycle and Flare Times on Charge Diffusion and Solar Motion

1.0 Large Solar Motion about the COM of the Solar System as Source of the Solar Cycle

We begin by noting that ambipolar charge diffusion model assumes a rotating charge, and hence, a (rotation induced) electrical current and resulting core magnetic B field relative to the faster moving more shallow components of the sun's radiation zone. We also note the large motion of the sun about the center of mass of the solar system (Figure 2). The sun can move its diameter about the COM in 12 years for example.

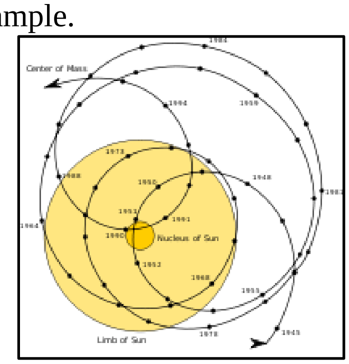


Figure 2. Barycenter (COM) Motion of the Sun

Saturn Effect on Sun's Motion about the COM of the Solar System

On average Saturn is in syzygy with Jupiter *twice* over the time Jupiter moves between perihelion and aphelion *once* (Figure 3). Thus it increases solar COM speed at syzygy Jupiter opposition and decreases it on the other side resulting in a net 2X Saturn effect. Thus the ratio of their respective Δgravity COM forces on the sun is equal to:

$$\frac{2\frac{GM_s m_{sat}}{r_{sat}^2}}{\frac{GM_s m_{jup}}{r_{jup-peri}^2}-\frac{GM_s m_{jup}}{r_{jup-aph}^2}} \equiv 2F_{sat}/F_{jup} \approx .901$$

where F_{jup} is difference in Jupiter's gravity (on the sun) from aphelion to perihelion.
Thus adding all these COM motion effects gives Saturn nearly an equal COM Δsolar motion contribution to Jupiter's. Therefore we can add the two COM effects directly as we will do in the dL/dt=0 (Fick's law B diffusion flux) method of the next section:

$$2(1/2)\sin\omega_1 t + \sin\omega_2 t = \sin\omega_1 t + \sin\omega_2 t = 2\sin((\omega_1+\omega_2)t/2)\cos((\omega_1-\omega_2)t/2) \text{ ,thus}$$

$$(\omega_1+\omega_2)/2=\omega=2\pi/T, \text{ So } T=10.8 \text{ years (Solar Cycle Period)}$$

Including lag of Uranus and Neptune 10.8→11 years

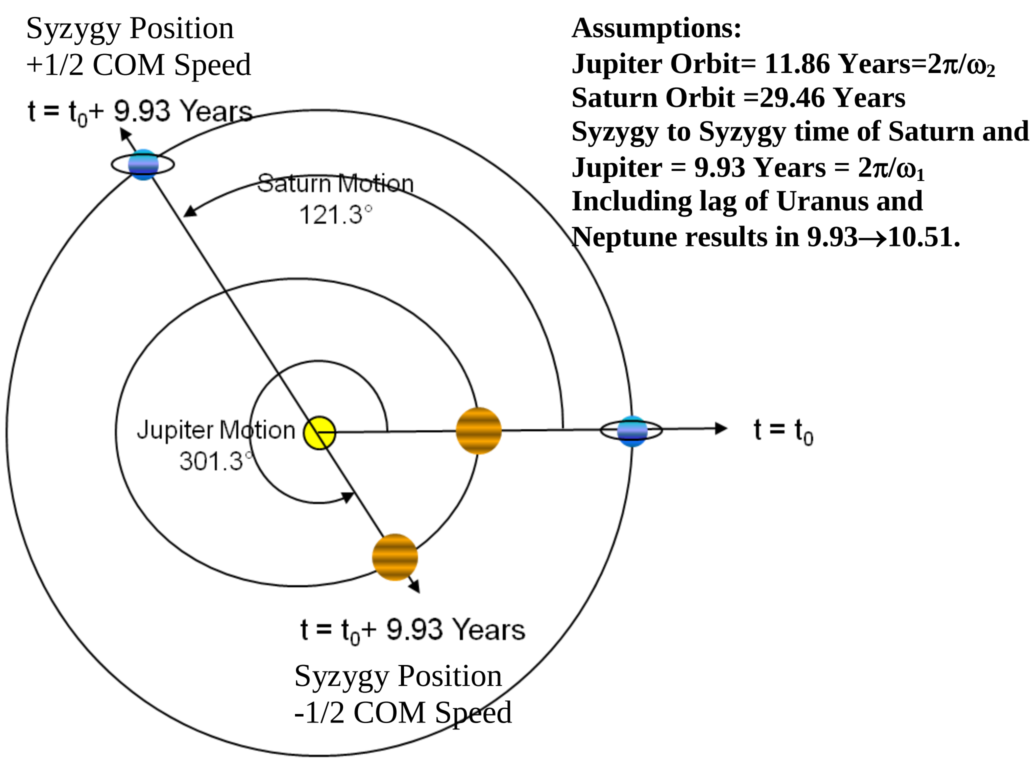
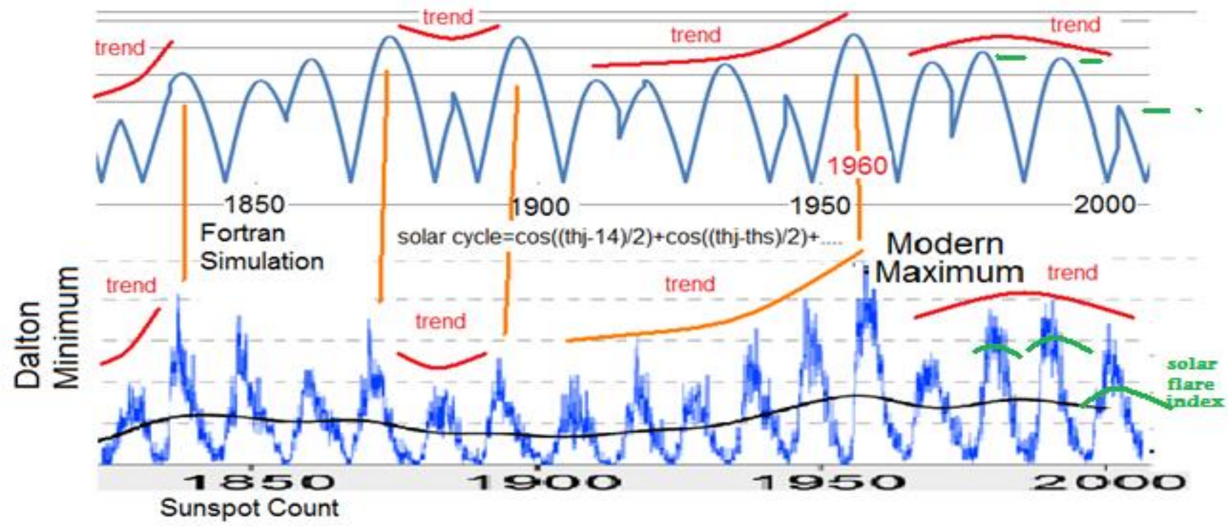
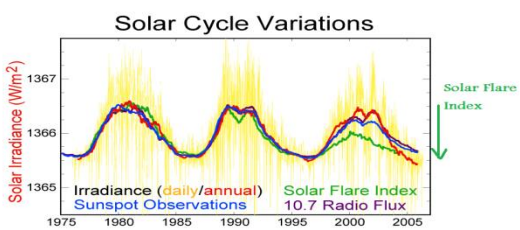


Figure 3. Saturn and Jupiter Syzygy

Using this information and combining it with the force associated with the tidal effects of the planets ($\Sigma F_i|\cos\theta_i|$ in equation 1 below, sine terms from above), one can predict the solar cycle:

$$|(\partial^2(\Sigma F_i|\cos\theta_i|)/\partial t^2) - C|\sin((\omega_1+\omega_2)t/2)\cos((\omega_1-\omega_2)t/2) = \text{Solar cycle} \quad (1)$$





Solar flare index lower for cycle23

Using the Sun’s Motion about the COM to Explain Solar Cycle Magnitude

Movement of the sun about the center of mass (COM) of the solar system creates a current j due to the charge movement whose magnitude changes as a function of where the sun is relative to the COM. The largest delta for the magnitude of this current occurs when Jupiter is at aphelion. If the sun is rotating at an angular velocity greater than its own COM angular velocity about the solar system COM the difference in the distance moved (from perihelion to aphelion) in a given amount of time by the farthest point (from the COM) is twice as great as the solar center if the COM of the solar system is located near the solar photosphere. So the change in the motion of the part of the sun farthest from the COM is larger than the change in motion located on the sun that is closest to the COM. Near surface plasma motion relative to the electrical current around the sun’s core creates an effective B field change. This results in an increase in the magnetic field caused by the core current which results in less Fick’s law charged particle diffusion from inside the sun and thus the change of the solar flux output characteristic of the solar cycle. Here we will calculate these plasma motion changes and the resulting changes in the magnetic field that electrical current change creates. The result will be the fractional change in the solar flux over an entire solar cycle.

Physical Parameters Used in Calculating Solar Cycle Magnitude

M_{sun} =2X10^{30} kg = mass of sun
M_e=6X10^{24} kg = mass of earth
M_j=318Xm_e = mass of Jupiter
e_j = .04875=Jupiter’s orbital eccentricity
Pj =11.859X365.256363X24X3600 sec = Period of Jupiter’s orbit
G=6.67X10^{-11} Nm^2/kg^2 = Universal gravitational constant

r_{jo}=7.4X10^{11}m = radius of Jupiter's orbit
r_{sun}=7X10^5km =radius of sun's orbit about the COM of solar system

Determining the Rotational Velocities of the Solar Surface Using Conservation of Angular Momentum

For Jupiter going from perihelion to aphelion use angular momentum conservation dL/dt=0 i.e., $r_1v_1=r_2v_2$: We first determine the distance of the center of the sun from the solar system center of mass x:

$$(M_sx+M_jy)/(M_s+M_j)=0=(2*10^{30}x+1.91*10^{27}*7.4*10^{11})/(2*10^{30}+1.91*10^{27})$$
$$2*10^{30}x=1.41*10^{39}$$
x=707000km (distance of the center of the sun to the COM of solar system)
$$2\pi r_{large}/(11.86X365.25X24X3600) = 4.4X10^9/3.74X10^8$$
$=11.76$m/sec$=v_1$ (speed of Sun at aphelion)
$v_1r_1=v_2r_2$ (conservation of angular momentum)
$$11.76*7.07*10^8=7.07*10^8 \text{ X } 11.7\,6/(1+.04875)]=7.4*10^8*v_2$$
v_2=12.33m/sec (speed of Sun at perihelion)

Rotational Velocity of Sun

The baseline stellar rotation rate, the speed of the sun's equator, is approximately 2000 m/s= $2\pi r/T=2\pi(7.07X10^8)/(2.19*10^6)=2X10^3$ m/sec (sun's equatorial speed, appendix also)
The added effect of the velocities calculated in the above section on the sun's equatorial speed is shown below:

2000+11.76=2011.75m/sec (at aphelion)
2000+12.33=2012.4m/sec (at perihelion)
[(2012.33-2011.76/2012.4]100=.028% =Percent difference

The net effect result of v_1 and v_2 on the sun's equatorial speed is doubled because we are at the point farthest from the COM (2X.0003=.06%). The effect of Saturn going through syzygy with Jupiter is about .901 of this Jupiter perihelion-aphelion effect so the net effect is about double ~ 2X.0006=0.12%. But the effect is distributed only over about half the sun so we divide by 2 to get .0006. Also note that the high energy particles participating in high energy interactions such as X ray, EUV, UVC emission are more sensitive to magnetic field diffusion and are also the biggest contributors to changes in the solar cycle.

Fick's Law Applied to Charge Particle Diffusion through a Magnetic Field

Recall Fick's law of diffusion where J is the diffusion current, D is the diffusion coefficient, $\partial\phi/\partial x$ is the density gradient which is essentially constant here:

$$J=-D\partial\phi/\partial x$$

Also recall that diffusion through a magnetic field μ_oH is given by(1):

$$D=cnkT/(\sigma H^2)$$

where D is again the diffusion coefficient, c=speed of light, n=particle density, σ=conductivity of plasma, H=magnetic intensity, T = temperature, k=Boltzman's constant. Note in Fick's law the diffusion current J is proportional to D. Also the average of 10 year Saturn syzygy effect with Jupiter and Jupiter perihelion-aphelion motion given Saturn's smaller contribution gives the 11 year solar cycle.

The electrical current j around the solar equator is proportional to these rotational v_1 and v_2. From Ampere's law: $\nabla XH=j/\mu_o$. so the j=KH; thus:

$J_{Max}/J_{Min}=1/1/CH_{Min}{}^2/1/CH_{Max}{}^2=1/1/v_{Min}{}^2/1/v_{Max}{}^2=1/K(1)^2/1/K(1+.0006)^2=1+2(.0006)=1+.0012$

The sun is taken to be a solid body with the solar system COM right near the solar surface. The magnetic field changes are then affecting the more slowly rotating deep interior. So we get for the solar flux ratio between solar max and solar min:

$$J_{Max}/J_{Min} = 1+.0012 \text{ or } \approx .1\% \qquad (2)$$

Thus we have a .1% radiance solar luminosity difference between the sun at solar min and the sun at solar max which is what we would expect. *The motion of the sun about the solar system COM is large enough to explain the solar cycle.*
A generic graphical representation of this computation of motion about the COM can look like:

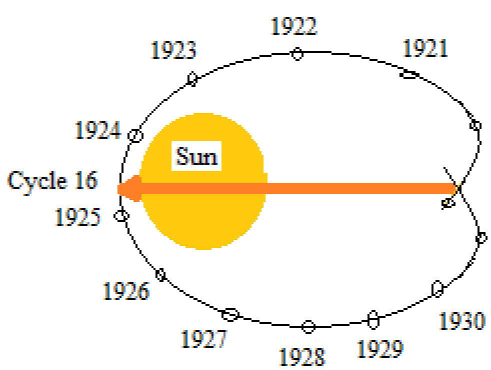
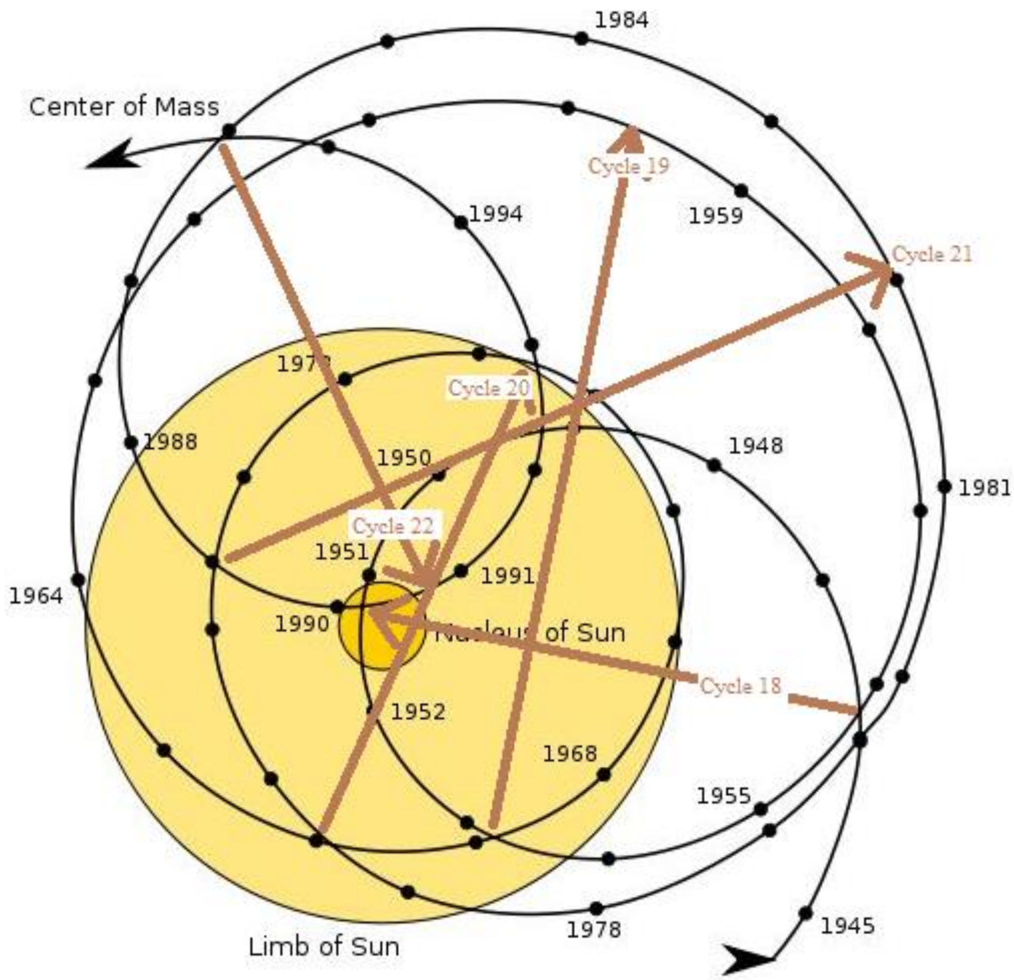
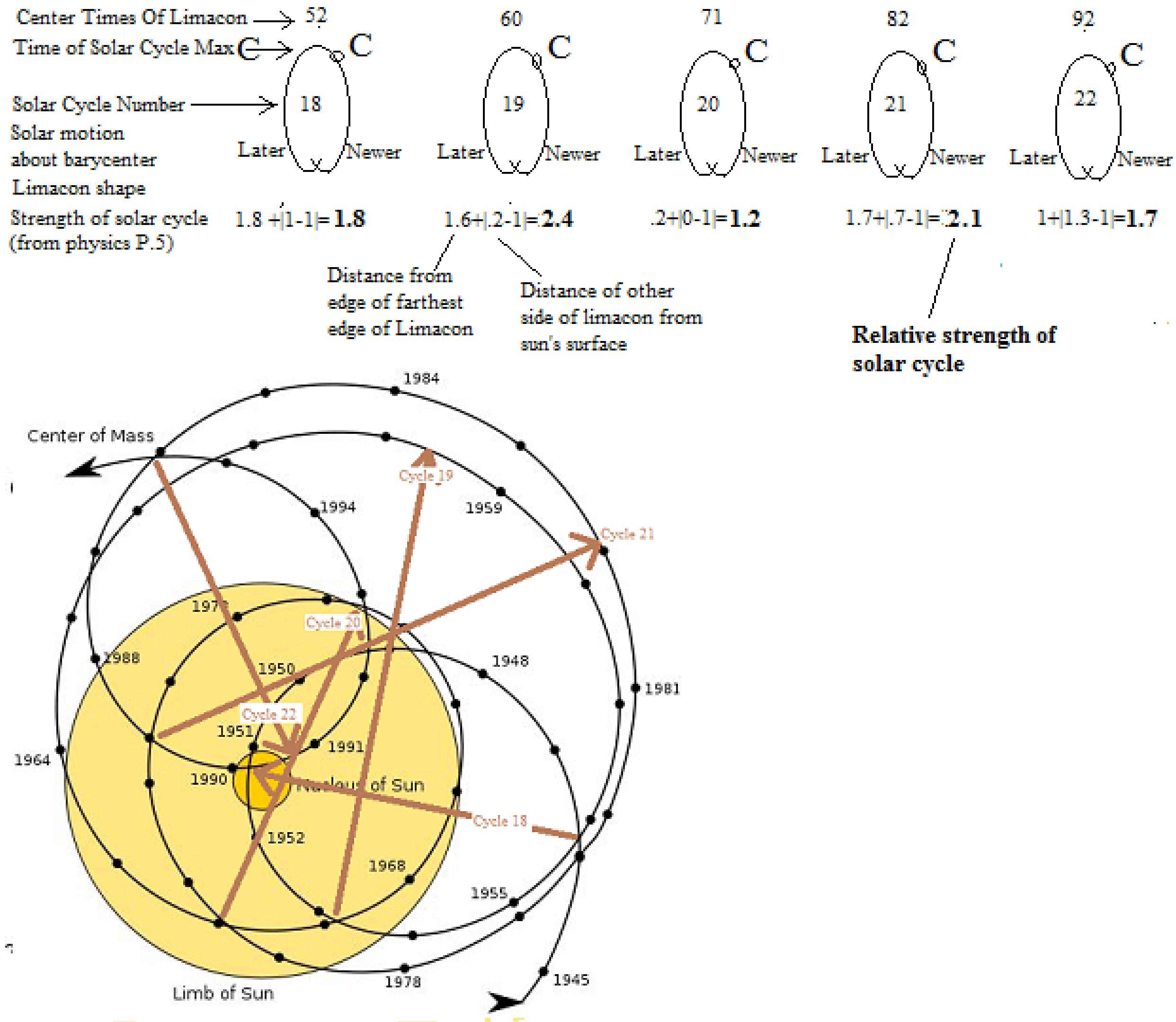


Figure 4 Generic fictitious sun COM motion (closed loop) for given just Jupiter motion from its aphelion to perihelion and Saturn orbital motion as outlined in the above derivation: Note that one such limacon corresponds to each solar cycle implying solar COM motion is indeed the cause of the solar cycle In the actual COM motion of all the planets and the sun we that each solar cycle has its own such closed loop limacon:

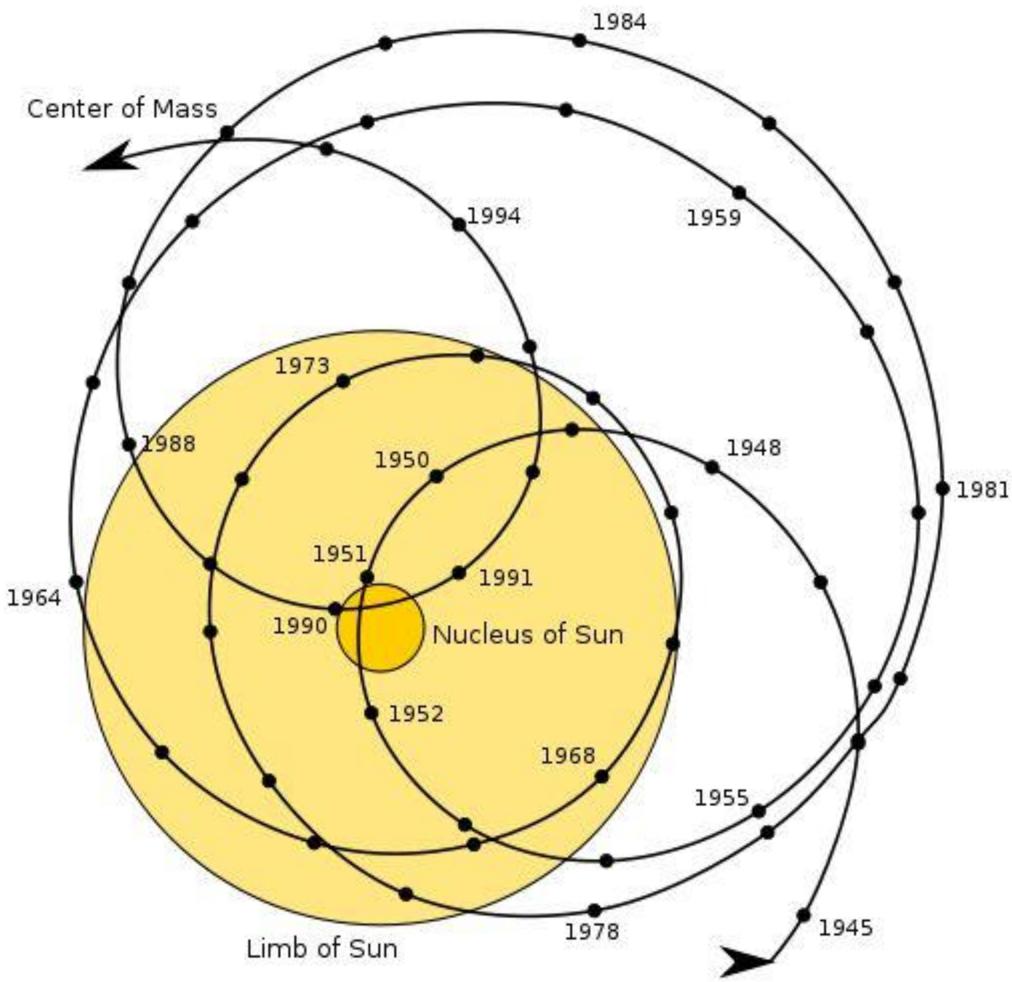


The figure 4 variation in solar COM due to Saturn motion and Jupiter perihelion to aphelion motion was first introduced in the article:
I.R.G.Wilson, et al
Does a Spin-Orbit Coupling Between the Sun and the Jovian Planets Govern the Solar Cycle?
CSIRO Publications of the Astronomical Society of Australia 2008, 25,85-93.

Summary Of Solar Cycle Magnitude Results Using This Limacon Shape
Note the above section on the rotation of the solar surface implies that the equatorial current is roughly proportional to how close the tachocline is to the solar system COM (barycenter) thereby allowing us to calculate the magnitude of the effects of planetary motion on that current.
Thus from the conservation of angular momentum to have a maximum change from low to high points in the solar cycle the farthest edge should be “far” and the nearest edge close to that point. Thus the distance from the edge of the farthest edge of the limacon plus the absolute power of the distance of the other side of the limacon from sun’s surface minus the sun’s radius gives a measure of the magnitude of the solar cycle normalized to our above equation 2 calculated value. Note also that the time of the maximum of the solar cycle is given by the point nearly opposite of the limacon line intersection point.



Note that each solar cycle has its own limacon shape which is yet further proof of the cause and effect connection of the solar cycle and the rate of change of tides.



Motion of solar system Center Of Mass (COM) Relative To The Sun

Results of Ambipolar Diffusion Model and Motion About the COM

Jupiter's motion between perihelion and aphelion and the 2X Saturn-Jupiter syzygy effect gives not only the *magnitude of that change of solar flux over a solar* cycle but *also the correct average period of the solar cycle*.

So we have used our new solar ambipolar charge diffusion model to explain both the solar cycle change in luminosity and to find the average period of the solar cycle given the sun's motion about the solar system's COM. Next we discuss how the ambipolar diffusion model and the rate of change of solar tides give solar flares.

2.0 The Rate of Change of Solar Tides as the Cause of Solar Flares

The Effects of Planets on Solar Events Mentioned In The Literature

Many others have identified a relationship between flares and planetary positions (2,3,4,5,6,7). For example Arthur Shuster in 1911 found correlations between various solar events and heliocentric longitudes of Mercury, Venus, and Jupiter at the time of the event (*The Influence of Planets on the Formation of Sunspots*, proceedings of the Royal Society of London). Glyn Wainwright, Leeds UK, performed a Fourier decomposition of the sunspot cycle and found that one of the leading terms had a periodicity corresponding to the tidal force of the planets on the sun (New Scientist, March 20, 2004). Ching-Cheh Hung in his article "*Apparent Relations Between Solar Activity and Solar Tides Caused by Planets*"(8) indicated that "**variation in the tide potential** (the time derivative in our equation 1 below**)**, not the magnitude of the tides", determine the tidal effect. Hung uses a parameter he calls an "alignment index", **$|\cos\theta_i|$,** to predict solar events (also a coefficient in our equation 1 below), where θ_i is the angle between the net planetary force and the given i^{th} planet. This 'rate of variation in the planetary tides' and planetary 'alignment index' are also at the core of our method for predicting the occurrence of solar flares.

Evidence of Solar Tide Effect On Flares

Tidal forces typically create bulging, or in this case flaring, on both sides of an object (diurnal) at once as we notice with ocean tides on the earth. In that regard we note that nearly all flares occur in pairs, occurring on both sides of the sun at once thereby implying a tidal effect. Examples of such occurrences are shown below in Figure 5

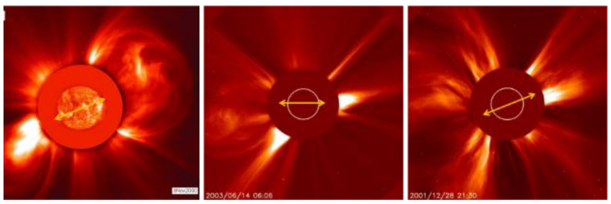


Figure 5.Two sided Simultaneous flaring

We did a study of 21 flares on the solar limb so that both front and back flares could be observed and found that within 24 hours of a given flare only one in 20 did *not* have a corresponding flare on the other side.

The Source of Solar Differential Rotation and Equatorial Plasma Tubes

Ambipolar diffusion in the radiation zone gave a negative charge layer at the tachocline and an associated E field and B field due to the rotational motion current j of this charge layer as later discussed in (below) section 3 of this article: $B=E/v_{diffusion}$. We will also find in (below) section 3 that the plasma tube velocity **v** from our solar differential rotation equation the Poynting vector flux

$$|EXH| = \tfrac{1}{2}\rho v^3$$

With this understanding of the origin of the equatorial plasma tubes we can then discuss their sources of instability.

Plasma Tube Instability

The ∇P term in Suydam's criterion(10) for kink instability of these EXH Poynting vector equatorial plasma tubes can be related to ∇P through the MHD equation:

$$\mathbf{r}JXB=r\nabla P+r\rho g-(g/|g|)R\rho T/M \text{ (the MHD equation(2)) with } A \propto F_i|\cos\theta_i|.$$

from equation 1. A new electrical current j_1 is created by the tidal effects of the long period outer planets through Faraday's and Ohm's laws:

$$-BdA/dt =V=Rj_1= kd|\cos\theta_i|/dt.$$

For the short period planets a change in this j_1 due to their planetary tides changes the B through Ampere's law[1] $\nabla XB=j_1\mu_o$ If all the other quantities (except for JXB and $\nabla P=dP/dr$) are constant in the MHD equation then $\nabla P \propto JXB$. Applying Faraday's law for the short term planets:

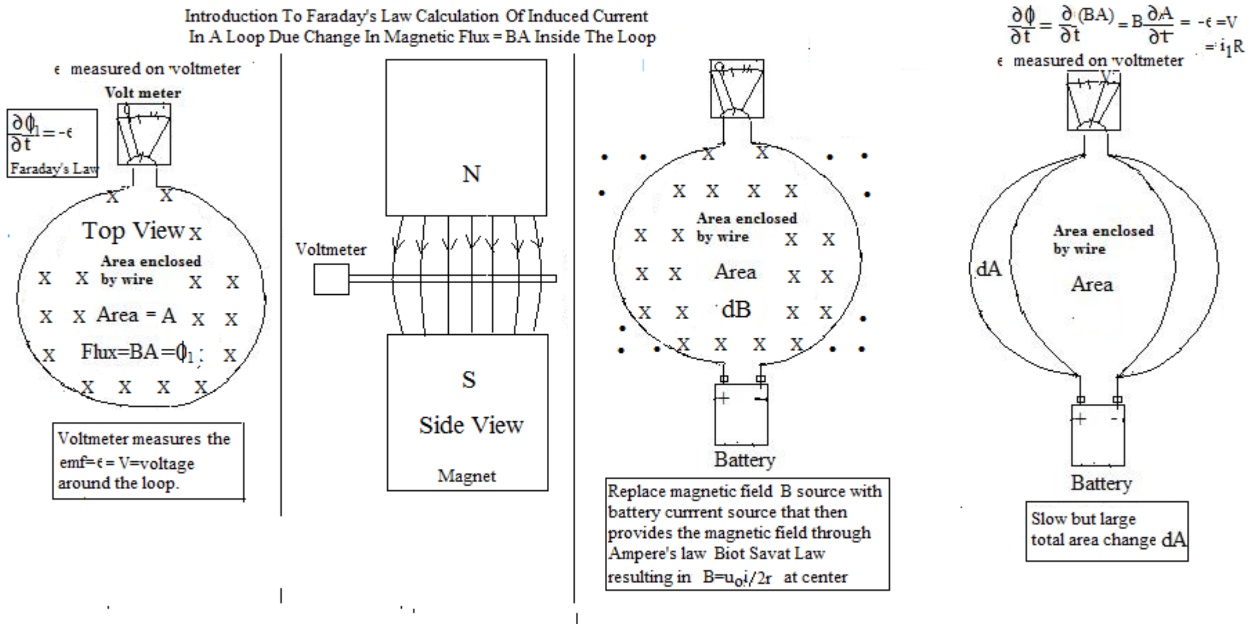
$$-AdB/dt =Kdj_1/dt=Rj_2 =d^2|\cos\theta_i|/dt^2.$$

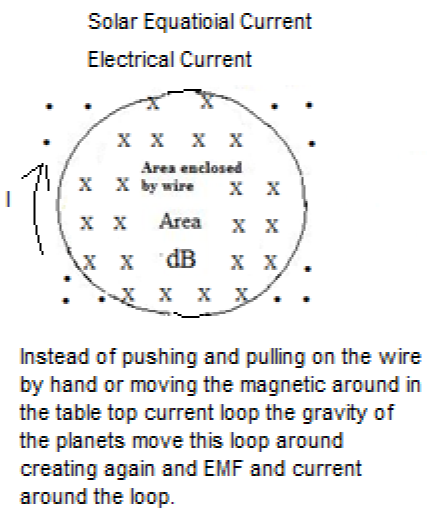
So in the MHD equation the rate of change of dP/dr is proportional j_2XB. Therefore:

$$dP/dr \propto j_2XB\propto d^2(F_i|\cos\theta_i|)/dt^2=k\delta(\cos\theta_i)=\text{delta function} \qquad (3)$$

$\cos\theta\approx 0$

dP/dr can become large negative because of that delta function spike and we then have satisfied Suydam's criteria (2) for the sausage instability and thus flaring.
It is also possible this outer planet effects let's say the earth (or Venus) by itself and then that resulting current is changed in the same way by Mercury let's say. You then have a **far smaller third derivative Id3 result** You could continue this kind of analysis again and again until you have at the end of it $(Id1+Id2+Id3+Id4+Id5+\ldots)^{\wedge 2}$ with the Id3 contribution being much smaller than Id2, Id2 being much smaller than Id1 as we also see is the case of the actual F10.7 data, etc.The first derivative of a Dirac delta function is still a spike and so should still cause a flare.





Equation 3 $\partial^2(\Sigma F_i|\cos\theta_i|)/\partial t^2)$ and Solar cycle $d|\cos\theta_i|/dt$

Note from equation 3 that $\partial^2(\Sigma F_i|\cos\theta_i|)/\partial t^2)$ =Jump in dP/dr. From the first section Define Id2= $d^2|\cos\theta_i|/dt^2$ for flares and Id1=$d|\cos\theta_i|/dt$ for above solar cycle. This is the statistics of the combined $(Id2+Id1)^2$ (+metric quantization compensation) fortran code –simulation output. Note from equation 3 then that flaring should occur most frequently when $\cos\theta_i=0$, $\theta_i=90$deg which we have shown to be true after finding many examples (Figure 6). Thus we use the alignment index times the planet force to determine when solar events will occur. Our θ_i is that angle between the net planetary force (e.g., solid red line below) and the given ith planet.

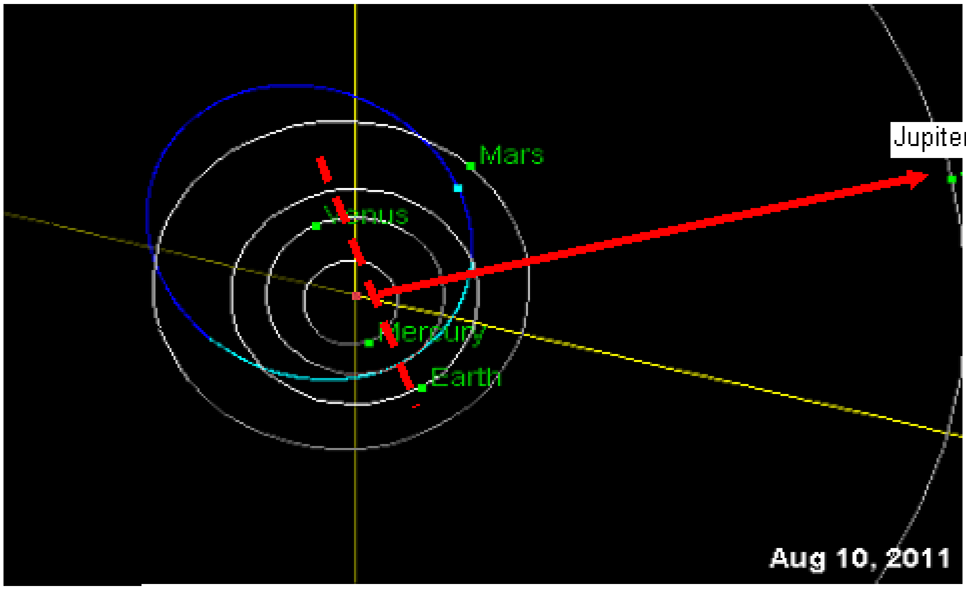
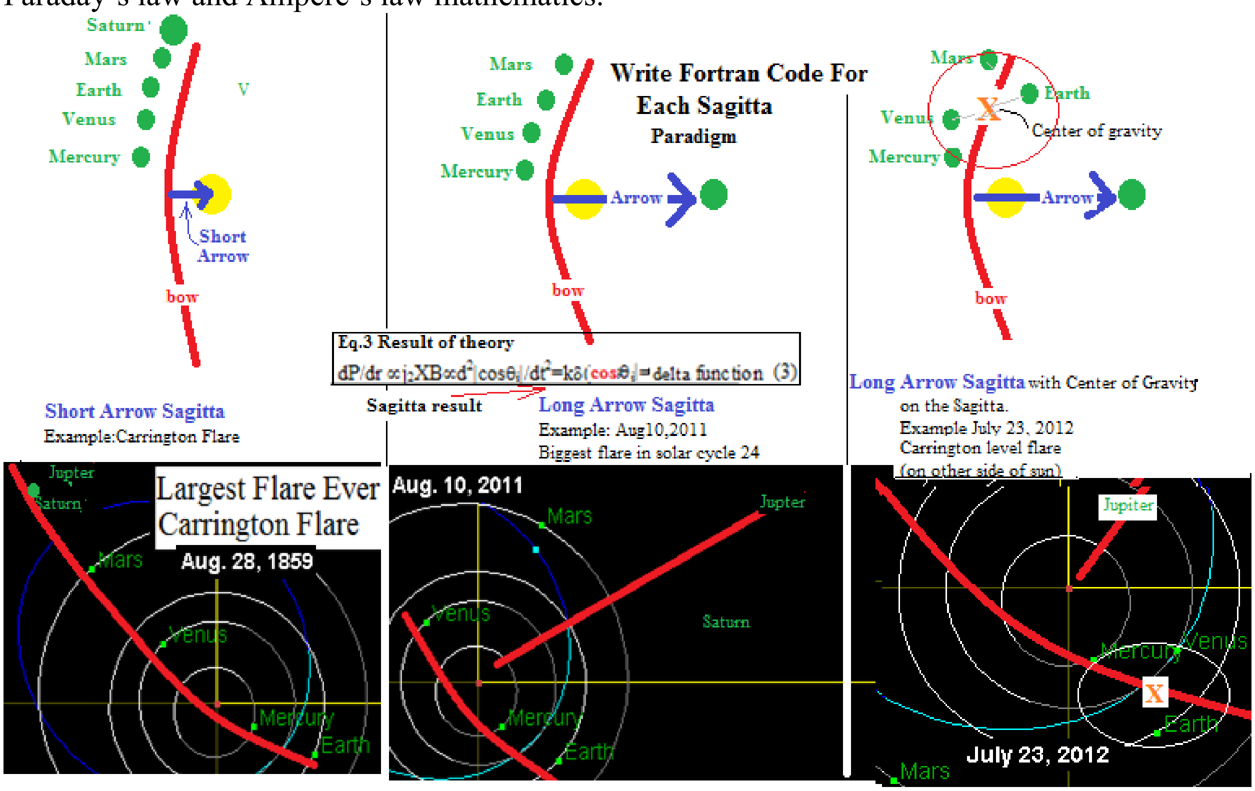
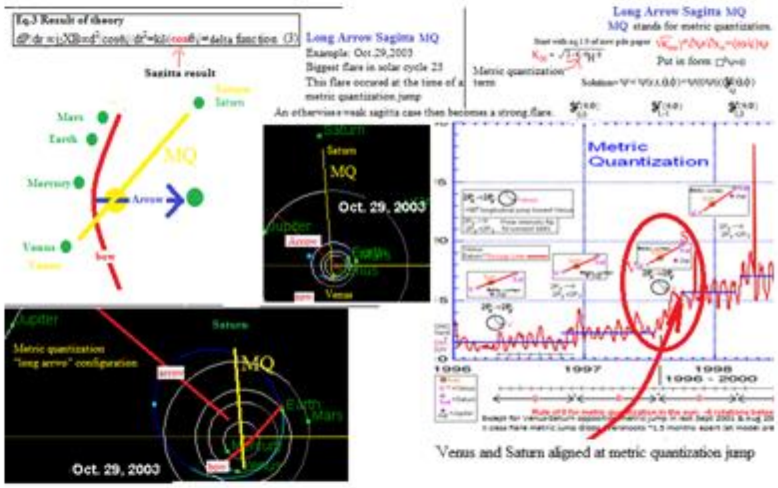


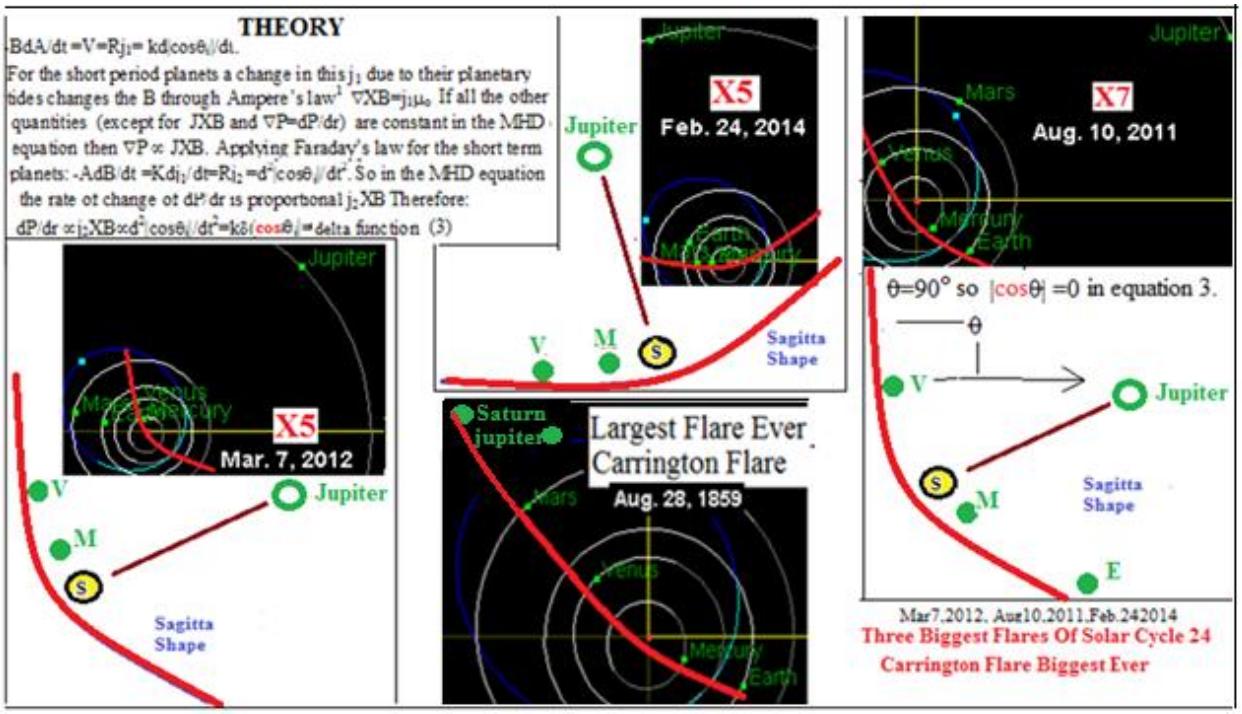
Figure 6. Alignment Index Example X6.9 flare Occurred On Aug.10,2011

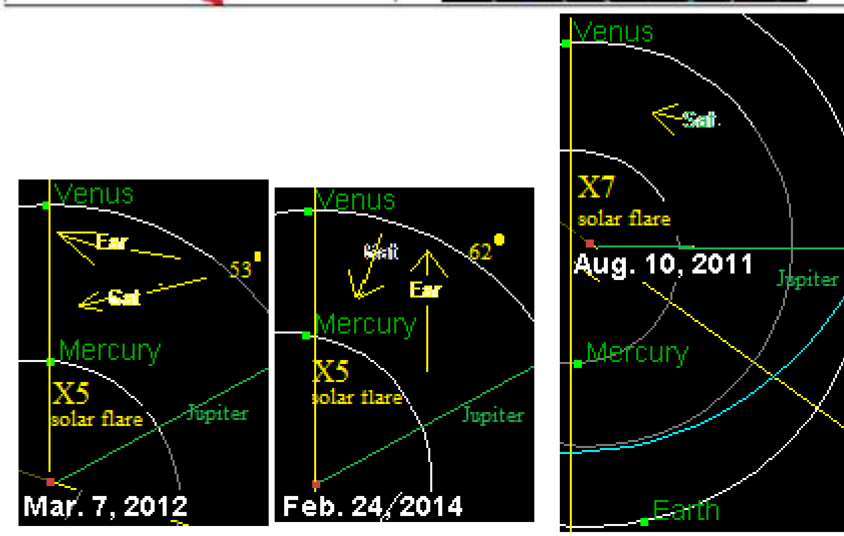
Note rare and near perfect sagittal alignment along dashed line of Mercury, Venus and Earth so that cos90°≈0 for each in equation 3. Note 90° angle between net (thick red line) and dashed red line to the positions of Venus, earth and Mercury. There was an X6.9 flare August 10, 2011, largest in all of cycle 24 so far. This is a strong reality check on the validity of the above Faraday's law and Ampere's law mathematics.

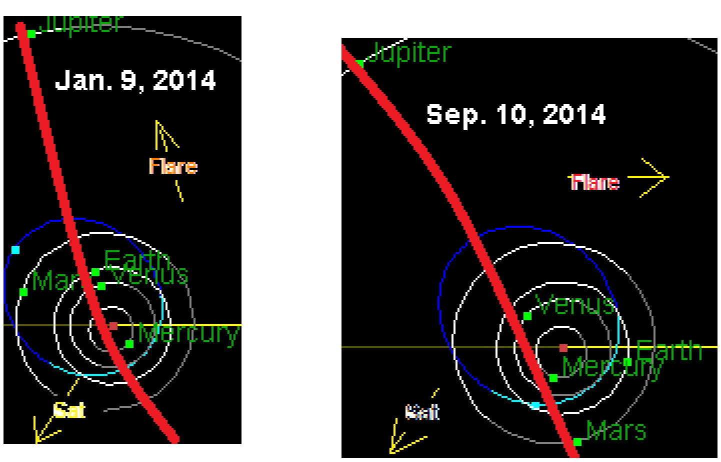


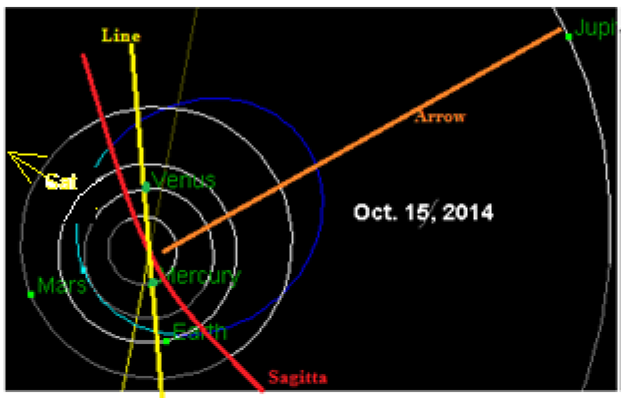


Venus and Saturn aligned at metric quantization jump


THEORY
BdA/dt =V=Rj1= kd|cosθi|/dt.
For the short period planets a change in this j1 due to their planetary tides changes the B through Ampere's law[1] ∇XB=j1μ0 If all the other quantities (except for JXB and ∇P=dP/dr) are constant in the MHD equation then ∇P ∝ JXB. Applying Faraday's law for the short term planets: -AdB/dt =Kdj1/dt=Rj2 =d²|cosθi|/dt². So in the MHD equation the rate of change of dP/dr is proportional j2XB Therefore:
dP/dr ∝ j2XB∝d²|cosθi|/dt²=kδ(cosθi)=delta function (3)
Jupiter
X5
Mar. 7, 2012
V
M
S
Jupiter
Sagitta
Shape
Jupiter
X5
Feb. 24, 2014
Jupiter
V
M
S
Sagitta
Shape
Saturn
jupiter
Largest Flare Ever
Carrington Flare
Aug. 28, 1859
Venus
Mercury
Earth
Jupiter
Mars
X7
Aug. 10, 2011
Venus
Mercury
Earth
θ=90° so |cosθ| =0 in equation 3.
θ
V
Jupiter
S
M
Sagitta
Shape
E
Mar7,2012, Aug10,2011,Feb.242014
Three Biggest Flares Of Solar Cycle 24
Carrington Flare Biggest Ever


Venus
Ear
Sat
53
Mercury
X5
solar flare
Jupiter
Mar. 7, 2012
Venus
Sat
62
Ear
Mercury
X5
solar flare
Jupiter
Feb. 24, 2014
Venus
Sat
X7
solar flare
Aug. 10, 2011
Jupiter
Mercury
Earth


Jupiter
Jan. 9, 2014
Flare
Earth
Venus
Mercury
Sat
Jupiter
Sep. 10, 2014
Flare
Venus
Earth
Mercury
Sat
Mars


Note to satisfy equation 3 the line and the sagitta have to be colinear.

The line appears to give the largest flare of the clump and can ea
from these kinds of orbit diagrams (ie., by eyeballing).
The timing of the greatest correlation of positions with the sagi
appears to determine the center time of the clump and comes o
program. Together the line and the sagitta define both the flare c
largest flare of the clump.
The line and the sagitta coincided for the Aug.10,2011 flare whi
case for the Oct.14, 2014 flare.. that made it easier to determine
the Aug.10, 2011 flare..

If the line is not close to a sagitta we then have a single huge flar
duration flare clump, at that time. If the line and the sagitta coin
biggest flare of the clump is at the center of the clump time.

For weaker flares this analysis becomes quite complicated and mu
more ambiguous than for these more clear cut examples (such a
Oct14, 2014, Feb14, 2014, Aug10,2011, etc the paradigm cases
mentioned)

Plasma Tube Instability

The ∇P term in Suydam's criterion(10) for kink instability of these EXH Poynting vector equatorial plasma tubes can be related to ∇P through the MHD equation:

$$rJXB = r\nabla P + r\rho g - (g/|g|)R\rho T/M \text{(the MHD equation(2)) with } A \propto F_i|\cos\theta_i|.$$

from equation 1. A new electrical current j_1 is created by the tidal effects of the long period outer planets through Faraday's and Ohm's laws:

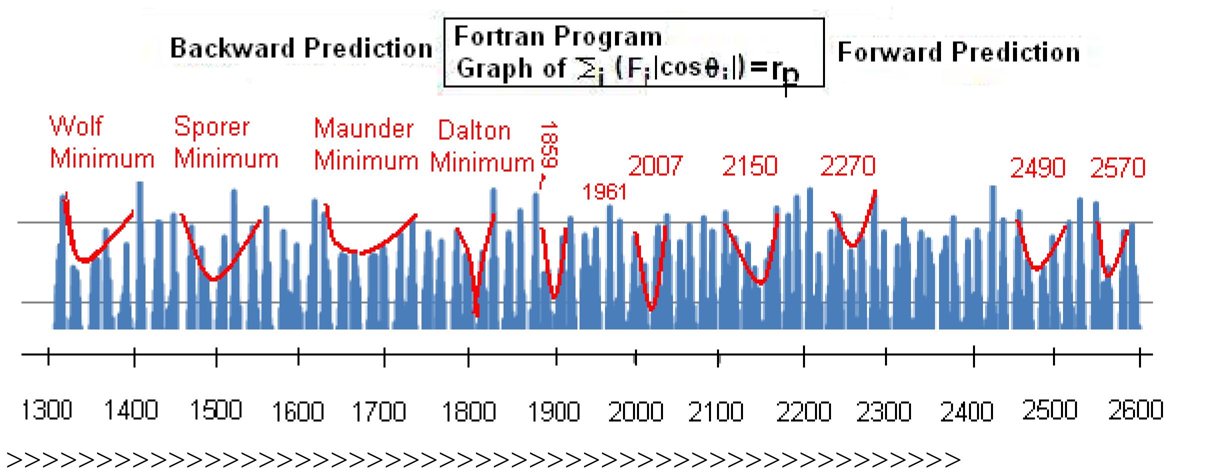
$$-BdA/dt = V = Rj_1 = kd|\cos\theta_i|/dt.$$

For the short period planets a change in this j_1 due to their planetary tides changes the B through Ampere's law[1] $\nabla XB = j_1\mu_o$ If all the other quantities (except for JXB and $\nabla P = dP/dr$) are constant in the MHD equation then $\nabla P \propto JXB$. Applying Faraday's law for the short term planets:

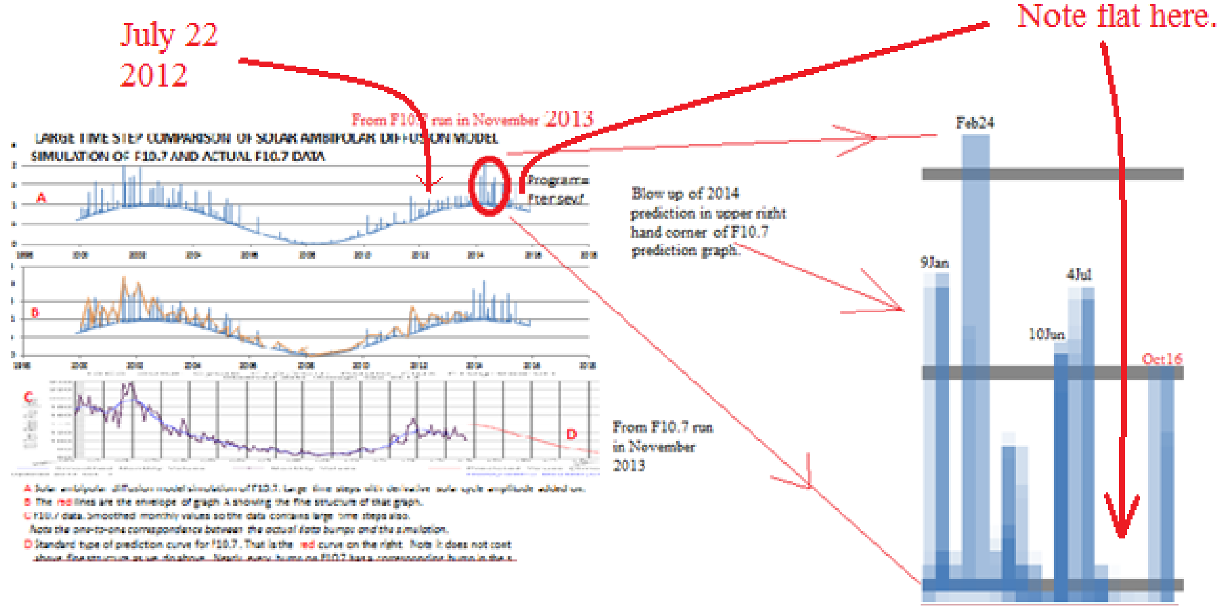
The line in the above diagram appears to give the largest flare of the clump and can easily identified from these kinds of orbit diagrams (ie., by eyeballing). The timing of the greatest correlation of positions with the sagitta appears to determine the center time of the clump and comes out of the fortran program. Together the line and the sagitta define both the flare clump and the largest flare of the clump. Note it is more difficult to determine flare time when the line and sagitta do not coincide.

Results of Flare Analysis

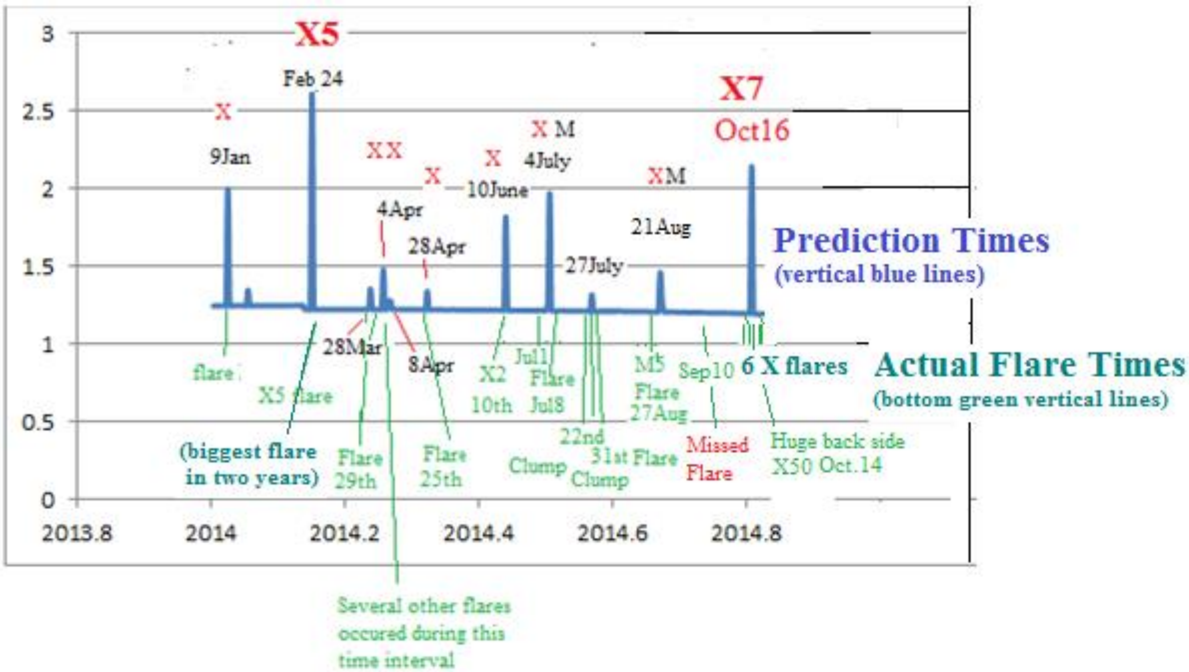
This new solar ambipolar diffusion model implies a charge layer at the tachocline. The rotation of the sun then implies a current j and a resulting magnetic field. Planetary tidal effects change this current. Ampere's law and Faradays law thereby imply a Dirac delta spike j in jXB =dP/dr +… and therefore **a spike** in dp/dr and therefore Suydam kink instability and flaring. When the $|\cos\theta_i| = 0$ spike is realized for several planets (approximately 90° to the F_{net} which is close to Jupiter's direction) we find very large flares occur constituting a *reality check* for this kink instability derivation. We also found that the model works well at predicting solar flares providing yet another *reality check* on our Faraday's Law derivation of that Dirac delta kink instability in those plasma tubes. Also this model only the middle of solar flare clumps and gives more accurate timing of the largest flares.

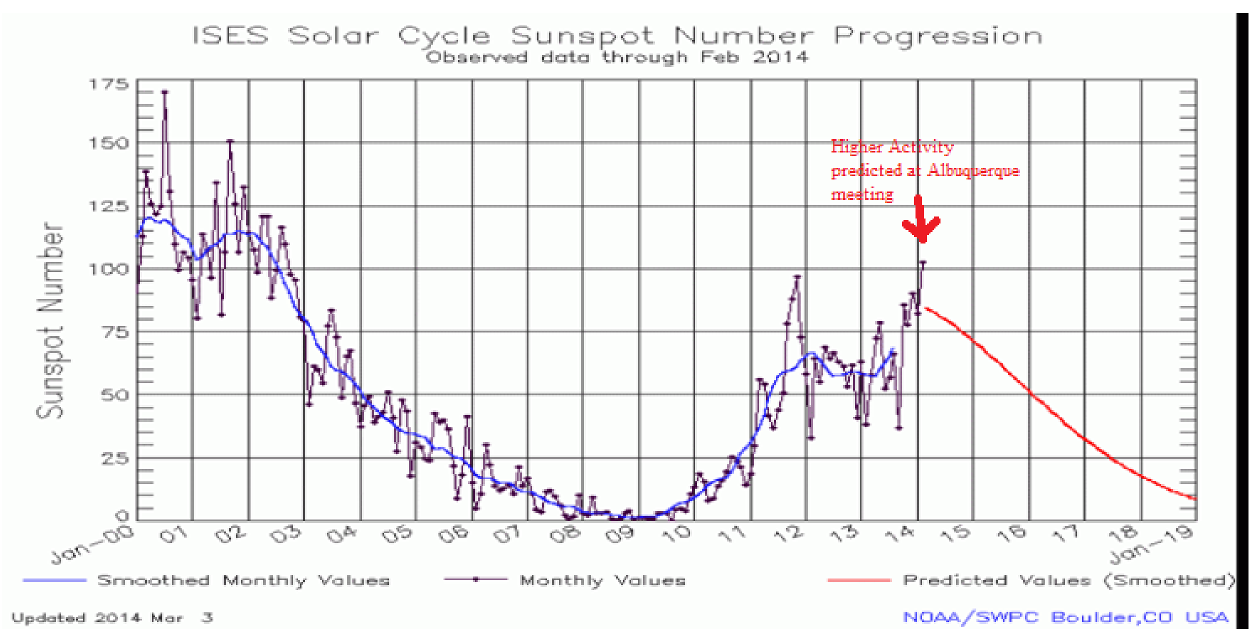


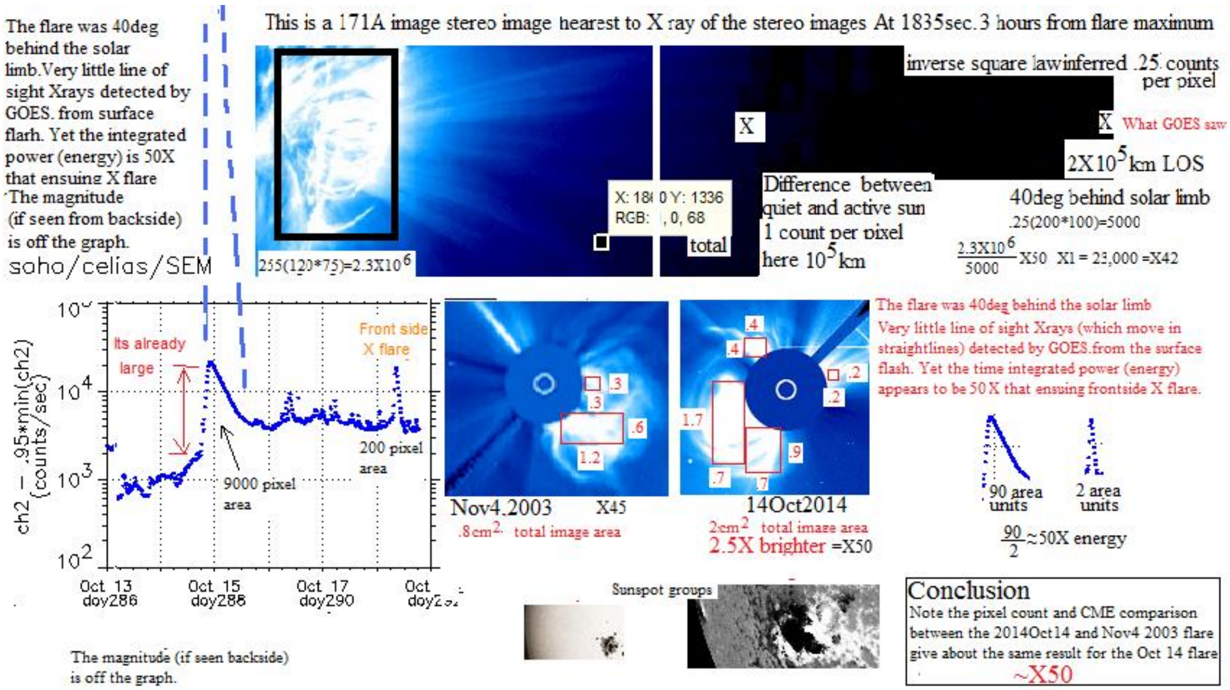
Backward Prediction
Fortran Program
Graph of $\sum_i (F_i|\cos\theta_i|) = r_p$
Forward Prediction
Wolf Minimum
Sporer Minimum
Maunder Minimum
Dalton Minimum
1859
1961
2007
2150
2270
2490
2570
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600



July 22 2012
Note flat here.
From F10.7 run in November 2013
LARGE TIME STEP COMPARISON OF SOLAR AMBIPOLAR DIFFUSION MODEL
SIMULATION OF F10.7 AND ACTUAL F10.7 DATA
A
B
C
D
Program
Blow up of 2014 prediction in upper right hand corner of F10.7 prediction graph.
From F10.7 run in November 2013
Feb24
9Jan
4Jul
10Jun
Oct16


X5
Feb 24
X
9Jan
XX
X
X
10June
X M
4July
4Apr
28Apr
XM
21Aug
27July
X7
Oct16
Prediction Times
(vertical blue lines)
28Mar
8Apr
flare
X5 flare
(biggest flare in two years)
Flare 29th
Flare 25th
X2 10th
Jul1 Flare Jul8
22nd Clump
31st Flare Clump
M5 Flare 27Aug
Sep10
Missed Flare
6 X flares
Huge back side X50 Oct.14
Actual Flare Times
(bottom green vertical lines)
Several other flares occured during this time interval
2013.8
2014
2014.2
2014.4
2014.6
2014.8


ISES Solar Cycle Sunspot Number Progression
Observed data through Feb 2014
Sunspot Number
Higher Activity predicted at Albuquerque meeting
Smoothed Monthly Values
Monthly Values
Predicted Values (Smoothed)
Updated 2014 Mar 3
NOAA/SWPC Boulder,CO USA



Directionality Of Solar Flare Relative to The Earth

M*E-(J*S-J*V)|MXJ|=DIR=Directionality with respect to the earth of the flare leaving the sun. If Dir=Max the flare is directed straight toward earth, if Dir=-Max it is directed away from earth. If Dir<0 the photospheric source of the flare of the flare is unobserved.

S=Sat,E=Earth,V=Venus,M=Mercury and J=Jupiter are all unit vectors pointing in the direction of the respective planets. A, It appears that the tidal effects on the sun of Venus and Saturn are nearly equal.

3.0 Poynting Vector Cause of Solar Differential Rotation and Plasma Tubes

Introduction to Poynting Vector Calculation

Solar differential rotation is actually initiated (jump started) by metric quantization (appendix A). But assuming that motion was instead caused by the H and E through a Poynting vector flux EXH mechanism allows us to derive H and thereby connect this phenomena to the solar ambipolar diffusion model. For example Feynman, in a gedanken experiment (9) written up in his famous lecture series of books, showed that *momentum* is carried by the $EXH/c^2=P/c^2$ = (Poynting vector)/c^2 for dipole B and radial E spherical configurations. But how is the Poynting vector related to the *kinetic energy* (in contrast to the momentum) of a highly conductive plasma in Feynman's same spherically symmetric configuration given a ambipolar diffusion (model) field and conductor rotation? Here we describe a gedanken experiment for this case as well, giving us also the cause of the solar dynamo, differential rotation and equatorial plasma tubes.

Review of the Derivation of the Poynting Vector

The power per unit volume τ expended in changing the electric and the magnetic fields is $E \cdot \dot{D}$ and $H \cdot \dot{B}$ respectively. The power per unit volume in other forms is $E \cdot J$ (e.g., Ohm's law and KE). Note the latter term can be both mechanical power dKE/dt=dW/dt and thermal energy rate of change $n_o(3/2)kdT/dt=dU/dt$. The power flowing into volume τ then is obtained by integrating the sum of these three terms over the volume τ, that is:

$$P = \int \left(E \cdot \dot{D} + H \cdot \dot{B} + E \cdot J\right) d\tau + \int S \cdot ds = 0$$

We then write the integrand in terms of Maxwell's third and fourth relations $\dot{B} = -\nabla X E$ and $\dot{D} + J = \nabla X H$ respectively. The integrand then becomes:

$$E \cdot \nabla X H - H \cdot (\nabla X E) = \nabla \cdot (H X E) = -\nabla \cdot S$$

S ≡EXH called the Poynting vector.

Cause of the Dynamo Effect

Again Feynman pointed out that **EXH** can indeed carry E&M field momentum. But **EXH** is also power per unit area, which can also be the rate of flow of *mechanical* energy through an area into this volume V. Furthermore note that one of the above terms in **E•J** contains a kinetic energy term, as well as others, which is more than just a field term. Note this charge is rotating with the sun's surface in this model there has to be a magnetic field B. Also to get a net zero force set qE+q(vXB)=0 so that v=E/B. If the charge is not quite moving at this velocity v it will begin moving in a circle and so the flux through the "circle" will change and thus there will be an emf generated from (given the Lenz's law component of) Faraday's law that will either speed up the charge or slow it down. By that means, the charge will then eventually flow at this constant v in the relaxation limit. Also, any point in plasma is continuously shifting between an unshielded (charge) and shielded (Debye radius) condition in a statistical mechanical fashion. Note also that a *non*superconductor, but still good conductor, does not shield a static magnetic field, only a static electric field. In the *un*shielded condition (which is about half the time since equilibrium is quickly established), the E field due to the ambipolar charge stops the diffusion. But what about the shielded condition? In that regard note that $mv^2/r=qvB$. So $r=mv/qB=m_ev/(eB)$ so that r is smaller than the Debye length because m/e and diffusion v are small. In this region E is not allowed (Faraday cage) but there is still that average density gradient so the charge will still move at speed v anyway on average let's say because of that diffusion mechanism. In that case the particle will readily start moving in a circle at radius r (=mv/qB) at speed v from Fick's law, thus possibly perpendicular to both the diffusion $j/\sigma=E_{effective}$ and B. This is our nonzero curl possibility. Thus in the shielded case the magnetic field acts to stop the diffusion current, not the E field whereas in the unshielded case the charge layer electric field acts to stop the diffusion current. In both cases E/B=v with the same magnitude of E and B in each case. This gives zero net force so minimizes work ∫Fdx *so minimizes energy as in δ(total energy)=0 thereby again implying B=E/v, the preferred relaxation* time condition for the diffusion current charges. This *0 net force* explains why Bahcall's standard solar model(11) does not require these new E&B fields. His speed of sound calculations , isostatic equilibrium, and jXB (in the MHD equation) for example need not be altered since there are no new additional (net) forces here and the diffusion current j is halted, made zero in the relaxation limit as discussed above.

In any case the above discussion constitutes the first part of our derivation of the origin of the dynamo effect which gives an electrical current in a rotating conductor if there is an initial B field. Here we found the source of that initial B field is that rotating charge layer required for the dynamo effect to work in the sun. Of course eventually the E in $E\sigma=j$ stops this radial flow of charge j altogether, thereby determining the value of this final static E and thereby B.
Also recall from the above definition of the Poynting vector that:

$$E \cdot \dot{D} + H \cdot \dot{B} + \dot{E} \cdot \dot{J} = -\nabla P$$

Ambipolar Diffusion In the Radiation Zone

Recall the mass of the proton is 1836 times the mass of the electron. Thus in the plasma environment of the sun, there is an ambipolar radial electron charge diffusion current j and a resulting charge layer and (and thus defined to be a) ambipolar E field that cancels that diffusion current as in $E\sigma=j$. Because of solar rotation this charge layer motion results in a dipole B field from Ampere's law. So there is a nonzero Poynting vector $EXH=EXB/\mu_o$.just above the radiation zone of the sun. Note as the system finally relaxes to the steady state $\dot{D}$ and $\dot{B}$ go to the zero limit. So all that we have left in equation 1 in the asymptotic relaxation time limit in a curl free environment is:

$$-\nabla S=J\bullet E\rightarrow E_R J_{NR} + E_R J_C$$

where E_R is the radial field and J_c is the circumferential current density, J_{NR} is the non radial current density associated with thermal motion. $E_R J_C$ is always zero because the radial E field is perpendicular to the circumferential current by definition. Thus now all we have left is:

$$-\nabla S=J\bullet E\rightarrow E_R J_{NR}.$$

But after relaxation we are in a curl free environment and there are also no sources or sinks: the rate of energy input equals rate of energy output. In that regard $-\nabla S=0$ for no sources or sinks which is the case after a large relaxation time. Thus after relaxation:

$$-\nabla S=E_R\bullet j_{NR}\rightarrow 0 \quad \text{so}$$

$$j_{NR}=0$$

Thus the only component of j that is nonzero is the completely circumferential j_c in $KE=½mv^2_c$ since the other component(s) j_{NR} went to zero. So the only non zero component of the average of ∇P (i.e., $<\nabla P>$) is this one.

Conservation Of Energy

Again Feynman showed that momentum is carried by a radiation field Poynting vector flux. But if momentum exists so does energy. So the energy flux is going somewhere given the conservation of energy and here would be absorbed by the plasma because there are no Bdot or Edot terms in the plasma as we showed. Recall we also proved above that the Poynting vector energy is not going into thermal energy. It then has to be going into KE where the v in the KE term is the circumferential v_C in the J_C circumferential current. Note also that $\rho\equiv$mass/volume =mass(kg)/1m^3.

Coaxial Cable Model Of The Equatorial Convection Zone

PA=ΔKE/Δt = Poynting vector times area equals rate of flow of energy=power
Assume as above that the mass of the convection zone is carrying the power associated with the Poynting vector. The analogy would be with a coaxial cable EXH carrying the power.

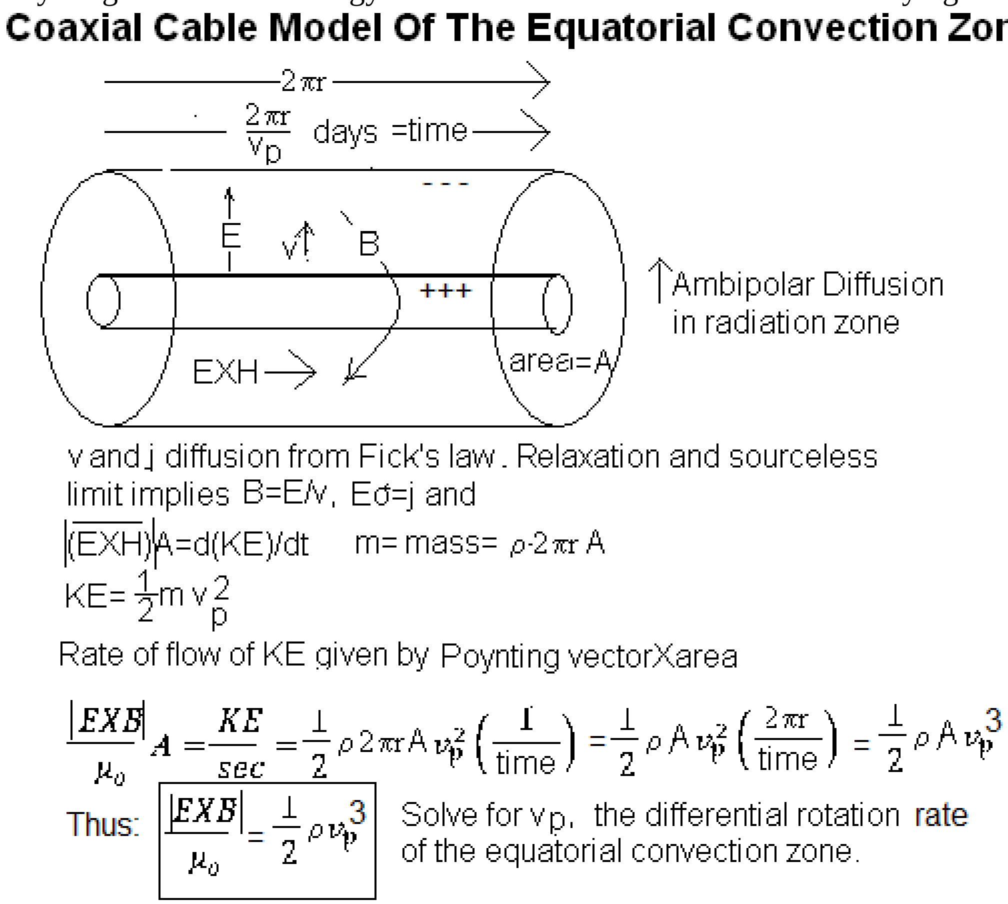


Figure 8. Coaxial Cable Representation of Equatorial Convection Zone

Thus the v in |EXH| =(½ρv^3+vΔ$U_{thermal}$) is the differential solar rotation rate and Δ$U_{thermal}$ =0 for thermal energy coming out of the EXH term. Thus finally:

$$|EXH| = \tfrac{1}{2}\rho v^3 \qquad (5)$$

Again we can calculate the value of v from this equation since all the kinetic energy is associated with the angular momentum circumferential motion v_C. Thus from this gedanken experiment we have derived the mechanical (kinetic) energy in terms of EXH for this ambipolar diffusion case. This is analogous to Feynman deriving his momentum from EXH in his own gedanken experiment (9).

We have also derived here the source of the solar dynamo which was responsible for our B=E/v term. The depth of the tachocline by the way is determined from the standard solar model of Bahcall’s (11), from his radiation zone opacity theory calculations.

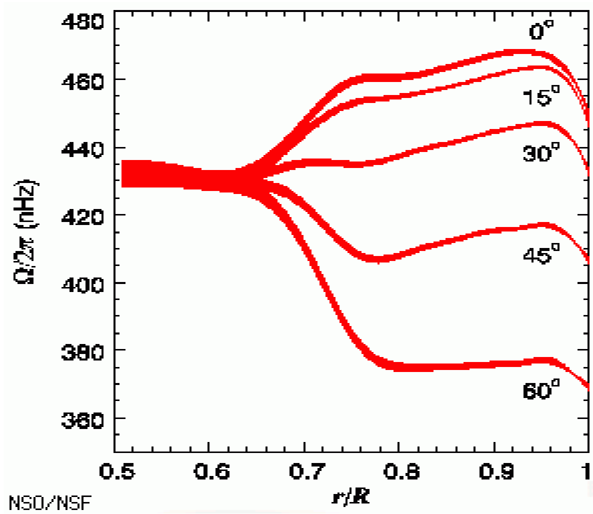


Figure 9. Differential Rotation as a Function of Depth and Latitude

Note that the Tachocline exists between 0.68 and 0.72 r/R. Note that in .7R-.8R region that $E_{radial}XB_{dipole}=0$ at the poles so there is no differential rotation there. $E_{radial}XB_{dipole}$ is maximum at the equator. Below we use the values of Ω above the top of the tachocline at about 0.8R. From the above graph we have 460nHz rotation at 0deg equator and 430nHz at 30deg at 0.8R. Note that 30 deg is the latitude of 0 differential rotation. What if we increased the angular velocity at 30 deg to 460nHz, what would the speed be? The difference in these speeds we define as differential rotation.

$$7X10^8X2\pi 430X10^{-9}\cos 30=1638\text{m/sec}$$
$$7X10^8X2\pi 460X10^{-9}\cos 30=1752\text{m/sec}$$
$$1752-1638=114\text{m/sec.}$$

Calculation of the Solar Differential Rotation Rate from Ambipolar Diffusion in the Sun

Here we use equation 2 to obtain the differential rotation rate. To do this we first calculate the ambipolar diffusion coefficient using Chapman-Enskog diffusion theory. We use this result to calculate the diffusion current j and then the ambipolar E field required to cancel this diffusion current. The E field is used to derive the B field for constant velocity current and all this is plugged into equation 5: $|EXH|=\frac{1}{2}\rho v_p^3$ to get the v_p.

Nomenclature

$$Debye\ length = \qquad \lambda_D = \sqrt{\frac{\epsilon_o k T_e}{n_o e^2}} \qquad (3)$$

n_o is the density in the mid radiation zone, T the temperature there. The Debye length is 1/10A at center of sun. Use the proportionality with associated square root of n_o and T to then calculate it at other depths. Also recall from Chapman-Enskog diffusion theory:

$$D = \frac{1.858X10^{-3}T^{3/2}\sqrt{\frac{1}{M_1}+\frac{1}{M_2}}}{p\sigma^2\Omega} \tag{4}$$

Recall Fick's Law of Diffusion $J=-D\nabla\varphi(r,t)$

σ ($=\lambda_D$) is the Debye length in Angstroms. It is stated to be .1A in the sun's core, and is found to be ~.5A in the middle of the radiation zone found by taking $\sqrt{(T/n_o)}$ ratios.

λ= sqrt(k(5X10^6/1.77) at center of radiation zone. Temperatures and density from Bacall.

λ_p=.1=sqrt(k(1.58X10^7/150.5)=Debye length at center of sun, equation 5.

Thus again by taking ratios:

λ=.52A.

M_1 is the electron mass which is 1/1836 the proton mass (~1g/mole) in molecular weight units.

85kg/m^3=ρ at the top of tachocline at .8R from Bacall(11).

J=kg/(m^{2}sec) =mass diffusion flux calculated from Fick's law.

T=5X10^{6}K at mid radiation zone from an average from Bacall.

.168keV=E at the top of the tachocline. Cu resistivity 1.72x10^{-8} Ω-m for 1keV. From Rose et al gives at 50keV resistivity 350X lower so use energy ratioX7 to find resistivity and so conductivity. At 1.3X10^{6}K and .168keVso resistivity is 7/.168=42 times higher than at 1keV. It is 1,300,000K at the top of the tachocline at .8R from Bacall. Divide by 7 (per Rose,9) and multiply by Cu resistivity (as a comparison number) so 1.72X10^{-8}X42 =7.2X10^{-7}. So σ=1.4X10^6 /(Ω-m)

σ=1.4X10^6/(Ω-m) estimate of conductivity σ at the top of the tachocline from this extrapolation from: Rose D, *Plasmas and Controlled Fusion*, Wiley, pp.173.

From Ohm's law we can find the electric field required to cancel the diffusion current at the top of the tachocline.

P=2.25X10^{11} bars at r=0.

T=7.8X106K, 21g/cm^3 at r=0 from Bahcall (11).

T=1.35X10^{6}K and .85g/cm^3 at middle of radiation zone from Bacall (11).

Using ideal gas law PV=nRT ratios then P=1.58X10^9 bars in middle of radiation zone.

ρ=21.4g/cm^3 for mid radiation zone from Bahcall.

For top of radiation zone ρ=.195g/cm^3 from Bahcall.

7X10^{10}cm=radius of sun. 3.5X10^{10}cm =thickness of the radiation zone.

Pressure found indirectly from temperature and density at radiation zone. Use ideal gas law. $\rho T \propto P$ proportionality to do this given pressure at center of sun listed in several documents. Electrical current density j found by using q/m ratio for electron, the diffusion coefficient D and the electron mass density at mid radiation zone.

Derivation of Rotation Rate Due to E X H

Here we derive the EXH=Poynting vector motion associated with the differential rotation of the sun from the ambipolar field and the associated EXH forcing of the equatorial rotation. The ambipolar effect is taken over the entire radiation zone so averages (e.g.,T,P,ρ, λ_D) over the radiation zone are used in all diffusion calculations. The mass flow at the top of the radiation uses the plasma mass density there. Plug into the Chapman-Enskog diffusion theory equation 4 for the diffusion coefficient D:

$$D = 2.26 = \frac{1.858X10^{-3}\left(5X10^6\right)^{3/2}\sqrt{\frac{1}{1/1836}+\frac{1}{1}}}{1.58X10^9X.5^2X1} \tag{5}$$

=diffusion coefficient. From Fick's law applied to the radiation zone diffusion:
J=-D∇φ(r,t)=

$$2.26\left(\frac{20-.2}{3.5X10^{10}}\right)=1.28X10^{-9}\frac{g}{seccm^3}$$

$$1.28X10^{-9}\frac{g}{seccm^2}\left(\frac{1kg}{1000g}\right)\left(\frac{10^4cm^2}{1m^3}\right)=1.28X10^{-8}\frac{kg}{secm^2}$$

$$1.28X10^{-8}X\frac{kg}{sec-m^2}X\frac{1836}{85}\frac{m^3}{kg}=2.76X10^{-7}\frac{m}{sec}=v$$

for the electron diffusion rate at the top of the tachocline.

$$1.28X10^{-8}\frac{kg}{secm^3}\frac{1.6X10^{-19}}{9.11X10^{-31}}=2250\frac{C}{m^3sec}$$ =j rate of flow of charge

From Ohm's law we can find the electric field required to cancel the diffusion current. We also need a magnetic field to do this as well since the current can also have nonzero curl

$E\sigma=j$ Thus:

$EX1.4X10^6=2250$ at top of tachocline. So:

E=.0016 V/m

Poynting Vector Calculation of v_p

Also recall from equation 5:

$$\frac{|EXB|}{\mu_o}=\frac{1}{2}\rho_{plasma}v_p^3 .$$

Also given our gedanken experiment nonzero curl possibility we must use

$$\frac{E}{v}=B$$

Thus:

$$\frac{E^2}{v\mu_o}=\frac{1}{2}\rho_{plasma}v_p^3$$

$$\frac{2E^2}{\rho_{plasma}v\mu_o}=v_p^3$$

$$\sqrt[3]{\frac{2E^2}{\rho_{plasma}v\mu_o}}=v_p$$

$$\sqrt[3]{\frac{2(.0016)^2}{2.76X10^{-8}(85)4\pi X10^{-7}}}=v_p\text{=120m/sec} \quad (6)$$

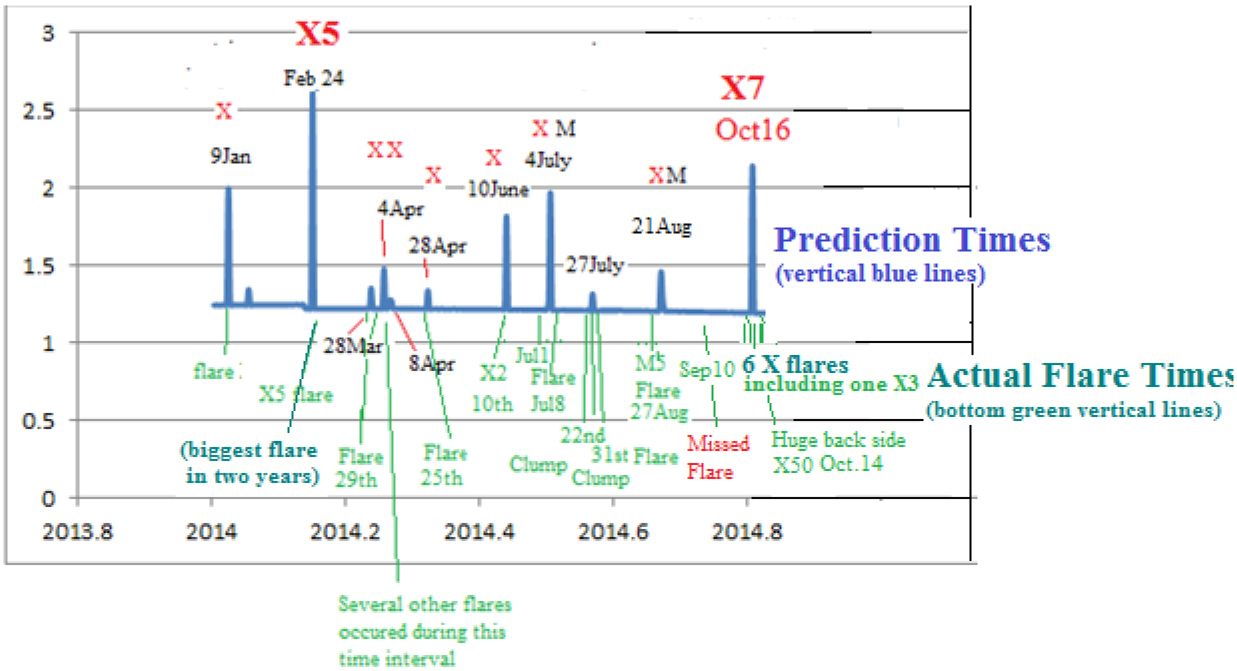
Average differential rotation rate is +**114**m/sec at the equator relative to 30deg
Our calculated rate is +**120**m/sec at the equator relative to 30deg.
Please see appendix C for the origin of the convection zone.

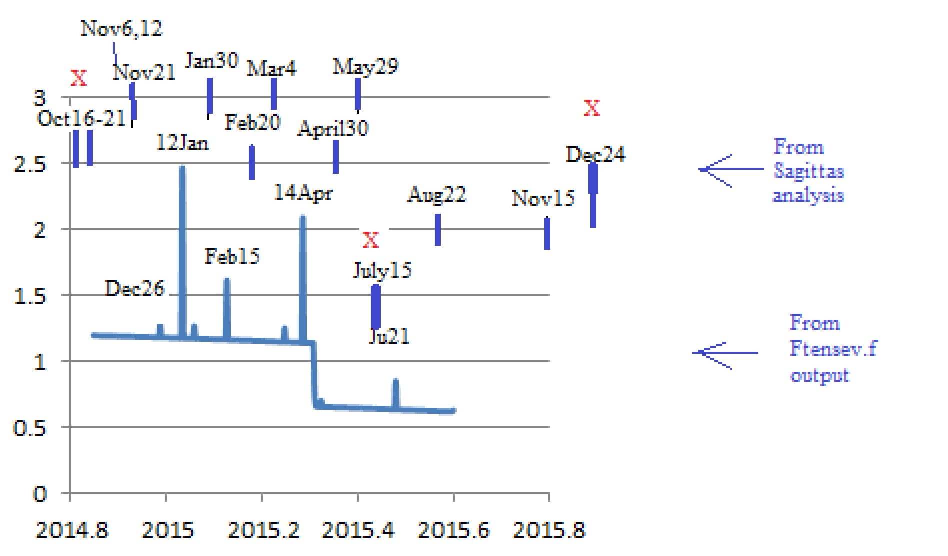
Combining Flare and Solar Cycle Current To Obtain Solar Power Output

Recall that solar ambipolar diffusion model
first derivative of $\Sigma F_i|\cos\theta_i|=Ti$ gives that convection zone first derivative current Id1 which in turn gives the solar cycle: So
Id1=long term solar cycle activity from solar motion with respect to the solar system COM.
Id1 is the first derivative of Ti.
Recall that Faraday's Law 2nd derivative gives the flares associated with a second derivative current
Id2=flare activity, second derivative of Ti.
so that total electrical current associated with solar activity =**I=Id1+Id2**
The total power from tidal effects that creates the output from the solar cycle is then

$$\mathbf{Power=IV=I(IR)=I^2R=((Id1+Id2)^2)R=((Id1)^2 + (Id2)^2+2Id1(Id2))R}. \qquad (7)$$

Note Id1>>Id2 usually so to measure solar activity due to rate of change of tides on the sun we use just have (eq.2): Power output= **solar activity=2Id1(Id2))R** $(+Id1^2)$.
Below are simulations of solar activity using the above equation 7:





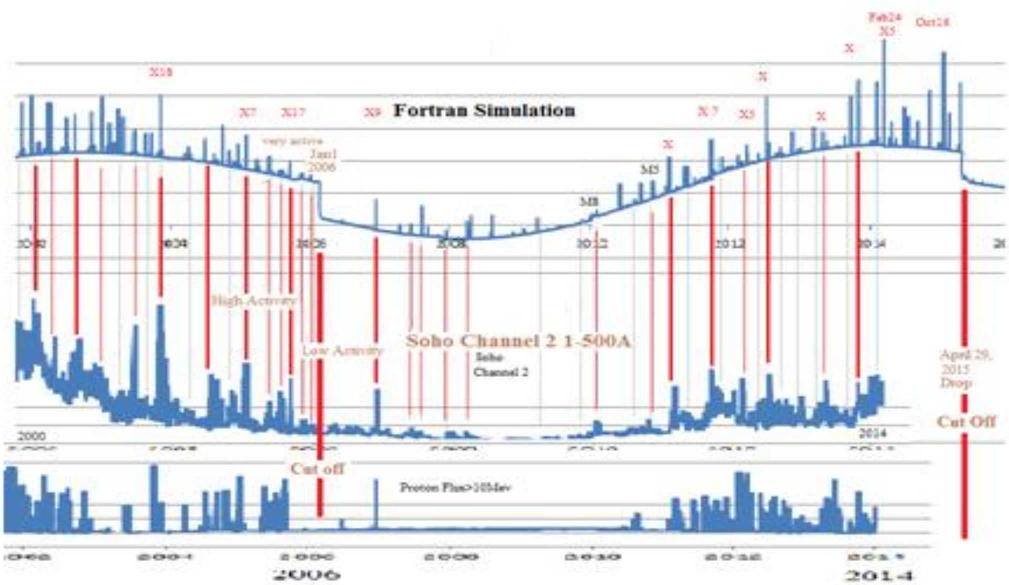


Figure 10

Note the equation 7 predicted sustained jump in activity beginning near the end of 2013 lasting about 1.5 years, until the Saturn drop April 29, 2015. Note also the **near perfect** one to one and onto **correlation of the simulation with the actual data**. Note also the big flare prediction (>X5) for Oct.16 (other predictions in between) and the predicted sudden drop in solar activity in April of 2015.

Flare Direction

formula for deriving the side of the sun the flare is on (relative to earth's direction). Dir=M*E-(J*S-J*V)|EXJ|. If Dir>1.6 the flare will be on the other side of the sun from earth. If Dir<1.6 it will be on our side of the sun. At the expected time of a solar flare E is the unit vector from sun to earth, M unit vector from the sun to Mercury, S=unit vector from the sun to Saturn, J=unit vector from the sun to Jupiter, V is the unit vector from the sun to Venus

Magnetic Cycle

The net magnetic field near the surface commoving with plasma rotation is the sum of the opposing B fields due to the core current +charge and the B field due to this differential plasma rotation relative to the tachocline charge motion current of the tachocline negative charge. They are about the same B fields and so nearly cancel at the surface. The outer layer motion is smaller when Saturn is on the side of the Jupiter's aphelion and larger on the side of Jupiter's perihelion so that every other solar cycle one current dominates over the other so one B field (either north or south) dominates. Thus we have a 22 year magnetic cycle. The Babcock model physics then changes the configuration of the magnetic field lines via the solar differential rotation over a solar cycle.

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11) Bacall's standard solar model data available at: http://www.sns.ias.edu/-jnb/SNdata/Export/BS200

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Appendix A

Metric Quantization

Metric quantization comes from that derivation of that new pde by introducing external objects (from derivation of new pde $\sqrt{\kappa_{\mu\mu}}\gamma^{\mu}\partial\psi/\partial x_{\mu}=(\omega/c)\psi$. It also requires that there exist a grand canonical ensemble (thus a chemical potential exchange of energy between physical systems) at some point in the formation of the system *for the conservation of energy to also hold* (so isolated projectiles will not do this for example).

From theory :

Metric quantization speeds at 100km/sec. and 1km/sec. due to objects B and C.
Smaller values due to nearby objects.

The differential rotation is first created (jump started) by metric quantization coming out of a new generally covariant generalization of the Dirac equation that does not require gauges (Appendix C). Metric quantization also requires that there exist a grand canonical ensemble (thus a chemical potential exchange of energy between physical systems) at some point in the formation of the system for the conservation of energy to also hold. Here we present observational evidence of velocity quantization obtained from Doppler measurements of stellar motion in the halos of galaxies and equatorial stellar velocities illustrating 100km/s=Δv quantization with most at 200km/sec. Figure A1 is a compilation of average halo velocities for various nearby galaxies showing an unambiguous metric quantization.

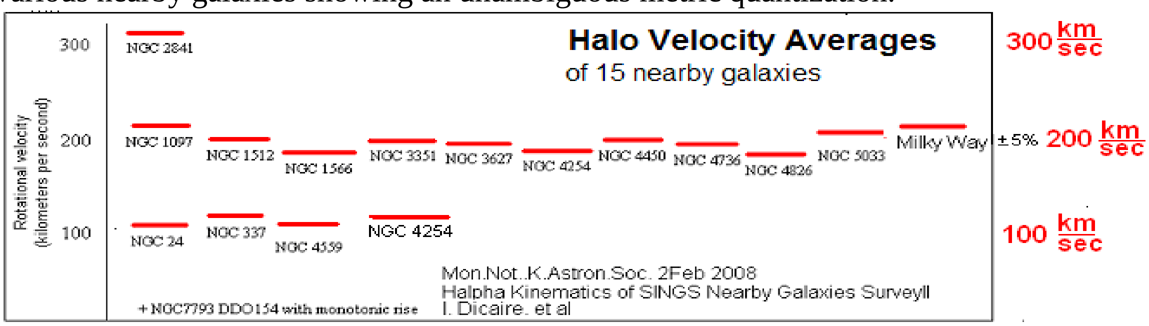


Figure A1 Velocity quantization In the Halos Of Nearby Galaxies (mostly 200km/sec)

Figure A2 is a compilation of average stellar equatorial velocities for main sequence stars also showing an unambiguous metric quantization at 200km/sec.

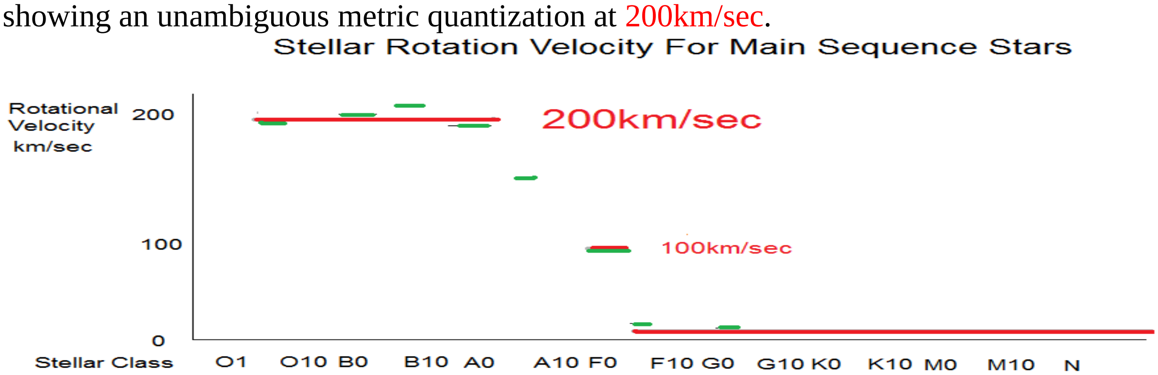
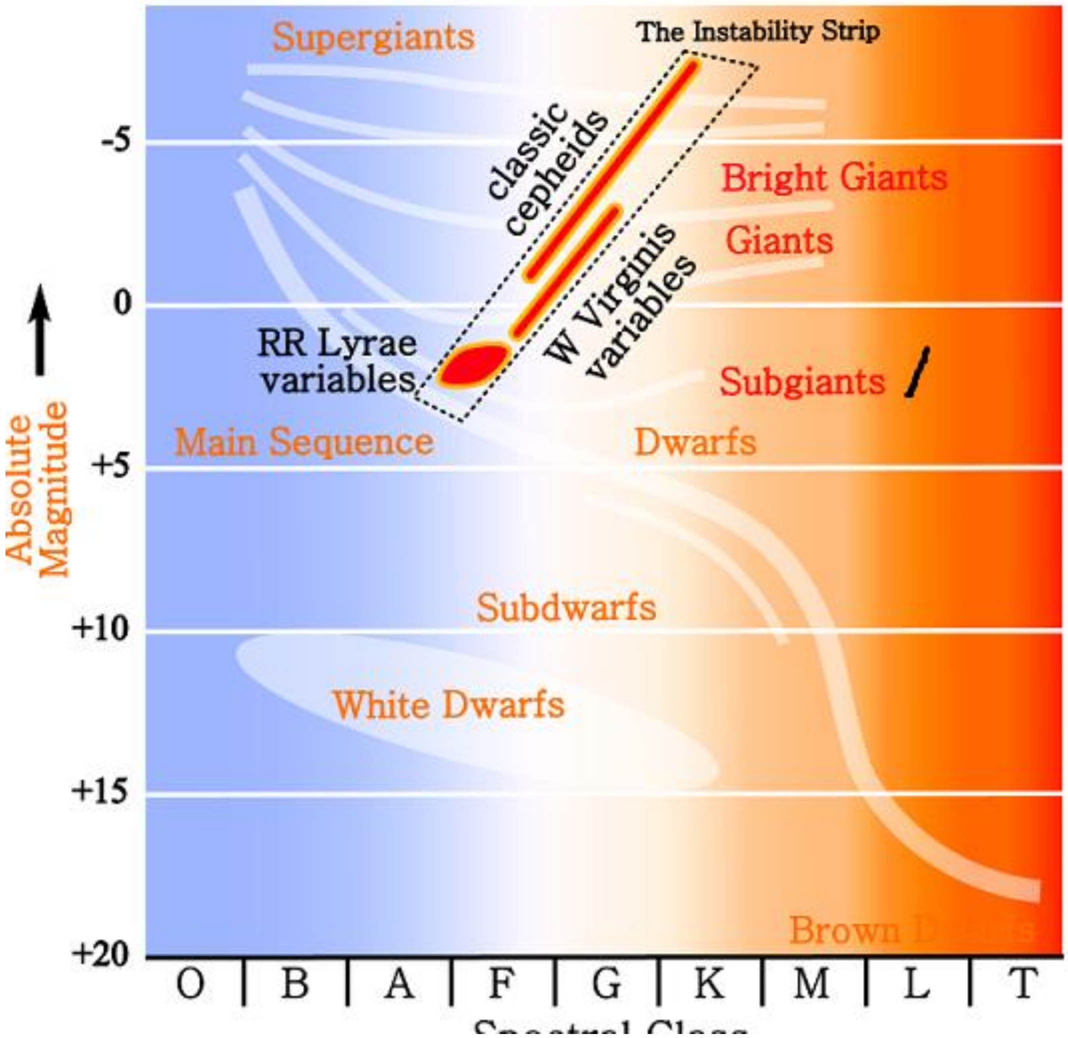


Figure A2 Velocity Quantization in O,B,A stars (mostly 200km/sec)

Note the same 200km/sec metric quantization of stellar equatorial velocities for O, B, A stars in Figure A2 so this *metric quantization is ubiquitous* (recall also figure A1 in that regard). See appendix C for theoretical derivation of these velocity quantization values.
Recall metric quantization results in stability, Here for O, B A   and G K M stars. This implies that the intermediate classes of stars should be unstable. This is the instability region of the HR diagram, see below.



Hand waving arguments about the opacity of Hell is the usual explanation for this instability. The metric quantization is clearly the reason as we see above.

There is a lower velocity metric quantization for main sequence stars F→M at about 2km/sec on the right side of the figure A2 which is what actually starts out the Δv=1km/sec differential rotation of the sun relative to the 1km tachocline rotation. The B field component we stated was responsible for the differential rotation is instead actually then *derived* from this metric quantization effect. The motion relative to that ambipolar diffusion charge layer already must exist for the B field to effect the co-moving convection zone plasma.

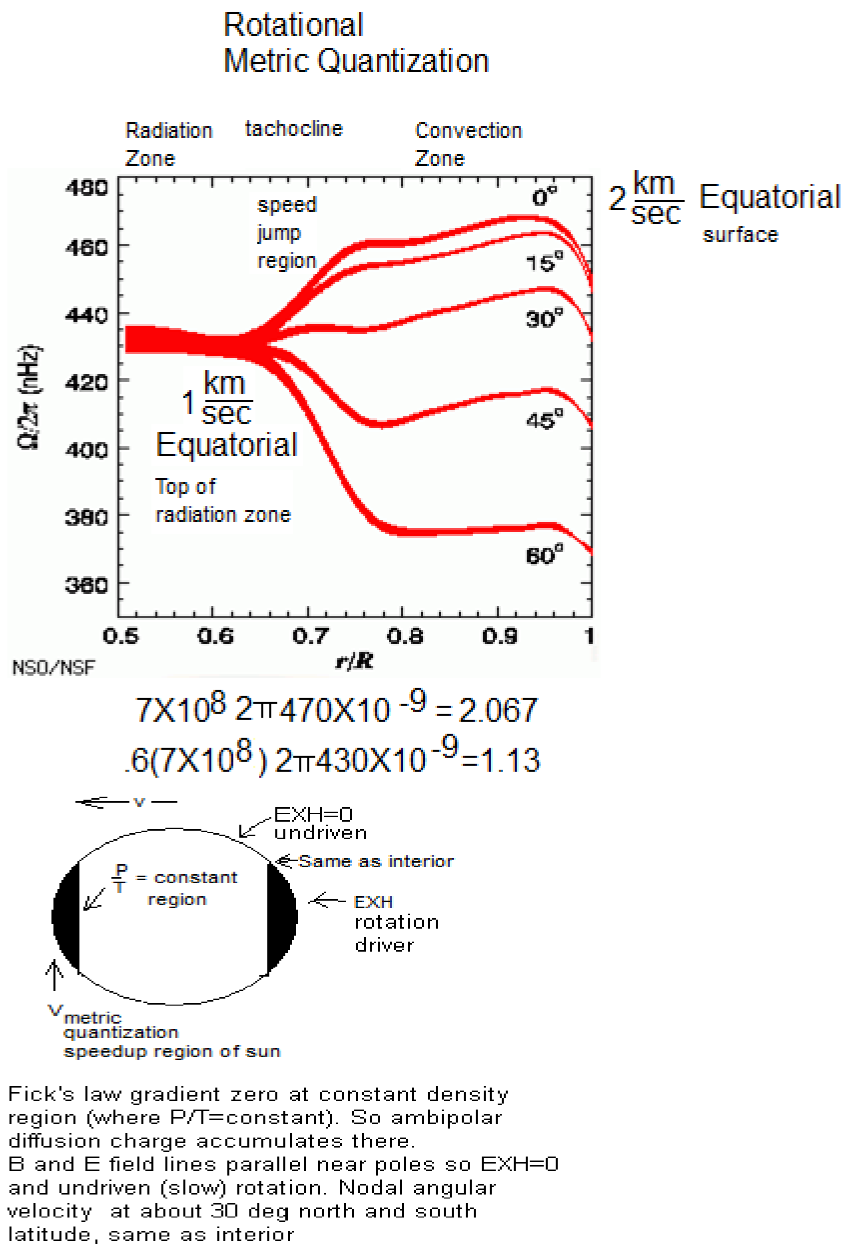


Figure A3

Solar Conveyor Belt

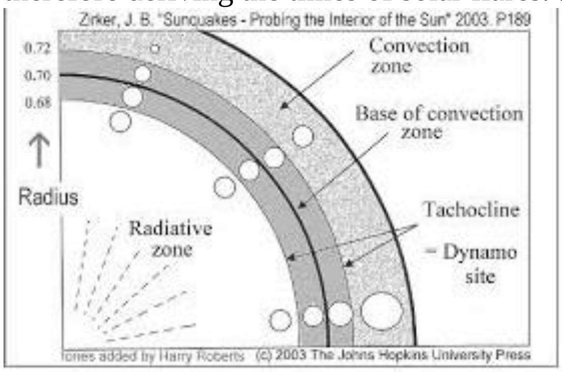
Recall that convection transfers heat more efficiently than conduction. Note the metric quantization implies a higher velocity in the outer part of the black region of the above diagram (also see figure 9) so there will be a higher Reynolds number so more convection and so a higher rate of heat transfer from the interior of the sun near the equator. Thus there is larger heating at the equator implying then convective heat flow from the equator to the poles via large convection loops, hence the observed (by helioseismology) north-south convection loops, hence the existence of the so called "conveyor belt" meridional flow.

Recall a second deeper conveyer belt has been found which in this theory carries the negative charge longitudinally.

The metric quantization velocity jump first hits the tachocline at the equator so accelerating the charge carrying plasma there.
The Reynold's number is large at the equator so the belt moves fast there, then slows up at the poles bunching up negative charge creating a strong repulsive electric filed forcing the negative charge back into the radiation zone and the process starts all over again.
So the bottom line here is that this negative tachocline charge inferred by the ambipolar diffusion model is not static,

Metric quantization allows you to prove the validity of a new of nonconstant ambipolar diffusion (the 1km/sec jump giving that large Reynolds number at the tachocline) model that also gives us insights into the origin of solar flares and the solar cycle.
Recall that electrons are 1836 times lighter than protons. Thus they diffuse through the density gradient of the radiation zone at the enormously $\sqrt{(1836)}=43$X greater rate than protons do. Also recall the 5min oscillation so there is a pulsed Fick's law density ϕ in $D\nabla\phi$=rate of diffusion with $D=\sqrt{(m_P/m_e)}=43$ provides a temporary "force" on the electrons. Protons have high inertia so there is a time delay allowing a temporary current to form. Also the equatorial tachocline transition from 1km/sec to 2km/sec has a high Reynolds number so high convection and so high density gradient, higher than up at 40° latitude. Also the rate of heat transfer is larger so there is plasma motion north and south of the equator. So the momentary Fick's law diffusion provides a larger EMF at the equator and smaller EMF at 40deg providing a temporary circuit for the flow of electric current. Thus this modified ambipolar diffusion method acts like a diode, causing the current to flow in only one direction in the loop. The resulting magnetic field changes in the area enclosed by this current loop in the 5 minutes pulse time so there is also a Faraday's law current induced. At around 30° the Coriolis force, along with the feedback mechanism (see below) helps form the resulting current loop plasma tubes and the associated magnetic fields giving that feedback effect. At 45° there can be no feedback mechanism since the 1km/sec metric quantized speed region is at the sun's surface so there is then no differential motion to create a magnetic field. To calculate the resulting current in these current loops we note that the convection zone is on the order of 10^8 m in depth, B at the surface is about .5G but is larger inside the plasma tubes (see them sticking out of the sun at sunspots) so .5G is a lower limit. $200/10^5$ =density ratio A for 5min oscillation given that 200km magnitude of the 5minute oscillation and the 10^5 km thickness of the convection zone.
$L=10^8$m, $A=10^{17}$m^2 . $\rho=.0000007\Omega$-m, B=.00005T, $R=\rho L/A= 7X10^{-16}\ \Omega$
$\phi=BA=5X10^{-16}$T-m^2, dt=3min=180sec, $IR=-d\phi/dt$ so $I=(-d\phi/dt)/RA=$**$8X10^{25}$**Amps. Note the extremely large electric currents that are possible inside the sun due ot the small plasma resistivity and large feedback magnetic fields.. Given this circumferential plasma tube current we will then use the motion of the sun about the solar system COM to explain the solar cycle and we will use the rate of change of the solar tides to derive the cause of solar flares using this model with the solar cycle (Figure 1) component of this derivation.
1) Determined the rate of change of the sun's motion about the solar system COM and thereby derive the resulting change of this (solar differential rotation) current and so change of B field over a solar cycle and its effect on charged particle-energy diffusion out of the sun thereby

giving the solar cycle. The metric quantization was responsible for the large Reynold's number at the tachocline.
2) We found the effect of the change of planetary tides on the areas enclosed by these currents give Faraday's law emfs with their own resulting Ohms law currents. The rate of change of these electrical currents give current spikes at certain times effecting the dP/dr MHD equation term allowing the derivation of a large Suydam kink instability in these plasma tubes and therefore deriving the times of solar flares. .



Feedback Mechanism

Note with infinite conductivity no electric field and hence no charge accumulation is allowed in a conductor, (eg., a plasma) and so you obtain trivial ambipolar diffusion drift at the ion speed of sound. That is because the standard theory of Fick's Law diffusion assumes *no rotation* for the electrons on the outer part of the plasma and no large change in temperature and so in that theory the electrons and protons both end up moving at the speed of sound of the ions $v_s=\sqrt{(kT/m_p)}$. But the 5min oscillation provides a temporary pulse in Fick's law density and we do have a differential rotation of the equatorial convection zone and a large temperature increase in the radiation zone. That allows nontrivial charge diffusion. See below.

1) This Fick's law pulsed diffusion creates at first a relatively small moving charge at the tachocline Q_i and so an associated current I_1 given the 1km/sec metric quantization increase in speed of the convection zone relative to the tachocline motion. In that regard recall that the amount of charge at the tachocline depends on the Fick's law diffusion in the radiation zone but also on plasma conductivity: the lower this conductivity the higher the charge accumulation (Using $E\sigma=j$, $E=Q/dC$, $C=4\pi\varepsilon_o/[1/a-1/b]$, a inner, b outer radius respectively, $b-a=d$].
2) Current I_1 thereby creates a small magnetic field B_1 according to Amperes law. Thus this feedback mechanism favors the formation of locally large magnetic field regions, *hence it is the reason why the equatorial plasma tubes exist*. In that case recall that the magnetic field falls off with $B=\mu_o I/2\pi r$ (not with $1/r^2$) around a long plasma tube so it is still very powerful even at a long distance away from the tube making this tube-feedback effect very powerful
4) Also recall that a magnetic field perpendicular to the direction of charge flow acts as a source of (magnetic) Ohmic resistance through the q(vXB) =force, thus lowering the conductivity of a plasma in the direction of charge flow.
5) This charge adds even more current, creating a larger magnetic field, ad infinitum in what constitutes a Feed Back Mechanism because there is a nontrivial relative motion and temperature differential here. So there is a feedback mechanism that in contrast does create a equatorial tachocline current in the sun. The H^2 dependence makes this a diverging process that can only quit when the current is the same as the diffusion current (density) coming out of the sun which is at about 2000 Coulombs/sec/m^2, and so is very large.

Because of the direct dependence of the B field on the current and the added change in the charge magnitude on the B field squared this is not a converging (to zero), die off, feedback mechanism. It will only level off when the diffusion charge flow rate equals the circumferential rate of flow of charge.

6)Recall the 5min oscillation so there is a pulsed Fick's law density ϕ (~.002 density fraction given the 200km amplitude in the 10^5km thickness convection zone) in $D\nabla\phi$=rate of diffusion with $D=\sqrt{(m_P/m_e)}=43$ provides a temporary "force" on the electrons. Protons have high inertia so there is a time delay allowing a temporary current to form. Also the equatorial tachocline transition from 1km/sec to 2km/sec has a high Reynolds number so high convection and so high density gradient, higher than up at 40latitude. Also the rate of heat transfer is larger so there is plasma motion north and south of the equator. So the momentary Fick's law diffusion provides a larger EMF at the equator and smaller EMF at 40deg providing a temporary circuit for the flow of electric current The resulting magnetic field changes in the area enclosed by this current loop in the 5 minutes pulse time so there is a Faraday's law current current. At around 30deg the Coriolis force, along with the feedback mechanism (see below) helps form the resulting current loop plasma tubes and the associated magnetic fields giving that feedback effect. At 45deg there can be no feedback mechanism since the 1km/sec metric quantized speed region is at the sun's surface so there is then no differential motion to create a magnetic field. To calculate the resulting current in these current loops we note that the convection zone is on the order of 10^8 m in depth, B at the surface is about .5G but is larger inside the plasma tubes (see them sticking out of the sun at sunspots) so .5G is a lower limit.

$L=10^8$m, $A=10^{17}$m^2 . ρ=.0000007Ω-m, B=.00005T, $R=\rho L/A= 7X10^{-16}\ \Omega$

$\phi=BA=5X10^{-16}$T-m^2, dt=3min=180sec, $IR=-d\phi/dt$ so $I=(-d\phi/dt)/R=$**$4X10^{27}$**Amps.Reduce this by .002 density change ratio of the 5min oscillation giving finally about $8X10^{25}$amps. Thus extremely large electric currents that are possible inside the sun due ot the small plasma resistivity and large feedback magnetic fields

Given this circumferential plasma tube current we will then use the motion of the sun about the solar system COM to explain the solar cycle and we will use the rate of change of the solar tides to derive the cause of solar flares using this model with the solar cycle (Figure 1) component of this derivation.

Battery Analogy

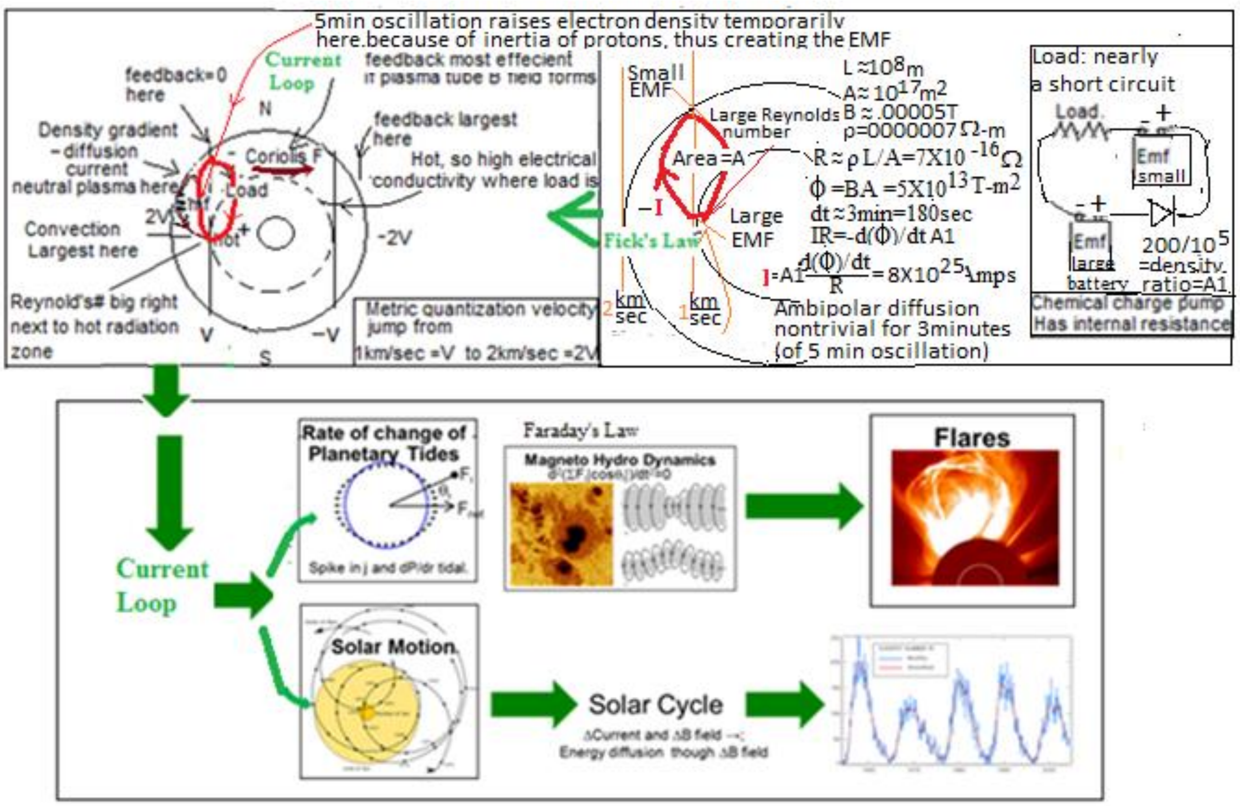


Figure 1. Dependence of Solar Cycle and Flare Times on Charge Diffusion and Solar Motion

4.0 Large Solar Motion about the COM of the Solar System as Source of the Solar Cycle

We begin by noting that ambipolar charge diffusion model assumes a rotating charge, and hence, a (rotation induced) electrical current and resulting core magnetic B field relative to the faster moving more shallow components of the sun's radiation zone. We also note the large motion of the sun about the center of mass of the solar system (Figure 2). The sun can move its diameter about the COM in 12 years for example.

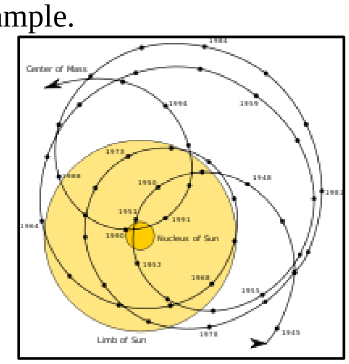


Figure 2. Barycenter (COM) Motion of the Sun

Saturn Effect on Sun's Motion about the COM of the Solar System

On average Saturn is in syzygy with Jupiter *twice* over the time Jupiter moves between perihelion and aphelion *once* (Figure 3). Thus it increases solar COM speed at syzygy Jupiter opposition and decreases it on the other side resulting in a net 2X Saturn effect. Thus the ratio of their respective Δgravity COM forces on the sun is equal to:

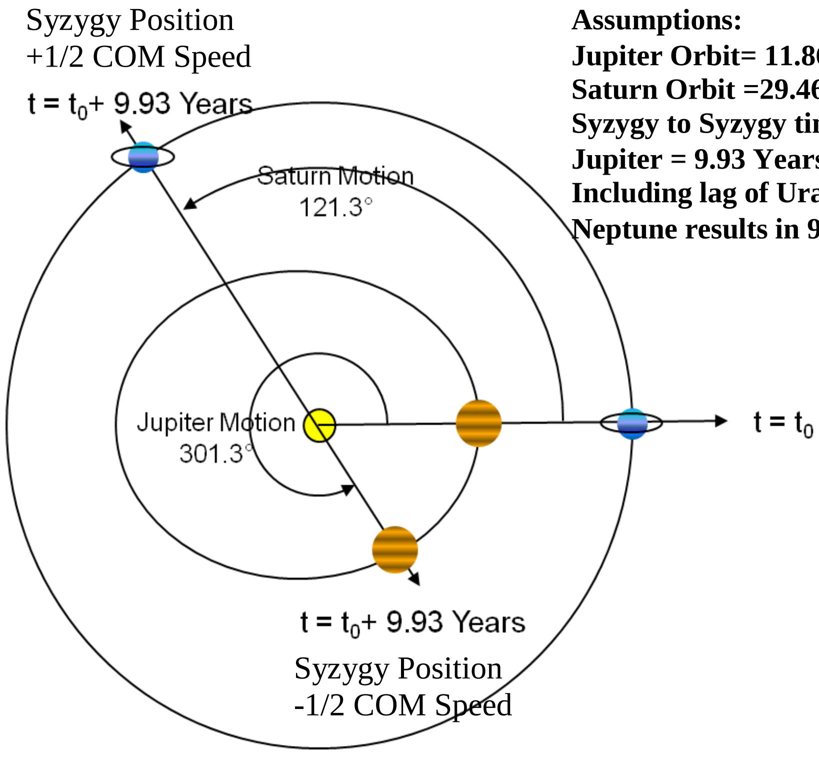
$$\frac{2\frac{GM_s m_{sat}}{r_{sat}^2}}{\frac{GM_s m_{jup}}{r_{jup-peri}^2}-\frac{GM_s m_{jup}}{r_{jup-aph}^2}} \equiv 2F_{sat}/F_{jup} \approx .901$$

where F_{jup} is difference in Jupiter's gravity (on the sun) from aphelion to perihelion. Thus adding all these COM motion effects gives Saturn nearly an equal COM Δsolar motion contribution to Jupiter's. Therefore we can add the two COM effects directly as we will do in the dL/dt=0 (Fick's law B diffusion flux) method of the next section:

$$2(1/2)\sin\omega_1 t + \sin\omega_2 t = \sin\omega_1 t + \sin\omega_2 t = 2\sin((\omega_1+\omega_2)t/2)\cos((\omega_1-\omega_2)t/2) \text{ ,thus}$$

$$(\omega_1+\omega_2)/2=\omega=2\pi/T, \text{ So } T=10.8 \text{ years (Solar Cycle Period)}$$

Including lag of Uranus and Neptune 10.8→11 years

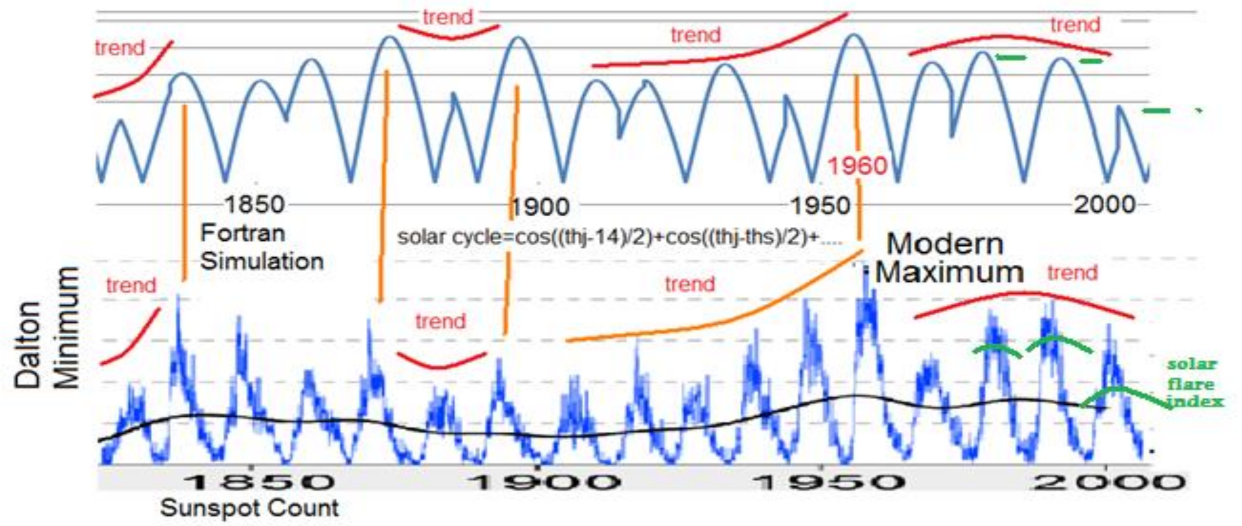


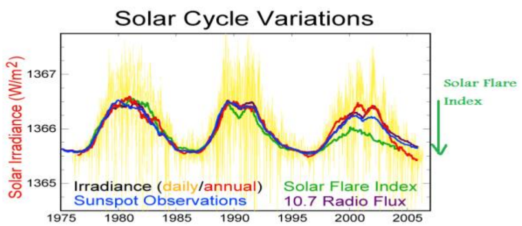
Assumptions:
Jupiter Orbit= 11.86 Years=2π/ω₂
Saturn Orbit =29.46 Years
Syzygy to Syzygy time of Saturn and Jupiter = 9.93 Years = 2π/ω₁
Including lag of Uranus and Neptune results in 9.93→10.51.

Figure 3. Saturn and Jupiter Syzygy

Using this information and combining it with the force associated with the tidal effects of the planets ($\Sigma F_i|\cos\theta_i|$ in equation 1 below, sine terms from above), one can predict the solar cycle:

$$|(\partial^2(\Sigma F_i|\cos\theta_i|)/\partial t^2)-C|\sin((\omega_1+\omega_2)t/2)\cos((\omega_1-\omega_2)t/2)=\text{Solar cycle} \quad (1)$$





Solar flare index lower for cycle23

Using the Sun's Motion about the COM to Explain Solar Cycle Magnitude

Movement of the sun about the center of mass (COM) of the solar system creates a current j due to the charge movement whose magnitude changes as a function of where the sun is relative to the COM. The largest delta for the magnitude of this current occurs when Jupiter is at aphelion. If the sun is rotating at an angular velocity greater than its own COM angular velocity about the solar system COM the difference in the distance moved (from perihelion to aphelion) in a given amount of time by the farthest point (from the COM) is twice as great as the solar center if the COM of the solar system is located near the solar photosphere. So the change in the motion of the part of the sun farthest from the COM is larger than the change in motion located on the sun that is closest to the COM. Near surface plasma motion relative to the electrical current around the sun's core creates an effective B field change. This results in an increase in the magnetic field caused by the core current which results in less Fick's law charged particle diffusion from inside the sun and thus the change of the solar flux output characteristic of the solar cycle. Here we will calculate these plasma motion changes and the resulting changes in the magnetic field that electrical current change creates. The result will be the fractional change in the solar flux over an entire solar cycle.

Physical Parameters Used in Calculating Solar Cycle Magnitude

M_{sun} =2X10^{30} kg = mass of sun
M_e=6X10^{24} kg = mass of earth
M_j=318Xm_e = mass of Jupiter
e_j = .04875=Jupiter's orbital eccentricity
Pj =11.859X365.256363X24X3600 sec = Period of Jupiter's orbit
G=6.67X10^{-11} Nm^2/kg^2 = Universal gravitational constant

r_{jo}=7.4X10^{11}m = radius of Jupiter's orbit
r_{sun}=7X10^{5}km =radius of sun's orbit about the COM of solar system

Determining the Rotational Velocities of the Solar Surface Using Conservation of Angular Momentum

For Jupiter going from perihelion to aphelion use angular momentum conservation dL/dt=0 i.e., $r_1v_1=r_2v_2$: We first determine the distance of the center of the sun from the solar system center of mass x:

$$(M_sx+M_jy)/(M_s+M_j)=0=(2*10^{30}x+1.91*10^{27}*7.4*10^{11})/(2*10^{30}+1.91*10^{27})$$
$$2*10^{30}x=1.41*10^{39}$$
x=707000km (distance of the center of the sun to the COM of solar system)
$$2\pi r_{large}/(11.86X365.25X24X3600) = 4.4X10^9/3.74X10^8$$
$$=11.76m/sec=v_1$$ (speed of Sun at aphelion)
$$v_1r_1=v_2r_2$$ (conservation of angular momentum)
$$11.76*7.07*10^8=7.07*10^8 \text{ X } 11.7\,6/(1+.04875)]=7.4*10^8*v_2$$
v_2=12.33m/sec (speed of Sun at perihelion)

Rotational Velocity of Sun

The baseline stellar rotation rate, the speed of the sun's equator, is approximately 2000 m/s= $2\pi r/T=2\pi(7.07X10^8)/(2.19*10^6)=2X10^3$ m/sec (sun's equatorial speed, appendix also)
The added effect of the velocities calculated in the above section on the sun's equatorial speed is shown below:

2000+11.76=2011.75m/sec (at aphelion)
2000+12.33=2012.4m/sec (at perihelion)
[(2012.33-2011.76/2012.4]100=.028% =Percent difference

The net effect result of v_1 and v_2 on the sun's equatorial speed is doubled because we are at the point farthest from the COM (2X.0003=.06%). The effect of Saturn going through syzygy with Jupiter is about .901 of this Jupiter perihelion-aphelion effect so the net effect is about double ~ 2X.0006=0.12%. But the effect is distributed only over about half the sun so we divide by 2 to get .0006. Also note that the high energy particles participating in high energy interactions such as X ray, EUV, UVC emission are more sensitive to magnetic field diffusion and are also the biggest contributors to changes in the solar cycle.

Fick's Law Applied to Charge Particle Diffusion through a Magnetic Field

Recall Fick's law of diffusion where J is the diffusion current, D is the diffusion coefficient, $\partial\phi/\partial x$ is the density gradient which is essentially constant here:

$$J=-D\partial\phi/\partial x$$

Also recall that diffusion through a magnetic field μ_oH is given by(1):

$$D=cnkT/(\sigma H^2)$$

where D is again the diffusion coefficient, c=speed of light, n=particle density, σ=conductivity of plasma, H=magnetic intensity, T = temperature, k=Boltzman's constant. Note in Fick's law the diffusion current J is proportional to D. Also the average of 10 year Saturn syzygy effect with Jupiter and Jupiter perihelion-aphelion motion given Saturn's smaller contribution gives the 11 year solar cycle.

The electrical current j around the solar equator is proportional to these rotational v_1 and v_2. From Ampere's law: $\nabla XH=j/\mu_o$. so the j=KH; thus:

$$J_{Max}/J_{Min}=1/1/CH_{Min}{}^2/1/CH_{Max}{}^2=1/1/v_{Min}{}^2/1/v_{Max}{}^2=1/K(1)^2/1/K(1+.0006)^2=1+2(.0006)=1+.0012$$

The sun is taken to be a solid body with the solar system COM right near the solar surface. The magnetic field changes are then affecting the more slowly rotating deep interior. So we get for the solar flux ratio between solar max and solar min:

$$J_{Max}/J_{Min} = 1+.0012 \text{ or } \approx.1\% \qquad (2)$$

Thus we have a .1% radiance solar luminosity difference between the sun at solar min and the sun at solar max which is what we would expect. *The motion of the sun about the solar system COM is large enough to explain the solar cycle.*
A generic graphical representation of this computation of motion about the COM can look like:

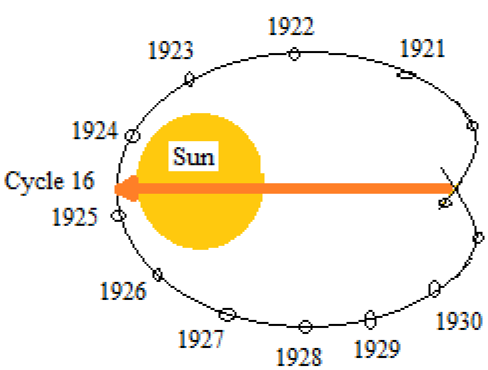
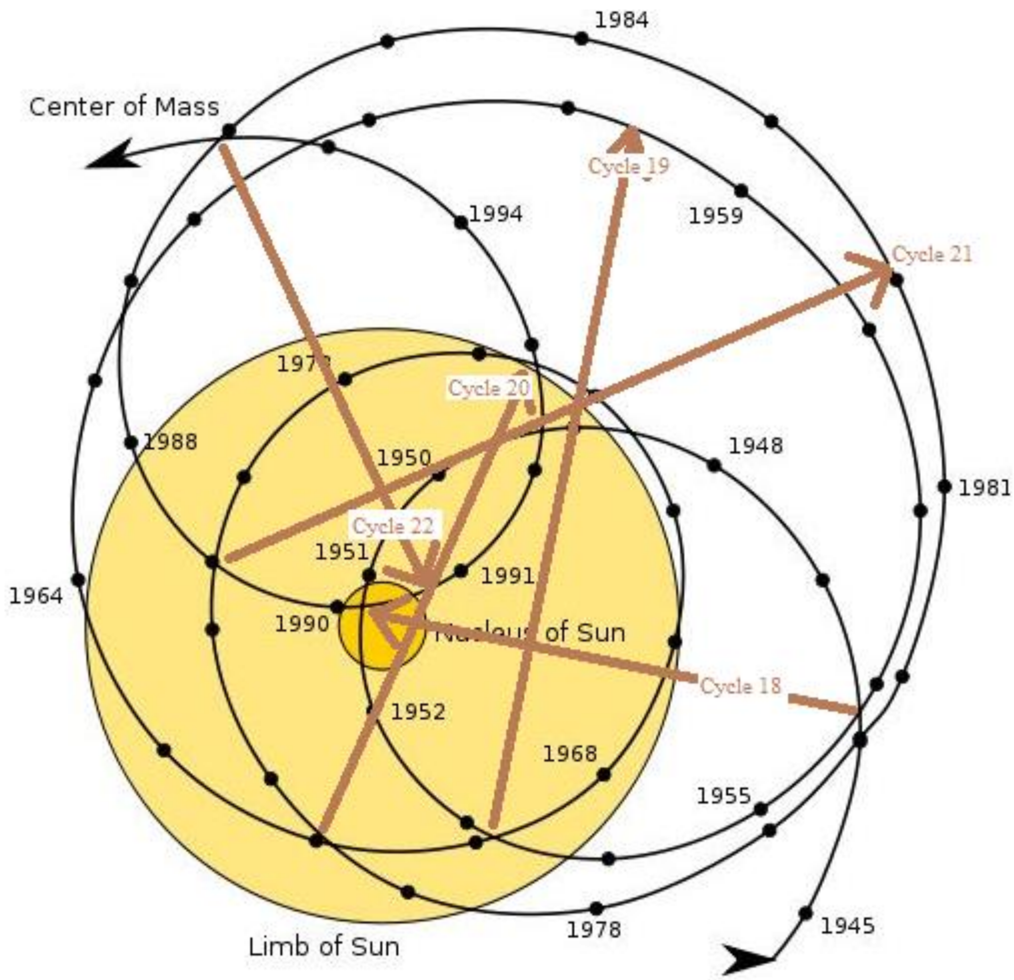
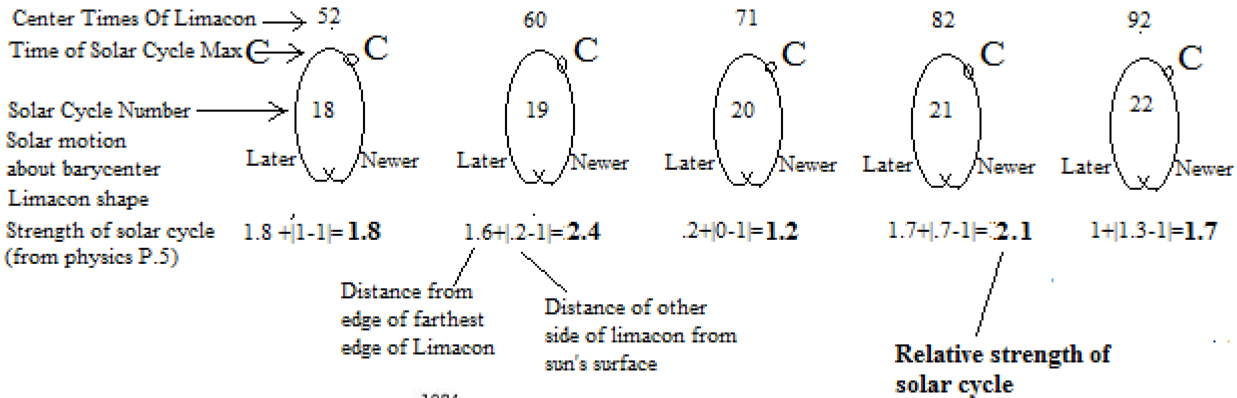


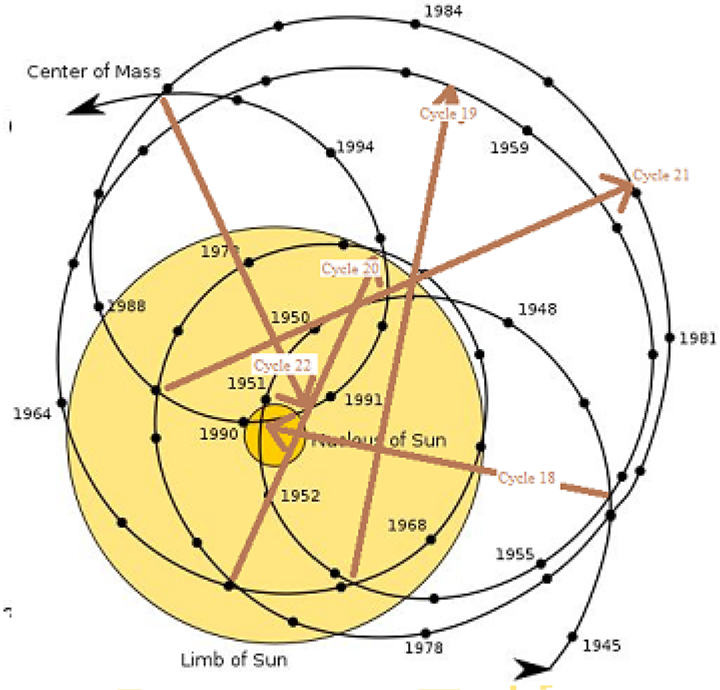
Figure 4 Generic fictitious sun COM motion (closed loop) for given just Jupiter motion from its aphelion to perihelion and Saturn orbital motion as outlined in the above derivation: Note that one such limacon corresponds to each solar cycle implying solar COM motion is indeed the cause of the solar cycle In the actual COM motion of all the planets and the sun we that each solar cycle has its own such closed loop limacon:



The figure 4 variation in solar COM due to Saturn motion and Jupiter perihelion to aphelion motion was first introduced in the article:
I.R.G.Wilson, et al
Does a Spin-Orbit Coupling Between the Sun and the Jovian Planets Govern the Solar Cycle?
CSIRO Publications of the Astronomical Society of Australia 2008, 25,85-93.

Summary Of Solar Cycle Magnitude Results Using This Limacon Shape
Note the above section on the rotation of the solar surface implies that the equatorial current is roughly proportional to how close the tachocline is to the solar system COM (barycenter) thereby allowing us to calculate the magnitude of the effects of planetary motion on that current.
Thus from the conservation of angular momentum to have a maximum change from low to high points in the solar cycle the farthest edge should be "far" and the nearest edge close to that point.
Thus the distance from the edge of the farthest edge of the limacon plus the absolute power of the distance of the other side of the limacon from sun's surface minus the sun's radius gives a measure of the magnitude of the solar cycle normalized to our above equation 2 calculated value.
Note also that the time of the maximum of the solar cycle is given by the point nearly opposite of the limacon line intersection point.





Note that each solar cycle has its own limacon shape which is yet further proof of the cause and effect connection of the solar cycle and the rate of change of tides.

Alfven Waves

You can calculate the emissivity of a plasma from:

$\varepsilon=1+(1/B^2)c^2\mu_o\rho$ so that E&M radiation speed inside the sun is:

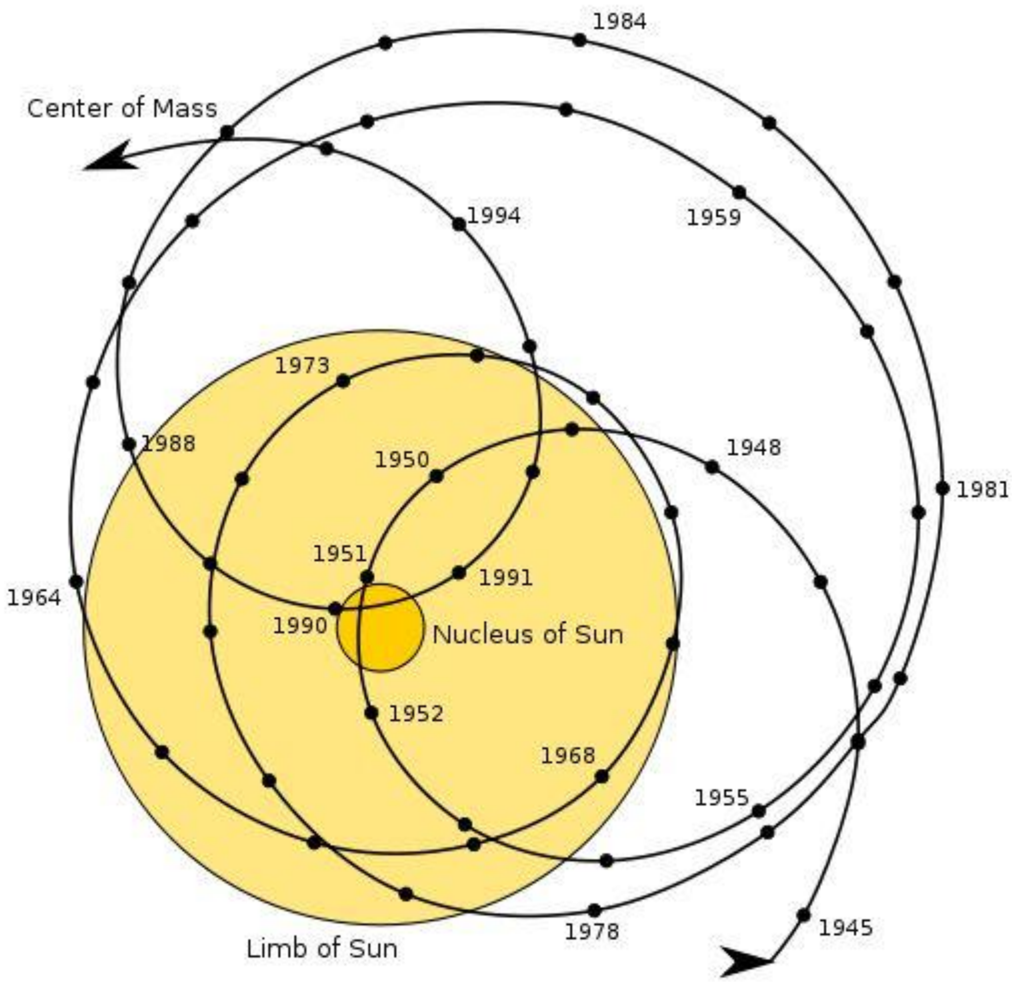
$V=c/\sqrt{\varepsilon} = c/\sqrt{(1+(1/B^2)c^2\mu_o\rho)}=v_A/(1+(v_A^2/c^2))$

For example at the surface (photosphere) of the sun yjr Alfven wave velocity is:

$v_A=B/\sqrt{(\mu_o\rho)}=.00005/\sqrt{(4\pi(.0002))}=.001$m/sec way to slow to have any effect over even over a thousand years since the wave moves moves 3600X24X365X11X.001=350km even over 11years.

ρ is the total mass density.0002kg/m^3 of photosphere, c speed of light, ε is the permittivity. B=.00005T, 1G=.0001T. So the Alfven wave velocity is:

At the bottom of the convection zone $v_A=B/\sqrt{(\mu_o\rho)}=.5/\sqrt{(4\pi(200))}=.01$m/sec 3600X24X365X11X.01=3500km in 11 years move a whole solar diameter in about 100 years and so could carry activity north south like the the author are saying.



Motion of solar system Center Of Mass (COM) Relative To The Sun

Results of Ambipolar Diffusion Model and Motion About the COM

Jupiter's motion between perihelion and aphelion and the 2X Saturn-Jupiter syzygy effect gives not only the *magnitude of that change of solar flux over a solar* cycle but *also the correct average period of the solar cycle*.

So we have used our new solar ambipolar charge diffusion model to explain both the solar cycle change in luminosity and to find the average period of the solar cycle given the sun's motion about the solar system's COM. Next we discuss how the ambipolar diffusion model and the rate of change of solar tides give solar flares.

5.0 The Rate of Change of Solar Tides as the Cause of Solar Flares

The Effects of Planets on Solar Events Mentioned In The Literature

Many others have identified a relationship between flares and planetary positions (2,3,4,5,6,7). For example Arthur Shuster in 1911 found correlations between various solar events and heliocentric longitudes of Mercury, Venus, and Jupiter at the time of the event (*The Influence of Planets on the Formation of Sunspots*, proceedings of the Royal Society of London). Glyn Wainwright, Leeds UK, performed a Fourier decomposition of the sunspot cycle and found that one of the leading terms had a periodicity corresponding to the tidal force of the planets on the sun (New Scientist, March 20, 2004). Ching-Cheh Hung in his article "*Apparent Relations Between Solar Activity and Solar Tides Caused by Planets*"(8) indicated that "**variation in the tide potential** (the time derivative in our equation 1 below**)**, not the magnitude of the tides", determine the tidal effect. Hung uses a parameter he calls an "alignment index", **$|\cos\theta_i|$,** to predict solar events (also a coefficient in our equation 1 below), where θ_i is the angle between the net planetary force and the given i^{th} planet. This 'rate of variation in the planetary tides' and planetary 'alignment index' are also at the core of our method for predicting the occurrence of solar flares.

Evidence of Solar Tide Effect On Flares

Tidal forces typically create bulging, or in this case flaring, on both sides of an object (diurnal) at once as we notice with ocean tides on the earth. In that regard we note that nearly all flares occur in pairs, occurring on both sides of the sun at once thereby implying a tidal effect. Examples of such occurrences are shown below in Figure 5

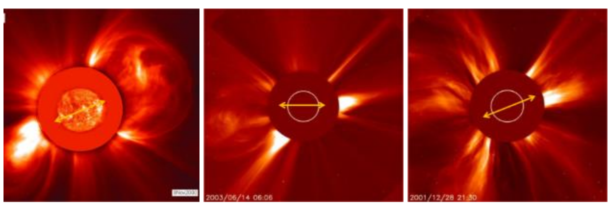


Figure 5.Two sided Simultaneous flaring

We did a study of 21 flares on the solar limb so that both front and back flares could be observed and found that within 24 hours of a given flare only one in 20 did *not* have a corresponding flare on the other side.

The Source of Solar Differential Rotation and Equatorial Plasma Tubes

Ambipolar diffusion in the radiation zone gave a negative charge layer at the tachocline and an associated E field and B field due to the rotational motion current j of this charge layer as later discussed in (below) section 3 of this article: $B=E/v_{diffusion}$. We will also find in (below) section 3 that the plasma tube velocity **v** from our solar differential rotation equation the Poynting vector flux

$$|E X H| = \frac{1}{2}\rho v^3$$

With this understanding of the origin of the equatorial plasma tubes we can then discuss their sources of instability.

Plasma Tube Instability

The ∇P term in Suydam's criterion(10) for kink instability of these EXH Poynting vector equatorial plasma tubes can be related to ∇P through the MHD equation:

$$\mathbf{r}JXB=r\nabla P+r\rho g-(g/|g|)R\rho T/M \text{ (the MHD equation(2)) with } A \propto F_i|\cos\theta_i|.$$

from equation 1. A new electrical current j_1 is created by the tidal effects of the long period outer planets through Faraday's and Ohm's laws:

$$-BdA/dt = V = Rj_1 = kd|\cos\theta_i|/dt.$$

For the short period planets a change in this j_1 due to their planetary tides changes the B through Ampere's law[1] $\nabla XB=j_1\mu_o$ If all the other quantities (except for JXB and $\nabla P=dP/dr$) are constant in the MHD equation then $\nabla P \propto JXB$. Applying Faraday's law for the short term planets:

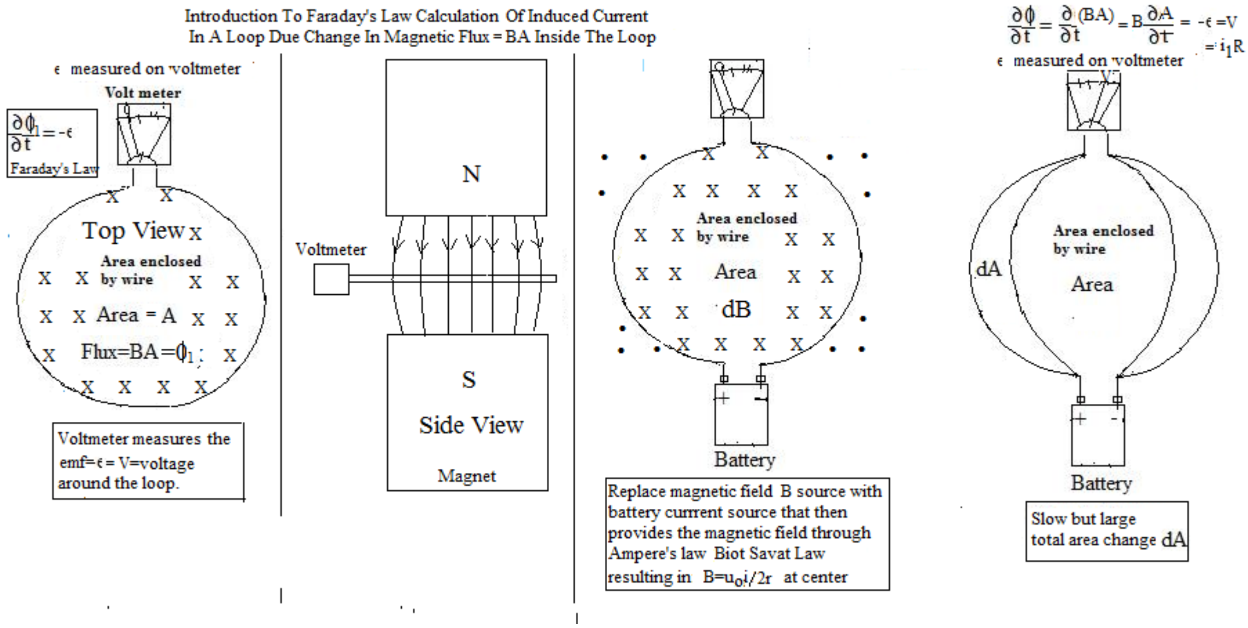
$$-AdB/dt = Kdj_1/dt = Rj_2 = d^2|\cos\theta_i|/dt^2.$$

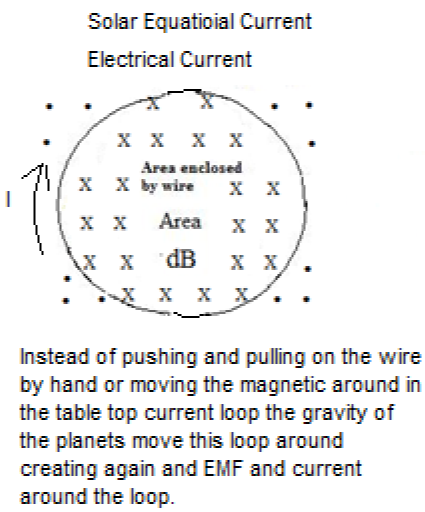
So in the MHD equation the rate of change of dP/dr is proportional j_2XB. Therefore:

$$dP/dr \propto j_2XB \propto d^2(F_i|\cos\theta_i|)/dt^2 = k\delta(\cos\theta_i) = \text{delta function} \qquad (3)$$

$\cos\theta \approx 0$

dP/dr can become large negative because of that delta function spike and we then have satisfied Suydam's criteria (2) for the sausage instability and thus flaring.
It is also possible this outer planet effects let's say the earth (or Venus) by itself and then that resulting current is changed in the same way by Mercury let's say. You then have a **far smaller third derivative Id3 result** You could continue this kind of analysis again and again until you have at the end of it $(Id1+Id2+Id3+Id4+Id5+\ldots)^{\wedge 2}$ with the Id3 contribution being much smaller than Id2, Id2 being much smaller than Id1 as we also see is the case of the actual F10.7 data, etc.The first derivative of a Dirac delta function is still a spike and so should still cause a flare.





Equation 3 $\partial^2(\Sigma F_i|\cos\theta_i|)/\partial t^2)$ and Solar cycle $d|\cos\theta_i|/dt$

Note from equation 3 that $\partial^2(\Sigma F_i|\cos\theta_i|)/\partial t^2)$ =Jump in dP/dr. From the first section Define Id2= $d^2|\cos\theta_i|/dt^2$ for flares and Id1=$d|\cos\theta_i|/dt$ for above solar cycle. This is the statistics of the combined $(Id2+Id1)^2$ (+metric quantization compensation) fortran code –simulation output. Note from equation 3 then that flaring should occur most frequently when $\cos\theta_i=0$, $\theta_i=90$deg which we have shown to be true after finding many examples (Figure 6). Thus we use the alignment index times the planet force to determine when solar events will occur. Our θ_i is that angle between the net planetary force (e.g., solid red line below) and the given ith planet.

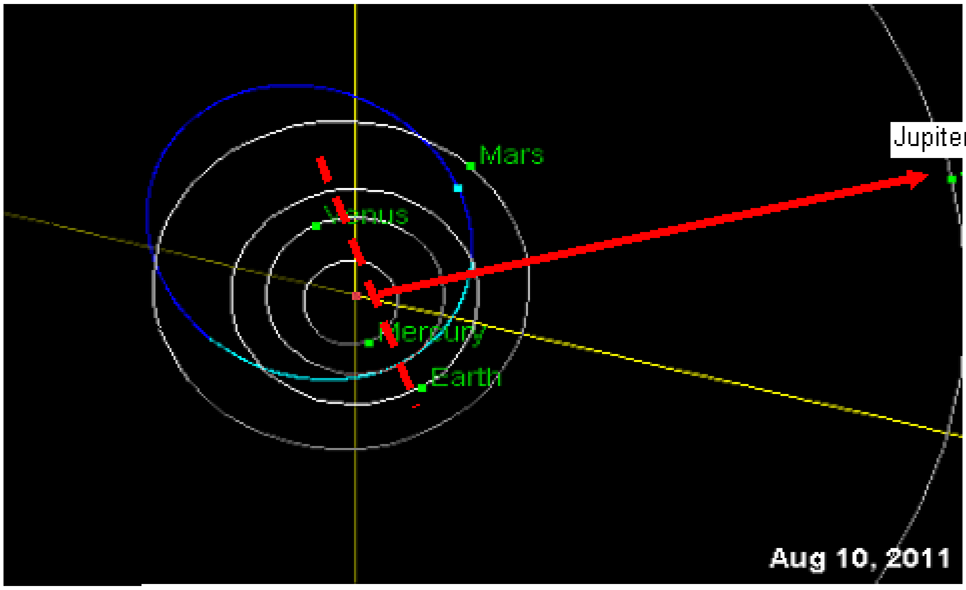
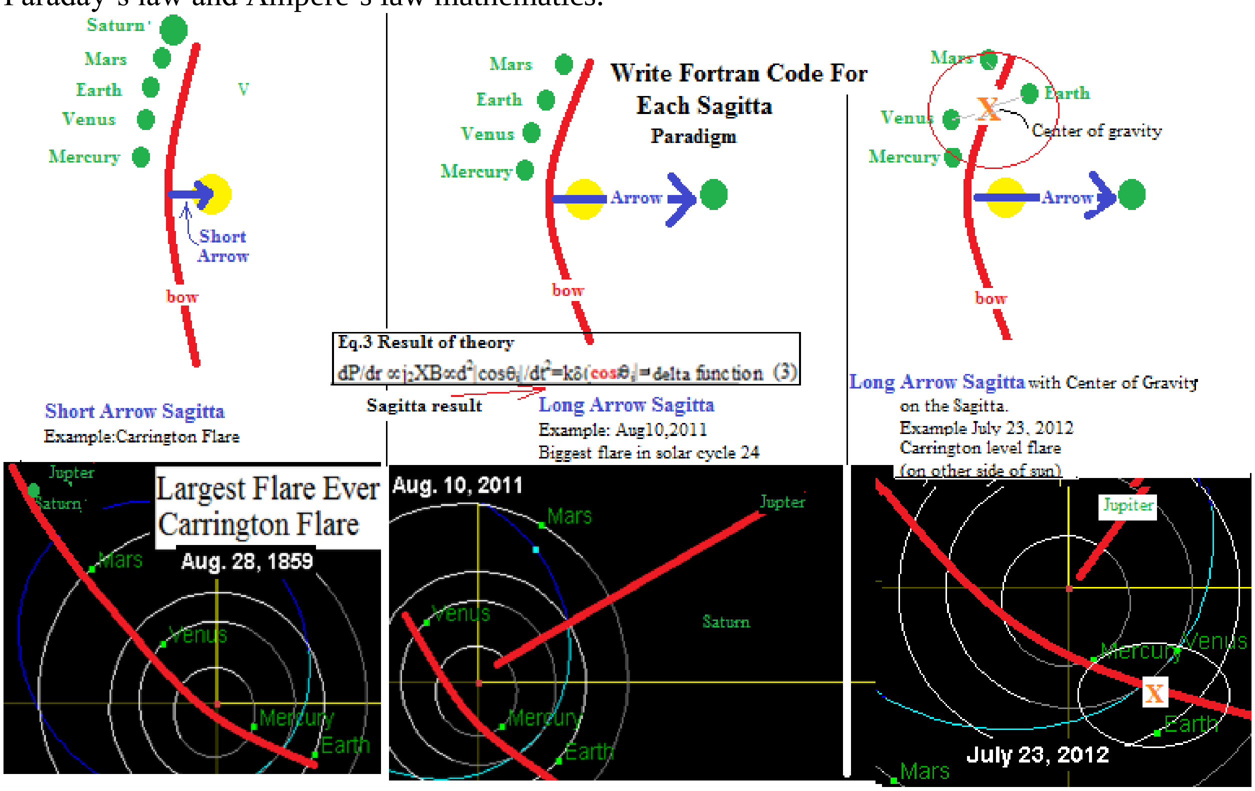
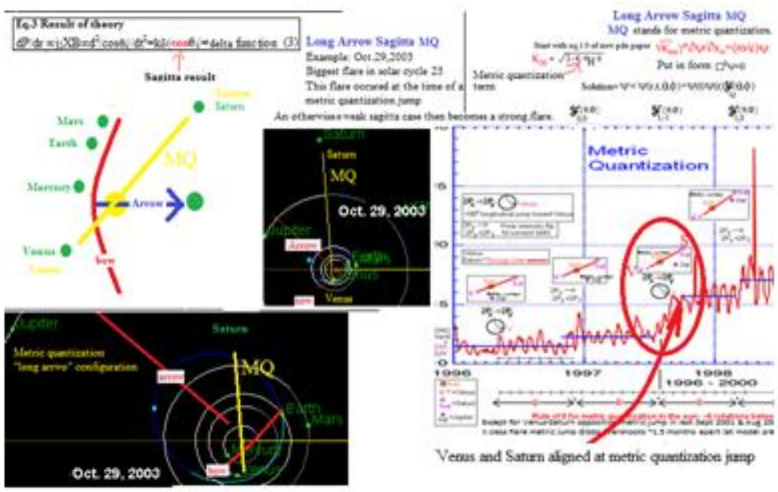


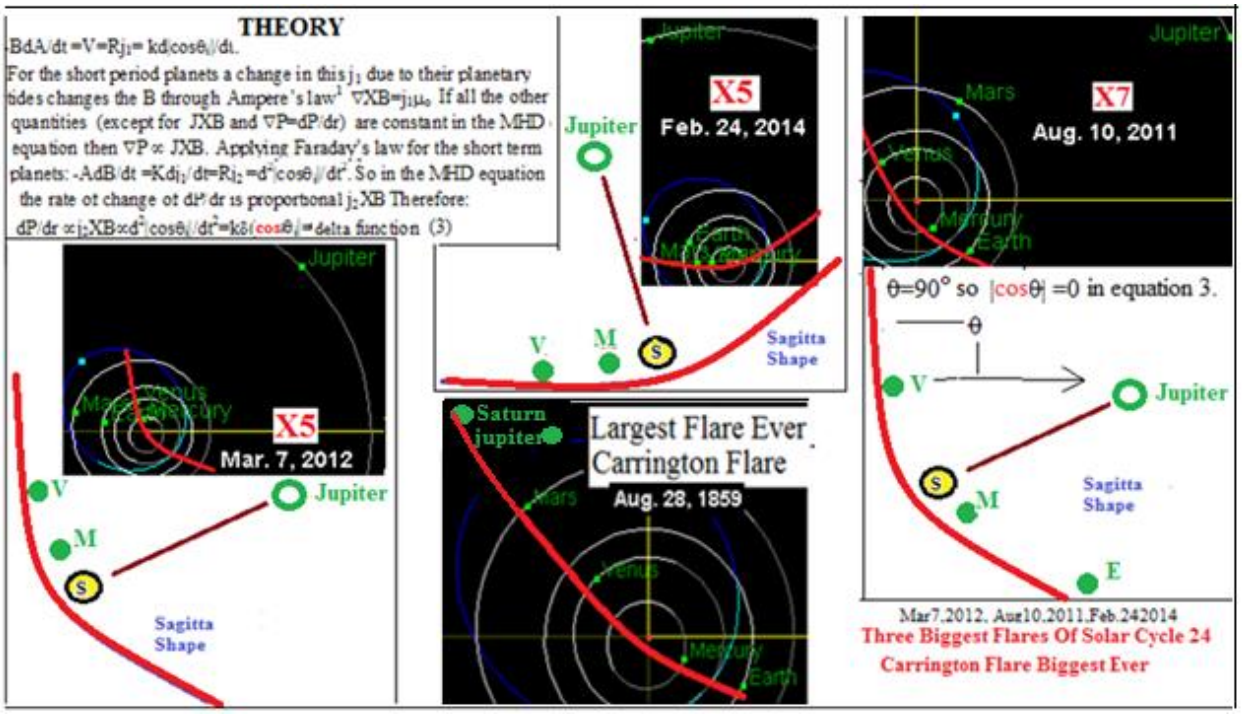
Figure 6. Alignment Index Example X6.9 flare Occurred On Aug.10,2011

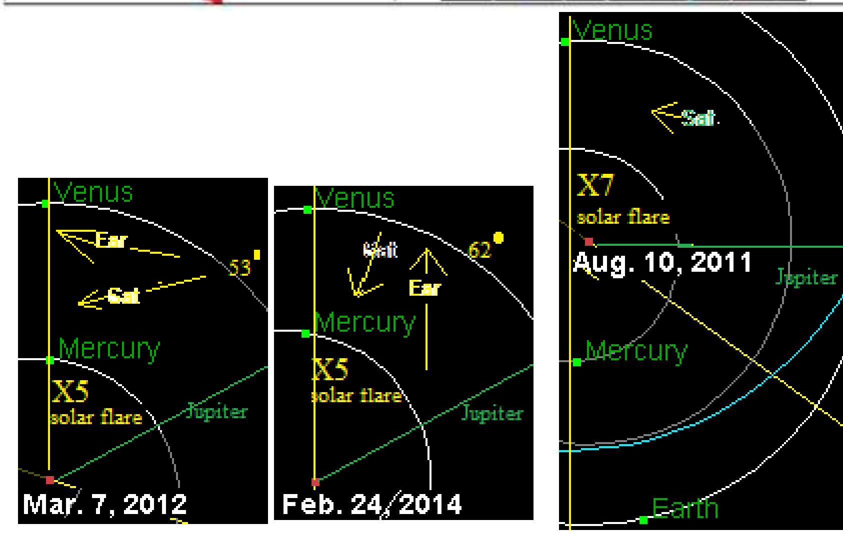
Note rare and near perfect sagittal alignment along dashed line of Mercury, Venus and Earth so that cos90°≈0 for each in equation 3. Note 90° angle between net (thick red line) and dashed red line to the positions of Venus, earth and Mercury. There was an X6.9 flare August 10, 2011, largest in all of cycle 24 so far. This is a strong reality check on the validity of the above Faraday's law and Ampere's law mathematics.

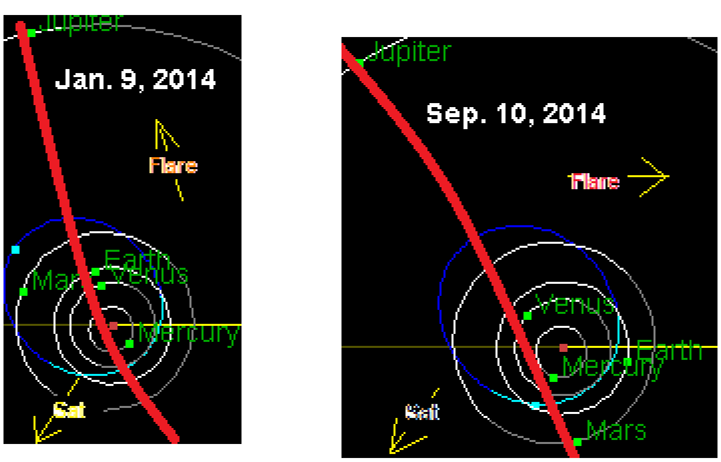



Eq.3 Result of theory
Sagitta result
Mars
Earth
Mercury
Venus
Saturn
MQ
Arrow
bow
Long Arrow Sagitta MQ
Example: Oct.29,2003
Biggest flare in solar cycle 23
This flare occured at the time of a metric quantization jump
An otherwise weak sagitta case then becomes a strong flare.
Long Arrow Sagitta MQ
MQ stands for metric quantization.
Metric quantization term
Put in form
Oct. 29, 2003
Jupiter
Metric Quantization
1996
1997
1998
1996 - 2000
Metric quantization
"long arrow" configuration
arrow
Venus and Saturn aligned at metric quantization jump

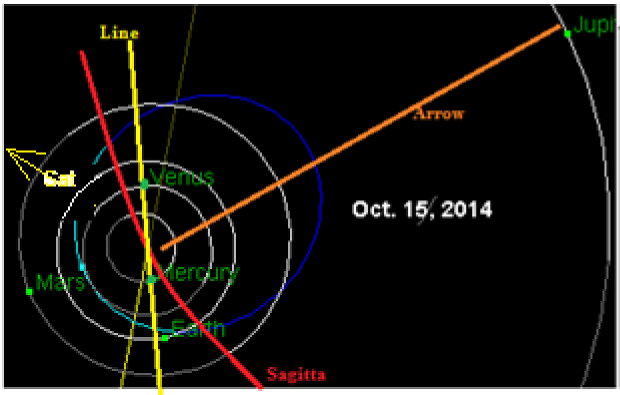

Saturn
jupiter
Largest Flare Ever
Carrington Flare
Aug. 28, 1859
Mars
Venus
Mercury
Earth


THEORY
BdA/dt =V=Rj₁= kd|cosθ|/dt.
For the short period planets a change in this j₁ due to their planetary tides changes the B through Ampere's law ∇XB=j₁μ₀ If all the other quantities (except for JXB and ∇P=dP/dr) are constant in the MHD equation then ∇P ∝ JXB. Applying Faraday's law for the short term planets: -AdB/dt =Kdj₁/dt=Rj₂ =d²|cosθ|/dt². So in the MHD equation the rate of change of dP/dr is proportional j₂XB Therefore:
dP/dr ∝ j₂XB∝d²|cosθ|/dt²=kδ(cosθ|=delta function (3)
Jupiter
X5
Mar. 7, 2012
V
M
S
Jupiter
Sagitta Shape
Jupiter
Feb. 24, 2014
X5
Sagitta Shape
Saturn
jupiter
Largest Flare Ever
Carrington Flare
Aug. 28, 1859
Venus
Mercury
Earth
Jupiter
Mars
X7
Aug. 10, 2011
Venus
Mercury
Earth
θ=90° so |cosθ| =0 in equation 3.
θ
Sagitta Shape
E
Mar7,2012, Aug10,2011,Feb.242014
Three Biggest Flares Of Solar Cycle 24
Carrington Flare Biggest Ever


Venus
Mercury
X5
solar flare
Jupiter
53
Mar. 7, 2012
Venus
62
Ear
Mercury
X5
solar flare
Jupiter
Feb. 24, 2014
Venus
X7
solar flare
Aug. 10, 2011
Jupiter
Mercury
Earth


Jupiter
Jan. 9, 2014
Flare
Earth
Venus
Mercury
Jupiter
Sep. 10, 2014
Flare
Venus
Earth
Mercury
Mars

Note to satisfy equation 3 the line and the sagitta have to be colinear.



The line appears to give the largest flare of the clump and can ea
from these kinds of orbit diagrams (ie., by eyeballing).
The timing of the greatest correlation of positions with the sagi
appears to determine the center time of the clump and comes o
program. Together the line and the sagitta define both the flare c
largest flare of the clump.
The line and the sagitta coincided for the Aug.10,2011 flare whi
case for the Oct.14, 2014 flare.. that made it easier to determine
the Aug.10, 2011 flare..

If the line is not close to a sagitta we then have a single huge flar
duration flare clump, at that time. If the line and the sagitta coin
biggest flare of the clump is at the center of the clump time.

For weaker flares this analysis becomes quite complicated and mu
more ambiguous than for these more clear cut examples (such a
Oct14, 2014, Feb14, 2014, Aug10,2011, etc the paradigm cases
mentioned)

Plasma Tube Instability

The ∇P term in Suydam's criterion(10) for kink instability of these EXH Poynting vector equatorial plasma tubes can be related to ∇P through the MHD equation:

$rJXB = r\nabla P + r\rho g - (g/|g|)R\rho T/M$ (the MHD equation(2)) with $A \propto F_i|\cos\theta_i|$.

from equation 1. A new electrical current j_1 is created by the tidal effects of the long period outer planets through Faraday's and Ohm's laws:

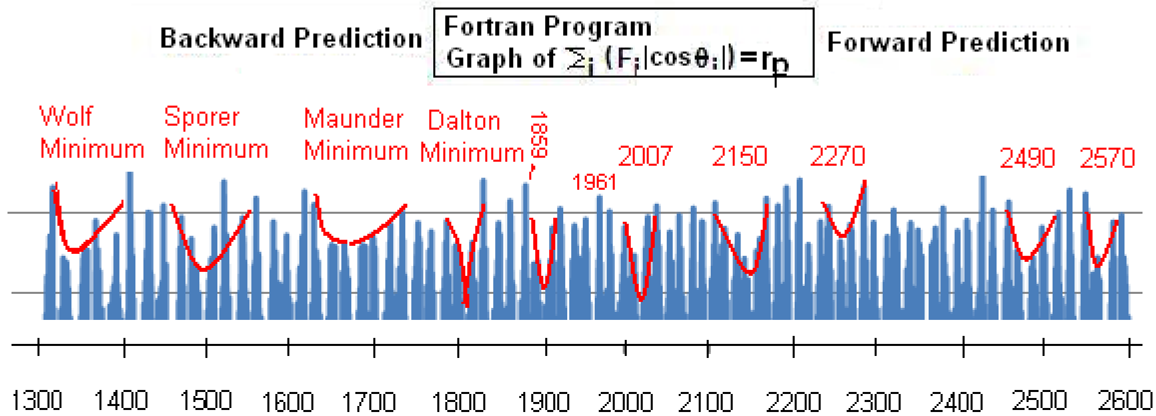
$-BdA/dt = V = Rj_1 = kd|\cos\theta_i|/dt$.

For the short period planets a change in this j_1 due to their planetary tides changes the B through Ampere's law[1] $\nabla XB = j_1\mu_o$. If all the other quantities (except for JXB and $\nabla P = dP/dr$) are constant in the MHD equation then $\nabla P \propto JXB$. Applying Faraday's law for the short term planets:

The line in the above diagram appears to give the largest flare of the clump and can easily identified from these kinds of orbit diagrams (ie., by eyeballing). The timing of the greatest correlation of positions with the sagitta appears to determine the center time of the clump and comes out of the fortran program. Together the line and the sagitta define both the flare clump and the largest flare of the clump. Note it is more difficult to determine flare time when the line and sagitta do not coincide.

Results of Flare Analysis

This new solar ambipolar diffusion model implies a charge layer at the tachocline. The rotation of the sun then implies a current j and a resulting magnetic field. Planetary tidal effects change this current. Ampere's law and Faradays law thereby imply a Dirac delta spike j in jXB =dP/dr +… and therefore **a spike** in dp/dr and therefore Suydam kink instability and flaring. When the $|\cos\theta_i| = 0$ spike is realized for several planets (approximately 90° to the F_{net} which is close to Jupiter's direction) we find very large flares occur constituting a *reality check* for this kink instability derivation. We also found that the model works well at predicting solar flares providing yet another *reality check* on our Faraday's Law derivation of that Dirac delta kink instability in those plasma tubes. Also this model only the middle of solar flare clumps and gives more accurate timing of the largest flares.



This is actually a flipped over version of $\Sigma_i F_i|\cos\theta_i|$ so these peaks are actually minima of this function. So the smaller the $\Sigma_i F_i|\cos\theta_i|$ gets the more active the sun, which makes sense since those orthogonality relations are smaller then.

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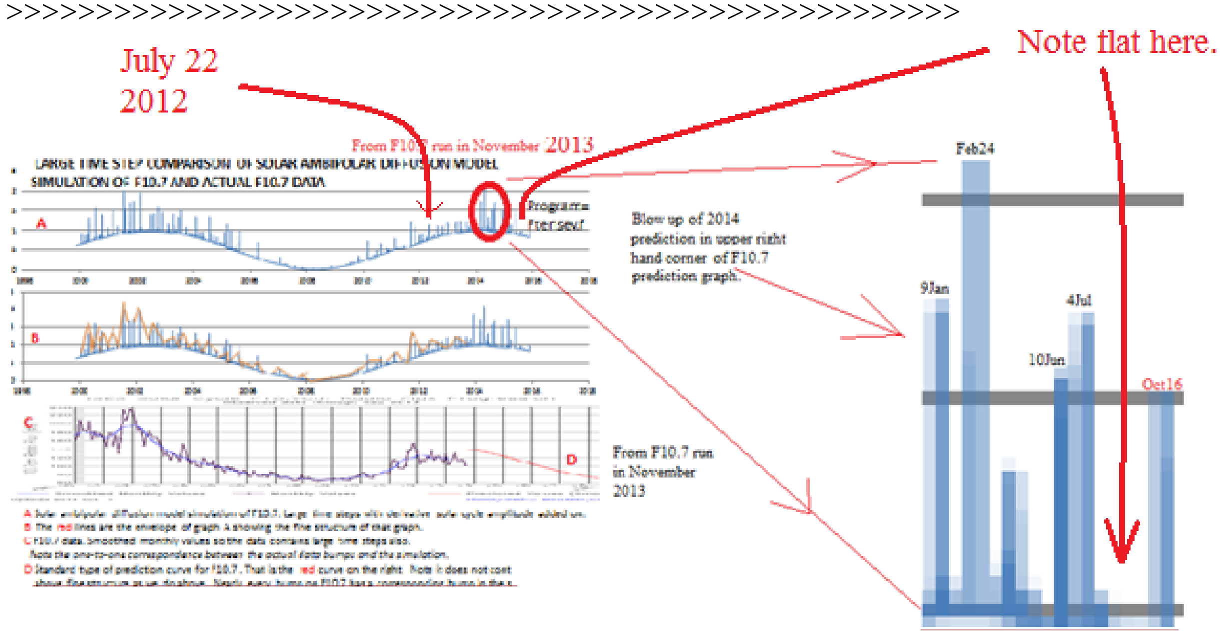
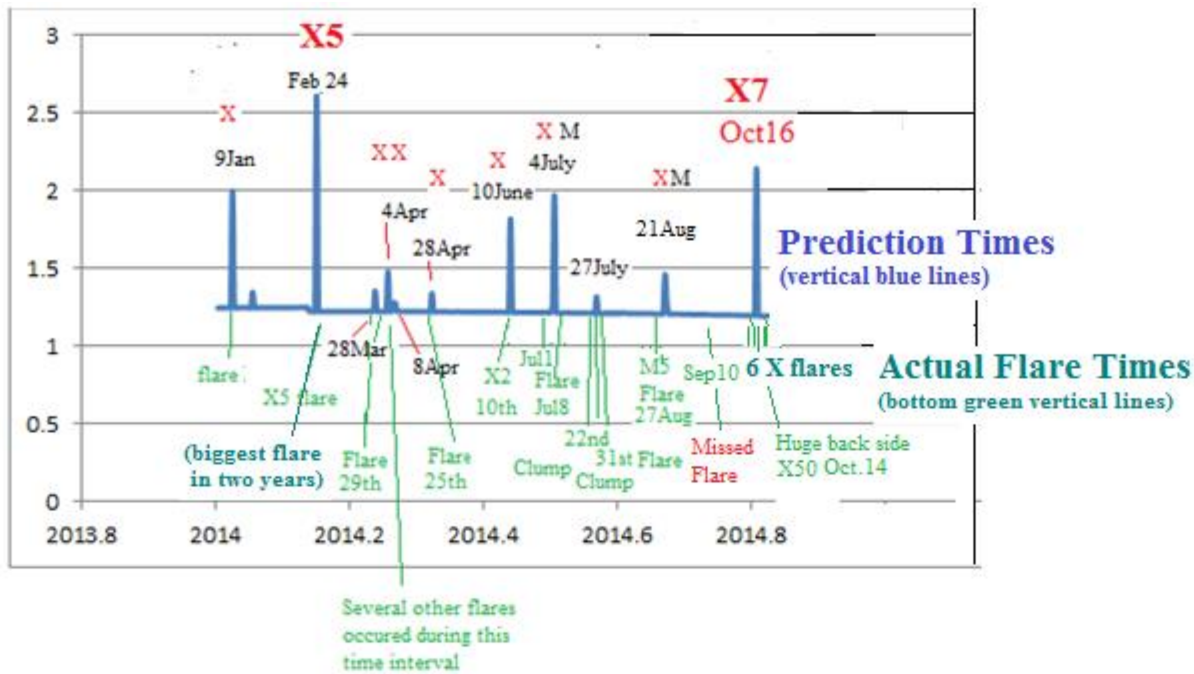
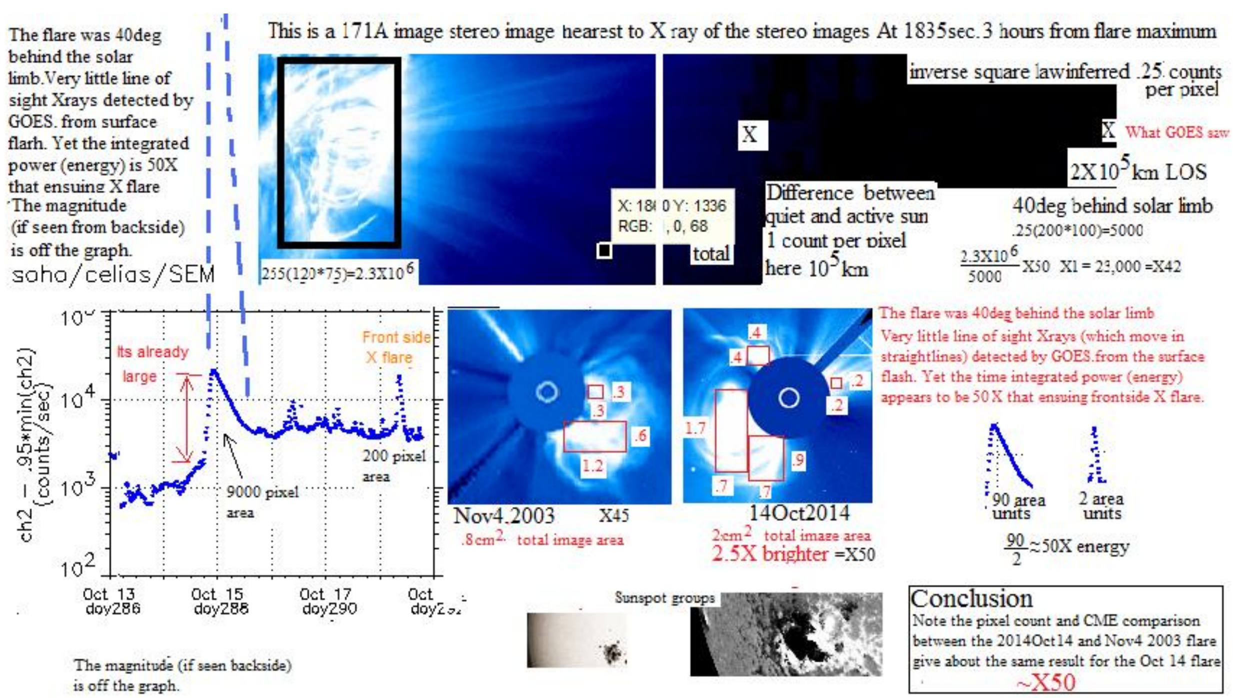






Directionality Of Solar Flare Relative to The Earth

M*E-(J*S-J*V)|MXJ|=DIR=Directionality with respect to the earth of the flare leaving the sun. If Dir=Max the flare is directed straight toward earth, if Dir=-Max it is directed away from earth. If Dir<0 the photospheric source of the flare of the flare is unobserved.

S=Sat,E=Earth,V=Venus,M=Mercury and J=Jupiter are all unit vectors pointing in the direction of the respective planets. A, It appears that the tidal effects on the sun of Venus and Saturn are nearly equal.

6.0 Poynting Vector Cause of Solar Differential Rotation and Plasma Tubes

Introduction to Poynting Vector Calculation

Solar differential rotation is actually initiated (jump started) by metric quantization (appendix A). But assuming that motion was instead caused by the H and E through a Poynting vector flux EXH mechanism allows us to derive H and thereby connect this phenomena to the solar ambipolar diffusion model. For example Feynman, in a gedanken experiment (9) written up in his famous lecture series of books, showed that *momentum* is carried by the $EXH/c^2=P/c^2$ = (Poynting vector)/c^2 for dipole B and radial E spherical configurations. But how is the Poynting vector related to the *kinetic energy* (in contrast to the momentum) of a highly conductive plasma in Feynman's same spherically symmetric configuration given a ambipolar diffusion (model) field and conductor rotation? Here we describe a gedanken experiment for this case as well, giving us also the cause of the solar dynamo, differential rotation and equatorial plasma tubes.

Review of the Derivation of the Poynting Vector

The power per unit volume τ expended in changing the electric and the magnetic fields is $E \cdot \dot{D}$ and $H \cdot \dot{B}$ respectively. The power per unit volume in other forms is $E \cdot J$ (e.g., Ohm's law and KE). Note the latter term can be both mechanical power dKE/dt=dW/dt and thermal energy rate of change $n_o(3/2)kdT/dt=dU/dt$. The power flowing into volume τ then is obtained by integrating the sum of these three terms over the volume τ, that is:

$$P = \int \left(E \cdot \dot{D} + H \cdot B +\dot{} E \cdot J\right) d\tau + \int S \cdot ds = 0$$

We then write the integrand in terms of Maxwell's third and fourth relations $\dot{B} = \dot{-}\nabla XE\,\dot{}$ and $\dot{D} + J \dot{=} \nabla XH$ respectively. The integrand then becomes:

$$E \cdot \nabla XH - H \cdot (\nabla XE) = \nabla \cdot (HXE) = -\nabla \cdot S$$

S ≡EXH called the Poynting vector.

Cause of the Dynamo Effect

Again Feynman pointed out that **E**X**H** can indeed carry E&M field momentum. But **E**X**H** is also power per unit area, which can also be the rate of flow of *mechanical* energy through an area into this volume V. Furthermore note that one of the above terms in **E•J** contains a kinetic energy term, as well as others, which is more than just a field term. Note this charge is rotating with the sun's surface in this model there has to be a magnetic field B. Also to get a net zero force set qE+q(vXB)=0 so that v=E/B. If the charge is not quite moving at this velocity v it will begin moving in a circle and so the flux through the "circle" will change and thus there will be an

emf generated from (given the Lenz's law component of) Faraday's law that will either speed up the charge or slow it down. By that means, the charge will then eventually flow at this constant v in the relaxation limit. Also, any point in plasma is continuously shifting between an unshielded (charge) and shielded (Debye radius) condition in a statistical mechanical fashion. Note also that a *non*superconductor, but still good conductor, does not shield a static magnetic field, only a static electric field. In the *un*shielded condition (which is about half the time since equilibrium is quickly established), the E field due to the ambipolar charge stops the diffusion. But what about the shielded condition? In that regard note that $mv^2/r=qvB$. So $r=mv/qB=m_ev/(eB)$ so that r is smaller than the Debye length because m/e and diffusion v are small. In this region E is not allowed (Faraday cage) but there is still that average density gradient so the charge will still move at speed v anyway on average let's say because of that diffusion mechanism. In that case the particle will readily start moving in a circle at radius r (=mv/qB) at speed v from Fick's law, thus possibly perpendicular to both the diffusion $j/\sigma=E_{effective}$ and B. This is our nonzero curl possibility. Thus in the shielded case the magnetic field acts to stop the diffusion current, not the E field whereas in the unshielded case the charge layer electric field acts to stop the diffusion current. In both cases E/B=v with the same magnitude of E and B in each case. This gives zero net force so minimizes work $\int Fdx$ *so minimizes energy as in δ(total energy)=0 thereby again implying B=E/v, the preferred relaxation* time condition for the diffusion current charges.
This *0 net force* explains why Bahcall's standard solar model(11) does not require these new E&B fields. His speed of sound calculations , isostatic equilibrium, and jXB (in the MHD equation) for example need not be altered since there are no new additional (net) forces here and the diffusion current j is halted, made zero in the relaxation limit as discussed above.
In any case the above discussion constitutes the first part of our derivation of the origin of the dynamo effect which gives an electrical current in a rotating conductor if there is an initial B field. Here we found the source of that initial B field is that rotating charge layer required for the dynamo effect to work in the sun. Of course eventually the E in $E\sigma=j$ stops this radial flow of charge j altogether, thereby determining the value of this final static E and thereby B.
Also recall from the above definition of the Poynting vector that:

$$E \cdot \dot{D} + H \cdot \dot{B} + \dot{E} \cdot \dot{J} = -\nabla P$$

Ambipolar Diffusion In the Radiation Zone

Recall the mass of the proton is 1836 times the mass of the electron. Thus in the plasma environment of the sun, there is an ambipolar radial electron charge diffusion current j and a resulting charge layer and (and thus defined to be a) ambipolar E field that cancels that diffusion current as in $E\sigma=j$. Because of solar rotation this charge layer motion results in a dipole B field from Ampere's law. So there is a nonzero Poynting vector $EXH=EXB/\mu_o$.just above the radiation zone of the sun. Note as the system finally relaxes to the steady state $\dot{D}$ and $\dot{B}$ go to the zero limit. So all that we have left in equation 1 in the asymptotic relaxation time limit in a curl free environment is:

$$-\nabla S=J\bullet E\rightarrow E_RJ_{NR} +E_RJ_C$$

where E_R is the radial field and J_c is the circumferential current density, J_{NR} is the non radial current density associated with thermal motion. E_RJ_C is always zero because the radial E field is perpendicular to the circumferential current by definition. Thus now all we have left is:

$$-\nabla S = J \bullet E \rightarrow E_R J_{NR}.$$

But after relaxation we are in a curl free environment and there are also no sources or sinks: the rate of energy input equals rate of energy output. In that regard $-\nabla S=0$ for no sources or sinks which is the case after a large relaxation time. Thus after relaxation:

$$-\nabla S = E_R \bullet j_{NR} \rightarrow 0 \quad \text{so}$$

$$j_{NR}=0$$

Thus the only component of j that is nonzero is the completely circumferential j_c in $KE=\frac{1}{2}mv^2_c$ since the other component(s) j_{NR} went to zero. So the only non zero component of the average of ∇P (i.e., $\langle\nabla P\rangle$) is this one.

Conservation Of Energy

Again Feynman showed that momentum is carried by a radiation field Poynting vector flux. But if momentum exists so does energy. So the energy flux is going somewhere given the conservation of energy and here would be absorbed by the plasma because there are no Bdot or Edot terms in the plasma as we showed. Recall we also proved above that the Poynting vector energy is not going into thermal energy. It then has to be going into KE where the v in the KE term is the circumferential v_C in the J_C circumferential current. Note also that $\rho \equiv$ mass/volume =mass(kg)/1m^3.

Coaxial Cable Model Of The Equatorial Convection Zone

$PA=\Delta KE/\Delta t$ = Poynting vector times area equals rate of flow of energy=power
Assume as above that the mass of the convection zone is carrying the power associated with the Poynting vector. The analogy would be with a coaxial cable EXH carrying the power.

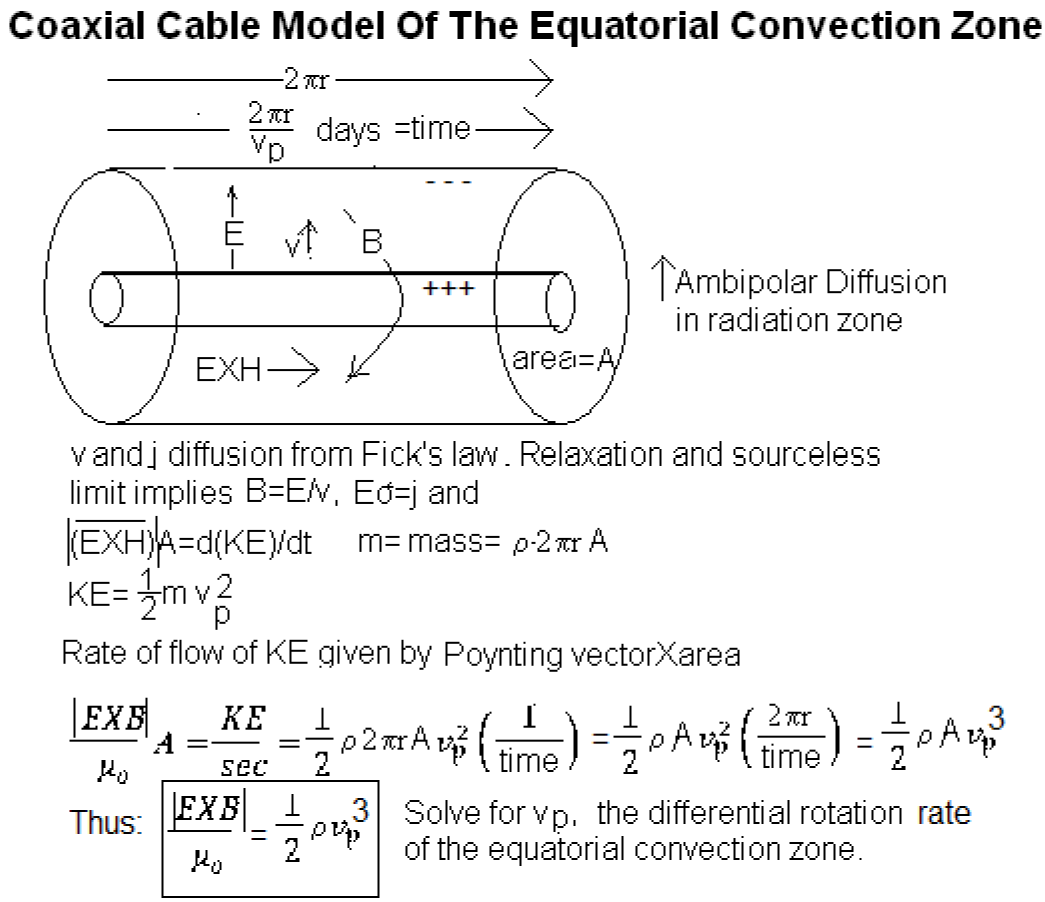


Figure 8. Coaxial Cable Representation of Equatorial Convection Zone

Thus the v in |EXH| =($\frac{1}{2}\rho v^3+v\Delta U_{thermal}$) is the differential solar rotation rate and $\Delta U_{thermal}$ =0 for thermal energy coming out of the EXH term. Thus finally:

$$|EXH| = \tfrac{1}{2}\rho v^3 \qquad (5)$$

Again we can calculate the value of v from this equation since all the kinetic energy is associated with the angular momentum circumferential motion v_C. Thus from this gedanken experiment we have derived the mechanical (kinetic) energy in terms of EXH for this ambipolar diffusion case. This is analogous to Feynman deriving his momentum from EXH in his own gedanken experiment (9).

We have also derived here the source of the solar dynamo which was responsible for our B=E/v term. The depth of the tachocline by the way is determined from the standard solar model of Bahcall's (11), from his radiation zone opacity theory calculations.

Calculation of the Solar Differential Rotation Rate from Ambipolar Diffusion in the Sun

Here we use equation 2 to obtain the differential rotation rate. To do this we first calculate the ambipolar diffusion coefficient using Chapman-Enskog diffusion theory. We use this result to calculate the diffusion current j and then the ambipolar E field required to cancel this diffusion current. The E field is used to derive the B field for constant velocity current and all this is plugged into equation 5: $|EXH|= \frac{1}{2}\rho v_p^3$ to get the v_p.

Nomenclature

$$Debye\ length = \qquad \lambda_D = \sqrt{\frac{\epsilon_o k T_e}{n_o e^2}} \qquad (3)$$

n_o is the density in the mid radiation zone, T the temperature there. The Debye length is 1/10A at center of sun. Use the proportionality with associated square root of n_o and T to then calculate it at other depths. Also recall from Chapman-Enskog diffusion theory:

$$D = \frac{1.858X10^{-3}T^{3/2}\sqrt{\frac{1}{M_1}+\frac{1}{M_2}}}{p\sigma^2\Omega} \qquad (4)$$

Recall Fick's Law of Diffusion $J=-D\nabla\varphi(r,t)$
σ ($=\lambda_D$) is the Debye length in Angstroms. It is stated to be .1A in the sun's core, and is found to be ~.5A in the middle of the radiation zone found by taking $\sqrt{(T/n_o)}$ ratios.
λ= sqrt(k($5X10^6$/1.77) at center of radiation zone. Temperatures and density from Bacall.
λ_p=.1=sqrt(k($1.58X10^7$/150.5)=Debye length at center of sun, equation 5.
Thus again by taking ratios:
λ=.52A.
M_1 is the electron mass which is 1/1836 the proton mass (~1g/mole) in molecular weight units.
85kg/m^3=ρ at the top of tachocline at .8R from Bacall(11).
J=kg/(m^2sec) =mass diffusion flux calculated from Fick's law.
T=$5X10^6$K at mid radiation zone from an average from Bacall.
.168keV=E at the top of the tachocline. Cu resistivity $1.72x10^{-8}$ Ω-m for 1keV. From Rose et al gives at 50keV resistivity 350X lower so use energy ratioX7 to find resistivity and so conductivity. At $1.3X10^6$K and .168keVso resistivity is 7/.168=42 times higher than at 1keV. It is 1,300,000K at the top of the tachocline at .8R from Bacall. Divide by 7 (per Rose,9) and multiply by Cu resistivity (as a comparison number) so $1.72X10^{-8}$X42 =$7.2X10^{-7}$. So $\sigma=1.4X10^6$ /(Ω-m)
$\sigma=1.4X10^6$/(Ω-m) estimate of conductivity σ at the top of the tachocline from this extrapolation from: Rose D, *Plasmas and Controlled Fusion*, Wiley, pp.173.
From Ohm's law we can find the electric field required to cancel the diffusion current at the top of the tachocline.
P=$2.25X10^{11}$ bars at r=0.
T=7.8X106K, 21g/cm^3 at r=0 from Bahcall (11).
T=$1.35X10^6$K and .85g/cm^3 at middle of radiation zone from Bacall (11).
Using ideal gas law PV=nRT ratios then P=$1.58X10^9$ bars in middle of radiation zone.
ρ=21.4g/cm^3 for mid radiation zone from Bahcall.
For top of radiation zone ρ=.195g/cm^3 from Bahcall.
$7X10^{10}$cm=radius of sun. $3.5X10^{10}$cm =thickness of the radiation zone.
Pressure found indirectly from temperature and density at radiation zone. Use ideal gas law.
$\rho T \propto P$ proportionality to do this given pressure at center of sun listed in several documents.

Electrical current density j found by using q/m ratio for electron, the diffusion coefficient D and the electron mass density at mid radiation zone.

Derivation of Rotation Rate Due to E X H

Here we derive the EXH=Poynting vector motion associated with the differential rotation of the sun from the ambipolar field and the associated EXH forcing of the equatorial rotation. The ambipolar effect is taken over the entire radiation zone so averages (e.g.,T,P,ρ, λ_D) over the radiation zone are used in all diffusion calculations. The mass flow at the top of the radiation uses the plasma mass density there. Plug into the Chapman-Enskog diffusion theory equation 4 for the diffusion coefficient D:

$$D = 2.26 = \frac{1.858X10^{-3}\left(5X10^{6}\right)^{3/2}\sqrt{\frac{1}{1/1836}+\frac{1}{1}}}{1.58X10^{9}X.5^{2}X1} \tag{5}$$

=diffusion coefficient. From Fick's law applied to the radiation zone diffusion:
J=-D∇φ(r,t)=

$$2.26\left(\frac{20-.2}{3.5X10^{10}}\right) = 1.28X10^{-9}\frac{g}{seccm^3}$$

$$1.28X10^{-9}\frac{g}{seccm^2}\left(\frac{1kg}{1000g}\right)\left(\frac{10^4cm^2}{1m^3}\right) = 1.28X10^{-8}\frac{kg}{secm^2}$$

$$1.28X10^{-8}X\frac{kg}{sec{-}m^2}X\frac{1836}{85}\frac{m^3}{kg} = 2.76X10^{-7}\frac{m}{sec} = v$$

for the electron diffusion rate at the top of the tachocline.

$1.28X10^{-8}\frac{kg}{secm^3}\frac{1.6X10^{-19}}{9.11X10^{-31}} = 2250\frac{C}{m^3sec}$=j rate of flow of charge

From Ohm's law we can find the electric field required to cancel the diffusion current. We also need a magnetic field to do this as well since the current can also have nonzero curl

$E\sigma = j$ Thus:

$EX1.4X10^6 = 2250$ at top of tachocline. So:

E=.0016 V/m

Poynting Vector Calculation of v_p

Also recall from equation 5:

$$\frac{|EXB|}{\mu_o} = \frac{1}{2}\rho_{plasma}v_p^3\ .$$

Also given our gedanken experiment nonzero curl possibility we must use

$$\frac{E}{v} = B$$

Thus:

$$\frac{E^2}{v\mu_o} = \frac{1}{2}\rho_{plasma} v_p^3$$

$$\frac{2E^2}{\rho_{plasma} v \mu_o} = v_p^3$$

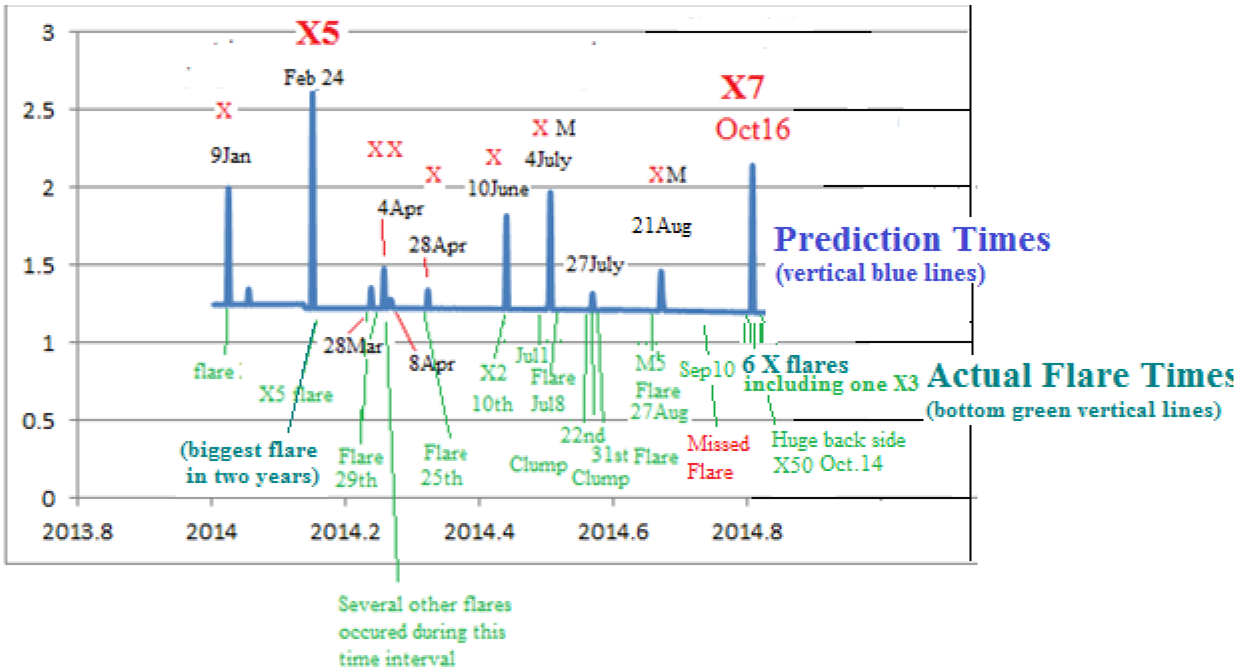
$$\sqrt[3]{\frac{2E^2}{\rho_{plasma} v \mu_o}} = v_p$$

$$\sqrt[3]{\frac{2(.0016)^2}{2.76X10^{-8}(85)4\pi X10^{-7}}} = v_p = 120\text{m/sec} \quad (6)$$

Average differential rotation rate is +**114**m/sec at the equator relative to 30deg
Our calculated rate is +**120**m/sec at the equator relative to 30deg.
Please see appendix C for the origin of the convection zone.

Combining Flare and Solar Cycle Current To Obtain Solar Power Output

Recall that solar ambipolar diffusion model
first derivative of $\Sigma F_i|\cos\theta_i|$=Ti gives that convection zone first derivative current Id1 which in turn gives the solar cycle: So
Id1=long term solar cycle activity from solar motion with respect to the solar system COM.
Id1 is the first derivative of Ti.
Recall that Faraday's Law 2nd derivative gives the flares associated with a second derivative current
Id2=flare activity, second derivative of Ti.
so that total electrical current associated with solar activity =**I=Id1+Id2**
The total power from tidal effects that creates the output from the solar cycle is then
Power=IV=I(IR)=I^{2}R=((Id1+Id2)^2)R=((Id1)^2 + (Id2)^2+2Id1(Id2))R. (7)
Note Id1>>Id2 usually so to measure solar activity due to rate of change of tides on the sun we use just have (eq.2): Power output= **solar activity=2Id1(Id2))R** (+Id1^2).
Below are simulations of solar activity using the above equation 7:



Flare Direction

formula for deriving the side of the sun the flare is on (relative to earth's direction). Dir=M*E-(J*S-J*V)|EXJ|. If Dir>1.6 the flare will be on the other side of the sun from earth. If Dir<1.6 it will be on our side of the sun. At the expected time of a solar flare E is the unit vector from sun to earth, M unit vector from the sun to Mercury, S=unit vector from the sun to Saturn, J=unit vector from the sun to Jupiter, V is the unit vector from the sun to Venus

Magnetic Cycle

The net magnetic field near the surface commoving with plasma rotation is the sum of the opposing B fields due to the core current +charge and the B field due to this differential plasma rotation relative to the tachocline charge motion current of the tachocline negative charge. They are about the same B fields and so nearly cancel at the surface. The outer layer motion is smaller when Saturn is on the side of the Jupiter's aphelion and larger on the side of Jupiter's perihelion so that every other solar cycle one current dominates over the other so one B field (either north or south) dominates. Thus we have a 22 year magnetic cycle. The Babcock model physics then changes the configuration of the magnetic field lines via the solar differential rotation over a solar cycle.

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Appendix A

Metric Quantization

Metric quantization comes from that derivation of that new pde by introducing external objects (from derivation of new pde $\sqrt{\kappa_{\mu\mu}}\gamma^{\mu}\partial\psi/\partial x_{\mu}=(\omega/c)\psi$. It also requires that there exist a grand canonical ensemble (thus a chemical potential exchange of energy between physical systems) at some point in the formation of the system *for the conservation of energy to also hold* (so isolated projectiles will not do this for example).

From theory :

Metric quantization speeds at 100km/sec. and 1km/sec. due to objects B and C.

Smaller values due to nearby objects.

.

Figure A3

Solar Conveyor Belt

Recall that convection transfers heat more efficiently than conduction. Note the metric quantization implies a higher velocity in the outer part of the black region of the above diagram (also see figure 9) so there will be a higher Reynolds number so more convection and so a higher rate of heat transfer from the interior of the sun near the equator. Thus there is larger heating at the equator implying then convective heat flow from the equator to the poles via large convection loops, hence the observed (by helioseismology) north-south convection loops, hence the existence of the so called "conveyor belt" meridional flow.

Recall a second deeper conveyer belt has been found which in this theory carries the negative charge longitudinally.

The metric quantization velocity jump first hits the tachocline at the equator so accelerating the charge carrying plasma there.

The Reynold's number is large at the equator so the belt moves fast there, then slows up at the poles bunching up negative charge creating a strong repulsive electric filed forcing the negative charge back into the radiation zone and the process starts all over again.

So the bottom line here is that this negative tachocline charge inferred by the ambipolar diffusion model is not static,

It moves around. **That equatorial metric quantization jump region makes it move**.

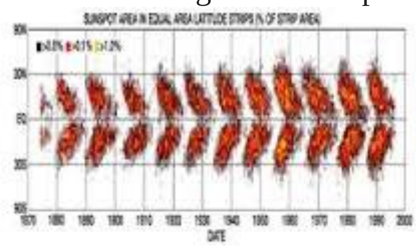
Coriolis Force Effect

I just wanted to explain the 'butterfly' diagram that depicts the latitude motion of the sunspots over a solar cycle.

Note that the metric quantization jump at the equatorial region is closer to the sun's core than the upper and lower latitude metric quantization jump regions. Thus we have more convection there, hence more north and south heat transfer from there. Hence we have a north south of the equator thermal gradient and therefore the transfer of heat from the equator to the poles and a resulting Coriolis force: $-2mwXv=F$ and so also have north-south convection loops(those conveyer belts that carry the sunspot roots).

Also recall that feedback mechanism favors the formation of locally intense magnetic field regions, hence it is the reason why the plasma tubes exist. In that regard recall that the magnetic field falls off with $B=\mu_o I/2\pi r$ (not with $1/r^2$) around a long plasma tube so the magnetic field is still very powerful at a long distance away from the tube making this tube-feedback effect very powerful. The intensity of the current carrying plasma tube is also determined by the Coriolis force. When the sun heats up at the beginning of the solar cycle the Coriolis force is strongest in the upper latitudes (since v and w nearly orthogonal there in wXv), near ±30°, when the inter-latitude heat transfer X Coriolis force product value is optimal. Note in the region of the photosphere at around latitudes 45° and -45° the convection zone and the radiation zone move at the same angular velocity so our feedback mechanism (section 1) will not create any plasma tubes there. The plasma tubes are thereby first created in the solar cycle at around 30 degrees north and south latitude where the Coriolis force is the largest. The Coriolis force becomes even

more powerful toward the middle of the solar cycle when that equatorial heat transfer to midlatitudes is the greatest, then it dies out at the end of the solar cycle.
Thus as the energy drops toward the later part of the solar cycle the conveyer belt stops except very near the solar equator and so the Coriolis force drops and the plasma tubes drop to the latitude in which they start interfering with each other, near the equator (since the north and south plasma tubes move in opposite directions) They thereby must vanish and the process then starts all over again. This explains the butterfly diagram of the solar cycle.

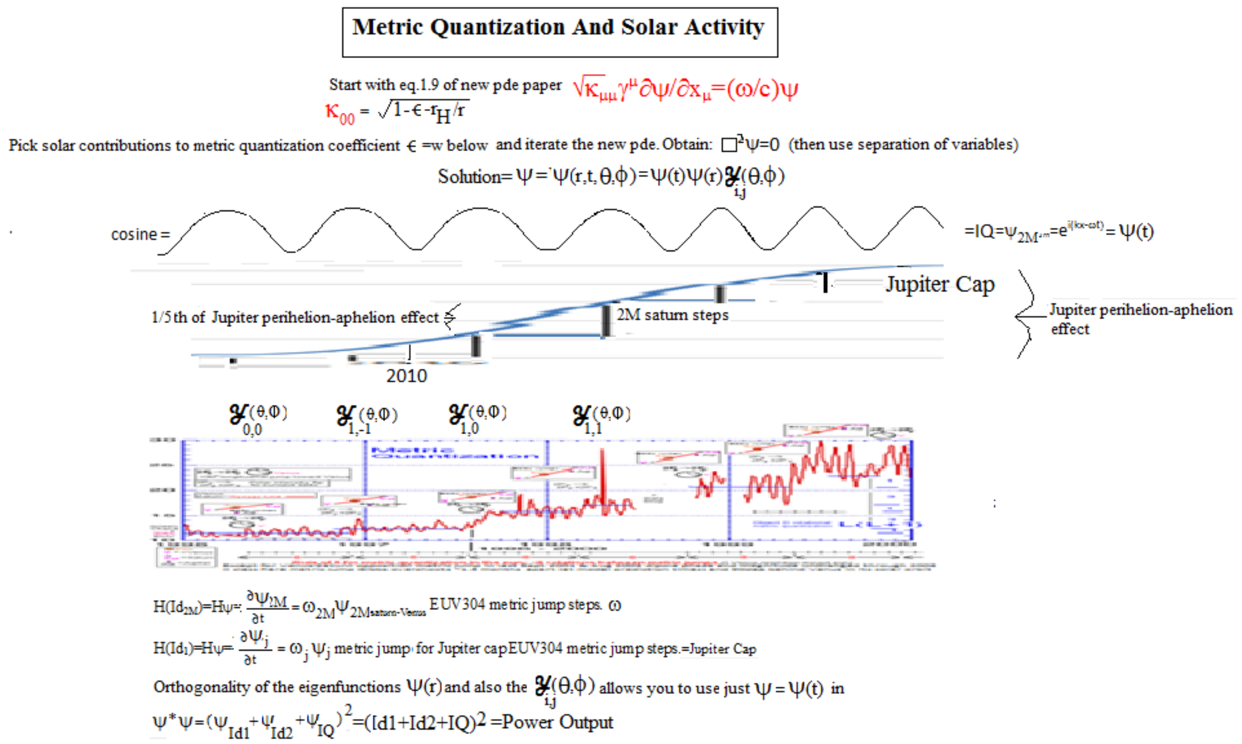

Butterfly diagram

Appendix B

Metric Jumps And The (near instantaneous) 90degree Solar Hot Spot Phase Shift

The sun usually has a dipole hot spot on it that rotates into view every 27.3 days, the synodic rotation period of the sun. This hot spot region is usually where solar flares originate. Also recall that large Saturn 2X effect concerning the origin of the solar cycle (see attachment). In that regard Venus gives about the same solar tide magnitudes as Saturn but much more frequently so that the Jupiter perihelion, aphelion effect dominates the solar cycle again at least momentarily and we have our L(L+1) metric 2P state quantization jump (appendix C) to its value. So when Venus is in opposition to Saturn we then get $2P_x \rightarrow 2P_z$ metric quantization jumps going into the solar cycle and so the solar left right hemispherical hot spot activity moves back 90° (changes phase) at the time of the metric jump (see above figure B1). When it is on the same side as Saturn we get another metric jump and $2P_y \rightarrow 2P_z + 2P_y$ jump as well and so a north-south change in intensity morphology, not an azimuthal 90° change in phase (figure B3). You can track the solar dipole and that phase jump this way since you will know when its longitude changes phase by 90°. Also X class flares occur 90° behind Venus in its solar orbit at metric jump Gibbs overshoot times otherwise calculated from the solar ambipolar diffusion model (section 2). Some are seen on earth and some not because they are behind the sun. During a low point in the solar cycle the Gibbs overshoot flares do not occur. In any case during more intense parts of the solar cycle you can determine the direction of solar flares since they are 90° behind Venus and in general are created at this hot spot. The ambipolar diffusion model along with Faraday's law (section 2) can be used to predict the time of the flares (recall part 2). Using the metric quantization Gibbs jumps to predict X flare magnitudes and directions you can then determine both the time and intensity of solar flares.

Figure B1 Metric Quantization Effects On Solar EUV Output



Coronal Metric Quantization And EUV304

In the corona of the sun metric quantization can occur because of the chemical potential arising from the low temperature exchange of energy (between it parts) in the chromosphere at the lower 1km/sec metric quantization level just below the corona and at the top of the photosphere. There is then enough time for a chemical potential to be exchanged. The lower corona is then most sensitive to metric quantization. The previous section (discussion) metric quantization effects then also are important in the corona (100km/sec) and at the top of the photosphere and in the chromosphere (1km/sec).

Note that the He304 spectrum would then be strongly effected by metric quantization. Note for example the stair steps in the above He304 SOHO solar flux vs time plot (Figure B1). The 27day sine wave in figure B1 is caused by that hot spot moving into and out of view as the sun rotates. In that regard it was found recently that the lower corona is where the EUV 304 comes from in the quiet sun.

"The EUV Helium Spectrum in the Quiet Sun, A By product of coronal Emission?"

Andretta Vincenzo,..et al

Thus the high corona temperature must be associated with metric quantization.

Recall the two most easily observed metric quantization levels of n1km/sec and n100km/sec where n is an integer (appendix A above).

Highly ionized iron Fe-XIV indicates a corona temperature of just above 1million degrees. 1.5million appears an average from the literature. For protons moving with one degree of freedom, in a straight line as they nearly all are in the corona magnetic fields:

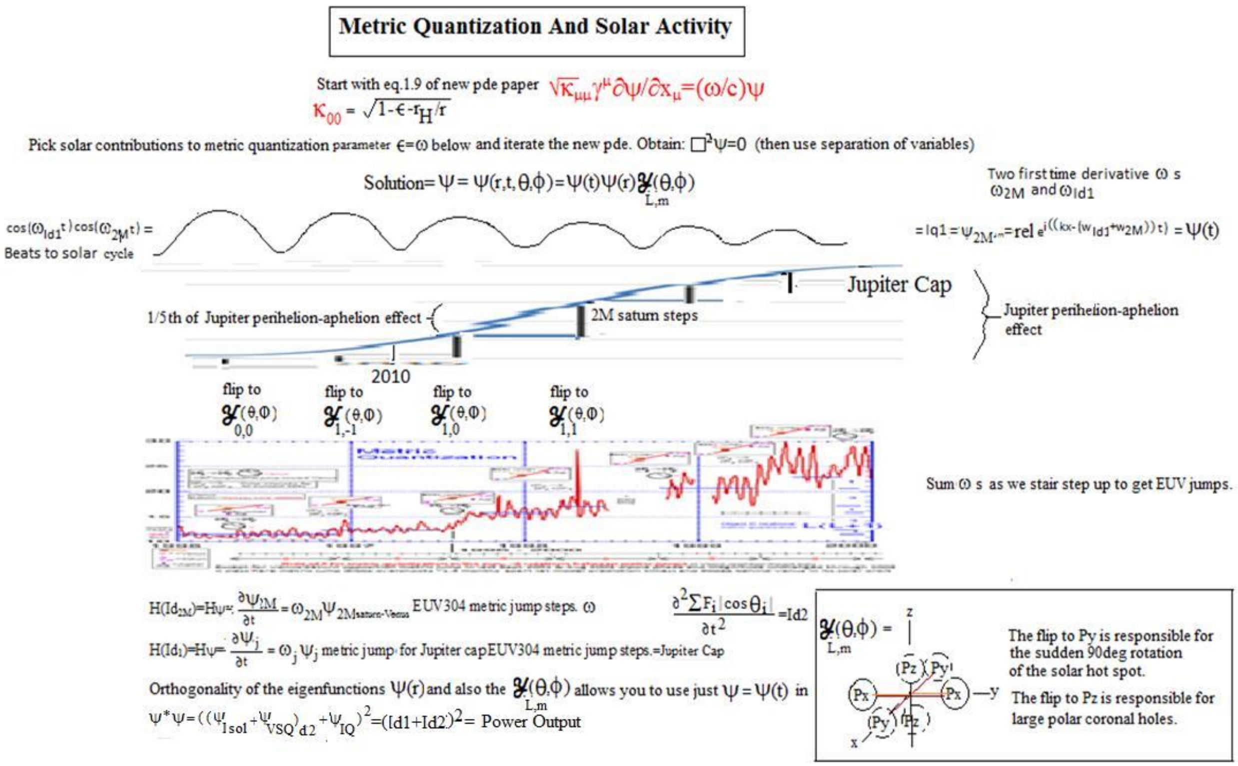
$$(1/2)mv^2=(1/2)kT \qquad (A1)$$

$k=1.38\times10^{-23}$, $T=1,200,000K$ lower corona temperature

$m=1.67\times10^{-27}$ kg =proton mass. Solve equation A1 for v to obtain v=100km/sec.

Recall the metric quantization gave **v=100km/sec** (see above figures A1,A2).

So indeed the temperature of the corona is intimately tied to metric quantization.
This would constitute a maximum velocity like in that rotation metric quantization.
Recall this high corona temperature is responsible also for the solar wind.
Thus the primary cause of the solar wind is that metric quantization.
Thus we have found the cause of the corona’s high temperature and the solar wind.
The metric quantization is responsible for the precise values of both of these quantities.



Coronal Holes

In contrast if a large region of the photosphere does not have sufficient energy the above (metric) quantization “jump” cannot be occur and so the corona is not created and so we have (a metric quantization explanation of) coronal “holes”: $P_y \rightarrow P_z$

As an analogy recall if an electron is not given enough energy to jump to a higher energy level in an atom it doesn't jump at all. Here there is not enough energy to jump to that 100km/sec velocity so the particles don't jump at all: just leak out into space in the usual Maxwell Boltzman distribution way (see arrows in photograph of hole for solar wind directions). Thus a coronal hole develops as seen in figure B3 below.

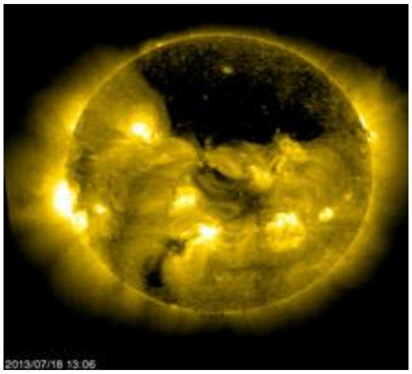
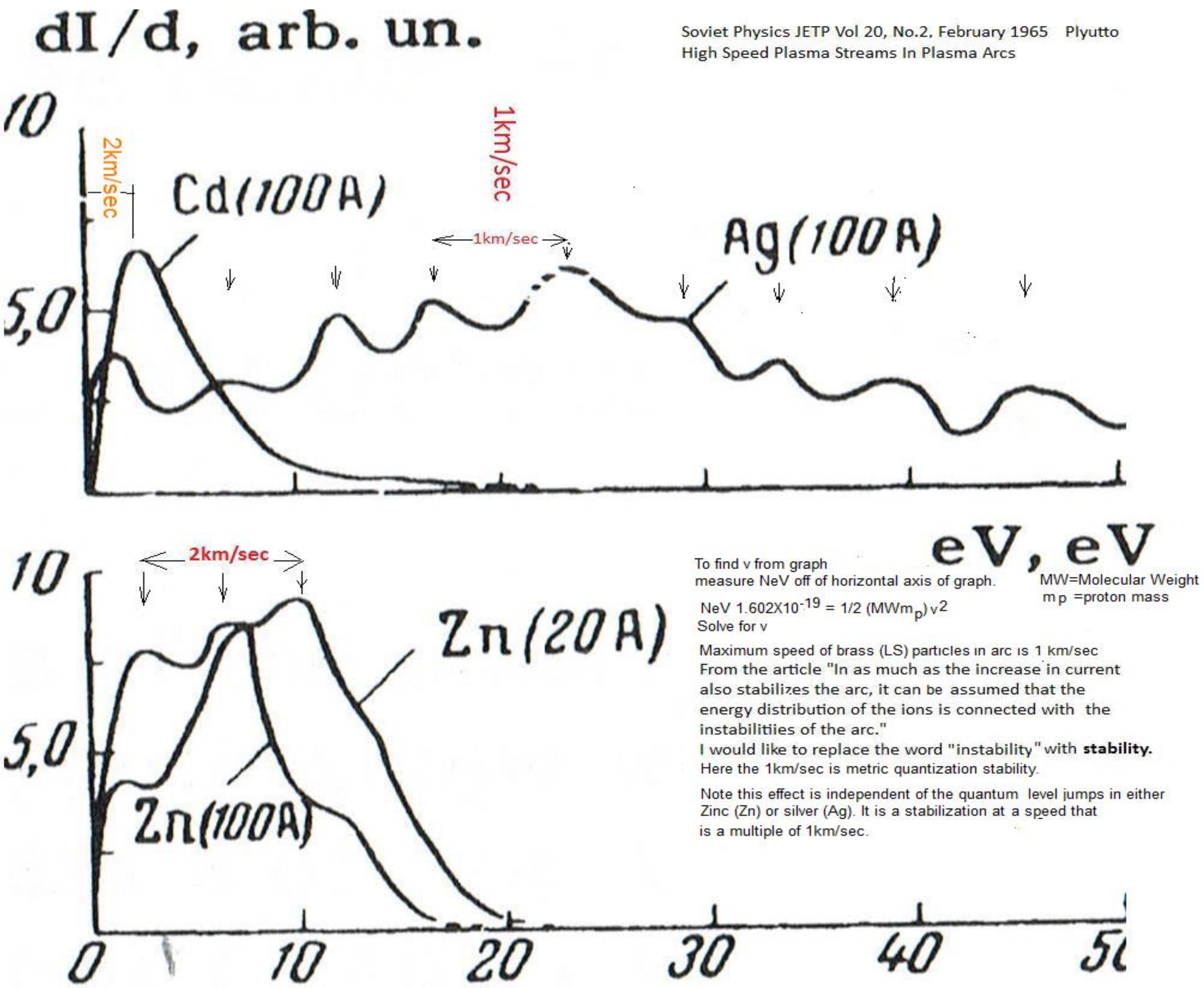


Figure B3 Coronal hole in the northern hemisphere

Recall the galaxy halo and O.B.A star 100km/sec (object B) and note the D ring **1km**/sec, C ring **2km**/sec and B ring **3km**/sec (object C) implying a kind of Pauli exclusion principle to these metric quantization states. But note also a new ringlet 20m/sec metric quantization. caused by the Milky Way Galaxy gravity and/or object D.

Recall I found that a combination of the Jupiter movement in going from perihelion to aphelion (10m/sec) and Saturn 2X effect (10m/sec) is ~20m/sec to get the solar cycle.

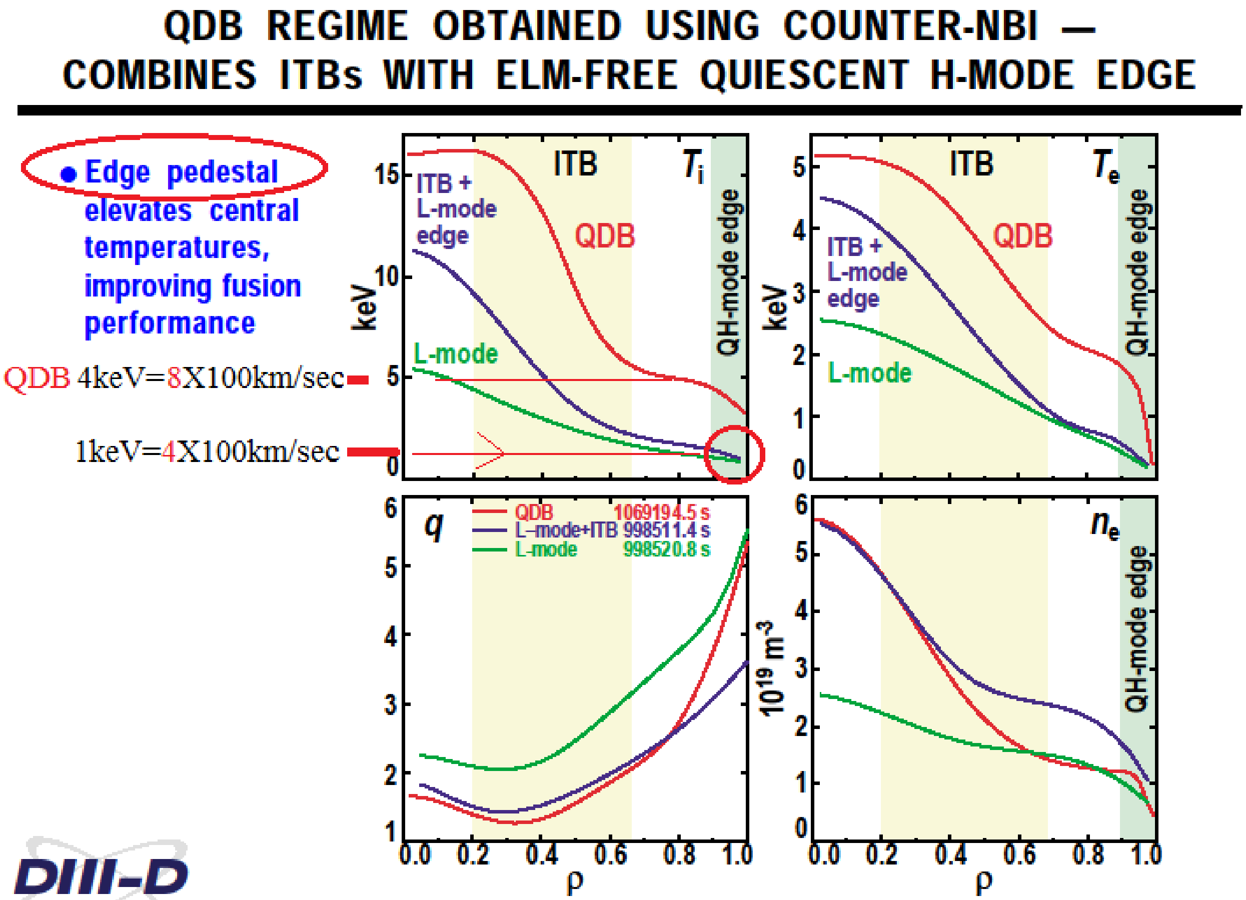
Apparently the stability of Jupiter's and Saturn's orbits and therefore the **solar cycle** itself also **depends on that (20m/sec) metric quantization!**



Note you have the same separation in velocities for both zinc(Zn) and silver(Ag) .
But silver and zinc have different energy levels and so clearly this 1km/sec effect is not associated with their energy levels, it is something more universal. Recall we also see a 100km/sec effect in tokomaks.
You probably are wondering why you can't observe metric quantization in your room for example given that it is also a grand canonical ensemble. The reason is that the next lower metric quantization speed is 20m/sec which for liquid helium4 gives us 0.065K which is difficult to observe (room temperature is around 300K). Helium4 is the only material still liquid at these temperatures and so it can still be in a grand canonical ensemble.

Metric Quantization In A Tokomak Plasma
Some people have asked me why no one has seen metric quantization in the laboratory. Well, they have and they simply don’t realize what they are looking at.
For example I was wondering whether N100km/sec metric quantization might be used to create stability in a man made plasma. After all metric quantization plays a big role in the sun.
My metric quantization will only work in a isothermal plasma with ion speeds of N100km/sec, where N is an integer. But I have heard of **4**X100km/sec=300km/sec =1keV proton (ion) temperature in the ITB Internal Transport Barrier (L mode +ITB at the QHmode high

plasma density edge where this metric quantization isothermal plasma might be located) in the high density region. So that **4**X100km/sec layer of plasma *is the actual transport barrier* in the newly discovered Internal Transport Barrier ITB phenomena. These ITBs are considered to be the next frontier in Tokamak fusion physics since they are a promising source of stability in plasmas. The ITER in Europe is to be designed around the ITB. So plasma physicists may have already stumbled on to metric quantization stability (ie., that ITB caused by that 4X100km/sec) and not even realized it! The edge pedestal of 4X100km/sec provides the Internal Transport Barrier plasma. This edge pedestal is where the stability source is in this new type of plasma.



Metric Quantization And The Calculation Of G

The most recent Physics Today magazine says that the value of Newton's gravitational constant G is currently only known to **3** significant figures (somewhere between **6.672** and **6.676** $X10^{-11}$ Nm^2/kg^2), really no significant advance beyond what Cavendish himself measured in the 1700s and a typical experimental error the students would have gotten in one of the many physics labs I used to teach! The problem is not in the experiments themselves which are accurate to around 20ppm-40ppm (even given torsion calculation uncertainties). The problem is in the spread of the results of these several very accurate, precise experiments.

Metric quantization is the problem here especially with the experiments that require a moving oscillating torsion bar to measure the torsion constant, where we can then have a grand canonical ensemble with nonzero chemical potential (as in Saturn's rings), the requirement for that metric quantization to effect relative speeds and here cause large errors in the torsion constant calculation and therefore the G calculation. The new experiments, with no such motion requirement (e.g.,floating the balls in mercury), will probably finally nail down the gravitational constant.

Appendix C

Theory Behind Galaxy Halo, Stellar Equatorial, Corona, Tachocline Speed Quantization

Here we introduce a generally covariant generalization of the Dirac equation (new pde) $\sqrt{g_{\mu\mu}}\gamma^{\mu}\partial\psi/\partial x_{\mu}=(\omega/c)\psi$ that does not require gauges (eq.1.9, Ch.1, www.davidmaker.com). Solve this new pde with local background metric $g_{oo}= e^{i\Delta\varepsilon}$. From particle mass considerations ε=.06, $\Delta\varepsilon$=.00058 ((1a), Ch.2) in the exponent of g_{oo}. These three values 1, ε, $\Delta\varepsilon$ are responsible for the masses of the three free leptons in that lepton equation (the new pde). Here the $\Delta\varepsilon$ perturbative contribution (to the ε term) in metric coefficient g_{oo} levels off to the quantized value $e^{i\Delta\varepsilon}$ in the galaxy halos and for stellar equatorial velocities: So we should set the Schwarzschild metric g_{oo} term equal to this metric term$\rightarrow$

$$g_{oo}=1-2GM/rc^2\rightarrow \mathrm{rel}(e^{i\Delta\varepsilon})=\cos(\Delta\varepsilon)=1-(\Delta\varepsilon)^2/2+.. \Rightarrow$$

$(\Delta\varepsilon)^2/2=2GM/rc^2$. Thus for circular (centripetal acceleration) motion:

$$v^2/r=GM/r^2=c^2(\Delta\varepsilon)^2/4r \Rightarrow$$

$v^2=c^2(\Delta\varepsilon)^2/4=(87\text{km/sec})^2$ after plugging in the values of $\Delta\varepsilon$ and c. So:

$$v^2 = \text{constant} \quad \text{or} \quad v=87\text{km/sec}$$

So the metric acts to quantize v. The actual measured velocities include the effects of both the metric and of visible matter. Thus in general $\mathbf{v_{measured} = v_{metric} + v_{matter}}$. The quantity $\mathbf{v_{metric}/v_{matter}}$ is approximately 9, the usual "dark matter" to visible matter ratio (no dark matter here however). So,

$$10+87=97\approx 100\text{km/sec.}$$

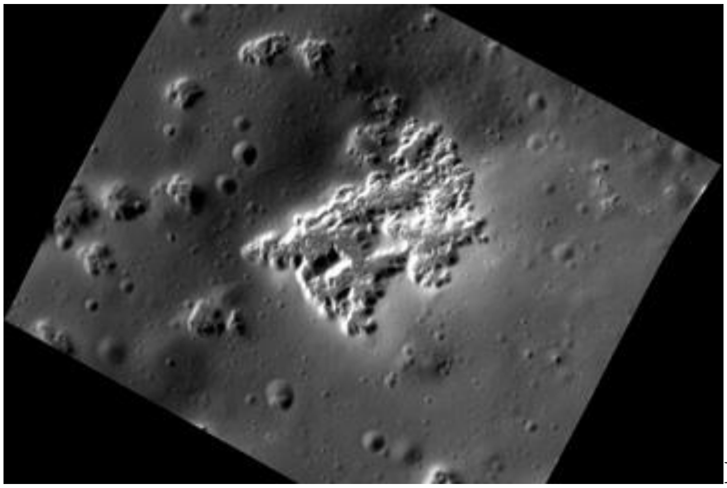
Thus v is a constant in galaxy halos *when the metric is quantized*. FigureA1 shows many such nearby galaxy halo velocity curves (sections 23.4$\rightarrow$ 23.6, (1a)). Note in section 23.4 there also is rotational energy quantization for the $\Delta\varepsilon$ rotational states (of outside object B) that goes as: $(L(L+1)) \propto \frac{1}{2}mv^2$ so $\sqrt{L(L+1)} \propto v$. Thus v is proportional to L, L being an integer in figures A1 and A2. Therefore,

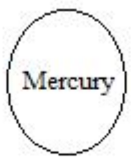
$$\Delta v = kL \text{ so } v = 1k,\ v = 2k,\ v = 3k,\ v = 4k\ldots\ v=N(100\text{km/sec})$$

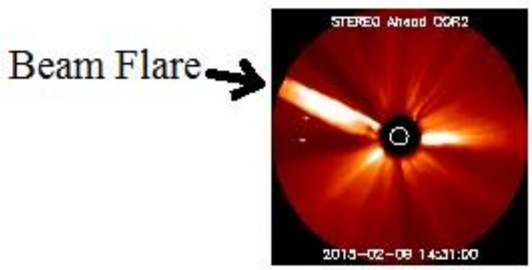
Compare this result with N=2 with figure A1 for galaxy halo velocities and figure A2 stellar class O,B,A equatorial velocities. The N=2, v= 200km/s is ubiquitous (object B). There is a smaller quantized v of 1km/sec (object C) that applies to the sun thereby apparently providing our Δv=1km/sec solar differential rotation and giving that H in the Poynting vector and also the H in the solar cycle calculation above. In that regard the solar equator moves with 2km/sec metric quantization and the equatorial radiation zone rotates with the 1km/sec metric quantization. Thus this 1km/sec metric quantization is the reason for solar differential rotation.

Contents

(1a) http://davidmaker.com


Hollows





Hallows, shallow features on Mercury. 6mi wide, few meters deep at most. Was this a beam solar flare evaporating sulfur from the surface?

$\psi=Ae^{-kt}$ Decay Of Solar Cycle

Another way of understanding this fusion rate change is through the Lawson Criterion. Recall from the Lawson criterion for breakeven fusion is proportional to timeXtemperatureXdensity. Given the temperature (increase) in the above (nontrivial Faraday Law) case is a function of time as well then $\psi=-kt^2$ so that $d\psi/dt=-kt$. 1/k is the ~period of the syzygy event which is large for the Jupiter-Saturn syzygy event. The integration constant is the amplitude A which is also large for the Jupiter-Saturn syzygy event in the $\Sigma F_i|\cos\theta_i|$ model. Each component of the solar activity cycle ψ then goes as: $d\psi/dt=-kt$ or:
$\psi=Ae^{-kt}$ where the A and k are provided by $r_e=\Sigma F_i|\cos\theta_i|$. Note each wedge in this r_e function (vs time) timeX(wedge height) =timeX pressure=timeXdensityXT from the ideal gas law implying from the Lawson Criterion a higher rate of fusion and solar energy release for a deep, wide wedge. For significantly larger rates need timeX(wedge height)^2 =timeXr_e^2.

A1 Explanation of Other Hitherto Unexplained Solar Observations

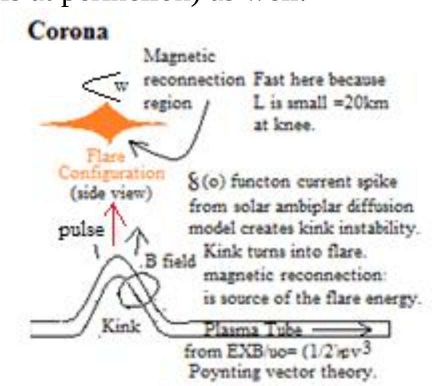
Recall the above charge diffusion model and those inner and outer rings of opposite charge. The sun rotates and so these charge rings also constitute electrical currents.
I found a simple analogy with the primary and secondary coils of a transformer.
The primary coil here is that outer ring of charge (i.e., electrical current since the sun rotates) and the secondary is the inner ring just above the sun's core.

This simple paradigm yields a lot of hitherto unexplained solar physics.
For example:

1) EXH Poynting vector parallel to the equator of the sun implies that the solar equator moves at a *higher angular velocity* than the region near the poles does. The current motion is close to the equatorial plane plasma that is moving.

2) A solar dipole field implies that field lines near the poles (for the deeper charge layer) are perpendicular to that circumferencial current j and so JXB is meridional. Thus deep in the sun there must be a meridional (but much slower) flow.

The two charge layers can vary in flow rate and therefore electrical current flow rate due to those planetary syzygy perturbations. Thus if one current (let's say the deeper one) is dominant the solar dipole has a north magnetic pole in the north let's say. When the other is dominant (let’s say the surface current) the other current will dominate. These currents are the source of the sun's magnetic field so that field can thereby flip back and forth due to these slightly changing electrical currents. One syzygy configuration with Saturn on the side of Jupiter’s aphelion pulls more on the outer current causing it to dominate. The other syzygy with Saturn near Jupiter’s perihelion gives relatively more force on the inner current causing it to dominate. The time between Saturn in opposition to Jupiter’s perihelion is about 29 years but Jupiter’s being located near it’s perihelion at that time is problematic creating a large uncertainty. The result is about a *25 ±5 year solar magnetic cycle*. This 5.5 year Saturn drift relative to Jupiter’s perihelion results in a *90year* and 180 year cycle (of when Saturn is in opposition to Jupiter precisely when Jupiter is at perihelion) as well.



Recombining, temporarily vertical B field induces horizontal particle circular motion about the z axis.
Oscillating circular motion causes the r equatorial and/or z direction pulse, hence the solar flare.