Stellar rotation is driven by magnetic fields in the galactic disc

Abstract

Stellar rotation is believed to be the result of the collapse of a stellar nebula when the star is born. This article will refute this idea and will show that stellar rotation is driven by changing magnetic fields in the galactic disc. It will show that Jupiter has a stellar cycle that drives its jet streams around the planet. Those jet streams are electrically charged by Jupiter stellar cycle to create the forward and backward flowing jets. The electric potential between adjacent jets drives spots like the great red spot. Similarly, it will be shown that the plasma belts in the sun are created by the solar cycle and that electric potential between adjacent belts drive the sunspots. The result of the flow of the plasma belts around the sun is the solar rotation and its associated differential rotation.

Abbreviations

SMBH – The supermassive black hole that reside at the center of every galaxy.

GRS – Jupiter Great Red Spot.

Stellar cycle, Solar cycle – In the context of this article, the stellar cycle is not created in the interior of stars by the dynamo effect, but is applied to the star from the outside by the galactic disc.

Changing Magnetic Fields – The same as the stellar cycle above, applied on the stars from the outside by the galactic disc to heat the stars.

Introduction

The first measurement of stellar rotation was done by Galileo when he observed that sunspot on the sun surface circle around. Later, Scheiner discovered the differential rotation by measuring different speeds of sunspot for different latitudes. Otto Struve used spectroscopy to measure stellar rotation of far away stars by analysis of line breath in spectra of stars. The rotating star has a receding side with red shift and approaching sides with blue shift, those shifts broaden the lines of the spectra. The rotation speed of stars along the main sequence is related to their mass. Generally, more massive stars rotates faster. There is a typical rotation speed to each star type in the standard classification (Figure 1).

There is also a link between the magnetic activity of the star and its rotation speed. A Stronger magnetic activity is also indicating a faster stellar rotation. It will be shown that the magnetic activity or the stellar cycle is driving the stellar rotation. The magnetic activity is a short term phenomena, while the stellar rotation is a long term phenomena that is created by millions of years of stellar activity.

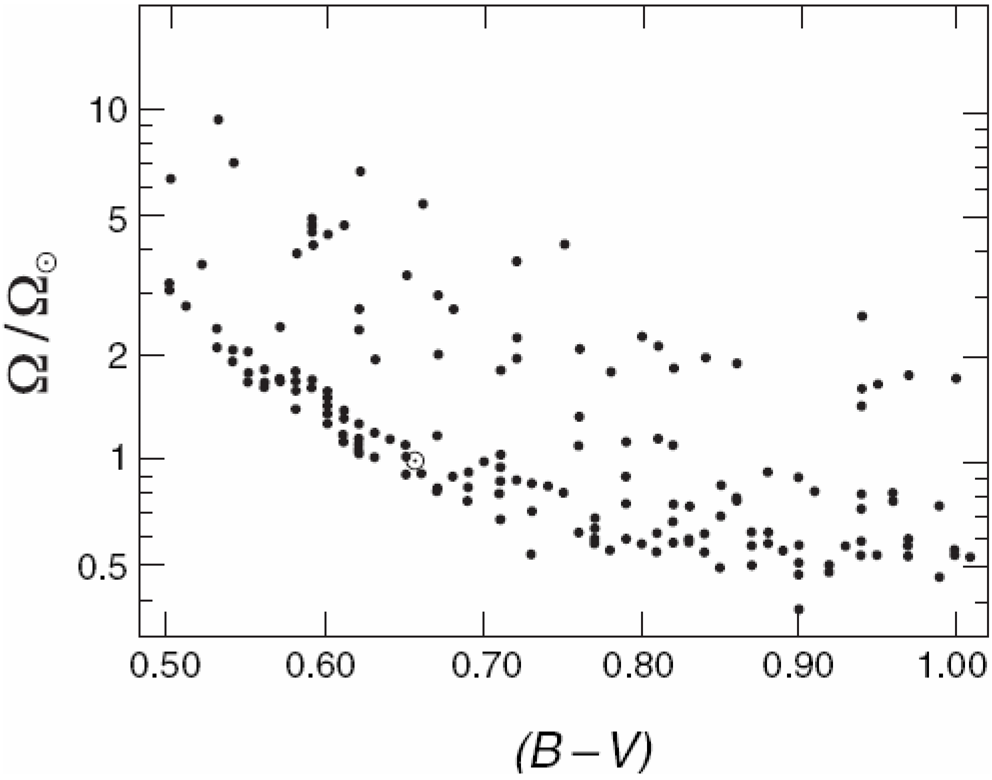

Figure 1 - The relation between the star rotation speed and the star color. The color of the star depend on its temperature, hotter stars have smaller B-V. B-V equal to 0.5 is a star of mass 1.2 sun mass and type F7, while B-V equal to 1.0 is a star of mass 0.7 sun mass and type K7. The graph shows that the hotter and more massive the star is, the faster it rotates. The changing magnetic fields in the galactic disc simultaneously heat and rotate the stars; hence the link between the color and rotation.

The standard theory that explains the stellar rotation is linked to the evolution of the stars. It is incorrectly believed that stars are born from stellar nebulas that collapse and their angular momentum is then turned into the stellar rotation. After the birth of the star, its angular momentum always decreases from the influence of the magnetized solar wind. As the solar wind expands, it magnetically brake the sun similar to an ice skater that rotate and spread his hands outward. According to this model, the new born stars are rotating fast and as the time pass the rotation speed is gradually decreasing. This gives a link between the star age and its rotation speed. If the star is old it rotates slowly, if the star is young it rotate quickly. However, this theory is incorrect because stars are not born from stellar nebula. In reference 1 it is shown that the energy source of the sun and other stars is from the solar cycle and magnetic fields in the galactic disc. The magnetic fields that cross the sun from the solar cycle induce currents in the sun according to Faraday’s law. Those very strong electric currents are the source of energy that heats the sun and not the fusion reaction. According to this model the stars does not carry internally the fuel for their operation but receive the energy from the outside by magnetic fields. Therefore, the age of the star is not limited by the amount of fuel that it carries but it is much longer. In other words, the stars do not resemble a candle that is getting shorter from the burning and has a correlation between its remaining length and the burning time. The stars receive their energy from the changing magnetic fields of the stellar cycle and convert part of this energy to mass that increases their size and promote them along the main sequence. The Hertzsprung-Russell diagram represents not only the relation of luminosity and temperature of many stars but also the development of a single star as it grows from red dwarf by the changing magnetic fields. In contrast to the common belief, stars with heavier mass like blue giants are older then smaller stars like red dwarfs. As the changing magnetic fields promote the star along the main sequence, they also increase its stellar rotation speed or angular speed. Older stars of class O, B, A absorb more energy from the changing magnetic fields, and therefore, are more massive and rotate faster than younger stars of class F, G, K, M.

The creation of new mass in the stars increases the mass of the galaxy and causes spawning of new galaxies and the expanding universe. This theory therefore cancels the Big Bang theory and removes the age limit provided by the Big Bang theory. The universe according to this theory is Infinite and everlasting.

The stars age, without the time limits mentioned above, could be several tens of billion years. With such a long life and knowing that the drag from the solar wind is always present, stellar rotation require a constant source of power and torque. This power is the solar cycle and the changing magnetic fields in the galactic disc. The magnetic fields in the galactic disc influence the stars in many ways; they heat the stars; they drive the stellar rotation; they increase the star mass; and they increase the speed of the star around the galactic center to provide the flat rotation curve of the galaxy.

Relation between the star temperature and its stellar cycle period

The energy cycle presented in reference 1 show that the stars energy source is the magnetic fields spread by the SMBH at the center of the galaxy. Many stars are very far from the galactic center so it is not possible that the magnetic fields are arriving directly from the SMBH. Instead, between the stars that absorb the energy from the magnetic fields and the SMBH there is numerous magnetic eddies and magnetic circuitry. Those circuitries operate like electric currents in a copper block under changing magnetic fields. The current eddies in the copper block heat the block in the same way as the magnetic eddies heat the galactic disc. Figure 2 shows that the magnetic fields absorbed by the stars are not directly from the galactic disc but are propagating in eddies along the galactic disc. The magnetic eddies are not symmetric as shown in the drawing but are chaotic in nature. In addition, the size of those magnetic fields eddies are much smaller then what is shown in the figure. The amount and strength of the changing magnetic fields of the magnetic eddies determine the structure of the galaxy. At the galactic center there are many strong eddies that supply energy to many stars to create the galactic bulge, at the galactic edge there are less magnetic eddies and the galactic disc is thinner. The amount of stars in specific galactic distance from the SMBH reflects the strength of the magnetic eddies at that location. The structure of the spiral galaxy is determined by two main factors the availability of magnetic energy to the stars and the rotation of the galaxy. The most recent research on SMBH found connection between the mass of the SMBH and properties of the galaxy that surround it (Ref. 13). It was found that the mass of SMBH is connected to the blue luminosity of the bulge of spiral galaxies or to the blue luminosity of the entire elliptical galaxies. This connection stems from the influence of the changing magnetic fields dispersed by the SMBH. The larger the SMBH the stronger the changing magnetic fields around it are, and as they heat the nearby stars, the stars are getting hotter and their blue luminosity increase. There is also connection between the SMBH mass and the rotation curve of the galaxies. This relation can be understood by comparing the spiral galaxy to an electric induction motor, where the changing magnetic field increase the rotation speed of the galactic disc as shown in Figure 7 in Ref. 1. The SMBH mass is also linked to the mass of the bulge in spiral galaxies as the changing magnetic fields produce new mass in the interior of nearby stars.

Figure 2 - The galactic center spread magnetic fields in the galactic disc using magnetic eddies. The eddies are magnetic circuitry that encompass thousands of stars. The magnetic fields from the galactic center are too weak to reach directly stars like the sun, located in the middle of the galactic disc far from the SMBH. The picture shows is an edge on view of a galaxy with red circles representing the interconnected eddies. In contrast to what is shown in the picture, the eddies has no ordered structure, but a chaotic and dynamic structure, similar to current eddies in a copper block placed under changing magnetic fields.

The transmission of power and energy from the SMBH to the stars at the galactic disc is conveyed through series of magnetic circuitry. The transfer of energy from the circuitry to the stars and from one circuitry to another can be compared to a series of electric transformer connected to one another (Figure 3). The secondary winding of one transformer is connected to the primary winding of the next transformer. Using many magnetic circuitry that act like transformers the energy is delivered from the SMBH to the stars at the galactic disc. The magnetic fields of the stars magnetic circuitry are like the core of the transformer where changing magnetic flux is flowing, the induced electric current inside stars is like the current in the transformers windings. The interstellar medium cannot conduct electric current so the magnetic circuitries induce current only inside the stars. The magnetic fields from the vicinity of the SMBH are like the first transformer in the transformer chain. They induce currents in nearby stars. This induced current creates magnetic fields and a new magnetic circuitry, which again create electric current in further stars. From the first transformer the power pass through numerous intermediate transformers until it reaches the stars at the galactic edge. The stars that carry the electric current are not necessarily the same stars that pass the magnetic flux, large scale magnetic fields that encompass many stars can induce current in nearby stars. There is no distinction between the stars that sit at the middle of the transformer chain and convey power and stars that sit at the end of the transformer chain and only receive the energy. All stars in the galaxy both convey the power, transmit it to other stars and at the same time heated by the currents of the transmission process. Therefore, the stars cannot be grouped into stars that convey the electric energy and stars that only consume it; each star is performing those two tasks.

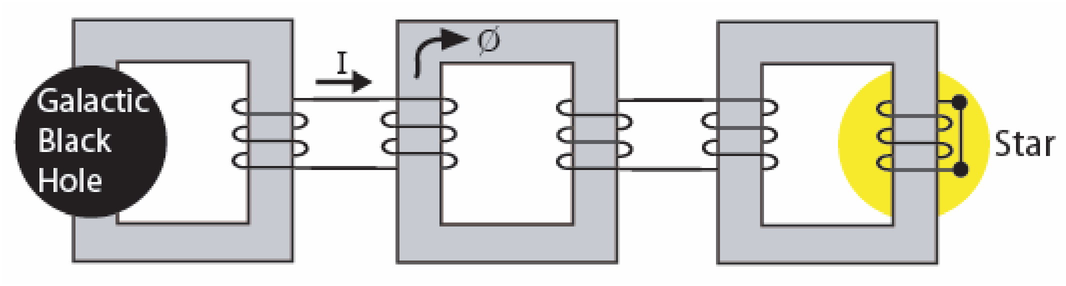

Figure 3 - The propagation of magnetic fields in the galactic disc is based on numerous eddies or magnetic circuitries. The interconnected eddies are similar in operation to a series of interconnected transformers. The core of the transformers represents the magnetic circuitries that carry magnetic fields in a group of star in the form of stellar cycle. The coil of the transformers represents the electric current passing in the interior of stars in response to their stellar cycle. The process starts in the galactic center at the left transformer in the image. The galactic center spread magnetic fields, which induce electric current in nearby stars. These induced currents create a further magnetic circuitry represented by the middle transformer. The last transformer at the right, supply magnetic fields to heat the star.

Planets like stars are also heated by magnetic fields in the galactic disc and are also having a stellar cycle as will be shown in next sections of this article. Planets like Jupiter are composed mainly from gas or partly ionized gas in contrast to stars that composed of hot plasma. The ionized gas has much higher resistance then the hot plasma of the stars. Therefore, while the planets receive energy from the magnetic fields they absorb most of it by ohmic heating and not transmitting any power to nearby planets. Therefore, planets sit only at the end of the transformer chain. The planets magnetic energy is transmitted by red dwarfs that are found in large number in the galactic disc and comprise about 75% of all stars.

Baliunas et al. 1995, showed a record of 25 years of stellar chromospheric activity of 111 stars on or near the main sequence. From this data, the stellar cycle period was calculated for many stars. The data reveal that stars have large variety in their stellar cycle period. Ranging from about 7 years for F5 stars to 14 years for K4 stars. Stars that are more massive generally show shorter stellar cycle period. Other facts that reveal the behavior of magnetic fields in the galactic disc is that the rotation axis of stars in the galactic disc is random, and does not show uniformity similar to that of the planets in the solar system. It is easy to find binary stars that each one of the pair has a rotation axis that is pointing to a different direction. Also, nearby stars does not show stellar cycle that are synchronized or having the same period.

The behavior of the changing magnetic fields in the galactic disc is Perplexing; why stellar cycle or magnetic field of one star does not affect other stars? Why high frequency stellar cycle of larger stars is not affecting nearby smaller stars? The answer is that stars have electric resonance similar to an Alternating current L-C electric circuit. The L-C circuit has resonance to specific frequency depending on the values of the capacitor and the inductor. The resonance of a star depends on its size, its temperature and its composition. For instance, stars that are more massive will have higher resonance frequency because their large size lower the internal resistance of the star. Hotter stars will also have higher resonance frequency because hotter plasma has lower resistance. The galactic disc carries changing magnetic fields in all frequencies and the stars are using the frequency that is close to their internal resonance frequency (Figure 4). However, the magnetic fields are chaotic in nature so the observed stellar cycle for a specific star could diverge from the stellar cycle expected according to the star mass and temperature. The stellar cycle of a star is also affected by the size of nearby stars. A sun like star among blue giants will show shorter stellar cycle than a sun like star among red dwarfs. Blue giant has the shorter stellar cycle since their hot temperature and large size give lower internal resonance. For smaller stars like the sun and red dwarfs, the stellar cycle period is getting longer as their internal resonance frequency is smaller. The planets are also getting heated by magnetic fields as evident by the surplus of heat from Jupiter and Saturn. The stellar cycle of the planets is very long and takes hundreds of years.

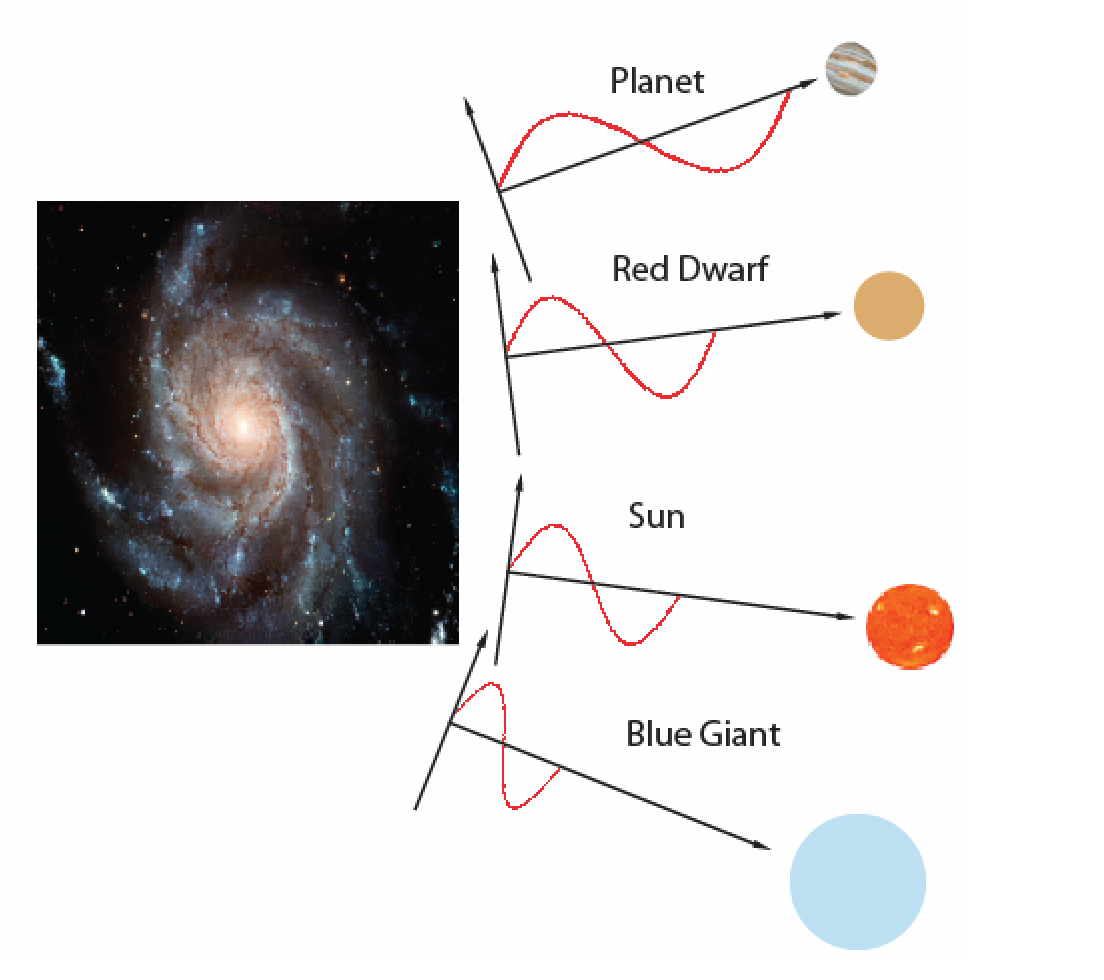

Figure 4 - The galactic disc conveys changing magnetic fields in a range of frequencies and supply energy to stars and planets. The stellar cycle is created by those changing magnetic fields and not by stellar dynamos. The frequency that a specific star uses is determined by its internal resonance frequency, affected by the size and temperature of the star. The stellar cycle frequency will diverge from the star resonance frequency because of the chaotic nature of the magnetic fields. The period of the

stellar cycle is inversely correlated to the stellar mass; it is longer for smaller stars. Planets like Jupiter have very long stellar cycle period that span hundreds of years, while Blue Giants have stellar cycle of a few years. The magnetic fields in the galactic disc and the stars are comparable to radio transmitters and receivers. The transmitters broadcast in a range of frequencies that all propagate through space while the receivers due to their internal resonance circuitry are tuned to specific frequency.

In Fourier analysis, a general function is described as the sum of sinusoidal or trigonometric functions. Similarly, the magnetic fields in the galactic disc can be represented as a sum of trigonometric functions. Each of those trigonometric functions represents stellar cycle of specific star class.

The magnetic fields in the galactic disc are like transmitters of radio wave and the stars are similar to receivers of radio waves. Radio transmitters transmit in many frequencies and the air is saturated with all frequencies. The receivers by their resonance circuitry can tune to the specific frequency. This is similar to the star that their internal resonance effect their stellar cycle.

Stars between types F to M are the majority among the stars in the galactic disc and therefore are the backbone that spread the magnetic energy in the galactic disc. Those stars will show more regular magnetic activity, while planets and giant stars will show random and chaotic magnetic activity.

It is possible that different frequencies of the changing magnetic field are spreading to specific angles. In that case, adjacent stars of the same size and class will have near parallel rotation axis and their solar cycle will have the same period. According to this idea, in a group of stars there will be statistical preference of stars of the same type and class to rotate in the same direction.

Blue giants and massive stars in general require strong magnetic fields to support their high luminosity. Blue giants are attracted by magnetic forces to regions in the galaxy that have strong magnetic fields like the galactic arms. At the same time, the presence of blue giants enables the propagation of strong magnetic fields, as the blue giants decrease the magnetic permeability in the region. This can explain the high concentration of blue giants in the galactic arms and the higher brightness of the galactic arms caused by their higher permeability and their ability to easily propagate the changing magnetic fields.

Jupiter has a unique stellar cycle with long period

In reference 1, it was indicated that star get their energy from changing magnetic fields in the galactic disc. The magnetic fields associated with solar cycle are not induced internally by a dynamo in the sun but is applied from the outside by the galactic disc. The solar cycle change its magnetic polarity every 11 years and its magnetic fields traverse through the sun parallel to the rotation axis. These magnetic fields create electric currents according to Faraday’s law and heat the sun by ohmic heating. As was mentioned in the previous sections there are evidence that the planets are also heated by changing magnetic fields. The first evidence is that many planets has heat surplus. They produce more heat than what they absorb from the sun. Further evidence is that many planets have jet streams that encircle the planets. Jupiter has

prominent jet streams, which are being accentuated by the different colors. The earth on the other hand has a weaker and less prominent jet stream. Jets streams or plasma belts are also found in the sun by helioseismology as show by Figure 19. If both the planets and the sun are showing the same jet streams, it means that there is a common source and physical explanation for them. Jupiter jet streams are not created by convection. Jupiter is too far from the sun to absorb enough heat to drive its massive jet streams by convection. The common source for the jet streams in planets and stars is therefore the changing magnetic fields in the galactic disc. The planets, similar to stars, should have a stellar cycle that is heating the planets and drive their jet streams. The sun and Jupiter does not show correlation or synchronization in activity or phenomenology that happens in both of them at the same time. Therefore, the sun and Jupiter has different stellar cycles with different periods. To understand why the sun stellar cycle does not affect Jupiter, and why the stellar cycle of Jupiter does not affect the sun, the resonance of the star can be applied. The stars have internal resonance frequency depending on their size and temperature. This resonance determines the star stellar cycle frequency.
Since Jupiter is much colder and smaller than the sun, its stellar cycle period is longer than that of the sun. The data from Table 2 in Baliunas et al. 1995 can be used to show the relation between the star stellar cycle and its temperature and by that to estimate Jupiter stellar cycle period. The points with poor FAP grade where removed and also four stray points for stars 157856, 114710, 201091, 201092 where removed. This data shown in table 1 in this article and is ordered according to the B-V color of the star. In Figure 5, the stellar cycle period versus the B-V color from table 1 is plotted. There is clearly a tendency of the stellar cycle period of the star to get longer as the B-V color is higher and the star is colder. Applying regression on the data gives the line:

$$P = -1.22 + 14.14\,(B\text{-}V)$$

Where P is the stellar cycle Period and B-V is the color index. This line is shown on Figure 5 that estimates the rise of the stellar cycle according to the star B-V color. This line is used in Table 2 to reveal the stellar cycle for very cold objects like red dwarfs and planets. The following formula is used to convert the star B-V color to the star temperature (T):

$$B\text{-}V = -3.684 \log(T) + 14.551$$

The stellar cycle period versus temperature from Table 2 is plotted in Figure 6. This graph can be used to estimate the stellar cycle periods for cold objects like red dwarfs and planets. For Planets like Jupiter, we can use a temperature around 286 Kelvin to get a stellar cycle of 76 years.

Plotting planets and stars on the same graph is inaccurate. Planets like Jupiter are made of gas that a small fraction of it is ionized while stars are made of hot plasma. The resistance of the hot plasma is very low near that of a superconductor, while the resistance of ionized gas is much higher. The stellar cycle period for planets should be higher than that shown in Figure 6 because the high resistance of the planets will give them resonance for lower frequencies.

Star HD Number	B-V Color Index	Stellar Cycle Period (Years)
18256	0.43	6.8
111456	0.46	7
187691	0.55	5.4
100180	0.57	3.56
154417	0.57	7.4
176051	0.59	10
78366	0.6	12.2
190406	0.61	2.6
81809	0.64	8.17
161239	0.65	5.7
Sun	0.66	10
1835	0.66	9.1
76151	0.67	2.52
20630	0.68	5.6
26913	0.7	7.8
103095	0.75	7.3
152391	0.76	10.9
82885	0.77	7.9
185144	0.8	7
219834A	0.8	21
26965	0.82	10.1
149661	0.82	17.4
10476	0.84	9.6
3651	0.85	13.8
165341A	0.86	5.1
166620	0.87	15.8
4628	0.88	8.37
219834B	0.91	10
115404	0.93	12.4
160346	0.96	7
16160	0.98	13.2
32147	1.06	11.1
156026	1.16	21
190007	1.17	13.7

Table 1 - The stellar cycle period in years and the B-V color index of the stars from Baliunas et al. 1995. This data was collected during 25 years on F2 to M2 stars. Identifying longer stellar cycle require longer observations and data collection. The data shows clearly that for a colder star (Higher B-V) the stellar cycle period is longer. There is also evidence that confirm a very long stellar cycle of 60 years (Ref. 12). This evidence supports the idea that Jupiter has a very long stellar cycle of 200 years that drives the great red spot. The data is taken from Baliunas et al. 1995 where the measurements denoted as poor where omitted.

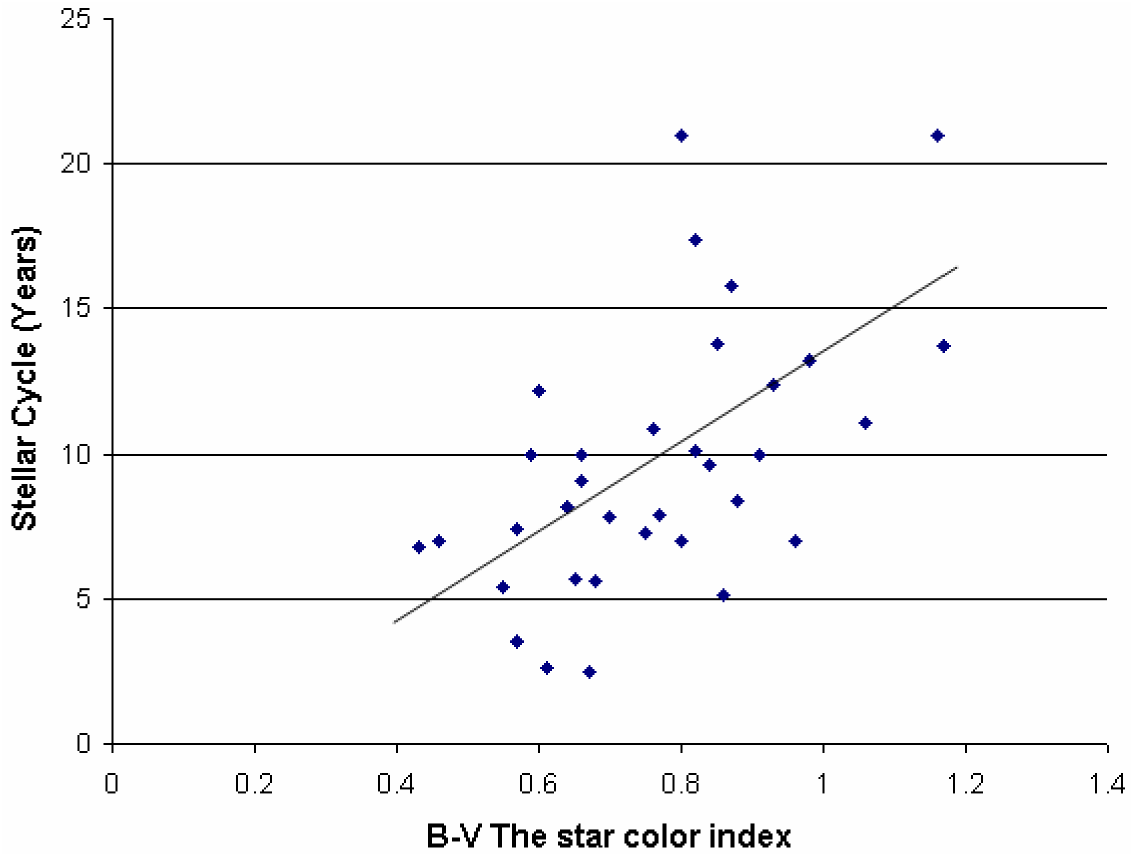

Figure 5 - The graph plot the stellar cycle period versus color from table 1, It shows clearly that for a colder star (Higher B-V) the stellar cycle is longer. Applying a linear regression on the points gives the line P = -1.22 + 14.14 (B-V) that is shown in the graph. This linear relation could be used to estimate the stellar cycles of objects like red dwarfs and planets based on their temperature. Few stray points where omitted to emphasize the linear relation.

B-V Color Index	Temperature (K)	Stellar cycle Period (Years)
0.4	6937.535	4.436
0.45	6724.082	5.143
0.5	6517.196	5.85
0.55	6316.676	6.557
0.6	6122.325	7.264
0.65	5933.954	7.971
0.7	5751.379	8.678
0.75	5574.421	9.385
0.8	5402.908	10.092
0.85	5236.672	10.799
0.9	5075.551	11.506
0.95	4919.387	12.213
1	4768.028	12.92
1.05	4621.325	13.627
1.1	4479.137	14.334
1.15	4341.324	15.041
1.2	4207.75	15.748
1.25	4078.287	16.455
1.3	3952.806	17.162

1.35	3831.187	17.869
1.4	3713.309	18.576
1.45	3599.059	19.283
1.5	3488.323	19.99
1.55	3380.995	20.697
1.6	3276.969	21.404
1.65	3176.143	22.111
1.7	3078.42	22.818
1.75	2983.704	23.525
1.8	2891.901	24.232
1.85	2802.924	24.939
1.9	2716.684	25.646
1.95	2633.097	26.353
2	2552.082	27.06
2.5	1867.122	34.13
3	1366	41.2
3.5	999.3752	48.27
4	731.1501	55.34
4.5	534.9146	62.41
5	391.3474	69.48
5.5	286.3126	76.55

Table 2 - This table is based on the linear regression P = -1.22 + 14.14 (B-V) shown in Figure 5. The B-V color index is converted to temperature using the formula B-V = -3.684 log (T) + 14.551. The table shows several points calculated by this relation including cold temperature that represent red dwarfs and planets. As the temperature of the stars is decreasing, the stellar cycle period is increasing. To show that planets like Jupiter has a very long stellar cycle period the low temperatures of the planets where used to give the long stellar cycles. For a Planet with temperature 286 K the stellar cycle period would be very long around 76 years.

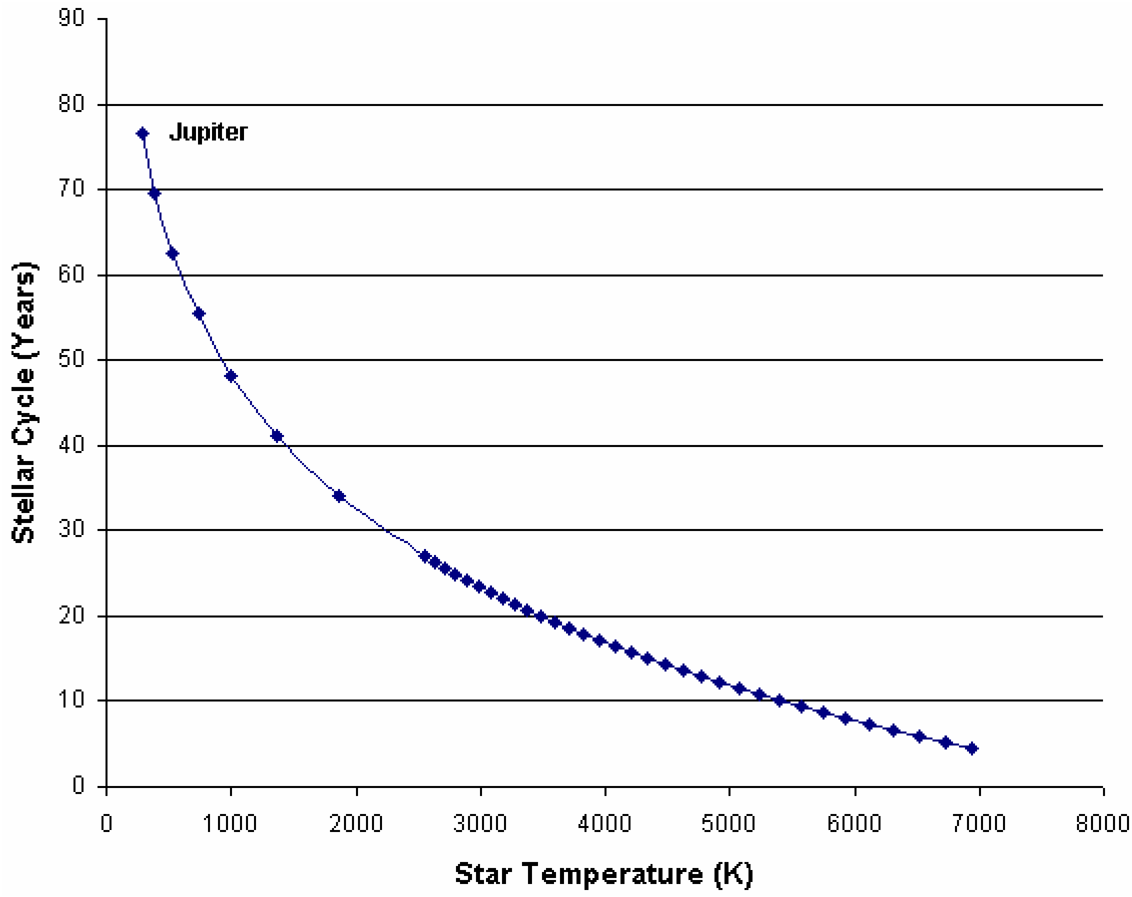

Figure 6 - The stellar cycle period versus the star temperature is plotted according to the data of table 2. Colder star has longer stellar cycle period so continuing this graph to very low temperature shows that planets like Jupiter have very long cycle. This relation is only estimation; Planets are not composed of hot plasma like stars so their electric resistance is much higher, therefore, planets stellar cycle is longer than that shown in the graph. Jupiter great red spot is driven by Jupiter stellar cycle and it is blowing for about 200 years; this is much higher than 76 years shown in the graph.

Jupiter stellar cycle is driving the massive jet streams and the great red spot. The jet streams in their present pattern and the great red spot are going on within one stellar cycle of Jupiter. If the stellar cycle of Jupiter will flip, the direction of the changing magnetic fields will flip and it will affect the jet streams. If now Jupiter middle jet stream EZ is moving to the right relative to the narrow jet streams on top and bottom of it, than when the direction of the changing magnetic fields will flip, the middle jet will flow to the left relative to the top and bottom jets. The middle jet stream EZ will change its flowing direction and will flow slower then the planet rotation. The great red spot will vanish when the changing magnetic field will flip, as will be explained in the next sections. Historical record of the great red spot and the jet stream can be used to evaluate the period of Jupiter stellar cycle. The great red spot was first shown in a drawing from 1831. Cassini and other astronomers observed a spot from 1665 to 1713 (Rogers 1995). However, the Cassini spot is not necessarily the great red spot. The Cassini spot was a temporarily spot that appeared when the changing magnetic fields where flipped. There is no observation of a great red spot prior to Cassini. The telescopes at that time could discern the great red spot and early astronomer would certainly mention this peculiar storm if they saw it. Therefore, the great red spot did not exist before 1831 and the Cassini spot was another storm. The conclusion is that Jupiter current stellar cycle started from around the 1831 drawing and continues to the present days. The long stellar cycle of Jupiter made the atmospheric winds on Jupiter look permanent and by that, they hide the existence of the stellar cycle. However, during the 21 century the changing magnetic fields of Jupiter will flip their direction to start a new stellar cycle and will affect the winds on Jupiter. The jet streams will reverse their relative direction; the forward winds will blow backward and the backward winds will blow forward. The great red spot will vanish as will be explained in the next sections.

The magnetic field of earth keeps its direction for hundred of thousands of years and it reverses the polarity of its magnetic field in average about 250000 years. If the planets and earth have stellar cycle of a few hundred years then it is unclear why the earth doesn't reverse its magnetic field with the stellar cycle as observed on the sun. The earth and the planets has two components of the electric field one is static that keeps its value constant and a second component of alternating magnetic field that changes periodically (Figure 7). The alternating magnetic fields supply energy to the planets, they cause the planets heat surplus and create the jet streams. The reason that the planets have static component and the stars haven't is that the planets resistance is higher so they can keep their electric charge longer in the rotating planet as will be explained in the next sections. The stars, on the other hand, have very low resistance that quickly dissipates the electric charges. Jupiter magnetosphere should reflect the alternating component of the magnetic field. Jupiter magnetosphere will change its size according to Jupiter stellar cycle and increase in size when the total magnetic field is getting stronger.

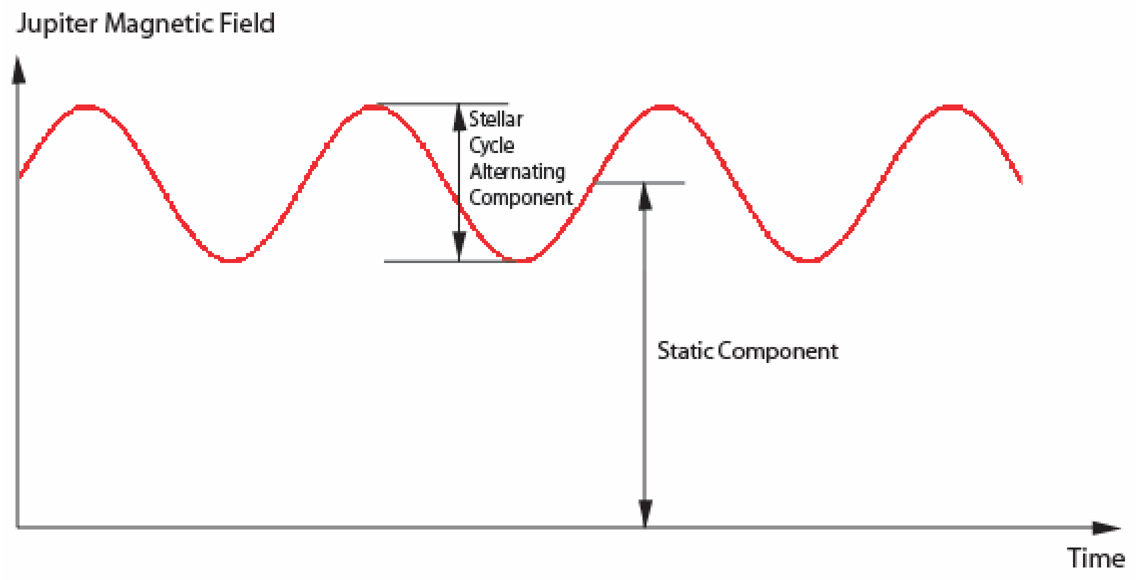

Figure 7 - Jupiter magnetic field is composed of two components. One is a static component that changes very little with respect to time. This static magnetic field is induced by the planet itself. The second component is the stellar cycle of Jupiter that is induced by the changing magnetic fields in the galactic disc. The stellar cycle magnetic field alternates and changes its polarity like the sun solar cycle. The stellar cycle magnetic field heats the planet and causes the jet streams, which are electric in nature. The magnetosphere of Jupiter will change its size according to the combined strength of the static and alternating magnetic fields.

The jets streams on Jupiter are driven by Jupiter stellar cycle

The jet streams are the most dominant features in Jupiter atmosphere. Jupiter jet streams are very fast and their latitude is stable compared to earth jet stream. The jet streams are visible from telescopes on earth, especially during outbreaks of spots. Many space craft like Pioneer, Voyager, and Galileo return spectacular images of Jupiter that revealed the complex atmosphere. Scientist where always puzzled by the jet streams and the forces that drive them. The usual explanation is that Jupiter jet streams are driven by convection. One heat source that was suggested to drive the convection is the sun radiation, but the distance of Jupiter from the sun is too far to supply the energy required by the jets. Another heat source could be emanating from Jupiter's hot interior. Still, it is hard to explain the complex structure of the jet streams from those heat sources.

Figure 8 shows the jet streams velocity as a function of latitude for the outer planets. Jet streams are also found on the sun and on earth. The common energy source that drives those jet streams is the changing magnetic fields from the galactic disc.

Jupiter has a magnetic stellar cycle similar to the sun solar cycle. Jupiter stellar cycle apply changing magnetic field that cross Jupiter along the rotation axis. The source of the changing magnetic field is the galactic disc and it provides energy to the planet. This energy is evident in the heat surplus of Jupiter and in the atmospheric phenomenon like the jet streams. As the changing magnetic fields cross Jupiter, it induces electromotive force or EMF according to Faraday's law:

$$\varepsilon = -\frac{d\Phi}{dt}.$$

The EMF (ε) create electric current that circle Jupiter (Both the EMF and the Electric Potential denote energy per unit charge and have the same unit of Volts, therefore, for simplification the term Electric Potential will be used instead of EMF in this text). Figure 9 demonstrate Faraday's law and its application to understand the jet streams. The atmosphere of Jupiter is composed of slightly conducting ionized gas. This gas is ionized by the many lightning that surround Jupiter atmosphere and by impacts with cosmic rays, solar wind and dust. The electric current that flow in the ionized gas, sweep the gas with the charged particles to create Jupiter Jet streams. The ionized gas is composed of positive and negative charges, negative charges are free electrons and positive charges are atoms that lost electrons. The electric field accelerates those charges and as they bump into nearby neutral atoms or molecules, they sweep the whole gas volume with them.

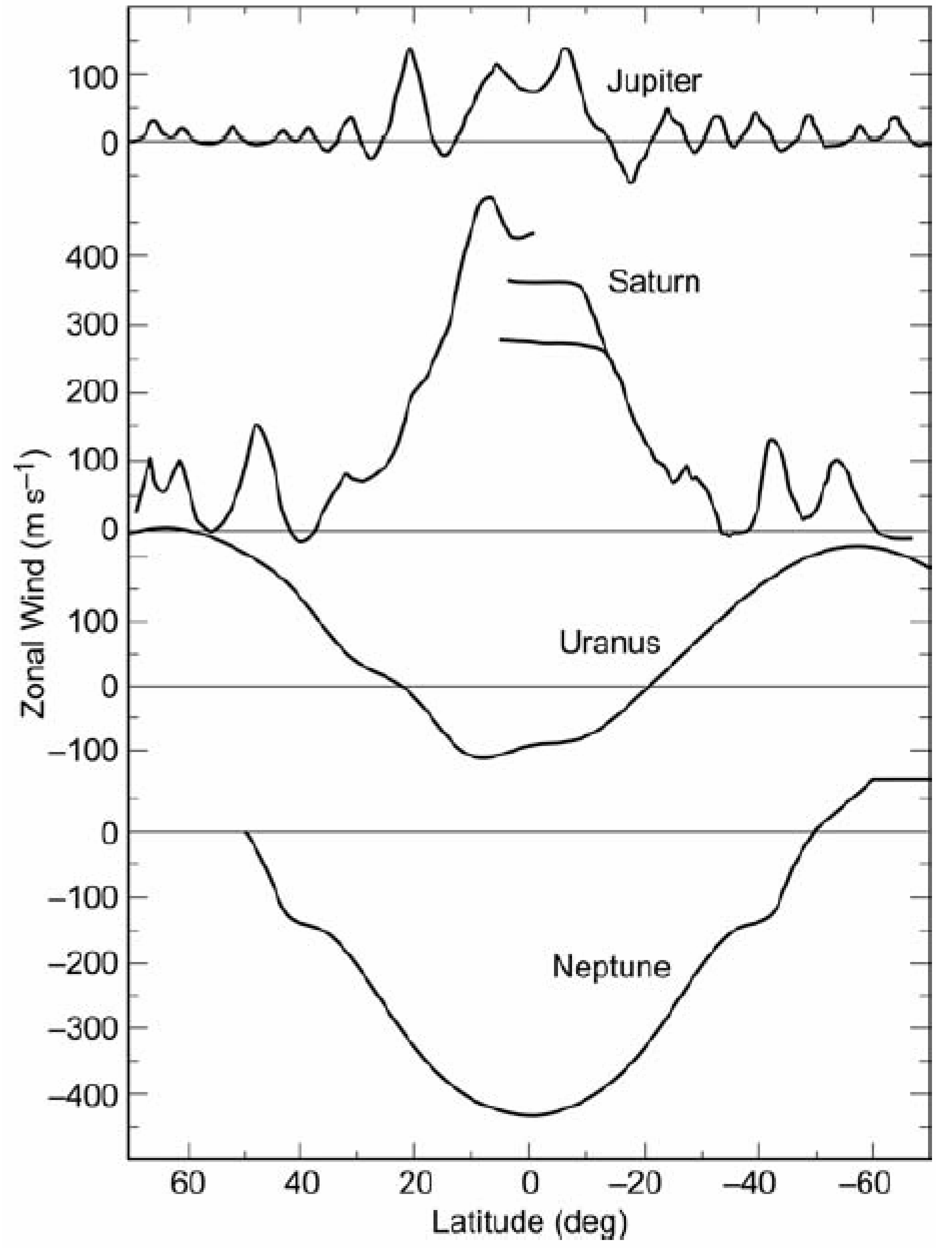

Figure 8 - The jet streams velocity as a function of latitude for the outer planets. In Jupiter, the jets with positive velocities are charged with positive electric charge, whereas the negative velocities denote negative electric charge. The velocities of the jets are proportional to the charge of the jet so a faster blowing jet has also higher electric charge density. The great red spot is driven by the electric potential between the positively charged middle jet EZ and the negatively charged jet right below it. Between those two jet streams, there is the highest speed difference and the highest electric potential. Jet streams in the other planets are indicating that those planets also absorb changing magnetic fields. (Image from Porco et al. 2003, *Science* 299, 1541–1547)

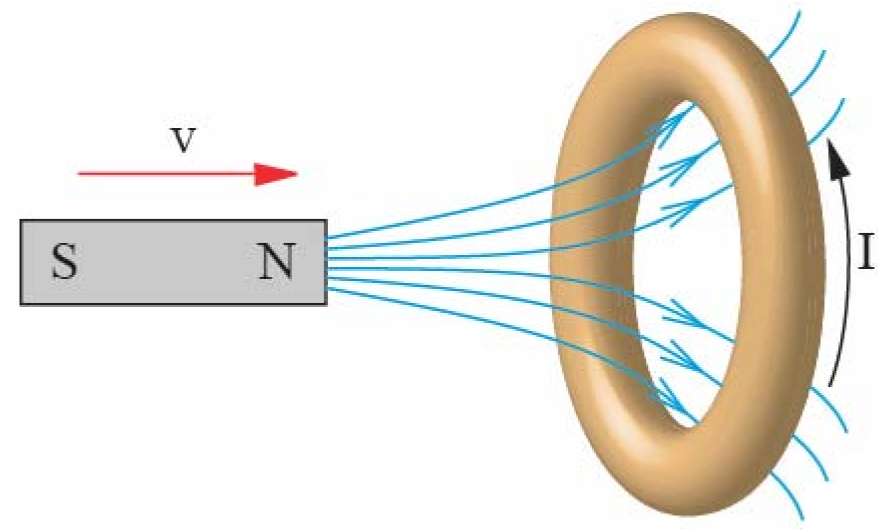

Figure 9 - The changing magnetic fields in Jupiter create electric potential according to Faraday's law that creates electric current in the ionized gas around Jupiter. Faraday's law can be demonstrated by a moving magnet and a copper loop. The changing magnetic field of the stellar cycle is like the moving magnet. In Jupiter, this induced current is split to positive and negative electric charges by the pinch effect that creates the jet streams. The changing magnetic field also makes the jet streams flow in opposite directions according to the jet streams electric charge. This image also explains the heating of stars by changing magnetic fields from the galactic disc. The induced currents heat the stars by ohmic heating. The direction of the changing magnetic field is almost parallel relative to the star rotation axis.

The creation of jet streams from electric potential can be demonstrate by an experiment in which slightly conducting oil is placed in a strong electric potential (Figure 10). The tank is filled with oil and has two electrodes at the right and left of the tank. The slanted upper electrode is connected to the right electrode. When the power supply is connected to the electrodes, the negative ions in the oil are attracted to the upper electrode and as they pulled to the right by the upper electrode, they create a stream in the oil. The charges in the oil are accelerated by the electric field and as they move, they drag a layer of the oil with them. Despite the scale difference between this experiment and Jupiter, there is a striking similarity between the appearance of the oil stream and Jupiter jet streams. The video that show the experiment can be downloaded from:
http://ocw.mit.edu/ans7870/resources/zahn/video/demo-7-5-1_300k.mp4
Or http://www.pixelphase.com/sun/demo-7-5-1_300k.mp4

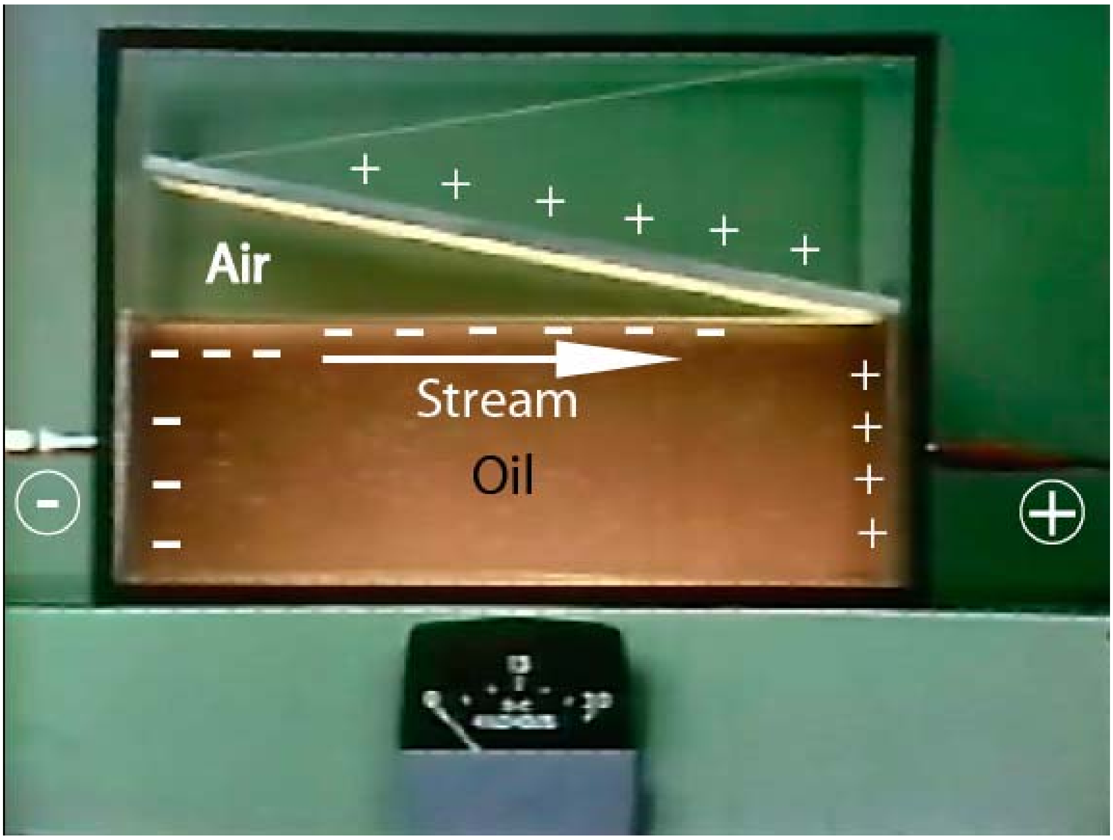

Figure 10 - This experiment shows the development of a stream by applying electric potential. The tank contains slightly conducting oil with two electrodes placed at the two sides of the tanks. Between the electrodes, there is electrical potential of 10,000 to 20,000 Volts. The upper electrode is slanted and connected to the right positive electrodes. When electric potential is applied, the upper electrode attracts negative charges in the oil. The slanted upper electrode also attracts the oil negative charges to the right as those charges aspire to be as closely as possible to the upper electrodes. The stream is created in the fluid by the movement of the charges in the oil. This experiment explains how the jet streams of Jupiter are driven by the changing magnetic fields and the electric potential they induce by Faraday's law.(From MIT OCW http://ocw.mit.edu/ans7870/resources/zahn/video/demo-7-5-1_300k.mp4)

The jets streams are divided to those flowing forward and those flowing backward. The electric current that circle Jupiter is not sweeping the entire outer layer in one stream; instead, it is divided into forward and backward streams. The source of this separation is the electric charges. The ionized gas of Jupiter atmosphere consists of both positive and negative charges. When the changing magnetic fields apply electric potential on the gas, the negative charges will accelerate in one direction and the positive charges will accelerate in the opposite direction. Even though the charges are moving in opposite direction the electric current is moving in a single direction, identical to the direction of the positive charges. If we imagine a thought experiment and isolate Jupiter from the changing magnetic fields for a while. Then when the changing magnetic fields are reapplied the positive and negative charges moves in opposite direction in the same volume of gas and bump into each other. After some time the charges are separated into opposite flowing streams, the positive charges move in jets that flow forward while the negative charges move in jets that flow backward.

This separation to forward and backward jet streams is the result of two factors. One is that the system is reducing viscous drag to a minimum and the second is the pinch effect. Here is a detailed description of the two:

Reducing viscous drag to a minimum:
When the gas is composed of forward and backward moving particles, the particles that move in the same direction will tend to stick together or attract each other. This can be explained by the kinetic theory. Particles that move in the same direction will collide less then particles that move in opposite direction. Let's take for instance a particle that is moving to the left. Above this particle, there is a stream of particles that moves to the left. Below this particle, there is a stream that moves to the right. The particle will collide more with particles of the stream below. It will experience pressure from below that will push it up into the upper stream; the stream that moves in the same direction as he is. The experiment shown in Figure 14 can demonstrate the creation of streams to reduce viscous drag to a minimum.

Pinch effect:
The pinch effect is usually an internal effect in hot plasma. Electric currents inside the plasma create strong magnetic fields that attract and squeeze the moving charged particles together. The pinch effect was first discovered in induction electric furnaces. Those devices where basically an Alternating Current transformer, that its secondary winding was a tunnel of molten metal. In the molten metal passed a current of about 100000 Amperes. This current applied strong pinch effect on the liquid metal that squeeze the liquid metal to a point that the electric current was cut in the liquid metal and the furnace failed. In 1907, it was investigated by C. Hering, which gave it the name pinch effect. Lightning bolts are also demonstrating the pinch effect. The strong current of the lightning bolt concentrate the charges and give the lightning its slim appearance. In Figure 11, there is a piece of copper tube that was part of a lightning rod that collapsed inward when struck by a lightning. The strong current of the lightning created strong magnetic fields that pulled the electrons inward to bend the tube. Another example that can demonstrate the behavior of the pinch effect and Jupiter jets is attraction between parallel conductors. Two conductors that carry electric current in the same direction will attract each other as the magnetic field of one conductor will attract the moving charges of the other conductor by magnetic force. Jupiter Jet streams develop their pattern of opposite flowing jets from a process similar to the pinch effect. The electric current that is flowing inside the jets is creating magnetic field around the jets. This magnetic field has a donut like shape with the jet stream passing inside. This magnetic field is attracting electric charges of the same sign, and repelling charges of the opposite sign. For instance, the EZ jet that has a positive charge will create a magnetic field around it that will attract additional positive charges and increase the charge density of the jet. This is true for the other jets, the positively charged jets will attract positive charges and the negatively charged jets will attract negative charges. In this way, the current from Jupiter stellar cycle is turned into positively charged and negatively charged jet streams (Figure 12).

The electric current that is produced by Jupiter changing magnetic fields is flowing in the same direction in all the jets. Both the Positively charged forward jets and the negatively charged backward jets have the same direction of electric current. By convention, the flow of electric current is opposite to the flow of the negatively charged electron. However, though the electrons are flowing backward by the electric current their drift speed by the electric current is slower then their speed by the rotation of the planet. Therefore, the rotation of the planet is what creates the magnetic fields around the jets that help to separate the charges by the pinch effect.

Figure 11 - The pinch effect is usually an internal effect in hot plasma. Electric currents inside the plasma create strong magnetic fields that attract and squeeze the particle together. The pinch effect can be found in other systems beside hot plasma, like on this lightning rod that the electric current from a lightning collapsed it inward. The strong currents created magnetic fields that effected the movement of the electric charges to collapse the rod. The thin appearance of lightning in the sky is also caused by the pinch effect; the lightning charged particles are squeezed together by the pinch effect. In Jupiter, the pinch effect contributes to the creation of the jet stream by increasing the density of the electric charges inside the jets. The changing magnetic field of Jupiter create electric currents. When those currents are flowing, the magnetic fields they produce activate the pinch effect to charge the jet streams.

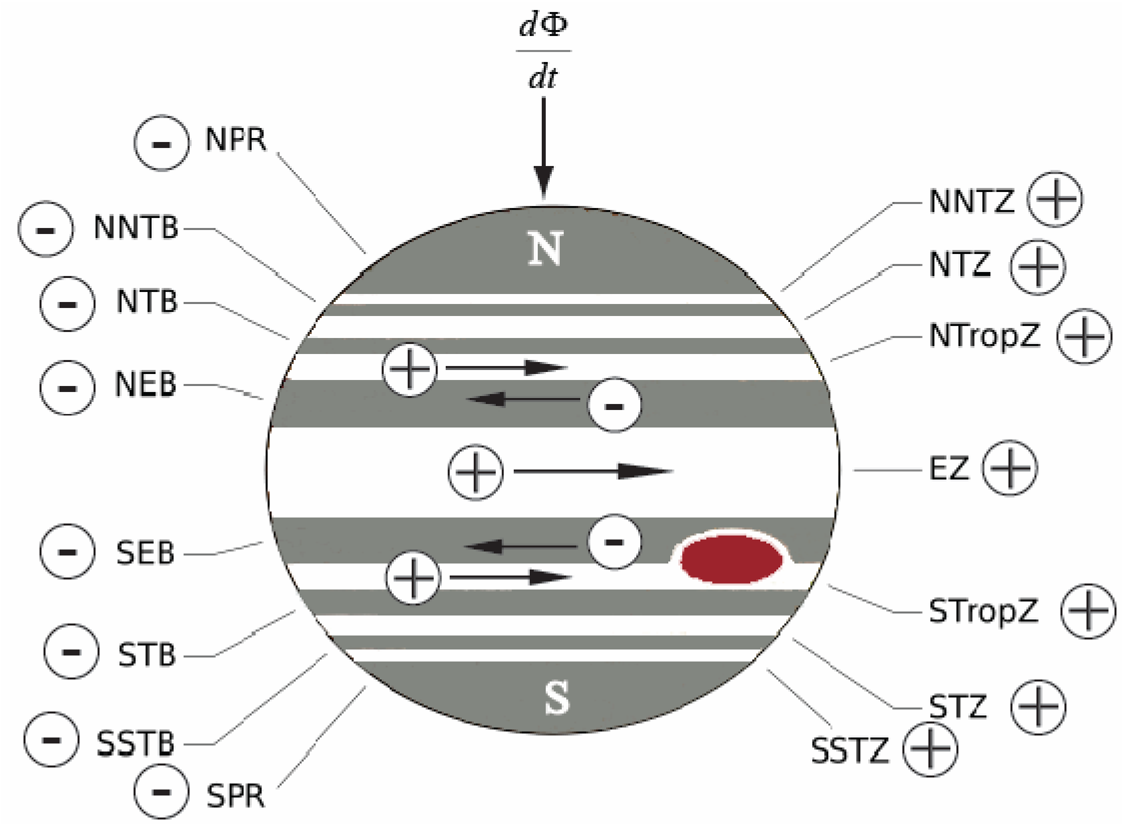

Figure 12 - Jupiter jet streams are driven by changing magnetic fields. The changing magnetic fields are almost parallel to the rotation axis; their direction is denoted by $\frac{d\Phi}{dt}$ in the image. According to Faraday's law the changing magnetic field generate electric potential that pass electric current around Jupiter. The ionized gas of Jupiter includes positive and negative charges that the pitch effect separate into forward and backward jets. While the opposite charges flow in opposite direction, the electric current is flowing forward in all the jets and has the same direction of the positive charges. Jets like the EZ jet that flow forward and faster then the planet rotation speed, carry positive charges, while the opposite jets carry negative charges.

Pioneer 11 passing near Jupiter revealed magnetic field rich in multiple harmonics relative to the amount of harmonics found on earth. This suggests that Jupiter dynamo source region is closer to the surface of the planet. The jets streams are electrically charged and rotate fast with the planet, so they generate Jupiter magnetic field and its magnetosphere.

The EZ middle jet of Jupiter is the biggest jet in Jupiter and its electric charge drive large part of Jupiter magnetic field. By knowing the direction of Jupiter magnetic field and the planet rotation direction, it is possible to find the charge of the EZ middle jet by Ampere's law (Figure 13). Knowing the charge polarity of this belt, reveal the charge polarity of all other belts. All forward jets have the same positive charge as the EZ main jet and the backward jets have negative charge.

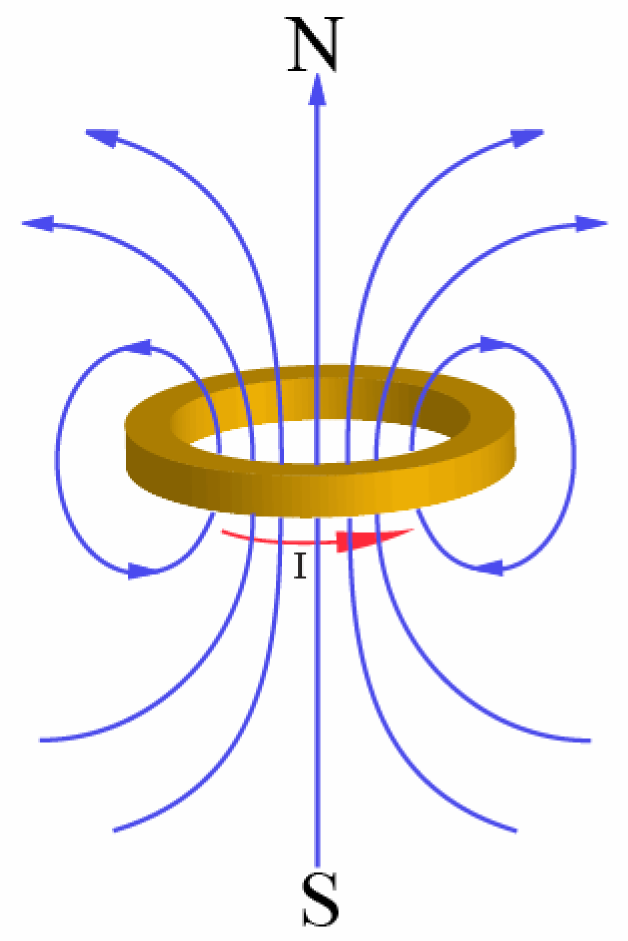

Figure 13 - Jupiter magnetic field can be used to find out the polarity of the charge of each jet according to Ampere's law. Jupiter EZ jet is the dominant jet on Jupiter and therefore, it must produce most of Jupiter magnetic field. The magnetic field of Jupiter is opposite to that of earth. In Jupiter, the planet north poll is the magnetic north. To produce this magnetic field the EZ ring must be positively charged and pass current in the same direction as the rotation direction. This is similar to a copper ring that passes current and produce magnetic field as shown in the image.

The creation of the opposite jet streams decreases the electric resistant of the outer layers and enables a stronger electric current to flow. The lower resistance increases the energy per time or power the planet absorbs from the changing magnetic fields. The reduced electric resistance can be explained with cars on a highway where the forward headed cars are positive charges and the backward headed cars are negative charges. If forward and backward headed cars where driving on the same lanes, they would bump into each other and their average speed would be slower as they stop from the collisions. If the lanes are divided into forward and backward lanes, the cars can drive in their lane faster without bumping into other cars.

The sun solar cycle flips its direction every 11 years, similarly, the changing magnetic fields in Jupiter will also flip their direction. When that happens, the overall magnetic field of Jupiter will maintain the same polarity, but will change its magnitude as shown in Figure 7. When the magnetic flip happens, the Jet streams will be arranged differently. The main EZ belt will keep its positive charge but will flow backward relative to the planet rotation and the negatively charged jets below and above it will flow forward relative to the EZ belt and the planet rotation. In this configuration, anticyclonic spots below the EZ belt will rotate in opposite direction to that of the great red spot. Historical evidence shows that the great red spot appeared in 1831, before that the changing magnetic fields where reversed and did not produce a dominant spot like the great red spot but smaller temporary spots. Therefore, at the next reversal of the changing magnetic fields, probably in the 21st century, the great red spot will disappear and temporary spots will replace it.

The electric charges that develop in the jet streams are driving the lightning bolts activity in Jupiter. This activity revealed by space crafts voyager, Galileo and Cassini. Galileo found that the lightning are concentrated in just a few zones of latitude influenced by anti cyclonic sheer. Galileo probe also heard 5000 lightning flashes during the 57.6 minutes of its descent to Jupiter. The average lightning on Jupiter are 10 times stronger then those on earth. Both Galileo and Cassini probes observed unusual strong lightning in the GRS wake this support the idea that the GRS is an electric phenomenon driven by the electric potential between two opposite jet streams.

The great red spot is an electric storm driven by the charged jet streams

The GRS is an anti-cyclonic high pressure spot that has been a permanent feature of Jupiter since 1831. The GRS is very different from hurricane on earth. While Hurricanes are powered by solar heating that evaporate water, the energy source of the GRS is the electric charge that develop in the jet stream. This electric charge provide electric potential that just like a battery can be a source of power and energy. Like the acceleration of electrons under an electric field in a cathode ray tube, the electric field between the jets can accelerate electric charges or ions in the gas that drift the gas volume to create vortex like the GRS. Coulomb's law depicts the attraction and repulsion forces between charges. Coulomb's law has resemblance to Newton's law of universal gravitation and both gives the magnitude of force. Newton's law gives the gravitational force and Coulomb's law gives the electrical force. Those two forces also create potential energy so while the GRS gain energy from electric potential hurricane gain energy from gravitation potential.

In Figure 14, there is an experiment that shows the creation of vortexes from electric field. This experiment can be used to explain both the GRS and sunspots. In the experiment, corn oil that is slightly conducting is placed in a tank. At the bottom of the tank, two electrodes are placed. When a high voltage power supply is connected to the two electrodes and electric field is applied between them, the corn oil form spontaneous vortexes. Those vortexes are driven by the electric field. There are free electric charges inside the corn oil that get attracted by one electrode and repelled by the other electrode. Those vortexes pass electric current between the electrodes. Without the oil vortexes the electric current between the electrodes will be smaller and the resistance of the oil higher. In addition, those vortexes form when the oil streams seek to reduce their viscous drag to a minimum. The video that show the experiment can be downloaded from:
http://ocw.mit.edu/ans7870/resources/zahn/video/ demo-7-5-2_300k.mp4
Or http://www.pixelphase.com/sun/demo-7-5-2_300k.mp4

The formation of GRS and sunspots is similar to the formation of the oil vortexes in the experiment. The electrodes of the experiment correspond to the jet steams and the slightly conducting corn oil is similar to the ionized gas in Jupiter atmosphere. The jet streams develop electric charge that applies electric field to drive the GRS. In Figure 15 there is a descriptions of the jets a round the GRS. The two dominant jets that drive the GRS are the EZ and the SEB jets. The EZ has positive charge and the SEB jet has negative charge. The source of power of the GRS is the electric field and electric potential between those two jets. Charged particles inside the GRS are accelerated by attraction force between opposite electric charges as stated by Coulomb's law. The negative ions from the SEB jet are attracted and accelerated toward the EZ positive charge and by that, push the GRS anticlockwise. The STropZ jet has a weaker part in driving the GRS and it is merely confining and directing the lower part of the GRS. Though the GRS is located at latitude 22 it is driven by the EZ and SEB jets that are found higher. The propulsion of the GRS is done by the SEB jet at the top part of the GRS or its north east part. The SEB jet is protruding into the EZ jet, and this decreases the distance between charges of the two jets. The decrease in distance converts the electrical potential energy between opposite charges and increases the kinetic energy of the charges to drive the GRS. Electric current is flowing in the GRS from the EZ jet to the SEB jet. This current slightly discharges the electric charges in those jets. This current multiplied by the electric potential between the EZ and the SEB jets gives the power that the GRS use. In Figure 8 it is shown that the difference in the velocities of the EZ and SEB jets is the highest in the planet. This means that the electric potential between those two jets is the highest in the planet and can easily support and supply energy to an electric storm like the GRS.

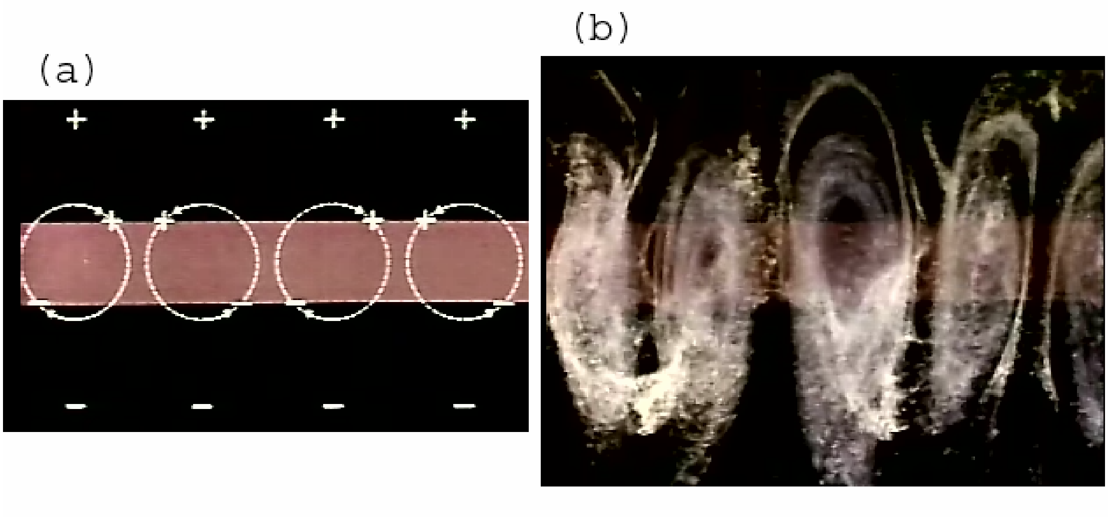

Figure 14 - In this experiment there are two electrodes submerged in corn oil inside a container. When high voltage is applied between the electrodes, free charges inside the slightly conducting oil start to flow between the electrodes to create electric currents. The left image (a) is a schematic of the experiment showing the electric polarity of the electrodes and the space between them while (b) on the right shows the actual experiment. Those electric currents drift the oil to create rotating cells or vortexes. The power consumed by the rotating cells is equal to electric potential between the electrodes multiplied by the electric current they consume. Jupiter Great Red Spot works on the same principle. Jupiter Middle jet and the jet below it create between them strong electric potential that drive the great red spot. The ionized gas in the Great Red Spot is accelerated by the electric potential to create the circular flow. The resistance of the oil with the vortices or cells is lower then the resistance of the oil without the cells; therefore, with the cells the electric current between the electrodes is higher. This process also drives

the sunspots. (From MIT OCW http://ocw.mit.edu/ans7870/resources/zahn/video/demo-7-5-2_300k.mp4)

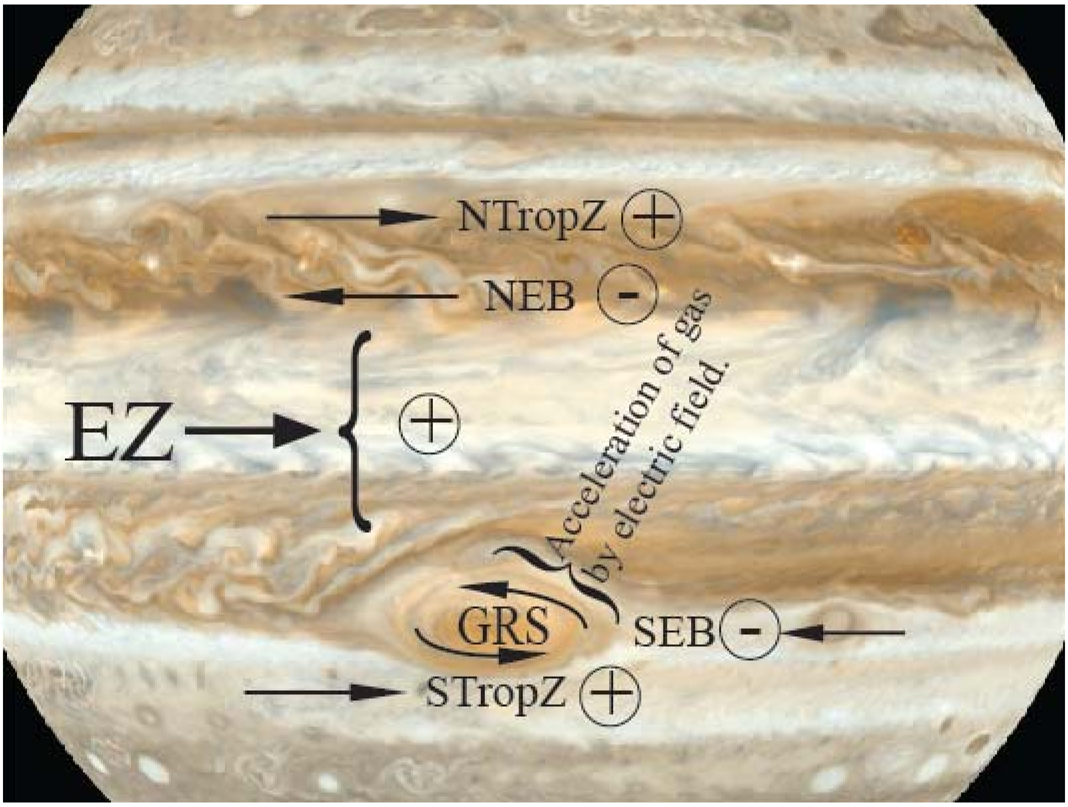

Figure 15 - Jupiter Great Red Spot is driven by the electric charges and electric potential between the jet streams EZ and SEB, in a process similar to the experiment depicted in Figure 14. The EZ jet has a positive charge and the SEB jet has a negative charge. The source of power of the GRS is attraction force between opposite electric charges as stated by Coulomb's law. Negative charges from the SEB jet are attracted and accelerated toward the EZ positive charges. Movement of the electric charges sweeps the gas around them and creates the vortex. The electric potential between the EZ and SEB jets create electric current that flow primarily through the GRS. The GRS just like the jet streams is formed by reducing viscous drag to a minimum.

Sunspots are electric vortexes created between two charged plasma belts

The sunspots existence was know before the invention of the telescope and there is evidence of this knowledge from the fourth century B.C. Sunspots come in a range of sizes up to a diameter of 20,000 km. The sunspots usually has a dark and cold umbra at the center and penumbra that surround it and consist of dark and light filaments (Figure 16). The umbra has an almost vertical magnetic field that can reach up to 0.3 Tesla. Usually sunspots appear in pairs that with respect to the sun rotation can be divided into a leading sunspot and a following sunspot. The two sunspots have usually an opposite magnetic polarity and the magnetic field is bipolar. There are also cases of single sunspot with unipolar magnetic field. The leading spot in a pair of spots show the same polarity throughout the solar cycle. In the opposite hemisphere, the leading sunspot has the opposite polarity. The leading sunspots change their polarity every 11 years according to the solar cycle **(** Hale**'**s Polarity Law **)** and reveal the changing magnetic fields that heat the sun. The sunspots have a short life compared with Jupiter spots and can last up to 100 days.

The sunspot appearance and disappearance remind the behavior of Jupiter spots and in the nineteenth century researcher tried to find a common explanation to sunspots and Jupiter spots (Ref .10). The probe MDI-SOHO found using helioseismology analysis that there are plasma belts around the sun. Those plasma belts are very much like Jupiter jets stream and suggest that the solar cycle drive those plasma belts by inducing current around the sun. Despite the high conductivity of the sun, and that this conductivity tends to shield electric fields by the Debye Shielding, the plasma belts are charged by pinch effect. The changing magnetic fields of the solar cycle supply energy and create electric currents that prevent the electric charges and electric fields of the belts from decaying. The probe MDI-SOHO also showed that the sunspots appear on the boundaries of the plasma belts. This indicate that just like Jupiter spots which are driven by the electric potential of the jet streams the sunspots are driven by the electric potential of the plasma belts. The experiment shown in Figure 14 can be applied to both Jupiter spots and the sunspots. Deep below the sunspots, there is an electric vortex that rotates in the boundary between plasma belts (Figure 17). This rotating vortex carries electric charges and create electric current that work like a solenoid to produce the magnetic field that characterize sunspots. There is helioseismology analysis of sunspots; however, this analysis can only show the surface behavior of the sunspots and not the deeper vortexes that drive the sunspots. It is known that the magnetic field of the sunspots can go to depth of 10,000 km.

Usually, sunspots come in pairs of a leading and following sunspots. Such pair requires two vortexes that rotate in opposite directions similar to nearby vortexes in the experiment of Figure 14. Observation shows that the leading sunspot appears first and then after a day or two the following sunspot appears. This suggests that the second vortex was created by the magnetic field of the first vortex to close a magnetic circuit. The electric vortexes below the sunspot can explain the diverse angle or tilt between the leading and following sunspots. The sunspots vortexes move around similarly to the observed movement of Jupiter spots. This movement creates the diverse tilt between the leading and following sunspots.

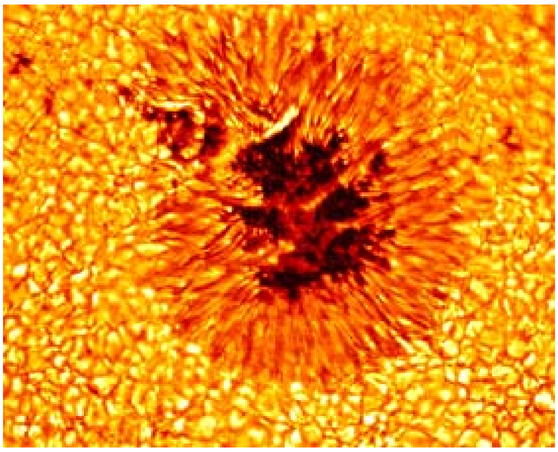

Figure 16 - Since the nineteenth century researchers suspected that there is a relation between Jupiter spots and the sunspots. The helioseismology research by probe MDI-SOHO revealed the existence of

plasma belts and that sunspots form on the boundaries of those plasma belts. This suggests that the sunspots formation is similar to Jupiter spots formation and that the plasma belts develop electric charge that creates vortexes as shown in the experiment in Figure 14. In those vortexes, electric charges are circulating and creating a strong magnetic field that appears on the sun surface as sunspot.

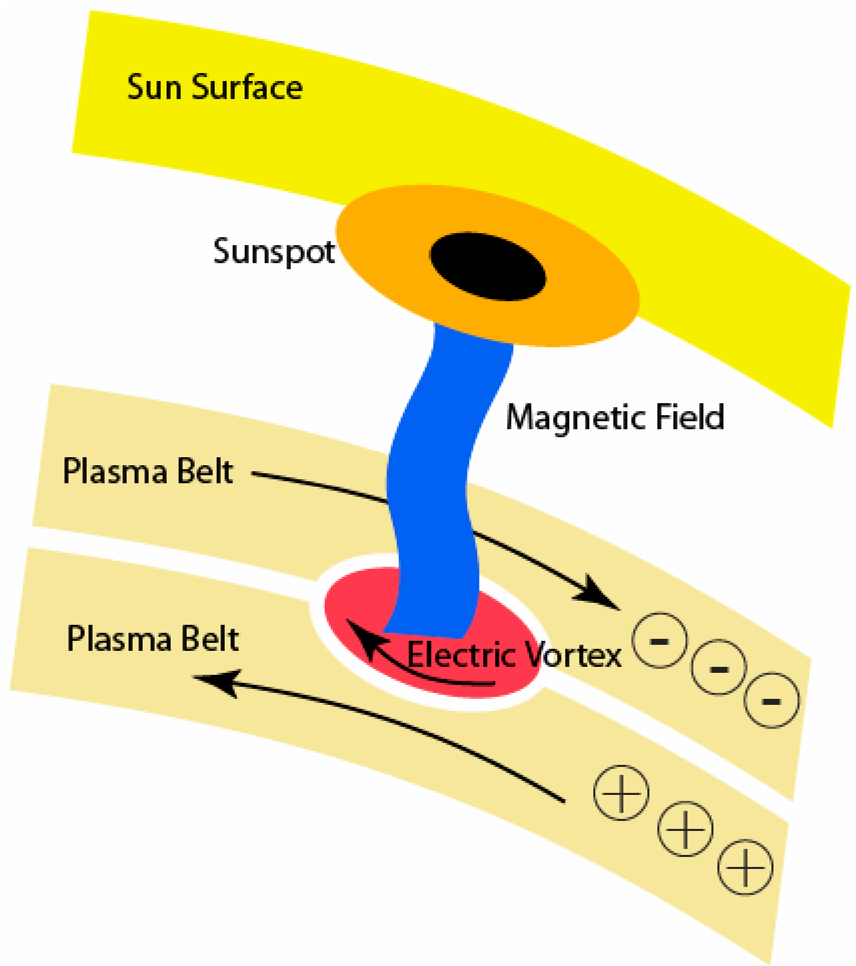

Figure 17 - Sunspots are only found on the boundaries of plasma belts, which suggest that they are electric vortexes similar to Jupiter GRS. The plasma belts are electrically charged by the solar cycle and this charge create an electric potential between adjacent belts that provide energy for the electric vortexes. As the electric vortex rotates, the electric charges inside it rotate with it and produce a magnetic field. This is similar to the magnetic field created by electric current flowing in the windings of a solenoid. The magnetic field from the electric vortex extends to the surface and creates the familiar look of the sunspot.

The butterfly diagram (Figure 18) shows the latitude of sunspots against their emergence time. Each solar cycle in the diagram looks like a butterfly. At the beginning of the solar cycle the sunspots appear at high latitudes around 30 degrees, and as the solar cycle evolve the sunspots appear lower near the equator. This behavior can be explained by the plasma belts. The plasma belts at higher altitude are smaller, they have a smaller diameter and they are narrower. As the changing magnetic fields of the solar cycle start to induce currents, the higher plasma belts due to their small size evolve faster. They gain rotational speed around the sun faster and they absorb electric charge by the pinch effect faster. The electric charge of the higher plasma belts increase faster and the sunspots that depend on the electric potential emerge faster. The lower belts are heavier, they have larger diameter and they are wider. It takes more time to charge the lower belts so the sunspots at the lower latitudes appear later on. At the end of the solar cycle the lower latitude belts gain higher speed around the sun and their electric charge increase; this enable them to conduct stronger currents that absorb all the energy from the changing magnetic fields and decrease the energy absorbed by the higher latitude belts. In other words, the development of the lower belts decreases the energy available to the higher belts. As the higher belts are weakened, the sunspots will appear only in the lower latitude near the equator.

It is possible to depict the belt development shown in the butterfly diagram by giving the belts capacitance. The high latitude belts have smaller capacitance then the lower latitude belts. Therefore, it takes shorter time for the high latitude belts to charge and develop high electric potential to produce sunspots.

Sunspots do not appear directly on the equator because the equator is occupied by a middle belt just like Jupiter EZ jet stream. This belt is considerably wide and the sunspots can only rise in the boundaries of this belt. This middle belt dominates the solar rotation and creates the differential rotation as it pushes forward the equatorial area of the sun. It is usually believed that the differential rotation is created by convection, but after a long and systematic search for massive convection plums that drive the sun differential rotation, there is no definite proof that they exist.

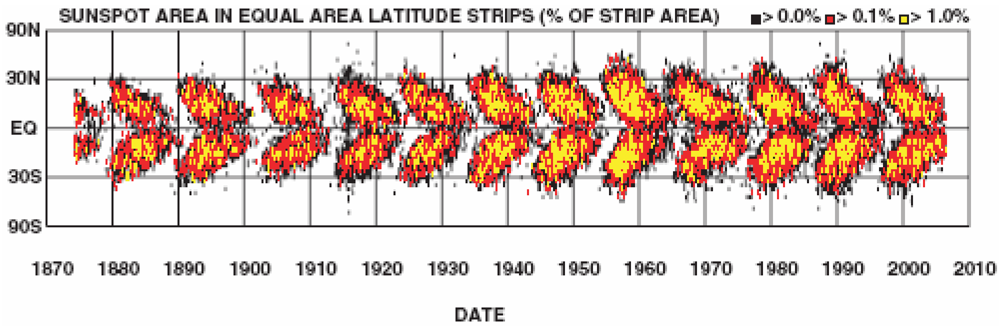

Figure 18 - The butterfly diagram of the sunspots shows that the sunspots appear in higher latitudes at the beginning of the solar cycle and then drift toward the equator as the solar cycle end. This behavior can be explained by the plasma belts. The plasma belts at the higher latitude has smaller diameter around the sun and smaller width. As the changing magnetic fields pass through the sun, the higher latitude belts are quickly charged by the pinch effect to produce the sunspots first. The heavier belts near the equator require longer time to charge and produce sunspots later on. As the belts near the equator are fully charged they absorb all the energy from the magnetic fields and starve the higher latitude belts, so at the end of the solar cycle there are sunspots only near the equator.

Sunspot have rotation rate that depends on their latitude (Ref. 11). At high latitudes, the sunspots have high angular speed and as the solar cycle evolves, the sunspot appears at lower latitudes with small angular speed. This behavior can be explained with the size and depth of the plasma belts. At high latitudes the plasma belt are narrower and closer to the sun surface. This enables the electric vortex at the base of the sunspot to be closer to the sunspot at the sun surface. This way some of the rotation of the vortex is coupled to the sunspot. At lower latitudes, the plasma belts are bigger and the electric vortex is deeper so it is harder for it to influence the rotation of the sunspot.

The changing magnetic fields are nearly sinusoidal in shape, as shown by the stellar cycle and the sunspots number recorded during the last 300 years. According to Faraday's law, there is a phase shift of 90 degrees between the changing magnetic fields and the induced electric potential. The electric potential lags 90 degrees behind the magnetic field. The electric potential is at its pick when the variation in magnetic field is the highest. At this point, the magnetic field is near zero and changes its polarity. This is also observed in the sun, as in the point of solar maximum, when the magnetic activity and the sunspot number is the highest, the sun reverses the polarity of its magnetic dipole.

Stellar rotation is driven by the plasma belts and the stellar cycle

Analyzing the jet streams of Jupiter, reveal the connection between the changing magnetic fields or stellar cycle and stellar rotation. Jupiter has large mass 318 times the mass of Earth, and despite its enormous size, it rotates very fast and completes a rotation in about 10 hours. There are forces that operate to slow the rotation of Jupiter for instance, tidal effects with the sun and Jupiter moons and drag from the solar wind. Jupiter exists for billions of years, so there must be a process that drives Jupiter rotation and prevents it from slowing despite the resistance. The changing magnetic fields of Jupiter rotate the jet streams around the planet and their flow drag the rest of the planet with them. The changing magnetic fields of Jupiter supply the energy from the galactic disc that drives the rotation of the planet. Jupiter also exhibit differential rotation mainly from the fast rotation of the EZ middle jet.

The stellar rotation is similar to Jupiter rotation. The internal structure of the sun was analyzed by helioseismolgy and revealed Plasma belts that resemble the jet streams of Jupiter (Figure 19). Those plasma belts are created by the solar cycle. As the changing magnetic fields cross the sun parallel to the rotation axis, they induce electric current according to Faraday's law that flow parallel to the equator. Those electric currents create the plasma belts similar to the creation of the jet streams on Jupiter.

When electric current flow in a conductor the flowing electric charges has very low speed of the order of ten millimeters per second. This is called the drift speed of electric charges. It is clear that this drift speed is much slower then the speed given to charges at the EZ middle jet by the rotation of the planet. The rotation speed of the planet increases the pinch effect of the jets because, the jets are electrically charged and moving charges create magnetic fields. In this way, the magnetic field and magnetosphere of Jupiter is produce by the fast rotation of the charged jet.

Jupiter rotation can be understood by analyzing the EZ middle jet that its mass and size has the largest effect on the planet rotation. The changing magnetic field has a sinusoidal wave form; it is repeatedly increasing and decreasing in strength. When the magnetic field is increasing, the EZ middle jet rotates faster then the rotation speed of the planet. When the magnetic field is decreasing, the EZ middle jet rotates slower then the planet. When the EZ middle jet is flowing faster, the pinch effect of the EZ middle jet is stronger. The stronger pinch effect attracts additional positive charges and repels negative charges. This increases the overall charge of the EZ jet. When current is flowing in this highly charged EZ jet, it is using mainly the positive charges

flowing forward and there are few negative charges flowing backward. The gas of the EZ jet will accelerate forward by the flow of only positive charges forward and lack of negative charges that flow backward.
When the planet stellar cycle flip, the changing magnetic field is decreasing, the EZ middle jet rotate slower to slow the rotation of the planet, but the pinch effect is weaker due to the slower rotation and there are more negative charges that resist the flow of the gas. Therefore, the forward push of the EZ middle jet when the magnetic field is increasing is stronger then its backward push when the magnetic field is decreasing. The similarity between Jupiter jet streams and the sun plasma belts suggest that stellar rotation is based on a similar process.

The equatorial or middle plasma belt in stars, change the polarity of its electric charge, when the changing magnetic fields change their direction.
In stars, both the increasing and the decreasing parts of the changing magnetic fields push the rotation forward. When the changing magnetic fields are increasing, the positively charged belts increase their charge by the pinch effect and the negatively charged belt loses some of their charge. The more concentrated positive jets are therefore pushing forward stronger then the negatively charge jets are pushing backward. When the changing magnetic fields are decreasing, the negatively charged belts increase their charge by the pinch effect and the positively charged belt loses some of their charge. The more concentrated negative jets are therefore pushing forward stronger then the positively charged jets are pushing backward.

The differential rotation of the star is caused when the middle plasma belt near the equator is pushing forward while the rest of the star is pulling back by its inertia. Some stars exhibits anti-solar differential rotation where the equatorial region rotate slower then the Polar Regions. This reverse differential rotation can be explained by analyzing Jupiter rotation. When the changing magnetic fields of Jupiter are increasing, the differential rotation is regular and the equatorial region is faster. When the changing magnetic fields are decreasing, the differential rotation is reversed and the equatorial region is slower. This could be happening in stars when the main belt is not changing its electric charge polarity as the changing magnetic fields change direction. This way the main belt is pushed backward by the changing magnetic fields.

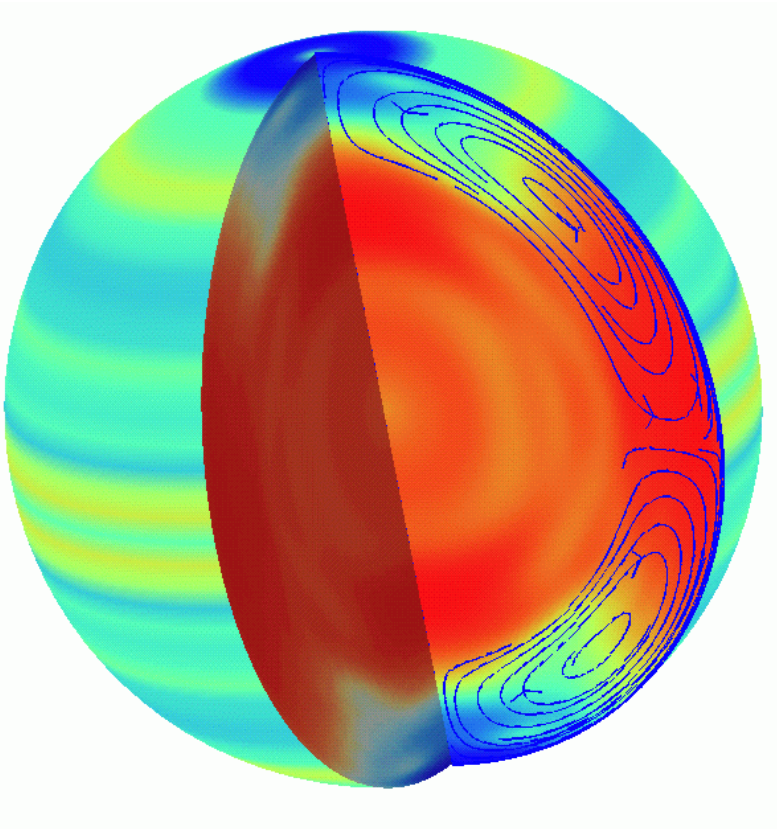

Figure 19 - The Sun has plasma belts that resemble Jupiter jet streams. The solar cycle and the changing magnetic fields that flow through the sun, drive electric current around the sun. This electric current produces the plasma belts that like Jupiter jet streams develop electric charges by the pinch effect. The rotation of the sun and other stars is driven by the flow of the plasma belts. The main plasma belts near the equator rotate faster then the rotation of the sun so they increase the rotation speed of the star. The electric current that drive the main belt is driving the rotation of the sun and at the same time create the differential rotation.

Stars are born from red dwarfs. As the red dwarf is heated by the changing magnetic fields, it converts energy to mass. This new mass is increasing the mass of the star, and promoting it along the main sequence. If the mass of the star is increasing, the gravity pull of the star is increasing and the density of the core is also increasing. To increase the core density mass is flowing from the outer layers of the star to the core. This is like the rotating ice skater that pulls her arms inward and her angular speed is increasing. The mass that flow to the core of the star increase its angular speed. The contribution of the mass falling inward to the stellar rotation is smaller then the contribution of the changing magnetic fields and stellar cycle. The mass that is created in the star is also increasing its angular momentum.

The axis of rotation of the star will incline toward the direction of the changing magnetic fields of the stellar cycle that create its stellar rotation. This inclination is created as the electric current and the middle ring flow will tend to be perpendicular to the magnetic fields. This can explain the diversity in the rotation axis of the solar system planets.

Arguing that the stellar rotation is caused by magnetic fields seems at first glance to contradict the conservation of angular momentum. The star floating in space seems to rotate by itself without any force acting on it. However, the source of the rotation is electrical in nature. This is similar to an electron placed in an electric field. The electron seems to accelerate by itself as no other object is pushing it. However, it is the electric force that pushes it. Similarly, the changing magnetic fields create electric field that circle the star and accelerate charges around to create the stellar rotation.

The uniformity of rotation in the solar system is caused by the solar wind

The solar system was born according to the common belief from a contracting solar nebula; however, this idea is incorrect. There are many difficulties in explaining how a dust cloud is contracting and turn into a solar system. According to the concept of this article, the origin of the solar system is different. The stars energy is from magnetic fields in the galactic disc and they convert energy to mass. The star mass is increasing and small stars are turn in billions of years to heavier stars. The sun and similar stars were born from red dwarfs, and in billions of years of converting energy to mass, their size grew and it reaches the size of a massive star like the sun. As the star is getting older, its mass is increasing and it is promoted along the main sequence. The Hertzsprung-Russell diagram represents not only the relation of luminosity and temperature of many stars but also the development of a single star as it grows from a red dwarf by the changing magnetic fields. Blue giants are therefore much older than red dwarfs.

The sun and the planets rotate in the same direction and all the planets orbit the sun in the same direction. This is attributed incorrectly to the creation by the solar nebula. Since the solar nebula rotated as one body in the same direction, it gave the sun and planet the same rotation direction. If there was no solar nebula, then why is the uniformity in the rotation direction of the planets? The solar wind is the cause of the uniformity in rotation direction of the planets (Figure 20). The sun by its strong gravity attracts large amount of cosmic dust that falls to the planets; there is about 40 tons of dust that fall to the earth each day. This dust as it is headed toward the sun is falling on the planets mainly on the side that is opposite to the sun direction. The dust is also drifted by the magnetic field of the solar wind and by impacts between the solar wind particles and the dust. Combining the fact that the dust is falling on the planets only on the side opposite to the sun with the fact that the dust rotate in the same direction as the sun, apply a torque on the planets. This torque exerted along billions of years gives the planets the same rotation direction.

There is also drag between the planets and the solar wind that push forward the planets in their orbit around the sun and at the same time brake the rotation of sun.

The interaction between the solar wind and the cosmic dust is also the source of the uniformity of the orbits of the moons around their planets. When the moon is opposite to the sun, the cosmic dust hits it and pushes it forward. When the moon is between the planet and the sun, the planet attracts all the cosmic dust and the moon is not pushed. This way there is a torque that rotates the moons in the same direction.

During the development of the solar system object that were captured from outside the solar system and by chance got into a reverse orbit where lost. Large asteroids that were captured by the sun in orbit opposite to the rotation of the solar wind got their rotation speed around the sun to gradually decrease until they fell to the sun. Similarly, asteroids that were captured by planets and rotated in the wrong direction fell to the planets. Objects that fit the rotation of the solar wind continued to exist as their rotation speed was sustained by the solar wind.

It is well known that the retrograde rotation of Venus is due to the tidal effect between the nearby sun and Venus atmosphere. Retrograde rotation in general can also be induced by magnetic influence (Figure 21). The magnetic influence on rotation can affect other bodies like binary stars that include a main sequence star and a neutron star. Tidal effects can also influence the orbits of planets and moons; earth rotation affects the orbit of the moon and increases the distance between the earth and the moon by 3 cm each year. The rotation of earth is slowing down while the moon is speeding up.

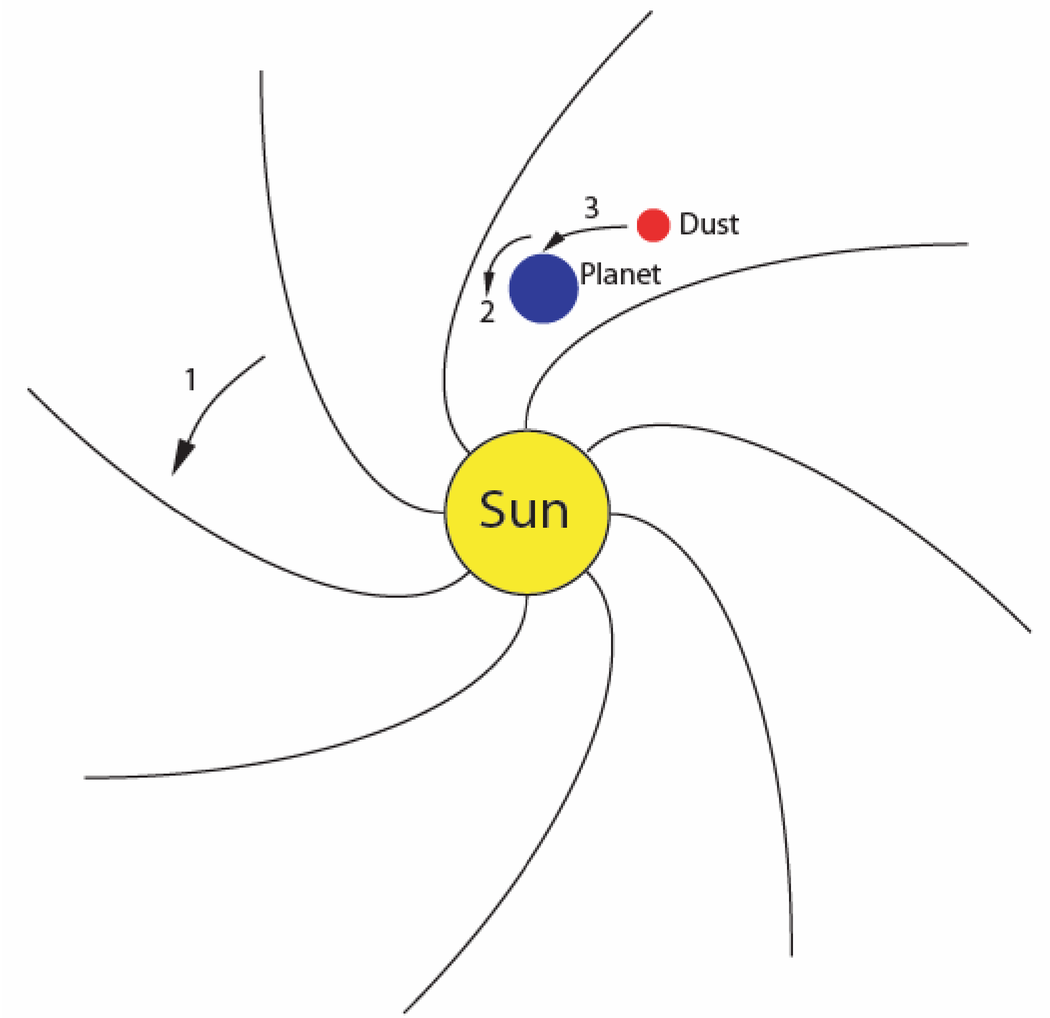

Figure 20 - The solar system was not created by a solar nebula. The match between the sun rotation direction (denoted 1 in the image) and the planets rotation direction (2) is caused by the solar wind (denoted in the image by the curved lines emanating from the sun). The solar wind rotates in the same direction as the sun and all cosmic dust particles that are falling to the sun are drifted by the movement of the solar wind to have an angular speed around the sun. The dust is falling on the planets only from the side that is opposite to the sun (3). Therefore, the dust that is falling on the planets applies a small torque that over billions of years creates the uniformity in the rotation direction.

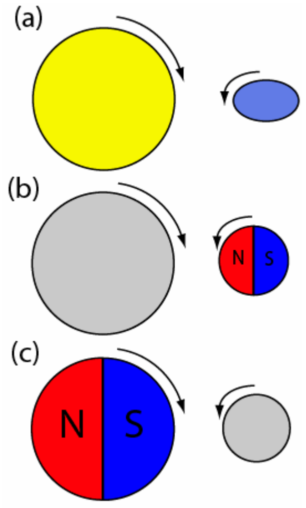

Figure 21 - There are three ways that a heavier body like a star can cause a retrograde rotation on a smaller object like a planet. (a) Tidal effect – The star is squeezing the planet and its atmosphere to apply a torque on it. (b) The star is a conductor while the planet produce magnetic filed that diverges from its rotation axis. (c) The star has a magnetic field that diverges from its rotation axis and the planet is conducting.

Rotation of the galaxy

Galaxies are born by other galaxies. Some of the globular clusters detach from the galaxy they are bound to and turn into separate galaxies. The energy cycle of the galaxy produce mass and energy that increase the mass and energy of the galaxy. The globular clusters absorb some of the mass and energy to get bigger and then to detach from the main galaxy. New galaxies are born from those globular clusters. Those new galaxies start with small mass and slowly during billions of years increase in size and mass. The angular momentum of the spiral galaxies is also increasing. The new born galaxies have small angular momentum while the older and more massive galaxies have larger angular momentum. Usually when an object angular momentum is increasing there should be a torque exerted on it from the outside. Such outside torque is not found for galaxies, there is no outside object that applies torque to increase the angular momentum of the spiral galaxies. As in the case of stellar rotation, the rotation of the galaxy is not given to it when it is born but is the result of forces during the life of the galaxy. The angular momentum of the galaxy is increasing from internal forces in contrast to the conservation of angular momentum. The galaxy does not conserve mass and energy - the mass and energy in the galaxy are increasing. The mass increase of the galaxy also increases its angular momentum.

Two factors increase the angular momentum of the galaxy. The first is the mass increase of the stars. As the stars absorb energy from magnetic fields and convert this energy to mass, the mass of the star increase. The angular momentum of the galaxy depends on the mass of the stars as in:

$$L_{Galaxy} = \sum_i m_i r_i^2 \omega_i$$

Where L is the angular momentum of the galaxy,

m_i is the Mass of a star in the galaxy,

r_i is the distance of the star form the galactic center and

ω_i is the angular speed of the star around the galaxy.

If many of the stars masses are increasing, the angular momentum of the galaxy is also increasing.

Some of the mass created by the stars is ejected as solar wind to the galactic disc and turn into gas and dust. The solar wind mass has on average the same angular speed as the star that created it around the galactic center. Some of the solar wind mass starts to drift towards the SMBH and in a long process falls to the SMBH. The solar wind mass has certain angular momentum and as it falls to the SMBH it conserve its angular momentum by increasing its angular speed. The increase in the angular speed of the gas and dust is absorbed in the galactic disc to apply torque on the galactic disc and to increase its angular speed. This is similar to the ice skater that spins on the ice and pulls his arms toward his body to spin faster. The arms are comparable to the solar wind and dust and the skater body is analogous to the galactic disc. The falling dust transfers its angular momentum to the galactic disc. While the dust angular momentum decrease the galactic angular momentum increase. The falling dust, as the ice skater arms, does not change the angular momentum of the galaxy but tend to increase the angular speed by decreasing the moment of inertia.

The second factor that increases the angular momentum of the galaxy is the accretion disc of the SMBH. As matter spiral into the black hole and approach the event horizon, the particles reach relativistic speeds. The mass of the particles increase and their angular momentum is also increasing. The increase of the angular momentum of the inner part of the accretion disc is transmitted to the outer parts of the accretion disc and to the galactic disc by magnetic fields.

If the spiral galaxies angular momentum is always increasing and there is nothing to stop them, their rotational speed would rise to a level that they would break up. The following factors limit the rotational speed of the galaxy to keep their integrity:

1. As the galaxy rotates faster, more dust is thrown to the intergalactic medium instead of falling to the SMBH. This lowers the energy production of the galaxy and thereby its rotation speed.
2. As the galaxy rotate faster, the stars get more distant from the SMBH and the galactic disc is getting thinner. As the galactic disc is getting thinner, the stars get less magnetic fields and eject less dust.
3. Nearby galaxies brake the rotation of the galaxy as magnetic fields from the rotating galaxy are crossing the nearby galaxies. The rotating galaxy induces currents in the nearby galaxies that according to Lenz's Law oppose the rotation of the magnetic fields and brake the galaxy.

The fact that nearby galaxies brake the rotation of the spiral galaxy also means according to Newton second law, that that the spiral galaxy apply force in the opposite direction that pushes away the nearby galaxies. This repulsion between the

galaxies, which emanate from the rotation of spiral galaxies, drives the expanding universe.
Therefore, we can enumerate four reasons that lead to the expanding universe:

1. The number of galaxies is rising as new galaxies are born.
2. The size, mass, and magnetic fields of existing galaxies are increasing.
3. The rotation of spiral galaxy repel nearby galaxies by magnetic drag.
4. Matter is easily created in the universe mainly in stars interior. However, there is no process that can easily destroy matter. Even in black holes, the falling matter is not destroyed and its mass is added to the mass of the black hole. In the rare occasions that particles like protons and neutrons are destroyed (for instance in particle accelerators), the process is so energetic that the total mass is increasing.

Spiral galaxies without nearby galaxies to brake them will rotate faster and will show thin and elongated galactic disc from edge on view. If there are too many galaxies around a spiral galaxy its rotation will slow down and its diameter will shrink. Lenticular galaxies are found only in cluster of galaxies; they are spiral galaxies that nearby galaxies brake their rotation and cause their edge on shape to be less elongated. Spiral galaxies need more space then elliptical galaxies and they also push away other galaxies. This can explain the fact that galaxy clusters show more elliptical galaxies than spiral galaxies. The elliptical galaxies do not push away other galaxies and by that, they keep the integrity of the galaxy cluster.

The fast rotation of the galactic disc tends to push outward material like gas and dust in the galactic disc, so this gas and dust must bypass the galactic disc in order to reach and fall to the SMBH. To bypass the galactic disc the gas must flow above and below the galactic disc. NASA Far Ultraviolet Spectroscopic Explorer (FUSE) satellite found that the galaxy has a hot gas circulating below and above the galactic disc, this idea known as the “Galactic Fountain” was first presented nearly 45 years ago by the astronomer Lyman Spitzer. The Galactic Fountain is the mechanism by which gas and dust from the galactic disc flow toward the SMBH and later fall to it to supply energy to the galaxy.

The Tully Fisher relation indicates a link between the galaxy luminosity and its rotation speed. It is incorrectly believed that the basis for this relation is the mass of the galaxy. In heavier galaxies there are more stars that produce more light and the rotation of the galaxy depends on the mass of the black matter in the galaxy halo. This is incorrect since there is no black matter, and the flat rotation curve is created by the changing magnetic fields in the galactic disc. The black matter associated with galaxy clusters is also due to magnetic forces between galaxies. Both the luminosity and rotation of the galaxy depends on the strength of the changing magnetic fields. Strong magnetic fields heat the stars to increase the luminosity in the galaxy and also rotate the galaxy faster as shown in Fig. 7 in Ref. 1.
Galaxies that have stronger luminosity and faster rotation are growing faster; the stars mass is increasing and new stars are born. This leads to the spawning of new galaxies.

Spawning of new galaxies is based on globular clusters

In reference 1, it was shown that galaxies spawn new galaxies using the arms of spiral galaxies. The magnetic fields in the galactic disc supply energy to stars, which get heated, and in their interior, they convert part of the energy to mass. The energy from the magnetic fields also triggers the birth of new stars especially in the galactic arms. It was suggested that the far edges of the galactic arms are getting heavier from the mass increase of the stars. Those arm edges then detach from the inner part of the arm to create new galaxy. However, this spawning mechanism is incorrect. The spawning of new galaxies is not based on the detachment of the galactic arm; if this process is at all possible, it is extremely rare. The spawning of new galaxies is accomplished by globular clusters. Globular clusters are found in large numbers in every galaxy. Spiral galaxies show globular clusters especially in the galactic halo. Elliptical galaxies show globular clusters in there outer edge. Figure 22 shows the giant elliptical galaxy M87 at the heart of the Virgo cluster. The picture shows many globular clusters at the outer edge of the galaxy. Some of those globular clusters will turn into dwarf galaxies and will depart from the main galaxy. The dwarf galaxies will increase in size and mass and will produce stronger magnetic fields that will repel the dwarf galaxy from the main galaxy M87. Of course, not all globular cluster will turn into galaxies, only those with preferred position and energy production will turn into galaxies. The giant galaxy M87 that lay at the heart of the Virgo cluster could be the ancestor of many of the galaxies in the Virgo cluster. The Milky Way that resides at the edge of the Virgo cluster and is considered to be part of it could also be a descendant of M87. There are much evidence of star groups that their size and position cannot clearly classify them as globular cluster or dwarf galaxies instead, they lay on the boundary between globular clusters and dwarf galaxies. Those star groups are an evolutionary link between globular galaxies and dwarf galaxies. They confirm that globular clusters are evolved first into dwarf galaxy and later into fully grown galaxies. Willman et al (2005) report on such star group found in the Milky Way that its properties place it between globular clusters and dwarf galaxies.

The globular clusters include a black hole at their center. At the early age of the globular cluster it has low mass and it is relatively close to the main galaxy. At this early stage, the globular cluster cannot supply its own energy consumption and it using the main galaxy to supply its energy. Dust and gas from the main galaxy is captured by the globular cluster black hole and by the dynamo effect is converted in the accretion disc to changing magnetic fields that heat the stars in the globular cluster. When the globular cluster is getting bigger, it can internally supply its energy demand. At this stage, there are a large number of stars that produce gas and dust that fall into the black hole where they are converted to magnetic fields. At the same time, the magnetic field of the globular cluster is getting stronger and this repels the globular cluster from the main galaxy. Globular clusters have intermediate mass black holes. Hubble telescope images show those black holes in the center of globular clusters M15 and G1. The evolution of Globular clusters to elliptical galaxies is a natural process since both of them have the same shape, but to evolve into full size spiral galaxies globular clusters must first transform to dwarf irregular galaxies. Gravitational pull from nearby galaxy may distort the structure of the dwarf galaxy turn it into irregular galaxy and then to spiral galaxy. The Magellanic Clouds are irregular dwarf galaxies that may turn into spiral galaxies. There are about 200 dwarf galaxies in the Local Group most of them born from galaxies in the Virgo cluster.

The mass of black hole at the center of galaxies and globular cluster indicate the age of the galaxy or the globular cluster. The black hole accretes material during the life of the galaxy. Longer living galaxies capture more material by the black hole to increase its mass.

The birth of new galaxies is not happening one galaxy at a time but many globular clusters are supported at the same time to spawn new galaxies. The number of globular clusters in a galaxy depends on the mass of the galaxy; heavier galaxies have more globular clusters. For instance, the Milky Way has about 150 globular clusters, the Andromeda galaxy has 500 and M87 about 10,000. This suggests that the mass and size of the galaxy determine the rate at which it creates new galaxies. Giant galaxies spawn new galaxies faster.

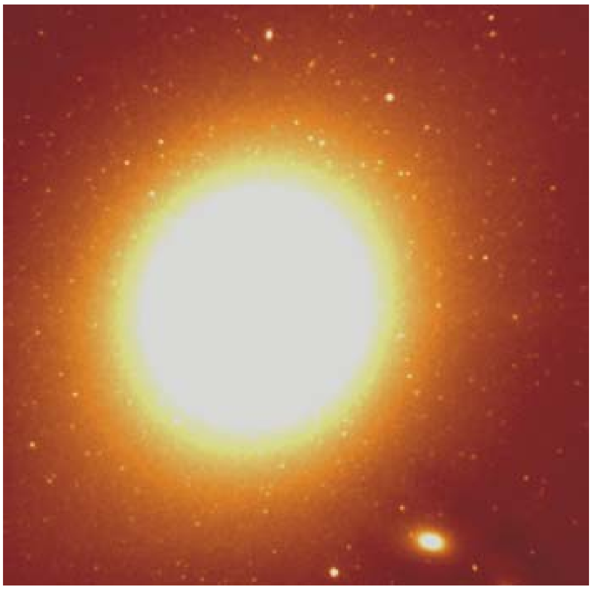

Figure 22 - This is an image of M87 a giant elliptical galaxy in the Virgo Cluster. Many of the point sources around the galaxy are globular clusters. Some of those globular clusters will evolve into new galaxies and will distance from the main galaxy M87 by magnetic repulsion. Many of the Virgo Cluster galaxies are descendent of M87. It is very likely that the Milky Way galaxy, a member of the Virgo cluster, is also a descendent of M87.

Conclusion

Changing magnetic fields are spread by the SMBH in the galactic disc. Those magnetic fields affect many aspects of the galaxy including its shape and development.
The magnetic fields supply energy to the stars and influence the stars in many ways: they heat the stars, they drive the stellar rotation, they increase the star mass; and they increase the speed of the star around the galactic center to give the flat rotation curve of the galaxy.
The stars start their life as a red dwarfs with low mass and low angular speed, as the stars get older they evolve along the main sequence and gain mass and angular speed

from the changing magnetic fields. Both high mass and fast stellar rotation are attributes of older stars. The changing magnetic fields that drive the solar cycle are not limited only to stars but interact also with planets. Jupiter has a stellar cycle that drives its jet streams and its spots, which are electrical in nature.
The solar cycle drive plasma belts around the sun. Those plasma belts are electrically charged, and they create electric vortexes in the form of sunspots. The plasma belts create the solar rotation as the middle plasma belt is pushed forward by the solar cycle. The middle plasma belt also creates the differential rotation as it pushes forward the equatorial region of the sun.

References

1. Bar-Zohar, D. (2006). The sun energy source is not nuclear fusion, but magnetic fields from the center of the Galaxy. The sun converts energy to mass and not mass to energy. PHILICA.COM Article number 65. http://www.philica.com/display_article.php?article_id=65
2. Bar-Zohar, D. (2008). The sun produces muon neutrinos flux without neutrino oscillations. PHILICA.COM Article number 126. http://www.philica.com/display_article.php?article_id=126
3. S. L. Baliunas et al Chromospheric variations in main-sequence stars II, 1995, ApJ, 438, 269B,.
4. The Giant Planet Jupiter, J. H. Rogers, Cambridge University Press 1995.
5. Donahue, R. A. and Baliunas, S. L. 1992a, Sol. Phys., 141, 181.
6. Hartmann, L., Bopp, B. W., Dussault, M., Noah, P. V., & Klimke, A. 1981, ApJ, 249, 662.
7. Stellar Rotation, J. Tassoul, Cambridge Univerity Press 2000.
8. Solar and Stellar Magnetic Activity, C. J. Schrijver C. Zwaan, Cambridge Univerity Press 2000.
9. Jupiter and How to Observe It, John W. McAnally, Springer 2008.
10. The Story of the Solar System, G. Chambers, McCluer 1895. Page 118.
11. Godoli G., Mazzucconi F., Piergianni I., Sunspot rotation rates along the butterfly diagram, Solar physics, 1993, vol. 148, n2, pp. 195-200.
12. Hartmann, L., Dussault, M., Noah, P. V., Klimke, A., & Bopp, B. W., Evidence for a starspot cycle on BD +26 deg 730, Astrophysical Journal, Part 1, vol. 249, Oct. 15, 1981, p. 662-665.
13. Joint Evolution of Black Holes and Galaxies (Chapter 1.7), M. Colpi, et al., Taylor and Francis, 2006.
14. Willman B. et al 2005 http://arxiv.org/abs/astro-ph/0410416v2 .

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