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The Sunspots Mechanism

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ABSTRACT

Sunspots are produced in the transitional zone of tachocline between the radiative and convection zone, at a suitable internal low magnetic lines of force (***LMLF***), with abundance electrons and protons, the production is carried out by slow process of both electrons and protons captured by the ***LMLF***, produced sunspots two pillars are later ejected to move to the adjacent photosphere solar latitude, then poleward.

1- INTRODUCTION

As a source of energy, the Sun continuously provide inhabit environment to our planet Earth. As an enormous enclosed sphere radiating spectrum of different wavelength, it fulfilled the basic requirements of providing different present species with survival needs, for that reason, early human beings created myths around the sun [1].

The Sun radiates electromagnetic radiations of different wavelength; it also exhibited phenomena such as the Prominence, Flares, corona mass ejection (***CME***), Solar wind, and the Sunspots [2]. These phenomena as they plays great roles, other roles start emerging, while other factors may be disclosed in future, now it is known that, all these phenomena relates to the Sunspots [3], which in turn represents part of the Sun's strong and complex magnetic field [4].

The Sunspots production and relation to other phenomena generates many debates and speculations [5], a good example is the Babcock Model [6] which explained the phenomenon within available related knowledge, with lack of alternative theory, and the model adds complexity to Sunspot mechanism and related phenomena. Solar activities resulted from the interaction of ionized solar plasma with the magnetic field produced by these plasma [7], thus it is interlock relation created by the plasma.

The basic knowledge of the solar system mechanism is crucial and essential for the survival of human kind, and we can't properly understand other stars and life elsewhere if we failed to understand mechanism that regulates our sun.

As an energy generator, the Sun engulfed with related knowledge in a mystic phenomena, which required different tools to help penetrate deep beneath the Sunspots.

Since the Universal energies (***UE***) [8] was published in 2003, three important satellites [9] were launched to study the Sun, the astonishing footages by NASA's Solar Dynamics Observatory (***SDO***) [10] and others, showed the dynamics of energy process in Sun's peripheries, these outstanding wealth of knowledge, as it generate questions, which will never reflects positively on human progress if never get proper answers and foundation to built upon.

A new analysis lead to conclusion that Pioneer V had failed to detected embedded solar magnetic field when first engulfed with solar plasma on Mach 30, 1960 [11], while high interplanetary magnetic field was measured five hours later by Pioneer V, after first been measured by Honolulu station, all of which suggested that an Interplanetary-External Magnetic Field (***I-ExMF***) is produced within the magnetosheath and other spatial areas within the interplanetary space [11], these finding shows an independent mechanism for local production of ***I-ExMF***, which is not related to the fields from the sun [12].

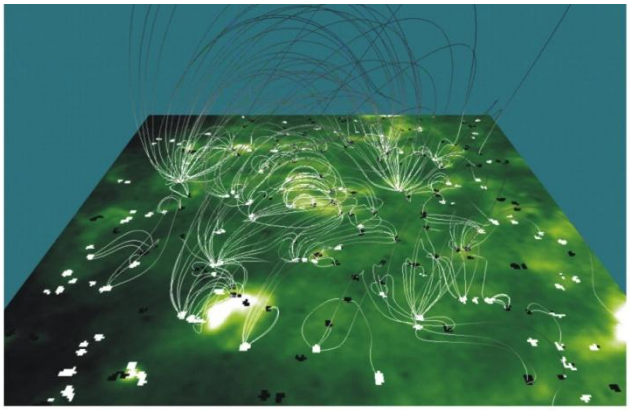

Fig.1. Model of Sun magnetic fields image developed from several instruments data in SOHO. It showed each magnetic field unit as separate entity [30].

This paper is aimed to help answer questions related to sunspots production and others questions, based on the new fundamental physics as introduced by The Magnetic Interaction Hypothesis (***MIH***) [13] and The Spinning Magnetic Force (***SMF***) [14] that leads to a process for production of external magnetic field (***ExMF***) which is shown in my Universal Energies (***UE***) document [8], it was further enhanced by the introduction of the Elements of Magnetic Lines of Force (***EMLF***) [15], these has led to an entirely new hypothesis for energy transformation.

Although sunspots complexity was deepened by the difference between what is seen on solar photosphere and the long internal mechanism producing the phenomenon, the difference between both could take a period of months as for the reversal fields [16] or years as for the sunspots, but sunspots knowledge has been approached differently by the suggestion that what lay beneath the

sunspots is a pillar shape structured from the plasma [17]. The important aspects of this paper, is that it laid the bases upon which solar activities and ***ExMF*** could better be understood.

2- Structure of the Dynamic Spinning Sun

The Sun is composed mainly of plasma (electrons and protons), hydrogen, helium and other elements [2], it is thought to consist of the core, radiative, tachocline and convection zones [18], most of internal structures and mechanisms was interfered from characteristics exhibited by the Sun, and recently advanced methods of Helioseismology enabled investigation of internal structures and dynamics of the Sun [19]. Solar main known characteristic was the Sunspots, which is explained as resulted from twisting magnetic lines and the Dynamo process [18], there is no comprehensive dynamo theory **[20].**

Since Sunspots as part of solar activities, emerged or tend to formed between latitudes $\pm 40^{o}$ degrees north and south of the solar hemispheres, while the last appear at $\pm 8^{o}$ of the equator [7], this formations gives butterfly shape [21], and the sunspots' fields are decay sinking [2], these either shows the Sunspot may have a different system of spinning or movement or it emerged from a spinning gaseous body of different spinning.

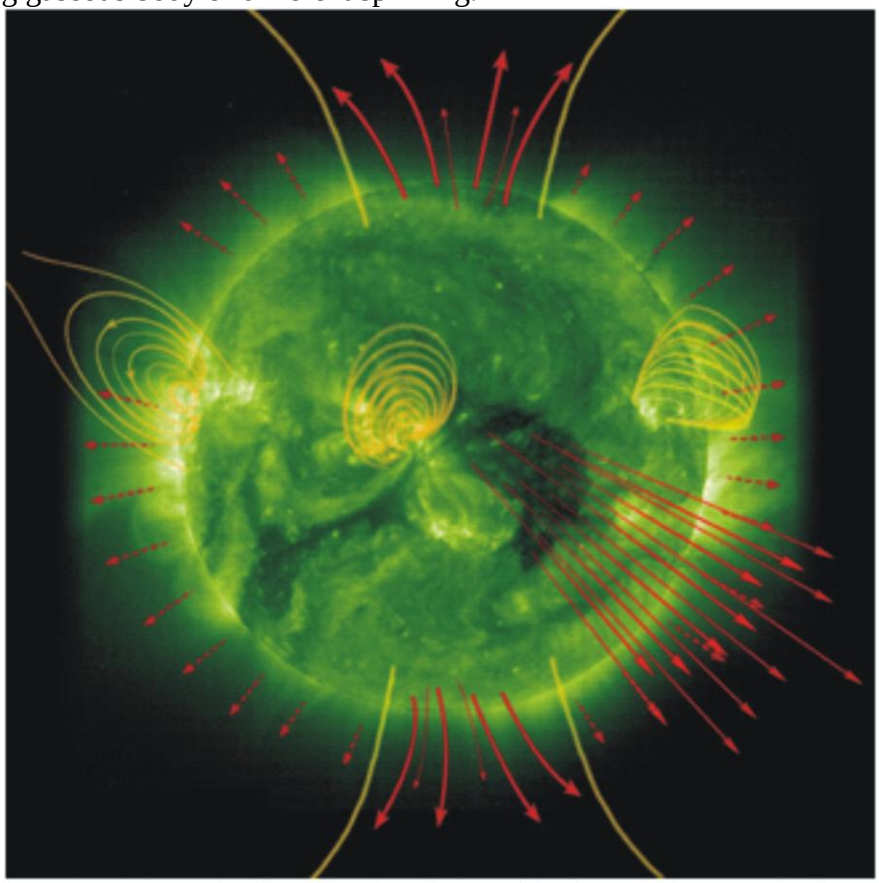

Fig.2. Open (yellow lines) and closed (red arrows) magnetic lines of force, protrude the Sun [33].

The manner in which recent solar phenomena, exhibited by satellites, in photos and movies, showed solar flares and corona mass ejection (CME) [22] in a continual process, suggested a different structure of the Sun and a different mechanism for solar phenomena.

The consistent different images of Solar Magnetograms [23, 24] shows magnetic fields protruding all over the sun [25], it showed the complex internal structure of the sun consisting of negative and positive polarities protruding from inside [26], it leads to different postulations and computers and images of the Sun [27, 28, 29, 30], as shown in Fig.1.

Ulysses satellite established that, field lines near the solar equator are not closed loops [31], and the amount of outward magnetic flux in the solar wind did not vary greatly with latitude, [32] which means most of solar magnetic lines of force are opened, these opened fields are significant feature of the sun, as shown by red arrow in Fig.2 [33].

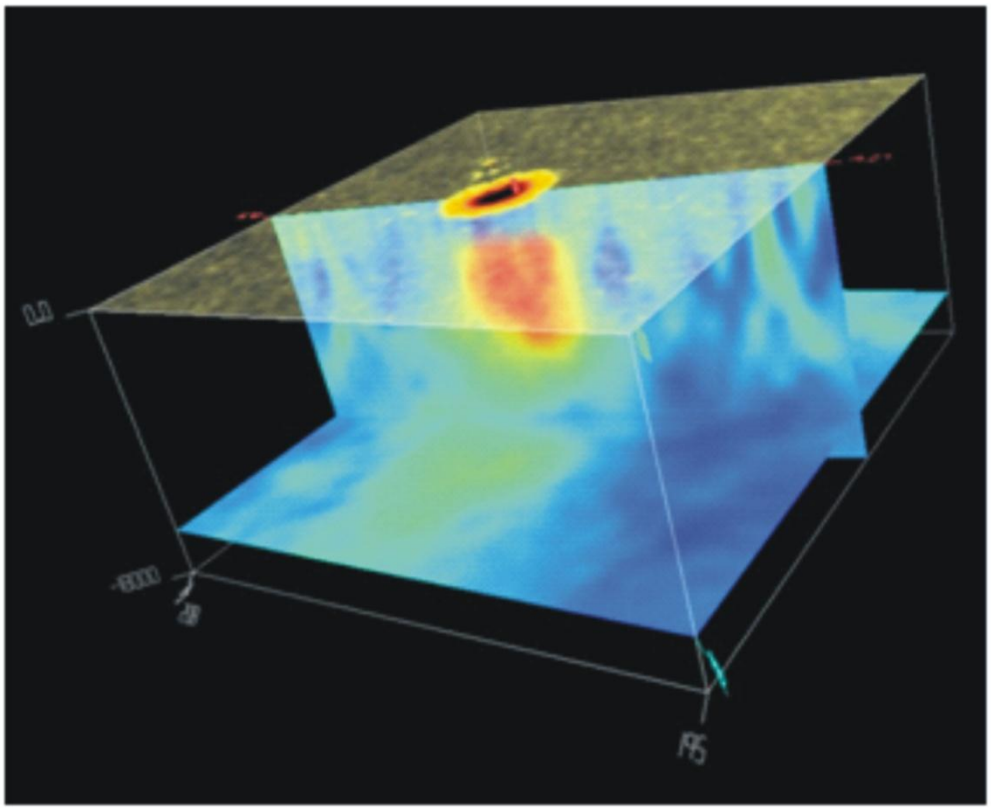

Fig.3. The three dimensions of sunspot surface and subsurface structures, both the umbra and penumbra are at the surface. The figure clearly shows sunspot as a pillar with depth to several kilometers [38].

Linked with Sun's structure, and a transitional layer of tachocline between radiative and convection zones [19], where sunspots are generated [18], and proved to have flows of gas at the tachocline at depth of about 225,000 km [19], the Tachocline thickness range from 0.016 R- at equator to 0.039 R at 60 latitudes [34] where the speed of the gas changes abruptly [**35**], and this

was depicted in a movie [36], attention will be focused on this layer of the tachocline, where sunspots are produced.

3- Sunspots Building and Movement

Sunspots are confined to equatorial belt between ±35 degrees south and north latitudes [21]. At the beginning of a new solar cycle, sunspots tend to form at high latitudes, but as the cycle reaches a maximum (large numbers of sunspots) the spots form at lower latitudes, near the minimum of the cycle, sunspots appear even closer to the equator at maximum of the cycle, and as a new cycle starts it moved back to higher latitudes, this regular variation shows the nature of sunspots [25], based on butterfly patterns [21], meanwhile sunspots have movements in horizontal direction called Evershed effect [37].

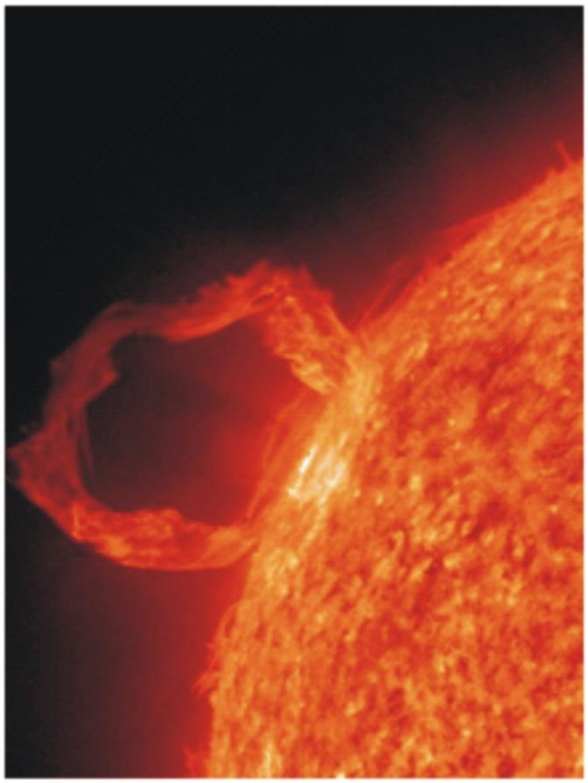

Fig.4. The famous prominence eruption movie of March 2010, captured by NASA's Solar Dynamics Observatory (SDO). The momentarily upper toroidal magnetic field attracted by the lower intense sunspot [43]

SOHO solar satellite draw image of the subsurface structure bellow the sunspot shown in Fig.3, the three dimension figure clearly shows the sunspot with downward extension similar to cylindrical body [38], relating this to 1998 tornadoes of Giant spinning clouds of gas first found on the Sun by the SOHO spacecraft [39, 40], and an images like a tornado does on Earth, from NASA's STEREO satellite taken on April 9, 2008 [41] of Solar Tornado [42]

Also the first images from NASA's Solar Dynamics Observatory (SDO), April 21, 2010, taken on the sunspot structure on sun's surface shows a twist like Tornado [43] Fig.4, this twist

movement, also occur in solar jets, which produce tornado-like events close to the sun's poles [44] shown in Fig.5.

As present results are difficult to be accommodating within such theory as the Babcock Model [6], a different theory model developed for solar activities based on the Magnetic Interaction [13] and related paper of the Universal Energies [8] is proposed.

4- Sunspots: the pillars Formations

The solar internal mechanism produce low magnetic lines of force (***LMLF***) at the core as sown in **Fig.2 [33]**, which rotates with both the internal and external bodies, as shown in Fig.5 and Fig.6, while the tachocline inner space is thought to contain large amount of highly concentrated charged particles, the rotating ***LMLF*** interacts with electrons and protons in the plasma space, the particles attracted towards the rotating ***LMLF*** [13, 14], the capturing process is given by Eq. {1}.

$$C_{Cp} = B_{s1} B_{p(e)} r_m^2 \, c \, v_B \, \vartheta \, t_{SSF} \qquad \{1\}$$

Where, $\boldsymbol{B_{S1}}$ is single solar magnetic line of force, $\boldsymbol{B_{p(e)}}$ proton or electron circular magnetic field (***CMF***) [13], $\boldsymbol{r_m^{\,2}}$ is charged particle magnetic radius, c is the speed of light, $\boldsymbol{v_B}$ is the ***LMLF*** velocity, ϑ is a factor that will be known with time, $\boldsymbol{t_{SSF}}$ is the period started at the interaction time, and $\boldsymbol{C_{CP}}$ is the capturing process.

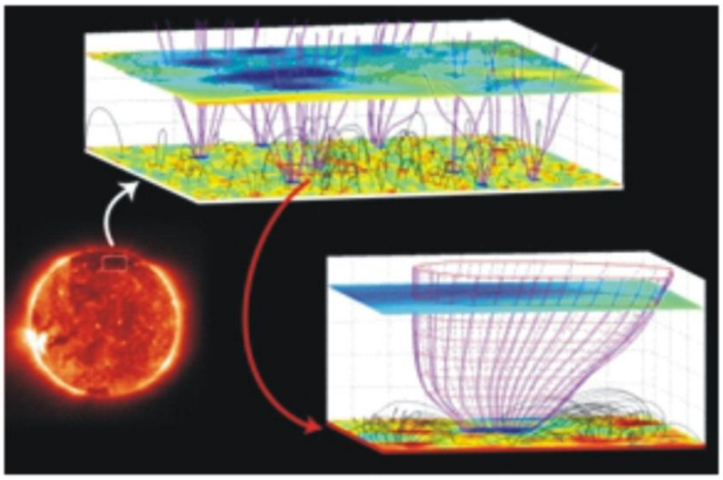

Fig. 5. The location and geometry of three-dimension magnetic field structures in the solar atmosphere [44]. Each unit of vertical magnetic lines of force clearly related and similar to the sunspot three dimensions shown in Fig.3.

Electrons gyrate at smaller radius, while proton gyrates at larger radius [13], the process leads to slow formation of pillars of two layers of rotating charged particles by each magnetic lines of force, as shown in Fig.6.

The magnet interaction of circular magnetic field (CMF) [13], produced external magnetic field (***ExMF***) [14] as showed for three orbits of protons in Fig.7, with the produced field shape shown

in Fig.8, where gyrate protons around ***LMLF*** increased in numbers with time and ***ExMF*** intensity, the same with electrons.

The intense produced ***ExMF*** given by Eq.2, decrease the radius of gyration for all electrons and protons, and reduced distances between two adjacent electrons and protons [8].

$$\boldsymbol{B_{SEI}} = \left(\gamma_{PS}\left(B_{1\rightarrow n} + \frac{(n_m) l q^3 B_{1\rightarrow 1}^2}{m^2\, v_c\, c}\right)\right) \quad \{2\}$$

Where, $B_1 \rightarrow n$ is the previous magnetic field (starting with original field $\boldsymbol{B_1}$) in Tesla, c is speed of light in $m.s^{-1}$, ***l*** is the effective length of the magnetic lines of force (along which charged particles gyrates) in meters, q is the elementary charge in Coulomb, n_m is the number of charged particles along one meter length, m is the mass of charged particles in kg, v_c is velocity of captured charged particle in $m.s^{-1}$, γ_{ps} is the relative magnitudes of the primary and secondary ***ExMF*** in the final production of solar ***ExMF*** [45], and the produced $\boldsymbol{B_{SEI}}$ is in Tesla.

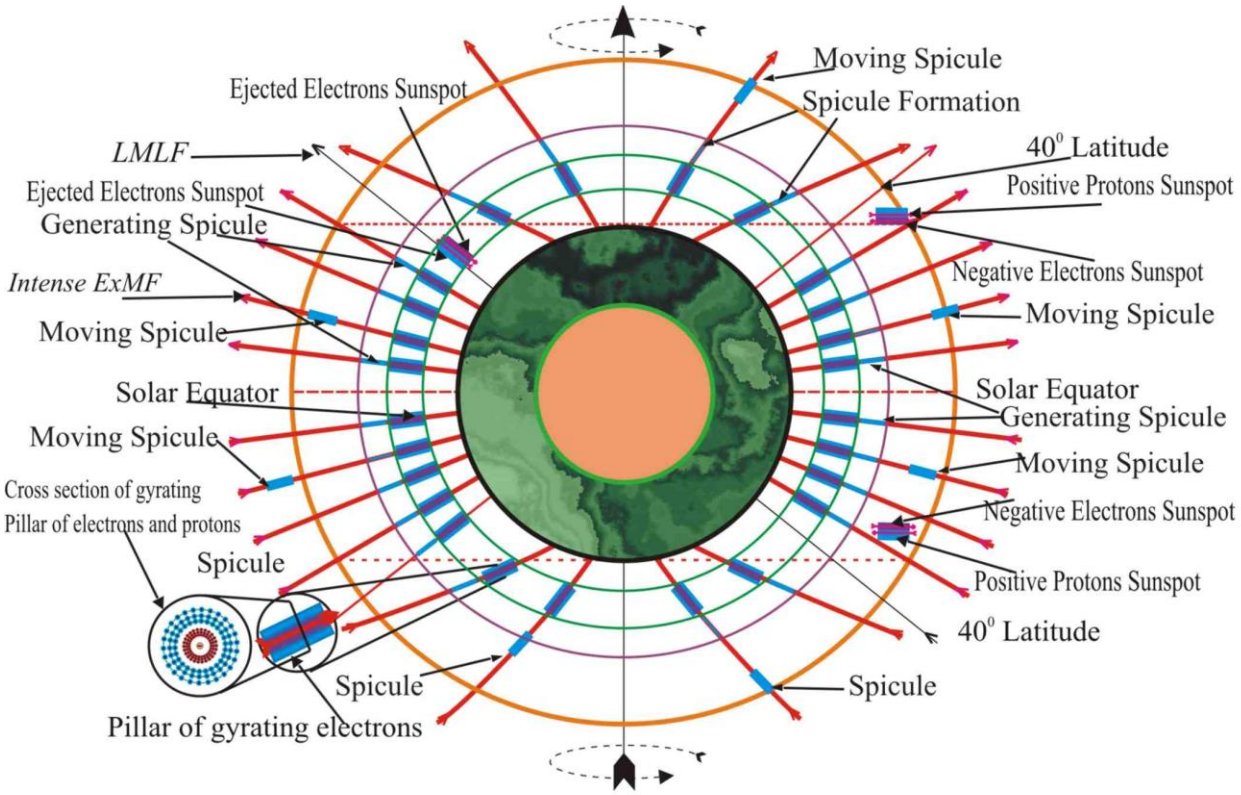

Fig.6. Cross-Section along the two solar sphere, it shows the rotating Low Magnetic Lines of Force (***LMLF***), the building up protons (Blue) and electrons (Pink) and producing External Magnetic Fields (***ExMF***), spicules mechanism are also shown.

Thick pillars of both electrons and protons formed at tachocline zone, producing intense ***ExMF*** [8, 45], the produced ***ExMF*** increased the energization of both electrons and protons [8, 13, 45], given by

$$K = B_{SEI} B_2 r_m^2 \, c \, d_K \sin\theta = q \, v_c B_{SEI} d_K \, sin\theta \quad Joules \quad \{3\}$$

Where, $\boldsymbol{B_{SEI}}$ is the rotating magnetic field, which is the sunspot fields in Tesla, B_2 is the circular magnetic field of charged particle (***CMF***) in Tesla, $\boldsymbol{r_m}$ is the magnetic radius of ***CMF*** in meter, θ is the angle between the two fields $\boldsymbol{B_{SEI}}$ and B_2 (***CMF***) at interaction moment, $\boldsymbol{d_K}$ ($\boldsymbol{d_X} = \boldsymbol{d_Y} + \boldsymbol{d_Z}$) is three dimension distance traveled by the magnetic line of force in meters.

The change of energy K_i subjected to by electrons and protons at the transitional layer of tachocline [19] is given by:

$$K = q \, v_c \, d_K \, c \left(\gamma_{PS} \left(B_{1\to n} + \frac{(n_m) l q^3 B_{1\to 1}^2}{m^2 \, v_c \, c} \right) \right) \sin\theta \quad Joules \quad \{4\}$$

Where, the kinetic energy K is in Joules.

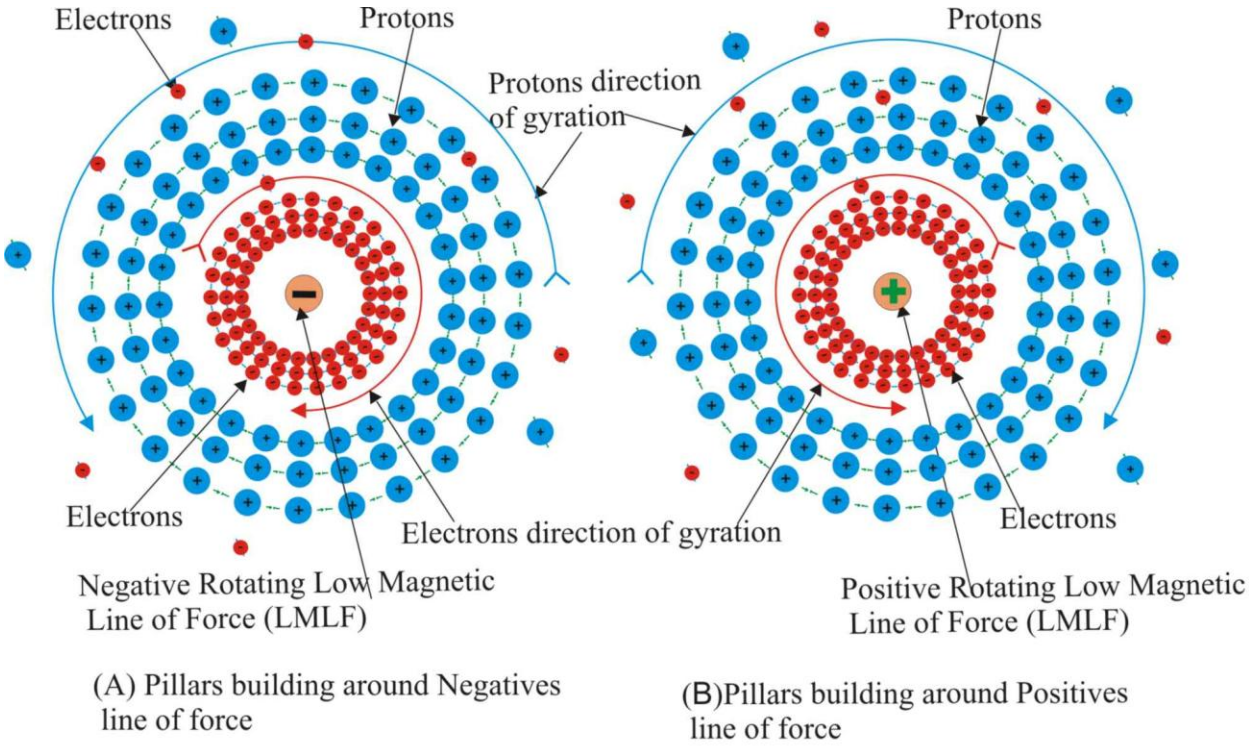

Fig.7. Electrons and Protons gyrating around positive Low Magnetic Line of Force (***LMLF***) in (A) and negative (***LMLF***) in (B), producing circular magnetic fields (CMF) shown in Fig.8. Sunspots Pillars in Fig.9, is built from such structure.

But as the ***ExMF*** increased, this reflects on the final energization process, which is given by:

$$K_{TS} = K_1 + K_2 + K_3 + \ldots\ldots K_n \varepsilon \quad Joules \quad \{5\}$$

Where, K_1, K_2 …… K_n are energization executed at each stage, $\varepsilon = \varepsilon_i$ where ε_i is the error of continuity approximation at step i, and the total approximate energy radiated to the corona system K_{TS} is in Joules.

5- Pillars Ejection Process

Pillars building process shown in Fig.6, continued for around 1.5 years [46], till a saturation point is reached, where orbits of inner electrons of the internal gyrating pillars shown in Fig.6, reached state of electrons fusion, where the whole internal electrons layers in the pillar fused, then ejected from the ***LMLF*** [8, 45]. While in anti-clockwise rotation, fused electrons pillar is ejected, penetrating surrounding gyrating protons. This action ejects the clockwise gyrating protons pillars from the ***LMLF***, as shown in Fig.6.

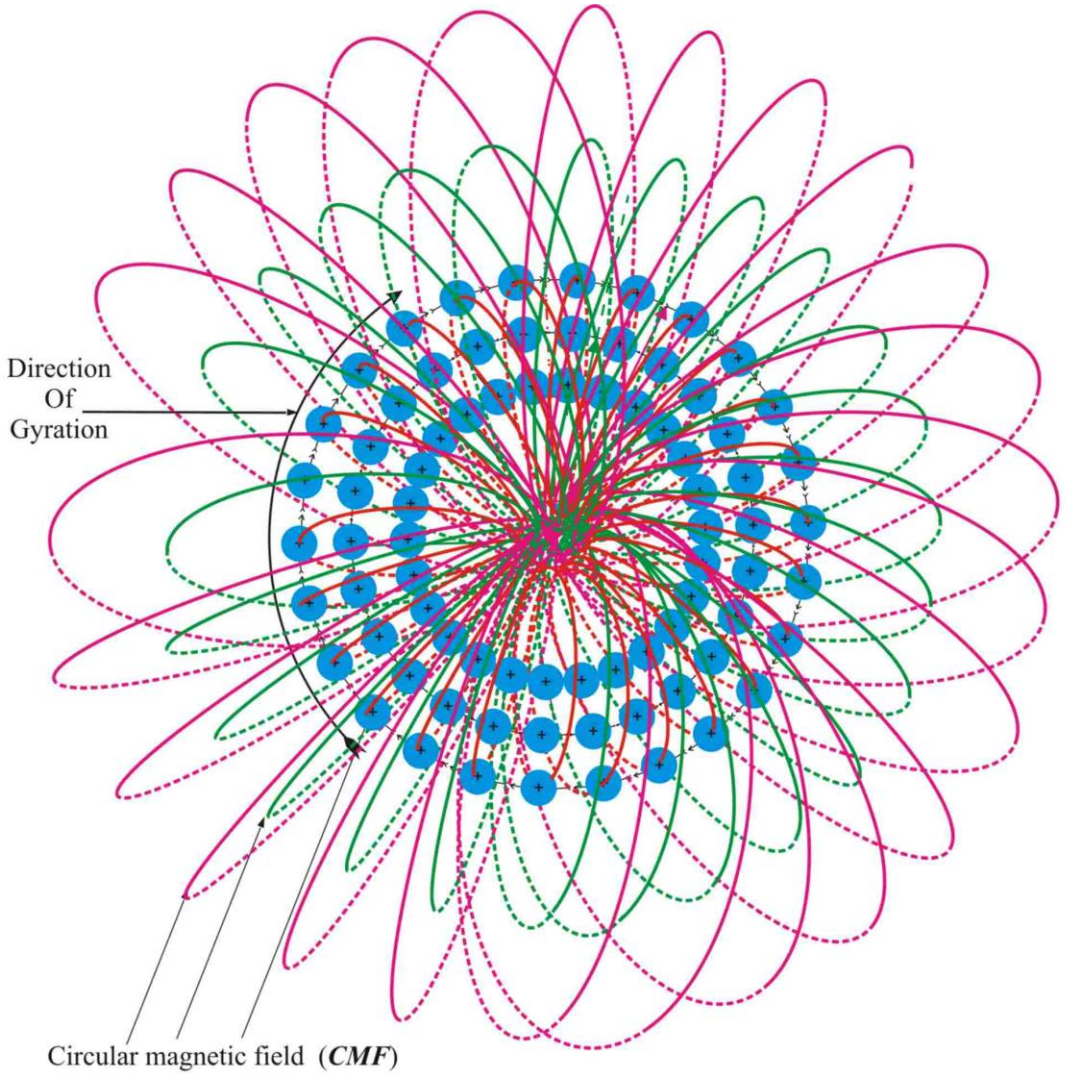

Fig.8. Sunspot magnetic field originated from Circular magnetic field (***CMF***), produced by protons or electrons; these are combined to form the External magnetic field (***ExMF***) [8], shown in Fig.9.

Ejected electrons and protons pillars, keeps rotating and producing intense ***ExMF*** while moving like two hurricanes, preceded by the larger protons pillar of intense ***ExMF*** when northern pole having positive magnetic fields and followed by the smaller negative electrons pillar of low ***ExMF***, this process is reversed in the opposite solar hemisphere. The movement is related to ***LMLF*** that ejected the sunspot. The proton pillar is shown in Fig.9.

6- *Sunspots Movements*

As both pillars moved towards the photosphere, it gains more charged particles, the momentum, and velocity increased, thus the ***ExMF*** intensity. As it is known the positive or preceding (protons) sunspot is larger with magnetic flux three times that of the negative or following (electrons) [2].

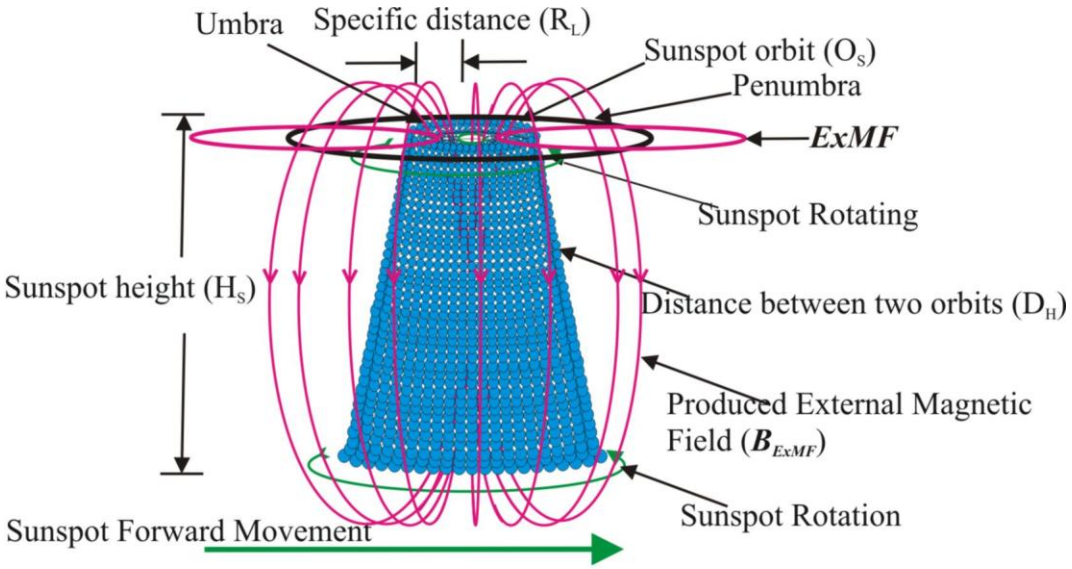

Fig.9. Single sunspot composed of protons, showing some parameters. The penumbra is formed by granules at photosphere.

As shown in Fig.6, since higher latitudes pillars were first to be formed, they are the first to be saturates hence ejected, followed by pillars of lower latitudes, until the last and final pillars near the equator are ejected during the magnetic reversal [46], and since these pillars are produced from a system the equator of which is corresponding the photosphere equator, therefore any pillar moving from the ***LMLF*** will emerged at corresponding latitudes on the solar surface, thus higher latitudes sunspots indicates starts of solar cycle [46].

The solar cycle is thought to be given by [46]

$$S_{CP} = \frac{t_{SSF} + 2\,(t_s + t_p)}{31{,}536{,}000} \quad years \quad \{6\}$$

Where, the t_{SSF} is the sunspots formation around the ***LMLF*** in seconds (mentioned in Eq.{1}), t_s is the drift periods towards the surface in seconds, t_p is poleward drift period In seconds, and the solar cycle periods S_{CP} in years [46].

Since charged particles in the sun are energized to high levels [47], and it is detected by TRACE with material upward movement from below to above the photosphere [48], therefore, such continual energization process in sunspots given by Eq.{5} are dissipated through the coronal zone.

Emerging from the photosphere, Sunspots ***ExMF*** becomes intense, the gyrating two pillars constantly attracted each other along the way and above the photosphere as a black magnetic lines of force or the umbra, surrounding by solar granules or the penumbra [49]

Since Ulysses satellite established that, field lines near the solar equator were not closed loops [31], therefore ***LMLF*** are closed at the equator, hence electrons and protons can't interacts in the same manner, thus sunspots pillars are not produced at or nearer the equator.

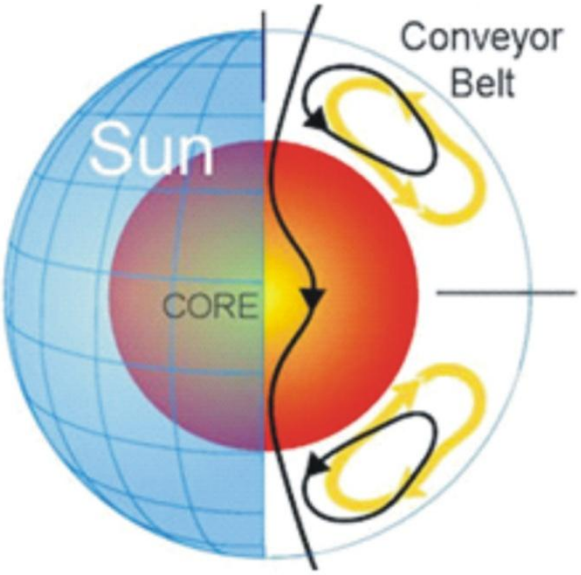

Fig.10. The conveyor belt, where sunspots are moving northwards and Southwards from the equator, after a brief appearance on the photosphere surface [50].

As detected by SOHO [50] and shown in Fig.10, convey belt represents part of the Sunspots movement, where they moved from photosphere surface towards the poles, therefore from this, the general mechanism for Sunspots movements is shown in Fig.11, in which Sunspots are produced around the Sunspot-Belt in the transitional solar tachocline zone shown with the pink circle. When saturated both electrons (negative) and protons (positive) pillars disintegrated (Fig.6), and moves towards the solar photosphere surface shown in Fig.11 with Blue-Arrows, at surface it drifted into sideline movement, shown by Brown-Arrow to the conveyor-Belt and to both northern and southern poles from each respective hemisphere.

During each solar flare, most of sunspot disintegrates after the explosions into energized primary charged particles with ions [53], therefore nearer the two poles and after the big flares [54] solar cycle periods (S_{CP}) started once again [46].

7- The Hurricanes Pillars

The sunspots pillars, with hurricanes movements are known from specific characteristics, and computer stimulated model, the wider is the positive pillar, its magnetic field is intensive, and vertical, interaction with surrounding granules materials gives the penumbra with related horizontal field, while the negative pillars composed of electrons with less diameter and intensity [51], the shapes and types of ***ExMF*** produced by these sunspots hurricanes and shown by TRACE satellite [52], gives a complex magnetic field that could be computerized simulated, based on present theoretical perspectives.

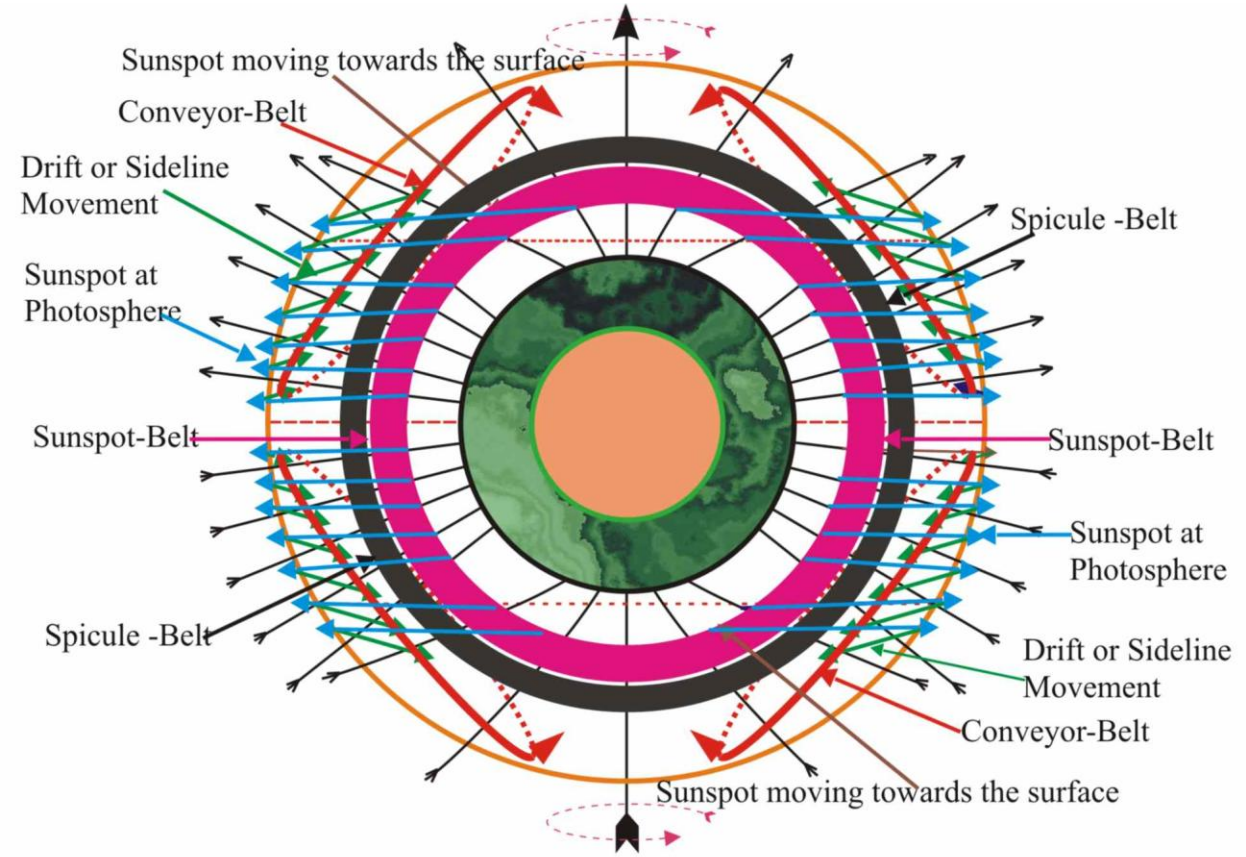

Fig.11. The general mechanism of sunspots production and movements. Produced around Sunspot-Belt, when saturated both disintegrated and moves towards Sun's surface at end of Brown-Arrow, from surface it goes into sideline movement with Red-Arrow to the conveyor-Belt [50], then to both poles.

The sunspot shown in Fig.9, contained charged particles gyrating in an orbit as shown in Fig.7, it radiates electromagnetic radiations of several wavelength [8], this may explain the source of radio noise storms [7] as caused by the Solar Flares or the External Nuclear Fusion [53].

8- ACKNOWLEDGEMENT

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