Xournals

Academic Journal of Modern Applied Sciences

ISSN UA | Volume 01 | Issue 01 | January-2019

Sunspot Cycle-Window to Our Galaxy's Past and Future

Anushka Patil[1]

Available online at: www.xournals.com

Received 14th September 2018 | Revised 8th October 2018 | Accepted 18th December 2018

Abstract:

The succession of day and night and the cycle of seasons are two acquainted natural cycles around which many human happenings are planned. But there is a third natural cycle also which is of great importance for humans. There was an event took place on 13 March 1989 where the electricity went out for many hours in Canada: a large detonation on the sun was exposed as the reason for this shutdown. In further researches, it was cleared the mystery that explosions occur above sunspots which is actually dark structures on the surface of the Sun that have been detected through telescopes since the period of Galileo. The first ever record that is found to be in written about sunspot sighting dates back to 28 B.C There's fascinating science behind the sunspot cycle. Astronomer S.H. Schwabe is regarded as the first scientist who describes the 11-year sunspot cycle. The sum of sunspots has been found to undergo alternate increases and decreases over a period of 11 years. This cycle was exposed less than two centuries ago, it is becoming progressively significant for us as human civilization becomes more reliant on technology. For nearly a century after its discovery, the root of the sunspot cycle stayed completely masked in unidentified situation. In 1908 strong magnetic fields were discovered which made that the 11-year cycle is actually the magnetic cycle of the sun. It is only throughout the last few eras that major growths in plasma physics have at last given us the linking evidence to the backgrounds of the cycle and also about how the large explosion is affecting the earth.

Keywords: *Sunspot Cycle, Earth, Temperature, Magnetic Field, Changes.*

Authors:

1. *Tata Institute of Fundamental Research, Mumbai, Maharashtra, INDIA.*

Introduction

Sunspots

A dark spot on the surface of the sun having the planet size is called sunspot. This dark spot is cooler the left part of sun (surrounding area of sun). The temperature of this sunspot is about 4,000 K which is very lower than the bright photosphere's temperature i.e., 5,800 K of the sun and the area of environs the sunspots.

This sunspot is darker than the sunny side of sun. If this sunspot size is cut off from the sun and placed in sky at night, it will shine as full moon. There are two side of sunspot; one is lighter periphery known as penumbra, and another one is darker middle region is known as umbra.

The production of sunspot is the bursting of magnetic field on the photosphere (visible part of the sun). Because of the powerful magnetic field, the active region on sun is generated. Through this magnetic field, solar flares and Coronal Mass Ejections (CMEs) are formed and entitled as solar storms.

The duration of the formation of sunspots is days to weeks or may exceed to months. The visible region of sunspot ion the brighter part of sun is not always same, it is up and down in cycle. According to the historical records of sunspot confirmed that the duration of this sunspot cycle is about eleven years.

Sunspot Cycle

The deviation is seen between the sunspot's sums year to year. This increase and decrease in the count of a sunspot is a cycle. The life span of the sunspot is about only 11 years. The cycle was observed in 1843 by German astronomer Samuel Heinrich Schwabe. The Solar Maximum (solar max) is the peak of the sunspot count. While it is the sunspot minimum (solar min) in which few sunspots are seen. An example of a current sunspot cycle spans is from 1986 when only 13 sunspots were appeared to 1989 when the spot reached up to 157 sunspots and again the sunspot decrease in 1996. The duration of the sunspot cycle is around 11 years but this cycle fluctuates. In the duration from 1700 to present, the sunspot cycle has been varied as short length is nine years to long as fourteen years.

To determine the sunspots on the sun is very difficult task. Some spots are larger than the others, mopst of the spots appear in the bulk but some sunspots cross relaxed at their boundaries. In 1848, the finest way was determined for tallying the sunspots count by a Swiss astronomer named Rudolf Wolf. The Wolf formula is used to count the sunspot, now recognized as the Wolf sunspot number. The earlier astronomers' data was used by Wolf to reconstruct sunspot counts as far back as the 1755-1766 cycle, called "cycle 1". Then, the total of the successive cycles were done and in 1996, the solar minimum is cycle 23. At the time of hight count of sunspot, the Sun is usually very energetic and active. The demonstration of the sunspots is as the magnetic field of sun is twisted up to ground for the production of coronal mass ejections and solar flares. In solar max, the radiation through sun is more and the produced extra energy alters the upmost layers of Earth's atmosphere extensively.

Size of Sunspots

Sunspots are considered as very big structures. The impact of these sunspots are less as compared to the sun but remember the diameter of the Sun is 1.4 million km (870 thousand miles).

Most sunspots might gulp a planet! Many sunspots are large in size than the Earth! The range of the sunspots size is from 1,500 km (932 miles) to 50,000 km (31,068 miles) in diameter. The large sunspots have the size equal to the planet Jupiter, shown on the surface of sun.

Sunspots and its Magnetic Fields

As we know the sunspot is generated from the sun's magnetic field. The process of the sunspot formation is very complex as the magnetic ropes breaking through the brighter surface (photosphere) of the sun, where the rope of magnetic field comes up from the surface of solar result in the formation of one sunspot while other sunspots are formed by the falling of ropes into photosphere. Scientists stated that the sun revolves in different ways due to which magnetic ropes are generated. The exchange of the gaseous sphere of the Sun is done at high rate at its equator rather than its poles due to which the whole magnetic field of sun becomes distorted and twisted over time. The twisted field lines come through the photosphere at the end of the day and shows as the sunspots. When the twisted fields extent a "breaking point", like a rubber band, it breaks due to tightening of the wound and emit the huge amount of energy as the field lines recombine. And lead to the formation of solar flares and Coronal Mass Ejections.

The influence of Sunspots on the Earth's Environment

in spite of having the darker, cooler regions compare to the other part of sun, the activity of the sunspot are connected with a very negligible growth in the total energy production of the sun. The plages are the area on sun where dark sunspot areas are encircled by areas of increased brightness. During the sunspot activity, some parts of the solar band, especially ultraviolet, rise a great deal. Actually the contribution of ultraviolet radiation is very less but the fluctuation in the radiation give the impact on earth atmosphere, mainly the energy stability and interaction of the outer atmosphere. Even the interaction among the sun's activity and the earth's atmosphere is doubtful and have many debates. The duration of 1645 to 1715 is called the Maunder Minimum which had the low activity of sunspot overlapped with the duration of long cold winters and harshly cold temperatures in Western Europe, is known as "Little Ice Age."

According to Fisher, "It's debatable whether the earth climate is affected by the solar cycle. One activity of sun that is solar activity, the general characteristic of having magnetic fields on the sun, which shows how much energy is coming out from the sun -on the level of a few tenths of a percentage. This make possible to convert the earth's climate in this cyclic manner, but it is appeared as controversial." The controversy is due to the difficulty of the earth's environment. It is tough to flatten out the many dynamics that support climate change.

Dearborn is also thoughtful about assigning climate impacts to sunspot cycles: the assumption is made that the climate effects results in the form of sunspots but it is very hard to say this and need more research to find the impact of climates.

Unconventionalities in the sunspot cycle shows the less impact on the climate of earth rather the human activity right now. There are many activities which affects the climate that is burning of fossil fuels or deforesting. Han there is a need of more research about the sunspots and their impact on the climate. (Explotarium.edu)

Review of Literature

Hathaway, Wilson, and Reichmann (1993), studied about the chronological behavior of a sunspot cycle which were described by the International sunspot numbers on the basis of four parameters: amplitude, starting time, asymmetry and rise time. The limitation which handles the loophole occurred among solar max and solar mini is present in small amount from cycle to cycle which can be solved at a specific value for all cycles. The rising time and amplitude have the relation which permits for an exemplification of each cycle by a role having only two factors: amplitude and the starting phase. For the previous 22 sunspots cycles, these parameters are determined and tested for any expectable activities. The amplitude of cycle and the length of previous cycle show the weak relationship which permits to find the amplitude within 30% at the cycle beginning. As the cycle developed, the amplitude of the cycle can be estimated within 20% in 30 months and within 10% in 42 months. Thus it provides a better estimation of both size and time of the sunspot maximum and behavior of the lasting 7-12 years of the cycle.

Hathaway, Wilson, and Reichmann (2002), examined the 'Group' sunspot numbers built by Hoyt and Schatten for the determination of their usefulness in describing the solar action cycle. The comparison made between group sunspot numbers with the Zurich sunspot numbers monthly, 10.7-cm radio flux, and total sunspot area. They establish that 10.7 cm radio flux and total sunspot area measurement are followed by the Zürich numbers which is little better than the Group numbers. Through the help of both, Group numbers and Zurich numbers, they analyzed the various important features of sunspot cycle. It was also determined that 'Waldmeier Effect' which shows the anti-correlation amongst time elapsed between maximum and minimum cycle and cycle amplitude, is greater in the Zürich numbers. While the 'Amplitude–Period Effect' which shows the anti-correlation among the length of the previous cycle from minimum to maximum and cycle amplitude, is also greater in the Zürich numbers. In the similar way, the 'Amplitude–Minimum Effect" means the correlation among the activity level at previous minimum and cycle amplitude is same in both the Zürich numbers and the Group numbers. The 'Even–Odd Effect' – in which odd-numbered cycles are larger than their even-numbered precursors – is somewhat stronger in the Group numbers but with a tighter relationship in the Zürich numbers. On the other side, the 'Secular Trend' which is the increment in cycle amplitudes ever since the Maunder Minimum is stronger in Group numbers. The scientist also observed the small clue regarding the correlation among the cycle

amplitude and its duration or for a bimodal circulation of cycle periods. He decided that the in the extension of sunspot cycle data, Group numbers play a critical role which also add more cycles and improve the statistics. Though, for the characterization of the level of sun's activity, the Zürich numbers have been proved more useful compare to group numbers.

Volobuev (2009), described empirically the figure of the sunspot cycle which is the oldest issue of sola physics. According to him, there are two parameter for the 23 solar cycle correlation among the factors of our fit offers the opportunity of a one-parameter fit if the times of the modicums are recognized as a priori. They also demonstrated that one parameter is used to serve as a criterion for the comparison of various dynamo models. One parameter decides the shape of coming cycle via a prediction of one parameter that changes synchronously with the worldly difference. An earlier assessment of the impending decadal typical sunspot number is transformed into the prediction of the shape of the 24th cycle with a maximum of 118±26 W. The correctness is incomplete mostly by the doubts of the foretold worldly difference and the doubt of the time of the minimum.

UCAR (2012), discussed that the counting of sunspots seen on the sun's surface diverges from year to year. The falling and increasing in the counts of sunspots very in cyclical way which around 11 years on average. In 1843, the sunspot cycle was discovered by the amateur German astronomer Samuel Heinrich Schwabe. The sunspot cycle is about 11 years which is completely half of the solar activity that is 22 years. The sunspots are fall and rise every time by the effect of magnetic field of sun having the sunspots reverse polarity. Therefore, the duration of the sunspot is 11 years in terms of magnetic fields, while solar cycle have the duration of 22 years, twice the period of the sunspot cycle.

Choudhuri (2015), studied that in his book Nature's Third Cycle: A Story of Sunspot, he has described the whole series behind sunspot phenomena. From its origin to its cycle and various other phenomenon related directly to solar cycles. He explained that how sunspots reveal about the sun's rotation. In his book he explained the role of differential rotation of Earth and sun and also about that how can dis parameter can affect other phenomena that holds everything in its correct timing and place and what could be the possible changes may occur if there arise any turbulence in the natural process. Further, in included The Little Ice Age, it's the duration when there is no visible sunspot because of which there are various kinds of changes on the sun like changes in temperature, magnetic field etc. which eventually leads to changes on Earth as well. It was considered an an epoch in which auroral sighting was rare and also the corona also had gone missing in total solar eclipse falling during the epoch. In his book, he confirmed that Maunder minima were undoubtedly a reality. His book further investigates that whether the unusual climate changes on Earth and disappearance of sunspots was merely coincidence or related phenomenon.

Conclusion: Discovery of the sunspot cycle was a phenomenal event of the history in itself. Sunspot cycle does not only cause changes on the sun but eventually is the source of changes on the Earth as well. Phenomena taking place on the sun reveals about the sun and more we are getting to know the sun, our solar star, more we get to know about past of humankind and its existence into the solar system. It's a window to our past and future as well. Studying the sun and phenomena occurring on it like-sunspots, will not only teach us about formation of the sun but might also tell us the formation of our galaxy and there might be the chances that if we once get to know about how our galaxy came into existence, we might get to know the other galaxies and the world also. Though this will take bulks of decades to resolve the mystery we must not stop and feel content with our knowledge. Scientists have already used a collection of apparatuses including giant solar telescopes that were specifically ventilated and chilled to perceive the sun's light without any distortion of the sun's its heat so that we can learn more about the physics of sunspots. It's the tedious work and consistent effort of researchers and scientists in this field that recently spots on other stars have also been discovered. With the help of researches that have already been done, considering it as guidance, we can progress every day into this journey towards a better knowledge because better we know, better we would survive.

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