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Sunspots and Its Effects on Space Weather

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Abstract: ***This study discussed the subject of space weather through the sun study that have a significant role in influencing the space weather and interest on the study of sunspots and focusing mechanism formed and characteristics that distinguish them from other aspects of the remarkable activity of the sun disk. Sunspots are the subject of interest to many astronomers and solar physicists. Sunspot observation, analysis and classification form an important part of furthering the knowledge about the Sun and space weather. Sunspots and Phenomena accompanying Affecting on the climate ground directly and indirectly, has resulted in solar activity over time to large changes in climate represented by the emergence periods of ice ages and periods of flooding and drought, as well as their impact on satellites and astronauts, and they relate to epidemics and other effects.***

Keywords: sunspot, climate, space weather

1. Introduction

The sun plays a central role in two important respects: Firstly it provides a cosmic laboratory for investigating processes that cannot be simulated in the terrestrial environment and secondly because of its relative closeness it serves as a proxy for understanding conditions in other stars.

Formed about 4.6 billion years from a cloud of gas dust and frozen ice the sun at the current epoch in its life is a normal main-sequence star of spectral classification G2 with an average surface temperature of around 5700 K.

The suns magnetic field that varies on a 22 – year cycle triggers activity and powerful eruptions that affect regions extending from the earths atmosphere to the distant edges of the solar system.

Despite the inherent complexities of these processes some progress has been achieved in understanding them through recent spectacular advances in observational techniques coupled with theoretical modeling.

The aim of the present review is to provide a broad overview of some modern development solar physics that have had a significant impact on the subject.

Sunspots are seen as “small” dark spots on the surface of the sun. They are easy to observe and count if the sunlight is strongly filtered. They were first noticed (in Western record) in the year 325 BC by Theophrastus, an Hellenic scientist, and they have been counted on a regular basis since the middle of the 17th century. They come and go in cycles which average about 11 years These “small” dark spots are conceived by modern astrophysicists to be intense “bubbles” of magnetic energy which somehow cool down the hot gasses within so that they appear dark compared with the surrounding solar atmosphere. These “cool” bubbles are not really very small; they are quite often the size of the Earth and many times giant spots many times the Earth can be seen.

2. Literature Review

Space Weather – Sun Earth Relations

Sun, a star of spectral type G2 is the main source of energy to the Earth. Being close to the Earth, Sun produces a resolvable disk of great detail, which is not possible for other stars. Solar flares and coronal mass ejections are the enigmatic phenomena that occur in the solar atmosphere and regularly bombard the Earth’s environment in addition to the solar wind. Thus it becomes important for us not only to understand these physical processes of the Sun, but in addition how these activities affect the Earth and it’s surrounding. Thus a branch of study called “Space Weather” had emerged in the recent past, which connects the Sun Earth relations. This paper details about the solar activity and associated energetic phenomena that occur in the atmosphere of the Sun and their influence on the Earth. (RAMAN ,K, S, February 22, 2011).

Physical Properties

Sunspots are regions in the Sun’s photosphere where intense magnetic fields cause the temperature and radiation to be less than in the surrounding, hotter and brighter photosphere gases. A single sunspot consists of one or more dark cores, called umbrae, often surrounded by a less dark area called penumbra. In the umbrae, very intense, longitudinally oriented magnetic fields cause the photospheric gases to become very cool, and thus dark compared to overall photosphere.

Sunspots have a tendency to appear in magnetically bi-polar groups. In each group there are normally two major spots, oriented approximately east-west, called the leading, preceding or western, and the following or eastern spot. The leading spot is usually larger in size and has stronger magnetic field strength. It is first to form, first to develop penumbra, and last to dissipate. Also the leading spot is often located slightly closer to the equator than the following spot.

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Structure

Sunspots, in contrast to the thin flux tubes associated with NBPs, are much larger structures (with typical thickness in the range of 10000 to 20000km) that are strongly magnetized (around 3000 G in the central regions). They are visible on the solar surface as dark features with a dark core called the umbra with a much lower temperature (around 4000 K) than the ambient atmosphere and surrounded by a lighter region called the penumbra. The darkness of sunspots has traditionally been attributed to suppression of convective energy transport (relative to the surrounding photosphere) by the strong magnetic field. Orientation of the magnetic field is mainly vertical in the centre of the the umbra and becomes increasingly inclined with radial distance to about 70° (with respect to the vertical) at the edge of the penumbra, where the field strength drops to about1000 G. The penumbra displays radial filaments along which fluid motions with speeds of several kilometers per second occur. This is the well-known Evershed effect, discovered in Kodaikanal, India in 1909, the origin of which is still being debated. Sunspot umbrae also reveal fine structure in the form of bright point's orumbral dots with a typical diameter of about 150 km and brightness comparable to the photosphere. It was earlier believed that the magnetic field in umbral dots is reduced compared to the background umbra but recent observations do not indicate a decrease in field strength. The physical mechanism responsible frothier formation is most likely related to convection in a vertical magnetic field. Recent high-resolution observations have shown that the penumbral magnetic field exhibits an "interlocking comb structure", consisting of two distinct groups of field lines associated with: (a) inclined bright filaments, and (b) almost horizontal dark filaments, . From a theoretical viewpoint this dual topology is also not well understood. It has been suggested that buoyancy and downward pumping of magnetic may contribute to creating and maintaining such structures.

Solar cycle

The number of sunspots and sunspot groups (sunspot number) present on the solar surface changes with time and exhibit a cyclic behavior with an approximately 11 year period. The amplitude of the cycle (often called the strength of the cycle) varies from one cycle to another. Sunspots occur typically in the latitude range ± 35° and drift in latitude towards the equator as the cycle progresses (Spörer's law). In recent years evidence has accumulated that the solar cycle has a long-term modulation consisting of epochs of hyperactivity (most recent being the Medieval maximum in the 12th century) as well as spells without sunspots (Maunder minimum during 1645-1715). These periods of abnormal activity are without explanation. Incidentally, the total solar irradiance (the energy from the Sun observed at Earth per unit area per unit time and unit wavelength interval) also exhibits a 11 year cycle which is in phase with the sunspot cycle and has implications for the terrestrial climate.

Sun Dynamics

The sun consists of very dense plasma gas this gas consists of some fast electrons and eleterentary particles. These fast particles can suitably described by special relativity (SR) where the time t ,displacement x and mass m for any frame moving with constant velocity v with respect to the particle is given by :

$$t = \frac{t_0}{\sqrt{1-v^2/c^2}} = \gamma_{0t_0}$$

$$x = \frac{x_0}{\gamma_0} = x_{0\sqrt{1-v_{c^2}^{2}}}$$

$$m = \gamma_{0m_0}$$

Where $t_{0,}x_{0,}m_{0,}$ are the time ,disp..and mass for the frame in which the particle is at rest with respect to it.

These SR relations ,suffers from atermstarding for potential energy. This motirate some physics to propose generalized version of SR.

Known as generalized SR (GSR).in this new model t ,x ,m are given by

$$t = \gamma t_0$$

$$x = \gamma^{-1} x_0$$

$$m = \gamma m_0$$

Where

$$\gamma = (1 + \frac{2\varphi}{c^2} - \frac{v^2}{c^2})^{-1/2}$$

Where

φ =potential per unit mass

$$\varphi = {}^{V}/_{m}$$

The particle energy E in this version is given by :

$$E = mc^2 = \gamma m_{0c^2}$$

For funately ,unlike SR ,GSR energy farmutaeredces to new tantian one for weak field and small velocity ,where V<< c $\varphi \ll c$

$$E = m_{0\,c^2}(1 + \frac{2\varphi}{c^2} - {}^{v^2}/_{c^2})^{-1/2}$$

$$= m_{0\,c^2}(1 - \frac{1}{2}\quad \frac{2\varphi}{c^2} + \frac{1}{2}{}^{v^2}/_{c^2})$$

$$= m_{o\,c^2 - \varphi m_{o + \frac{1}{2}} m_{oc^2}}$$

For repulsive force, the potential and kinetic energy are given by

$$V = -m_{o\varphi}$$

$$T = \frac{1}{2} m_{o\,v^2}$$

This the total energy is given by :

$$E = T + V + m_{o\,c^2}$$

Which is the usual newtan energy formula with additional term starding for rest mass energy.

Explanation of Darkness of sunspots By Using Genarelized Special Relativity:

Introduction

Sunspots are closely relafed to the sun magnetic storms. This relation is explained by using GSR Theory.

Plama Equation

Plama equation of motion relates the acceleration of particles to the applied pressure P and potential V according to the relation

$$\mathrm{nm}\frac{\mathrm{dv}}{\mathrm{dt}} = -\nabla \mathrm{p} - \nabla \mathrm{V}\ (1)$$

Where n is the number of particles per unit volume ,m is the mass of are particles and v is the particles velocity. Reananging (1) in are dimension yields

$$nm\frac{dv}{dt}\frac{dx}{dt} = -\frac{\partial P}{\partial x} - \frac{\partial V}{\partial x}\ (2)$$

This

$$nmv\frac{dv}{dx} = -\frac{dP}{dx} - \frac{dV}{dx}$$

$$nm\int vdv = -\int dP - \int dV + c$$

$$\frac{n}{2}mv^2 + P + V = C$$

Henle the energy per unit volume I.e the fluid energy density is given by

$$E = K_e + V + P\ (3)$$

Where K_e is the kmehi energy. henle

$$E = \frac{n}{2}mv^2 + V + P\ (4)$$

E t is interesting to note that this new expression consists of an additional term representing the pressure. For a single particle ,where neglecting pressure the energy reduis to the srdinary new tonian are ,ie

$$E = \frac{1}{2}mv^2 + V\ (5)$$

On the other hand GSR energy relation is given by

$$E = mc^2 = \gamma m_0 c^2$$

$$hf = \gamma hf_o$$

where

$$hf = mc^2 m_o c^2 = hf_o$$

$$hf = (1 + \frac{2\varphi}{c^2} - \frac{v^2}{c^2})^{-1/2} hf_o$$

ignoring the velocity effect by assuming very large potential compared to very low speed of reference frame yields

$$\mathrm{hf} = (1 + \frac{2\mathrm{m}_{\mathrm{o}\varphi}}{\mathrm{m}_{\mathrm{o}}\mathrm{c}^2})^{-1/2}\mathrm{hf} = (1 - \frac{2\mathrm{V}}{\mathrm{m}_0\mathrm{c}^2})^{-1/2}\mathrm{hf}_{\mathrm{o}}$$

by assuming that

$$\varphi \ll c^2$$

$$\mathrm{hf} = (1 - \frac{\mathrm{V}}{\mathrm{m}_{\mathrm{o}}\mathrm{c}^2}$$

this means that any attractive strong magnetic field lowers photon energy and make it the strong attractive umiform magnetic field.

$$\overline{\mathrm{E}} = -\mathrm{V}_{\mathrm{m}}$$

$$\mathrm{n}_{\mathrm{P}} = \mathrm{n}_{\mathrm{o}}\mathrm{e}^{-\mathrm{E}_{\mathrm{P}}/\overline{\mathrm{E}}} = \mathrm{n}_{\mathrm{o}}\mathrm{e}^{\mathrm{E}_{\mathrm{P}}/\mathrm{V}_{\mathrm{m}}} = \mathrm{e}^{\mathrm{hf}_{\mathrm{o}} - \mathrm{V}/\mathrm{V}_{\mathrm{m}}}$$

Where

V_{m} = average uniform magnetic field.

Space Weather Effects

The space weathers its effects on human life and then to cause malfunction and loss of human activities and also to influence the earth weather and climate change.

Communications systems

A lot of broadcast radio communication systems based on the reflection of radio waves from the ionosphere layer It is one of the upper layers of Earth's atmosphere, The altitude above the ground between 85 km and up to about a thousand kilometers. The air in this layer is exposed in El ionization (ie loose electrons from air molecules or atoms) due to the ultraviolet rays coming from the sun, as well as the impact of the solar wind. For this reason, this variable class constantly, where affected by a succession of night and day, and the succession of the four seasons and the cycle of solar activity.

Satellite navigation systems

Including Global Positioning System known as GPS and because of changes in terrestrial ionosphere layer during the solar storm, the radio signals issued by satellites GPS system has crossed the ionosphere that suffer so-called blink Scintillation, and therefore less accurate positioning at the reception on the ground devices, GPS "Global Positioning system" system is the US system, there is a Russian system "Gelosnas" "Glosnass", and there is also a European system "Galileo" "Gallileo", and finally entered China in satellite navigation systems technology.

Satellites

Storms geomagnetism affect as well as the increase in the radiation intensity above the solar radiation on the Earth's atmosphere, and it is through heating the atmospheric air and make it expands, which increases air resistance to the movement of satellites low orbits, making them slow down to the point where you may drop gradually towards the earth and burn in the atmosphere.

Something similar to the space laboratory Skylab orbital ksylab has happened during the geomagnetism storm in 1979, he fell toward the ground. As well as during the geomagnetism storm 1989, affected more than two thousand satellite, making the responsible institutions change in the orbits of these satellites up to avoid damage.

The other risk to satellites, is to the possibility of penetration of solar wind particles to the walls of the satellite (especially small ones), which may destroy electronic systems or may affect its computers and software.

3. Result and Discussions

1. Through research and study proved that there is the effect of space weather on the earth weather and climate.
2. Causing ionization top of the atmosphere of the planet is causing a series of short interruptions in the high-frequency wireless communication.

3. During the sunspot cycle affected by temperature positively or negatively and therefore affected by other weather elements.
4. There is the influence of sunspots on the overall communications systems.
5. Atmospheric ozone is linked to solar activity, as a result of the difference in the amount of ultraviolet radiation which vary according to the degree of solar activity.

The sun is currently undergoing know the great solar activity, a period that began in the twenties of the last century, and continued throughout the period of what became the space era.

in the case of minimum solar activity, will not notice the presence of those spots for several decades, and that the last time such a phenomenon has been observed during the years from 1650 to 1700.

Research indicates that most of the radioactive activities will strike the Earth during the middle of solar activity, which is considered high particles resulting rates for this problem Aeronautics and communications activity, the techniques were not present when it encountered the Earth solar phenomenon like this, has done research on the basis of clues and evidence collected the depth of the affected communities polar ice caps, and the trunks of trees, dating back to about ten thousand years ago.

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