Cargo Cult Science – The Solar and Sunspot Cycles

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Abstract – The description of the solar and sunspot cycle is being tagged herein as *cargo cult science* because it is incomplete. The solar cycle and sunspot cycle are the events that take place over time that alter the visible and dynamic characteristics of the Sun. Two prominent Sun cyclic events are the periodic change in the number of sunspots and the reversal of the Sun's magnetic field. The solar science community know the cyclic events are related but do not consider that an outside influence can cause them. There is evidence that a very long wavelength, multi-year, extremely high magnitude electromagnetic wave is responsible for the readily observable solar and sunspot cycles and much longer solar related cycles identified in Earth strata. All scientists before 1940 were unaware that electromagnetic waves, other than light, were traversing the cosmos. Even before and after 1940, the manner in which the basic characteristics of electromagnetic waves are taught can lead to an improper interpretation of electromagnetic related events when they do not fit the textbook descriptions. Sunspot characteristics identify the probable source of the electromagnetic wave or waves that are causing our Sun's variability. Solar scientists have identified the presence of the electromagnetic wave that causes the Sun's variability but have misidentified it.

I. Introduction

Richard Feynman introduced the term *cargo cult science* to the 1974 graduation class of the California Institute of Technology. Cargo cult science (CCS) is a process that gives the appearance of the scientific method. The actions performed that created the term *cargo cult* were the result of conclusions based upon *incomplete information*.

The Sun has been a focus of inquiry as long as man has been on this planet. For the bulk of the inquiry period it was not known that light from the Sun was an electromagnetic (EM) phenomenon. We have a very short history concerning the knowledge that EM waves exist. According to Merriam-Webster, the first known use of the term *electromagnetic* was in 1820. The 1801 double-slit experiment by Thomas Young provided evidence that light had characteristics of a wave. In 1851, James Clerk Maxwell published his theory that light was an EM wave.

In 1887, Heinrich Hertz demonstrated that EM waves, well below the frequency of light, can be artificially produced and these waves propagated in space in the same manner as light. Hertz concluded that the EM waves he created had transverse polarization.

Karl Jansky revealed in 1932, in a radio engineering publication, that radio waves of extra-terrestrial origin had been detected.[1] In 1940, Grote Reber published in a radio engineering and an astronomical publication that EM waves, other than light, were coming from the cosmos.[2] Thereafter, radio astronomy became a specific specialty of study.

The EM spectrum of celestial emissions being studied by radio astronomers has continually expanded as electronic devices and various sensor elements have been developed. The *radio window* identifies the frequencies that can be detected from the Earth's surface with the currently available sensors and electronic devices. Radio astronomers are not attempting to observe EM waves that have wavelengths longer than 10 meters. In 2008, the HAARP moon bounce experiment was performed using a frequency just above 7 MHz, with a wavelength about 40 meters long. The moon bounce signal was received at numerous Earth receiving stations. The French DEMETER satellite received EM emissions related to earthquakes that have frequencies in the single digit Hz range.[3] Magnetotelluric devices use very long EM waves, 1-10 Hz frequency, for seismic exploration. Man-made or natural terrestrial produced EM radiation that modifies or is influenced by the ionosphere can mask the presence of extra-terrestrial EM radiation in the same frequency bands at Earth based radio astronomy sites. It cannot be concluded that cosmic sources are not producing radiation in the frequency bands outside of the current radio window just because they have not been detected by Earth based receiving sites using contemporary sensing instruments. Extremely long wavelength EM waves from cosmic sources could be present but we have no direct way to detect and identify the presence of these signals except by observing secondary effects produced by the energy of these waves being transferred to an object being studied.

Our Sun and its planets are closely aligned in the same plane, its ecliptic, with the exception of two outer planets that are slightly misaligned. Our Sun-planetary ecliptic is not aligned with our galaxy ecliptic. "The galactic plane is tilted at an angle of 63 degrees to the celestial equator and at an angle of 60 degrees to the ecliptic (the path of the Sun on the sky)."[4]

The Sun rotates once every 25 days which produces 14.6 rotations in a year or a little over 160 rotations within a sunspot cycle.

II. Electromagnetic Wave Misinformation

The manner in which EM wave theory is taught is responsible for misinforming those that study celestial phenomenon. Textbook descriptions of harmonics, heterodynes and intermodulation frequencies are describing what happens in electronic circuits, not how they interact within plasmas in space. An article titled, "Cargo Cult Science – Electromagnetic Harmonics and Heterodynes," identifies the incomplete information provided in the textbooks.[5] The failure to emphasize that a single EM wave can have embedded on its waveform many different frequencies will produce erroneous conclusions when researchers are confronted with cyclic patterns that are unlike those presented in textbooks. Textbooks do not teach that multiple EM waves traversing the universe can interact with each other within plasma concentrations that mutually alters their waveforms. It was emphasized in ref. (5) that collinear, perfectly aligned, EM wave interactions in space would be a rare event.

For more than a century, everyone has been taught that higher frequency EM waves have more energy than lower frequency waves because of the formula $E=h$ f, where h is Planck's constant and f is frequency. In the real world, where there are always more than one unit of energy (h) involved in creating an EM wave, a multiplier has to be applied, such as $\boldsymbol{m}$, E=$h\boldsymbol{m}f$, to accommodate the number of charged particles that were responsible for producing a particular EM wave. The value of $\boldsymbol{m}$ will be related to the mass of the charged particles that produced the EM wave. Charged particles act upon each other at a distance and the composition of charged particles will vary.

James Clerk Maxwell recognized the difficulty in accommodating action-at-a-distance, thus he excluded it from his electromagnetic equations. Maxwell did not know of the existence of the electron, but his 1864 paper, "A Dynamical Theory of the Electromagnetic Field," mentioned the possibility of particles acting at a distance. He stated, "The mechanical difficulties, however, which are involved in the assumption of particles acting at a distance with forces which depend on their velocities are such as to prevent me from considering this theory as an ultimate one, though it may have been, and may yet be useful in leading to the coordination of phenomena." Computer based mathematics will alleviate some of the mechanical difficulties.

Antennas are more efficient if they are aligned with the polarity of the EM field and have a length related to a specific wavelength. It makes a difference whether you are detecting and aligning with the electric field or the magnetic field of an EM radiation source. Most antennas are designed to detect the electric field. Antennas designed to detect the magnetic field of an EM wave can be more compact than those used to detect the electric field. However, magnetic field detectors have not been developed to detect the presence of extremely long wavelengths. Scientists are identifying the presence of extremely long wavelength EM fields by observing the effects caused by these waves on celestial objects.

Our Sun is a plasma of conductive ionized material with varying density. Information is available on how plasmas interact with EM fields.[6] Plasma physicists have not considered the possibility that external long period high magnitude EM radiation sources are interacting with our Sun.

III. Low Frequency Celestial Electromagnetic Emissions

Radio astronomers are not attempting to observe EM waves that have frequencies in the low and sub-Hz ranges. After radio astronomy started, little interest was shown in lower frequencies, except by Grote Reber.[7] Reber and his associates made many recordings of signals in the 0.5MHz to 2 MHz range. Reber reached a conclusion in 1982 about his attempts to capture low frequency signals from celestial sources. "He later took a quite different view of his research, commenting that most of his results seemed to be atmospheric phenomena and that the frequencies at which he was observing were too low for the detection of celestial emissions." Reber's long term observations required paper strip-recorders. Why Reber stated the emissions were too low for celestial emissions is not known. Reber was unaware that very low frequency radiation, 1 to 3 Hz, is produced in earthquake zones prior to earthquakes.

It is not known if the above revelation made by Reber has influenced radio astronomers from trying to directly detect the hyper low frequency waves that are revealed by the Sun's solar cycle and other celestial phenomena that have long term cyclic characteristics. It takes considerable time to detect an EM wave that has a period of a year, and even more time to detect the 11 year sunspot cycle and the 22 year solar cycle. An amateur astronomer, Samuel Heinrich Schwabe, discovered the sunspot cycle in 1843.

Sensing elements that can respond to the long period waves and a way to record their presence are nonexistent. Currently, the effects created by these long period waves are extracted using visual observations that identify changes in the characteristics of our Sun and other stars that have variations.

The *megawalls* of galaxies that form across space have distinct cyclic characteristics.[8] There are multiple wave periods visually observable in the data set. The fast Fourier Transform (FFT) can be used to extract the repetitive frequencies identifiable within the megawall data set.

Arthur S. Eddington was unaware that EM waves, other than light, were traversing the universe. In his 1926 publication, "The Internal Constitution of Stars", he stated, "whatever the cause of the variability, whether pulsation or rotation, provided only that it is intrinsic in the star, and not forced from the outside, the density must be the leading factor in determining the period." Incorrect conclusions can be made if it is not recognized that long period high magnitude EM waves from the outside can influence the internal and visual characteristics of celestial objects.

IV. Sunspots

The earliest writings about sunspots were noted in Korean and Chinese documents around 800 B.C. [9] The first known observation of sunspots by a Western observer was in 1128 A.D. The telescope was invented in the early 1600s, which permitted a more detailed view of the Sun. From ref. (9), "The nature of sunspots remained unclear until 1908, when George Ellery Hale, using an instrument that observed the Sun in narrow ranges of color emitted by selected substances, reported that the light from sunspots was modified in ways that indicated it was produced in intense magnetic fields."

There are multiple ways to count sunspots.[10] The contemporary sunspot cycle is graphically presented in the same basic format as it has been done for several hundred years. The format was not changed even after it was discovered that the Sun's magnetic field periodically reversed in parallel with changes in the number of sunspots observed. A new way to count sunspots was introduced in 2015.[11] Not including the smaller sunspots will hide some of the frequency components of the EM wave that is creating them. An FFT performed on the complete count as compared to the Wolfe count will identify the wave characteristics that are different. A "complete ensemble empirical mode decomposition" (CEEMD) analysis method" was applied to sunspot data from 1700 to 2014.[12] It was not noted which sunspot count data was used to perform the CEEMD. The CEEMD periodograms, fig. 2 of ref. (12), indicates there is a definite 100 year cycle in the data set.

It is the constructive and destructive mixing of the waves which results in the final wave pattern. EM waves can be altered during their passage through various plasma densities. There is no assurance that the EM wave that is currently altering the Sun will not experience additional alterations. Not showing the polarity of the cycle and the presence of backward sunspots distorts the results.

The first appearance of a backward sunspot identifies the visual beginning of the hysteresis process that precedes the final change in the Sun's magnetic field. The number of backward and regular sunspots is identifying the characteristics of the hysteresis process, which is discussed in the *Hysteresis, Backward Sunspots* section.

The celestial events that are described as the sunspot cycle and the solar cycle have the characteristics of an EM wave process, but the manner in which the counts are graphically presented do not fit the textbook descriptions of EM waves. Even though the Sun's magnetic field reverses, an EM process, the sunspot graphics do not identify this characteristic. The sunspot counts should be shown to reflect this polarity. This can be accomplished by having the right vertical scale to show Sun polarity, N up and S down and the counts presented for the different polarity. Backward sunspots pose a problem for traditional black on white graphics.

A number of papers that discuss the 22 year solar cycle mention the presence of a *relic dipole magnetic field* that has a large inclination relative to the Sun's magnetic pole. Another paper uses the term *inclined dipole relic field*.[13] Rather than a *relic field*, it appears that researchers are detecting the presence of the magnetic field of the EM wave that is causing our Sun's magnetic reversal. In regards to its large inclination, ref. (13) stated, "inclined 72° southward of the solar equator." Our Sun's axis eclipses is inclined 63° relative to our galaxy's eclipses. None of the papers mentioned the possibility that a high magnitude EM wave, one that could be coming from the center or near the center of our galaxy, could be responsible for our Sun's variations. It may be determinable that variable stars nearby are being influenced by the same wave that is effecting our Sun. If some of these variable stars are closer to the source of the EM wave, it may be possible to identify future changes to our Sun's parameters.

A study by the Max Planck Society that went back 11,400 years, using C-14, indicates the Sun is more active now than over the past 8,000 years.[14] This suggests there is another cycle that is close to 8,000 years long. It is observable that there are at least three distinct cycle patterns within the period from 1700 to 2000. The researchers did not denote the suns polarity and did not indicate if they applied a FFT to extract the frequency sets present in the 11,400 year time period.

V. Hysteresis, Backward Sunspots

A material that supports the creation of a magnetic field can have a North or South magnetic pole and once magnetized it can be reversed. Even though a magnetic field is applied to cause a reversal, the magnetic material resists an instantaneous change. A distinctive pattern is observed when a magnetized material has its poles reversed and this is referred to as a hysteresis curve. The material that creates the Sun's semi-permanent magnetic field responsible for the North and South poles is considered a magnetically soft material. The hysteresis curve is different for hard compared to soft magnetic material.

When a sunspot minimum approaches, backward sunspots start to appear.[15] Backwards means the sunspots have a polarity that is opposite of those in the Sun's hemisphere for the current polarity direction. The sunspot counts graphics do not identify the number of backward sunspots. In a data search, it could not be determined whether the backward sunspots were included with the regular sunspots. Those sunspots that are backward should be shown with a different colored count bar to note their magnetic polarity because it is the reverse of what it should be for the hemisphere they are in. Not properly identifying the backward sunspots is providing incomplete information.

The backward sunspots are revealing the hysteresis characteristics of the Sun. The EM wave or some peaks of that wave that is causing the Sun's magnetic reversal is already into the next polarity and the actual Sun switching its magnetic polarity is delayed by hysteresis. There are many studies that reveal the hysteresis effect in processes associated with sunspots. None of the reports reviewed suggest that an external EM source is responsible for the hysteresis effect.

Individual sunspots can be caused by higher frequency waves that are impressed on the basic wave that is effecting the characteristics of the Sun. Sunspots have differing appearance times on the Sun's surface and the magnitude of a wave that produces a sunspot will determine its longevity.

VI. Butterfly Plot

The butterfly plot illustrates the latitude where sunspots occur in the North and South hemispheres of the Sun over the eleven year period of a sunspot cycle, see ref.(10). There are multiple sites that illustrate the butterfly pattern and the angle the butterfly pattern makes with the Sun's equator line varies depending upon date and latitude line spacings. At the beginning of a sunspot cycle, the sunspots occur close to the Sun's 40° latitude line and then at the peak they gradually appear closer and closer to 5° of the equator. The general positional shift of sunspots is identifying the shape of the EM field interacting with the Sun; it is definitely non-sinusoidal. A non-sinusoidal EM wave can contain a significant amount of power in its various harmonics. There is a high probability that sunspots are the result of one or more harmonics or heterodynes contained on the wave which ultimately causes the Sun's magnetic polarity to change.

All of the studies involving EM wave interaction involve collinear alignment, and this would be a rare event in space. Non-collinear interaction can cause extreme modification of the original waves that interacted. The backward sunspots can help identifying the shape of the EM wave during the transition from one polarity to the other. Because of the sunspot latitude change, there appears to be a general triangular shape to the external EM wave. It would be desirable to know if the waveform has axis symmetry. Examples of various non-sinusoidal waveforms are illustrated by material for an electrical engineering course.[16-17] It must be kept in mind that the signal interactions that resulted in the various waveforms in ref. (16-17) are the result of collinear interaction.

A main issue is identifying the source of a EM that could have a magnitude to influence the characteristics of our Sun. The angle of the butterfly plot suggests the EM source could be from a transverse wave with horizontal polarity that is close to parallel with the ecliptic of our galaxy. It appears that the butterfly pattern is illustrating the angle of interaction between an external transverse EM wave and the Sun. The angle the butterfly pattern makes relative to the Sun's equator is influenced how the latitude and date lines are established for a butterfly plot. The butterfly plots are not presented on a spherical projection and the time scale used can distort the angle. If the butterfly angle is close to 60° to the ecliptic of the Sun, this would suggest the source of the EM wave is aligned with the ecliptic of our galaxy. Present data cannot determine whether the EM wave is coming from the direction of the galaxy core or from a source coming from the opposite direction. There is nothing close in the opposite direction and there is a considerable amount of mass and plasma in the direction of the galaxy core. With all the pulsars being detected from the direction to the center of the galaxy indicates there is considerable plasma and EM activity from that direction.

It is difficult to determine if all the sunspots that occur are displayed by the butterfly plot, because some sunspot observers count only those sunspots that could be seen with a telescope in the 1840s.

VII. Electromagnetic Waves, Aether and Sensors

Light not needing anything in which to propagate created problems for early scientists, because everyone knew centuries ago that waves of every other kind required a medium in which to propagate. The aether, now officially written as ether, came to the rescue. Most early scientists were familiar with Greek and Latin, as those languages were known to the educated. Old Greek texts had a description of the aether, and this provided a convenient medium in which light could propagate, especially when it was noted in the 1800s that light could pass through the vacuum of a bell jar.

It is possible to transliterate a word from the alphabet of an old language to the alphabet of a different language, but the definition of the word is another issue. In examining the various descriptions of what the aether was stated to be, it is possible to suggest it has a fit to the description of EM waves. The original Western interpreters of what they thought aether meant had no knowledge of the existence of EM waves and it appears the earlier interpretations have been carried forward.

Then came the Michelson-Morley experiment, which claimed to have proven that the aether doesn't exist. That in itself was the subject of a paper titled, "Cargo Cult Science - The Michelson-Morley Experiment".[18] The result of the Michelson-Moreley (MM) experiment had unintended consequences which had to be corrected by radio astronomers a century later; optical astronomers have ignored the radio astronomer correction of dispersion measure (DM).

Until the photographic plate was invented, the human eye was the only sensor available to detect EM waves in the light spectrum. Artificial sensors are now available to detect EM radiation above and below the light spectrum. How high and how low the spectrum extends has not been identified. 1 Hz is not the lowest frequency, even though this value is defined by the duration of the SI second. For the sunspot and solar cycles it would be appropriate to use the time duration of a light-year (Lyr). But there are shorter and longer periods involved, which suggests a need for defining a decimal based time duration set for very long wavelengths that exceed the period of 1 second. Should there be a designation of very long time periods by appending a factor number to Hz, such as Hz^{-3}, Hz^{-6}, Hz^{-12}, etc?

Our current second is based upon Ephemeris time, which has 86,400 seconds in a day. The current SI definition does not mention that 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom was selected to fit the duration of 1 second of Ephemeris time.

It was not until the early 1960s that instruments were constructed to detect Schumann resonances. Even though it was possible to build instruments for that low Hz range before the 1960s there was no known reason to do so. The French DEMETER satellite was capable of detecting EM emissions in the single digit Hz range. Magnetotelluric instruments can generate and detect EM signals down to 0.1 Hz.

Even though the sunspot and solar cycles are very long, they are persistent. A detector developed for a specific resonance of a solar cycle wave would be a more efficient. Because the magnitude of the EM waves that are influencing our Sun are so high, a resonant detector could extract power from such a wave.

To aide in determining the shape of the EM wave that is causing sunspots, it is necessary to determine whether it takes a higher magnitude wave to produce sunspot pairs that are farther from the Sun's equator or nearer the equator.

The next issue is determining what effect the polarity of the EM wave is or is not aligned with the Sun's ecliptic. If the polarity is aligned with the equator of the Sun, this would put the magnetic field of the EM wave at 90° to the Sun's equator and the electric field parallel with the equator. If the polarity of the EM wave is not aligned with the Sun's equator, what effect does this have on displaying Sunspot locations over time?

Can the ecliptic of other variable stars be determined, and if so, what are their alignments to the galaxy ecliptic? Did the Sun change its polarity during the Maunder minimum even though sunspots were not displayed?

VIII. Electromagnetic Waves and Stars

EM waves come with many variations in magnitude and wavelength. Researchers have not even begun to identify the variations that will appear when EM waves interact within a plasma when the interaction is not collinear. Determining how EM waves interact with stars is in its infancy, primarily because astrophysicists and astronomers have not considered this type of action. Convincing astronomers that variable stars are the result of the interaction between a large magnitude EM wave has to overcome conclusions made, and are still accepted, when no scientists were aware that EM waves, other than light, were traversing the cosmos.

It is expected that the interaction of EM waves with stars will involve a considerable number of variables. A very large star would be expected to respond differently than a small star to a given EM wave magnitude and wavelength with the same intersection angle of the wave with the stars. The lack of sunspots on our Sun is probably be the result of a wave characteristic that does not permit the formation of sunspots.

The following is attributed to A. S. Eddington, "In seeking a source of energy other than [gravitational] contraction the first question is whether the energy to be radiated in future is now hidden in the star or whether it is being picked up continuously from outside. Suggestions have been made that the impact of meteoric matter provides the heat, or that there is some subtle radiation traversing space that the star picks up." Eddington was unaware of EM radiation, other than light, that is traversing the cosmos.

EM waves are generated within plasmas that are within the influence of a magnetic field by electrons that rotate counterclockwise about the magnetic field lines and ions rotating clockwise; these at different radii. The magnitude of the EM waves created within a plasma will be related to the density of the plasma and the strength of the magnetic field. A wide frequency range of EM waves can be created. The EM waves generated within the galaxy core could have very long wavelengths and very high magnitudes. The wavefronts of these plasma generated EM waves could be unlike those produced by traditional antennas, but they can be altered when interacting with another EM wave within the plasma. Our galaxy is a rotating plasma with a defined equator. The wavefront characteristics of the EM waves produced by a rotating spiral plasma are unknown, but would not be isotropic.

IX. Conclusions

This paper would have been unnecessary if EM wave theory was taught correctly in the first place. The information about stars and everything else in the galaxy is being obtained via EM sensors. Electrical engineers are taught that an EM wave can have multiple frequencies on a waveform and how to exploit selected frequencies that appear on the waveform. It is not pointed out in textbooks that EM signal mixing in electronic circuits produces collinear interaction. Collinear interaction between EM waves within a plasma in space would be a rare event and it would be even rarer to be able to detect such an event.

Scientists are identifying the presence of extremely long wavelength EM fields by observing the effects caused by these waves on celestial objects. It is reasonable to suggest that the cause of sunspots and the Sun's magnetic field polarity changes are the result of a very high magnitude multi-year period non-sinusoidal EM wave or waves that have multiple frequencies on them.

Applying the FFT to all the sunspot data counts can help identify some of the major frequencies present during the measurement period. It cannot be assumed that all the frequencies identified are the result of a single EM wave. If more than one wave is responsible, there can be in and out of phase periods that can cause extreme changes to the EM wave magnitude. For EM waves transiting the universe, a mere million year wave period need not represent a lowest frequency. It should be expected that waves produced at our galactic center can have a variety of long duration wave periods.

Research needs to be directed at EM wave sensors that will respond the the multi-year wavelengths that are transiting our solar system.

Until it is understood how external high magnitude very long wavelength EM waves interact within a high density plasma, such as the Sun, there will be considerable speculation as to how a star responds to various EM waves transiting the galaxy and the universe.

The 22 year Sun magnetic field cycle suggests the Sun has a low hysteresis core that is subject to the influence of very high magnitude electromagnetic wave or waves that are passing through our solar system. Conversely, the Earth has a high hysteresis core that is resistant to being reversed by the EM wave that is changing the Sun's polarity every 11 years.

Sunspots are identifying a dispersion effect when EM waves transiting the universe encounter solids and plasma concentrations. The classical dispersion measure defined by radio astronomers involves very small objects. Dispersion is an energy transfer mechanism.

It is extremely difficult to give credibility to contemporary theories about the characteristics of the universe and objects in the universe when the theorists presenting the theories were unaware of the presence of EM waves, other than light, transiting the universe.

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