Radio Astronomy Below 1 Hz

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Abstract – There is multi-century visual evidence that extremely long wavelength electromagnetic emissions are present in the universe. The megawalls of galaxies in both directions from Earth identify the presence of extremely long cyclic processes. Many long period events have been detected with instruments and visual observations, but never associated with electromagnetic waves. Optical and radio telescopes can maintain a constant celestial reference point for a fraction of a day, but this duration is sufficient to detect signals that are below 1 Hz. The electromagnetic emissions that are generated at or near our galactic core would be those that we should be able to detect directly. As lower frequency antenna/sensors become available the spectrum that needs to be scanned will gradually increase.

Introduction

Optical astronomers do not know it, but they have been observing and recording the effects of below 1 Hz electromagnetic (EM) waves for many centuries, this before they were aware that EM waves existed and that they were traversing the universe and interacting with celestial objects.

It must be noted that Arthur S. Eddington was unaware that EM waves, other than light, were traversing the universe.[1] 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." Contemporary solar scientists that are influenced by Eddington's teachings would not consider that external EM waves could be the cause of our Sun's variability.

An examination of solar data acquired since the 1600s indicates a variety of periodic activity, some very long and others short. There is a well defined ≈22 year cycle where the Sun's magnetic field reverses and then returns to the same polarity. A very long period EM wave with a large inclination with our Sun-planetary plane has been detected and it is referred as a *relic* solar magnetic field.[2] This is evidence that our Sun's variability is being forced from the outside.

The efforts of James Clerk Maxwell and Heinrich Hertz identified light as an EM phenomenon and that EM waves had a broad frequency spectrum. Currently, we do not know how to generate EM waves with periods that require days, weeks, months or longer to complete, but this does not mean that some processes in our galaxy or elsewhere are not producing them. It is possible that some of these electromagnetic waves would have very high magnitudes. However, you cannot reliably detect these very long period EM waves unless the antennas and sensors that can detect them have a constant spatial orientation (CSO) relative to some galactic reference.

The selection of the time duration used to establish EM wave frequency was done before the extent of the EM spectrum was known. Not knowing that 1 Hz improperly defines the low end of the EM spectrum has had considerable influence on how astronomers and other scientists interpret what causes the variability of celestial objects. The 1 Hz issue is just one of several misconceptions and omissions concerning the characteristics of EM waves that need to be addressed.

Constant Spatial Orientation Antenna

Optical and radio astronomers have antennas that can, for a partial period of a day, establish a CSO either mechanically or electronically on a specific celestial object or point in space. Below 1 Hz period waves that could have periods that exceed a day, a week, a month, a year, decades or centuries should be detectable using CSO antenna (CSOA). It is not necessary to monitor a segment of space continuously 24/7, but it has to be examined regularly over a long duration to detect long period EM waves.

Scientists have already identified the probable source for the longer period wave that cause sunspots and other sun variations, but they are still concluding our Sun and variable stars are responding to internal Sun processes. Ref. (2) identified what is concluded to be a *relic dipole field* or *inclined dipole relic field* that is “inclined 72° southward of the solar equator.” 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 and its sunspot activity. Our Sun and planetary axis eclipses is inclined 63° relative to our galaxy's eclipses. This suggests the EM wave that is causing our solar cycle variations is from a EM source slightly offset from the purported axis of our galaxy.

For the very long wavelengths, antennas designed to detect the magnetic field of the EM wave will have to be used. Currently, this type of magnetic field antenna will have to be large to respond to wavelengths that will have a period of even one day. The antenna will have to be maintained in a CSO relative to some celestial point in the same manner as conventional optical telescopes. It will take an extended period of monitoring time to determine whether a particular CSOA is actually pointing in the direction of a long period wave.

It has to be considered that very long EM wavelengths will readily penetrate the Earth such that they may be detected even with the antenna on the opposite side of the Earth from the distant source. The degree of attenuation may be relatively minimal because of the magnitude of the waves coming from a near galactic core source. When the Earth's orbit is on the opposite side of the Sun relative to the galactic center, it is not currently known whether the Sun's presence would interfere with efforts to detect long period EM emissions passing close to it. However, the Sun may not be a deterrent to century long EM wave periods. It is known that the Sun is reacting to the passing wave or waves because of the visual evidence of sunspots and the magnetic field reversal. There is evidence that the Sun responds to a 312 year period, which is discussed in the Multi-frequency Electromagnetic Wave section.

Electromagnetic Wave Unknowns

Everyone seems to have the impression that we fully understand the structure and purpose of EM waves. An examination of the writings of James Clerk Maxwell identified one of the unknowns. James Clerk Maxwell had suspicions that charged particles in motion were involved in the production of EM waves. The electron was not identified until 1897, well after Maxwell's death in 1879. Because charged particles were noted to influence each other at a distance, Maxwell recognized the difficulty in accommodating action-at-a-distance, thus he excluded it from his electromagnetic equations. In his 1864 paper, “A Dynamical Theory of the Electromagnetic Field,” Maxwell 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.” It is not known how Maxwell's decision impacted the accuracy of his equations.

Even though Hertz proved that EM waves can propagate through the air just as light, and that the EM waves he produced had transverse polarization, he, Maxwell and everyone thereafter did not identify what causes an EM wave to have a polarization. Not identifying what causes an EM wave to have a particular polarization is a serious omission.

There is a basic question that is not introduced or answered in basic physics and electrical engineering texts, “What is the purpose for the existence of EM waves?” Maxwell and Hertz did not address that question. The simplest answer is that EM waves are an energy transfer process. This fits with what is termed the Law of Conservation of Energy when we consider the Universe as an isolated system.

Planck's constant adds to the confusion in understanding the characteristics of EM waves. It is the manner in which Planck's constant is interpreted that creates an issue. Everyone is taught that a higher frequency will have more energy than a lower frequency. This is true only if every EM wave, short ones and long ones, are always produced with the same number of photons. If one wavelength fits within the time period of 1 Hz, its energy level will be as a minimum the result of the motion of one charged particle that produces a photon. If 1 million wavelengths fit within the time period of 1 Hz, its frequency will a million times higher as will the energy level in that period, but only if each individual wave in the period is produced by the same number of photons before Planck's constant can be used as a comparison. In the real world, the energy level of an EM wave is related to how many photons are involved in its production.

The mathematics related to the production of harmonics and heterodynes is well known, but the actual mechanism that causes charged particles in a gaseous or solid-state plasma to produce these frequencies is not explained.

Currently, there is a unknown spectral range between 1 Hz and DC. The definition of the frequency of a periodic process requires one to know the longest time period where 1 cycle of that event fits within that time period. Not mentioned in EM literature is why the time period of 1 second, was selected to represent the longest expected period of an EM wave when little was known about the spectrum of EM waves. This is a complex subject and is covered in a paper titled, “Cycle One.”[3] Cycle One is a concept that identifies a universal method to identify the frequency of electromagnetic waves without needing to know the largest physical size an EM wave can have, but you have to know the center of the EM spectrum. Radio astronomers have already identified the center but have not recognized it as such, in part, because of the erroneous selection of the time duration to describe the frequency of an EM wave period.

Multi-frequency Electromagnetic Wave

It has to be recognized that the EM wave or waves that are influencing the Sun and causing sunspots are composed of multi-frequency components. The multi-frequency aspects of EM waves are not presented well in text books which causes individuals to misinterpret the effects caused by these complex waves. There is an obvious multi-century cycle and a ≈22 year cycle, which is composed of two 11 year half cycles that are distinguished by the polarity of the sunspots. The process that creates the EM waves that are influencing our Sun can be creating harmonics and heterodynes. It is expected that the first direct evidence of extremely low frequency EM waves will be harmonics or heterodynes of much lower frequency EM waves.

A Bell Laboratory researcher presented the solar cycle by having one polarity above a zero line and the other below the zero line.[4] “The data were redrawn with alternate 11-year periods above and below the time-axis; this not only smoothed out the envelope of the maxima but also simplified the analysis by eliminating a computed mean value base-line which has been employed in previous analyses; the maximum-amplitude component becomes approximately 22 years instead of 11 years and the physical justification is the similarity in the polarity of the leading spots in alternate 11-year periods.” The computed mean actually suppressed the presence of the much longer waveform on which the shorter waveforms are embedded. From ref. (4), “It is of interest to note that the 22.25-year component which is largely responsible for the 11-year periodicity of sunspots has an amplitude of only about two-fifths of the greatest amplitudes of the resultant maxima.” This indicates that the Sun itself is responding differently to the different frequency components of the wave that is passing through our part of the galaxy. Ref. (4) also suggests that the shorter periods are possible harmonics of a 312 year period. A 312 year period at the end of the last Maunder Minimum would put us at the start of the next

Maunder type minimum. The use of the term *periodicity* rather than *cyclic* indicates the author of ref. (4) may not have considered that an external EM wave was responsible for the Sun's changing characteristics.

For more than a century after 1840, the official sunspot count included only those sunspots that had a magnitude that could be seen with a telescope of the 1840s. This has resulted in a significant loss of data for the time period this type of count was performed. The manner in how sunspots are counted was changed in 2015. Counting all sunspots that are visible, and their magnitudes, will increase the accuracy of the frequencies identifiable by a Fast Fourier Transform (FFT).

How our Sun responds to the various frequency components is complicated by the Earth-Sun planetary plane orientation relative to the galactic plane, which has an angle of about 63°.[5] The evidence that long period EM waves are coming from near the center of our galaxy is because of the sunspot butterfly effect, which produces a pattern that is approximately 55° relative to our Sun-planetary plane. The *relic* wave detected is at 72° to our Sun-planetary plane. Because we are observing effects of an EM emission, we have no way of currently determining if more than one wave is responsible for the observed effects.

The direct detection of relatively high frequency EM waves that create individual sunspots, where some last for just a few days, should be readily correlatable with visual observations.

Long Term Data Storage and Retrieval

The acquisition and retrieval of data acquired through long term monitoring, decadal, will have to be addressed. Recording media and methods can change dramatically in relatively short periods and there must be in place processes to upgrade data acquired through older recording and storage technology to contemporary recording and storage techniques to assure older data can be used and analyzed in the same manner with currently acquired data.

Instrument calibration against a reliable standard is a must to identify an EM wave variation that can take decades to be identified. The EM waves that are influencing our Sun will have very high magnitudes and care must be taken to protect instruments and personnel when sensors are developed that have resonance with these waves.

Conclusion

Below 1 Hz radio astronomy is needed to identify the source of the EM wave or waves that are influencing our Sun's characteristics. It will require long term persistence to monitor near the core of our galaxy for the general source of long period EM waves with frequencies below 1 Hz.

References

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[4] Anderson, C.N. "A REPRESENTATION OF THE SUNSPOT-CYCLE*" http://www.leif.org/EOS/TE044i002p00175.pdf

[5] Cosmos "Galactic Plane" http://astronomy.swin.edu.au/cosmos/G/Galactic+Plane