

Rupert Sheldrake
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Is the Sun Conscious?

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Annotation: *The recent shift in philosophy towards panpsychism opens up the possibility that self-organizing systems of any level of complexity, including stars and galaxies, may have experiences, awareness, or consciousness. An organic and holistic philosophy of nature also leads us in this direction. At the same time, field theories of consciousness assume that some electromagnetic fields are indeed conscious and that they are by their very nature integrative. When applied to the sun, such field theories suggest the possibility of the existence of a physical basis for the mental activity (mind *) of the sun, both directly in the body of the sun and throughout the solar system. If the sun is conscious, perhaps it deals with issues such as regulating its own solar body and the entire solar system through electromagnetic activity, which includes solar flares and coronal mass ejections. It is also possible that the sun is communicating with other star systems within the galaxy.*

* Translator's note: the English term mind can mean the following concepts: mind, reason, reason, intellect, consciousness, thinking, rational / intellectual / mental activity; experience - experience, sensations, experiences.

1. Introduction

Is the sun conscious?

Obviously not - from the point of view of mechanical materialism or physicalism. The universe is a mechanical system. There is no consciousness in nature. Examples of conscious minds are epiphenomena produced by physical activity of the brain; or they are identical to the physical activity of the brain, as, for example, water and H₂O are the same, but have different names; or is it an illusion generated by the brain; or it is nothing more than a popular belief of people still not enlightened by objective neuroscience (Churchland, 1986). Therefore, anyone who believes that the sun is conscious is committing a childish mistake by mentally transferring anthropomorphic illusions to inanimate nature. The fact that children often paint the sun in the form of a smiling face clearly demonstrates that this idea is literally childish. And the question itself is ridiculous.

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In almost all other societies and civilizations, including medieval Europe, the sun and other celestial bodies were considered living and intelligent beings. Our ancestors lived in an animistic world. The earth, sun, planets and stars were living beings for them. As Plato put it, 'This world ... arose truly as a living being, with soul and mind ... as a single visible living creature, containing all living things, the nature of which is of the same order' (Plato, translated by Cornford, 1959). For Plato and for many philosophers after him, the sun, planets and stars were 'visible gods', endowed with souls and intelligences (Runia, 2008). We still call the planets by the names of ancient gods and goddesses, such as Mars and Venus, and call our earthly home as Mother Earth or Gaia.

In some cultures, the sun was considered a masculine deity: for example *Sol* in ancient Rome and *Surya* in India. In other cultures, the sun was a goddess: *Amaterasu* in Japan and *Sunna* among the early Germanic tribes. In this regard, in modern languages derived from Latin, the noun "sun" belongs to the masculine gender, like the French word *le soleil*, and in Germanic languages - to feminine, like German *die Sonne*. One of the most important traditional chants in Hinduism, *Gayatri Mantra*, is an invocation to the divine light of the sun to illuminate our meditation. Translated by S. Radhakrishnan, 'We contemplate the delightful divine radiance of the sun; may he (the sun god Savitar) inspire our intelligence' (Radhakrishnan, 1994, p. 229).

This debate may seem purely historical or anthropological if it is taken for granted that mechanistic science has triumphed over the archaic worldview of mythologies and religions. Since the seventeenth century, the generally accepted starting point in science has been the postulate that the sun is unconscious; that it is an inanimate object, like everything else. To consider the sun as possessing consciousness is, at best, in the realm of poetry.

However, despite the dominant position of mechanistic theory, the idea that the sun and other stars may be conscious has never left the field of scientific debate. This theme recurs periodically in science fiction, especially in Olaf Stapledon's novel "*Star maker*", which is one of the classics of the genre (Olaf Stapledon, *Starmaker*, 1937), and in which the stars are conscious beings living in a consciousness-permeated universe in the process of self-discovery. I myself have repeatedly participated in discussions on this topic (Fox and Sheldrake, 1996; Sheldrake, McKenna, and Abraham, 1998) along with other authors who have investigated the issue of sun consciousness (e.g. Haldane, 1934; Sams, 2009; Harding, 2011).

Greg Matloff, a physicist and pioneer in propulsion technology for solar sailing spacecraft, opened up a new dimension in this debate with his 'volitional star hypothesis' (Matloff, 2015).

He offers an alternative to the generally accepted theory of 'dark matter'. This hypothetical form of matter is invisible by definition. There is no empirical evidence for this matter, despite numerous attempts to detect it (Bertone and Tait, 2018). I'll return to discussing Matloff's ideas below.

The question of whether the sun has consciousness takes on new significance in light of the recent revival of interest in the philosophy of panpsychism. Like traditional animists, panpsychists argue that mind, or cognition / experience, or forms of consciousness, or perception / awareness are aspects of nature at multiple levels of organization and are not limited by the physical limits of the brain.

2. Panpsychism and information integration

Much of the discussion in the field of panpsychism takes place in the context of the 'hard problem of consciousness'. The difficulty lies in explaining how and why we have phenomenal experiences, which are qualitatively different from the physical processes occurring in the brain and body. To avoid the problem of radical dualism, or a qualitative difference between minds and matter, panpsychists prefer to view this difference as quantitative.

One of the pioneers of modern panpsychism, Galen Strawson, puts this argument as follows: 'There was once a relatively disorganized matter with fundamental empirical and non-empirical properties. This matter has organized itself into increasingly complex forms, empirical and non-empirical, through many processes, including the evolution of natural selection '(Strawson, 2006). The philosopher Philip Goff makes a similar argument: 'Instead of trying to explain the existence of consciousness in terms of the absence of consciousness, the proponent of panpsychism seeks to explain the complex consciousness of the human brain and the brain of animals in the language of simple forms of consciousness, the existence of which is postulated as fundamental aspects of matter '(Goff, 2019, p. 115).

Both Strawson and Goff make it clear that they do not offer the idea of consciousness or perception in physical objects. Their arguments refer to self-organizing systems such as atoms, cells, and living organisms, not composite structures such as rocks, tables, and computers. As Goff writes, panpsychists' believe that the fundamental constituents of the physical world are conscious, but they need not assume that any arbitrary arrangement of these particles will result in a conscious subject. Most supporters of panpsychism reject the idea that your socks are conscious, while arguing that they are ultimately composed of components that are conscious' (*ibid.*, page 113).

The integrated information theory of consciousness (IIT), first proposed by Giulio Tononi, makes it possible to consider panpsychism from the point of view of integration processes. Systems such as the human brain have a high level of integrated information, quantified by the mathematical quantity Φ (phi); these systems, accordingly, have a high level of consciousness with complex and substantial experiences. Systems with a low Φ value have less consciousness with simple and rudimentary experiences. Systems with zero Φ have no consciousness.

The details of this theory will help us later in the discussion of sun consciousness in this article. In this context of TII, the word 'information' has a special meaning: it refers to 'differences that make a difference', depending on the amount of information that the system has about itself. A system contains causal information if its current state includes selective past causes and selective future effects (Tononi, 2012). The activity of the brain at a given moment is highly dependent on its previous states of activity and on its future states. The brain is, of course, influenced by external conditions, including body processes and the sensory environment, but the brain's responses are largely dependent on the brain itself. In the retina, for comparison,

According to TII, along with the presence of a high level of information about oneself, in order to have consciousness, the system must also be able to *integrate* this information. Integration depends on the interrelationships between the parts of the system, and integration is lost if the system is cut into parts. Integrated information is irreducible: it cannot be reduced to the level of information in subsystems that are not interconnected (Tononi and Koch, 2015). The amount of information that the system possesses about itself also depends on the number of possible states of the system. The brain is made up of billions of neurons with many different combinations of firing or not firing, which creates a huge number of possible states. In contrast, a simple photodiode can be either conducting or closed. It contains very little information about itself, since it has only two states.

TII has another requirement for defining a system as being conscious; this necessary condition is called the exclusion postulate. The conscious system is the maximum of integrated information. It needs to have more integrated information both than in the parts of which it is composed and in any other larger system of which it is a part. Thus, the brain as a whole must have a higher Φ value than any group of neurons contained in the brain, or the molecules and atoms that make up brain cells. Also, the Φ value for the brain should be higher than for the whole body, or for the Internet, or for any other larger system of which the brain is a part (*ibid.*).

A short formulation of consciousness was given by Hedda Mørch, 'Consciousness, according to TII, is a matter of optimal balance. On the one hand, consciousness requires complexity and variability; these are the conditions for higher levels of information. On the other hand, it requires unity and integration - the parts of the conscious system must be connected to each other by ties stronger than their ties to any other elements' (Mørch, 2017).

However, the mathematical calculations of TII contain such a large number of possible combinations of elements and subsystems that calculating Φ for the brain is practically impossible - even if one uses an improved version of the theory (Kleiner and Tull, 2020). Some calculations show that using CII algorithms to calculate Φ for a human brain, which contains 86 billion neurons, will take many times longer than the age of the universe. Even calculating Φ on a personal computer for a nematode worm brain, which contains 302 neurons, will take 5×10^{79} years (Brooks, 2020).

Another trend of panpsychism is rooted in the philosophy of Alfred North Whitehead, who began his career as a mathematician. Whitehead was the first philosopher to recognize the radical significance of quantum physics. He realized that the theory of the wave structure of matter destroys the old concept of material bodies as essentially spatial bodies, existing at moments of time, but not containing time inside themselves. According to quantum physics, each primary element of matter is an 'organized system of vibrational energy flow' (Griffin, 2008). A wave does not exist in one instant - it takes time; its waves connect the past and the future. Whitehead imagined the physical world not as consisting of material objects, but as consisting of *events*. An event is a kind of phenomenon or becoming. Time is contained within it. All physical objects are processes. Quantum physics shows that there is a minimum time period for events, since everything in nature vibrates, and no vibration alone can be instantaneous. The fundamental units of nature, including photons and electrons, are temporal and at the same time spatial. There is no such thing as 'nature, fixed at a certain moment' (*ibid.*).

Perhaps the most original feature of Whitehead's theory is that he saw the mind and body relationship as a *time*. In Whitehead's theory, mind and matter are related to each other as phases of the same process. Time, not space, is key to their relationship. Reality consists of processes, and one moment conveys information to the next. Distinguishing between moments requires the experiencer to feel the difference between a present moment and a past or future moment. Whitehead summed it up with the phrase 'Now the subject, then the object' (De Quincy, 2008). Experience is always 'now', and matter is always 'ago'. The link from the past to the present is physical causation, as in traditional physics, and the link from the present to the past is feeling or, to use Whitehead's technical term, prehension, which literally means "clinging" or "grasping".

Whitehead did not suggest that the consciousness of atoms is equal to ours; rather, he put forward the idea that they are experiencing and feeling (Segall, 2020). Feelings and experiences are more fundamental than human consciousness, and events taking place in mental space are informed and driven by material events. It is possible to know something only because the past flows into the present, forming and shaping it, and at the same time, the subject selects opportunities that will help him determine his future (De Quincy, 2008).

Whitehead was also one of the main pioneers of holistic or organismic philosophy of nature. In this philosophy of the organism, atoms are not inert particles of matter, as the old atomistic theory said. Thanks to the discoveries of quantum physics, it would be more accurate to say that atoms are structures of activity, patterns of energy vibration within fields. In Whitehead's words, "Biology is the study of large organisms, while physics is the study of small organisms" (Whitehead, 1925). Whitehead wrote his scientific papers before the existence of galaxies outside our own was recognized, and long before evolutionary cosmology appeared, which became generally accepted only after 1966 (Singh, 2004). In the light of modern cosmology, physics is also the study of very large organisms such as planets, solar systems, galaxies and the entire universe. The most famous example of this scientific approach is the Gaia hypothesis, or the idea that the Earth is a living organism (Harding, 2009).

In the light of the philosophy of the organism, wherever we glance in nature, at any level and on any scale, we will find unity, consisting of parts that are themselves a single whole at a lower level: for example, crystals are made of molecules, molecules are made of atoms, atoms from nuclei and electrons, nuclei of atoms from protons and neutrons, and protons and neutrons from quarks. Or: ecosystems consist of organisms, organisms from organs, organs from tissues, tissues from cells, cells from organelles, organelles from molecules ... Or: galaxy clusters consist of galaxies, galaxies from solar systems, solar systems from stars and planets. Languages are organized in the same way: sentences consist of phrases, phrases from words, words from syllables, syllables from phonemes (Sheldrake, 2012).

These organized systems are everything *nested hierarchies*. At each level, the whole includes parts. These parts are literally *inside* whole. At each level, the whole is more than the sum of all the parts, and has properties that cannot be predicted by examining the parts separately.

Arthur Koestler suggested using the term *holon* (holon) for such wholes, consisting of parts, which are themselves whole: 'Each holon has a dual tendency to preserve and assert its individuality as a quasi-autonomous whole; and function as an integrated part of a larger (existing or evolving) whole' (Koestler, 1967, p. 385). Koestler envisioned consciousness as a manifestation of the Integrative Tendency inherent in all holons.

For such nested hierarchies of holons, Koestler proposed the term *holarchy* (holarchy). At each higher level, the degree of consciousness increases: 'Since the variety of choice of alternatives increases as the complexity of the system increases at higher levels, each shift upward is accompanied by a subjective experience of freedom of decision-making' (*ibid.*, page 215).

The holistic philosophy of nature, together with various directions of panpsychism, inevitably raises the question of the possibility of the presence of consciousness in the sun and other stars.

For conscious activity, the sun needs to be able to track what is happening in its own body and over the entire area of its expanded body - in the solar system - and integrate this information. One way of integrating information is through field integration, including electric and magnetic fields. We turn to this discussion in the next section, after which we will consider the question of the possible presence of consciousness in the sun in the light of these ideas.

3. Electromagnetic field

Theories of consciousness

Fields are basically integrative. They are also holistic in nature. Imagine the magnetic field of a magnet in the form of an iron bar. This field comes from many microscopic magnetic domains found inside the metal. At the same time, it exerts a downward influence on these magnetic domains and builds three-dimensional patterns of influence beyond the material body of the magnet. If you sprinkle metal shavings around a bar-shaped magnet on a horizontal surface, a 2D image of a 3D magnetic field appears in the form of curved lines of force. Pieces of metal shavings are arranged in this way not due to local upward interactions; the downward magnetic field determines the shape of the chip patterns.

Gravitational fields also act from top to bottom. The gravitational field of the Universe contains everything that is in the Universe, and correlates all material bodies with everything else. All material bodies act on the gravitational field and, in turn, are under the influence of the gravitational field.

Likewise, electric fields affect anything that is within their range of influence and is electrically charged; magnetic fields affect anything that is or can be magnetized. These fields, in turn, are influenced by electric charges and magnetic fields.

In addition, electric and magnetic fields interact. As Michael Faraday demonstrated in his classic studies, a changing electric field creates a magnetic field, and a changing magnetic field creates an electric field. These principles underlie the operation of electric motors and power generators.

The nervous system in general and the brain in particular function as electromagnets. The membranes of nerve cells, or neurons, are electrically charged; the inside of the cell has a negative electrical charge relative to the positively infected outside. Resting potentials of nerve cell membranes are usually about 60 millivolts. When impulses travel along the axons of the nerves, which can be likened to the wires of the nervous system, the resting potential is temporarily depolarized. As the wave of depolarization travels along the axon, it changes the surrounding electric and magnetic fields.

Within the brain, large-scale rhythmic patterns of electrical activity arise from the activity of countless neurons, such as alpha waves (7-15 Hz), which can be observed in the brain of an awake person during relaxation with closed eyes, theta waves (3-8 Hz), observed during sleep time, and gamma waves (25-140 Hz) arising from large-scale brain activity and possibly playing a role in the formation of unified perceptions. These oscillating electric fields can be measured with electrodes attached to the skull, as in electroencephalography (EEG). These electrical waves create vibrating magnetic fields.

Electric fields inside the brain also affect the activity of the neurons themselves. Just as neurons are influenced by contacts between nerve cells through neurotransmitters released at synapses, they are also influenced by the electrical activity of nearby neurons through local electric fields; this process is known as 'ephaptic coupling' (Su *and etc.*, 2012). Most researchers agree that consciousness is somehow related to the electrical activity of the brain. Some go even further and suggest that the brain's electromagnetic fields *themselves actually* have consciousness. In his hypothesis of a 'conscious electromagnetic information field' (Cemi), JohnJoe McFadden points out that the brain generates electromagnetic fields and at the same time is influenced by them. The electromagnetic field affects the field-sensitive voltage-gated ion channels in neuronal membranes:

The information in the neurons, therefore, is combined, integrated, and reflected back into the neurons through the emfield of the brain and through its influence on the firing patterns of neurons ... (E) that self-referral loop has physical and dynamic properties that are exactly are combined with consciousness and which in the narrowest sense can be given a rational explanation provided that the em field of the brain is actually a substrate of consciousness and the conscious expression of will is the result of the influence of the em field of the brain on neurons that initiate motor acts. (McFadden, 2012)

McFadden also points out that such a field theory would offer a 'natural solution to the binding problem,' namely the problem of explaining how different sensory input and activity in different regions of the brain combine together and result in whole sensations and experiences (unified experiences).

Susan Pockett, a neurophysiologist, also argues that some patterns of the brain's three-dimensional electromagnetic field are conscious: 'conscious experiences may actually be short-term spatial patterns of large-field potentials: in other words, short-term spatial patterns of electromagnetism' (Pockett, 2012). She puts forward the idea that conscious fields, as opposed to fields that are not conscious, exist radially in the brain, perpendicular to the surface of the cerebral cortex, and contain a surface layer of negative charge over two deeper layers of positive charge, separated by a distinctly pronounced uncharged layer (*ibid.*).

There are at least eight other theories of consciousness based on the activity of electromagnetic fields (reviewed by Joye, 2019). In addition, the neuroscientist Todd Murphy has developed a primarily magnetic theory of consciousness. Murphy worked on the experimental induction of altered states of consciousness by transcranial magnetic stimulation of the brain. He's writing:

[C]ognition (the magnetic field of the brain) is constantly influenced by neural electrical activity through the classically known relationship between magnetic fields and electric currents ... What we experience at each moment in time is perhaps a phenomenological correlate of the most excited, connected or saturated with information areas of this field, or areas with the most pronounced information content ... [M]agnetic fields spread in the brain much faster than neuroelectric or neurochemical processes. This makes intracerebral communication by means of a magnetic field the fastest type of communication available. Organisms will react to threats and opportunities with greater speed if the magnetic substrate of the brain underlies consciousness, than if consciousness was based on slower chemical or electrical processes. (Murphy, 2019, p. 650)

Murphy also notes that the magnetic field hypothesis offers a solution to the bonding or combining problem. Magnetic fields, like other types of fields, are basically integrative.

Thus, for the most part, we see a scientific consensus that conscious mental activity is somehow related to the electromagnetic activity of the brain, and some researchers put forward the assumption that these fields are not only related to conscious processes, but *themselves are* conscious processes. Is it possible for any of these ideas to be relevant to the sun?

We first look at Matloff's hypothesis that some stars adjust their position within galaxies by controlling the direction of electromagnetically powered jets, and then move on to discussing the sun's electromagnetic fields.

4. The hypothesis of willing stars

Modern cosmology and astronomy are based on the hypothesis that the Universe contains not only known forms of matter, but also unknown forms of it, called "dark matter", the amount of which is much greater than the amount of ordinary matter. This is the premise of Matloff's hypothesis.

In the 1930s, Swiss astrophysicist Fritz Zwicky studied the motion of galaxies within galaxy clusters and concluded that clusters could not be held together by ordinary gravity. The galaxies were pulling each other towards them with too much force. The force holding them together seemed to be much greater than the gravitational pull that could be explained by visible matter (Singh, 2004). Zwicky's results were ignored for decades, but they became serious when it became apparent that the orbits of stars within galaxies could not be explained by the gravitational pull of known types of matter. It seemed too powerful a force acting on the stars. Astronomers plotted gravitational forces on the map and found that the visible sources of gravity did not match the observable structure of galaxies. *ibid.*)

Dark matter helps explain the movement of stars within galaxies and the relationship of galaxies within galactic clusters, but such an explanation comes at a high cost: no one knows what dark matter is, and all attempts to detect it experimentally have failed (Bertone and Tait, 2018) ... Some physicists believe that you can do without dark matter altogether if you make changes to the laws of gravity (Chown, 2014). But there is another possibility: the behavior of galaxies and stars probably cannot be fully explained in terms of gravity, but there is no need to introduce the concept of dark matter or change the laws of gravity. Here's a biological analogy: Imagine cells inside a growing embryo. They move of their own accord to take their proper place within the embryo.

In his hypothesis of willing stars, Matloff proposes the idea that stars adjust their position within galaxies by firing electromagnetic jets in one direction more than another, keeping course in their respective positions. 'The expression of will in stars in the galaxy may be analogous to the tendency of cells in a living organism to organize themselves to form organs' (Matloff, 2015, p. 146). He points out that this hypothesis makes several testable predictions. One of them is that the number of directional jets should increase as the distance at which the stars are located relative to the center of the galaxy increases. Another prediction is that the direction of the jets should be directed opposite to the galactic trajectory of the young star.

The will-star hypothesis is minimalist in the sense that moving towards the correct position relative to other stars does not necessarily require a high degree of consciousness; it probably requires no more consciousness than the cells inside the embryo have. On the other hand, volitional movements can be only one of the manifestations of a much higher degree of consciousness. People, for example, make volitional movements relative to other people, say, lining up in a queue, but human consciousness includes much more than the ability to build.

The philosopher Clément Vidal's view of willing stars is very different from the rest; he put forward the stellivore hypothesis. Vidal proposed the idea that some stars may be predators looking for their prey, from which they suck matter in order to refuel. This is how stars do in binary stellar systems, in which one star from a pair - a star-eating star - accumulates matter from the other (Vidal, 2016).

When we look at the sky, most of the stars appear as separate points of light, but upon closer inspection, it turns out that most are binary star systems or systems containing numerous stars orbiting each other. Binary star systems have been known since the seventeenth century; in the nineteenth century, scientists discovered that they revolve around each other in elliptical orbits. Some binary stars are located at a great distance from each other and behave more or less independently. Others are close to each other and interact through the transfer of matter. Sirius in the constellation Canis Major, one of the brightest stars in the sky, is actually a binary system. Sirius A shines brightly, and its much fainter companion, Sirius B, is a white dwarf; their orbital period is 50 years. Probably,

Mass transfer between binary stars is not controversial in scientific circles; but Vidal's interpretation of this phenomenon is striking:

[E] there are binary stars that move at high speed in the galaxy ... I predicted that if the star-eaters are alive, the motion of such moving at a higher speed double stars should not be random; it should be pointing towards the nearest star, because a star-eating star would be looking for the closest next food source.

We could also predict that faster-moving binary stars have satellites with less mass on average, which means that their energy source is nearly depleted and they need to find a new star and grow with it. This energy seeking behavior can already be tested against existing data; it would constitute a very entertaining evidence of intelligent behavior. (Vidal, 2020)

Fortunately, our own sun is a solitary star; it is not threatened by a star-eater, and it is not itself a star-eater.

5. Electromagnetic fields of the sun

There is a popular science cliché that 'the human brain is the most complex structure in the entire universe' (e.g. BBC, 2014). This self-importance claim looks unfounded in light of our expanding knowledge of heliophysics. The sun is an extremely complex electromagnetic system whose actions penetrate and extend far beyond the solar system due to the effects of electromagnetic radiation and cosmic rays.

The sun is made of plasma - hot, electrically charged matter in which atomic nuclei and electrons are separated. Most of the sun's atomic nuclei are hydrogen nuclei or, in other words, protons. The sun rotates on its axis and one revolution takes approximately 28 days. As the sun rotates, the plasma also rotates, with the outer layers moving at a higher speed than the inner ones. These movements of electrified plasma create a huge magnetic field that spreads throughout the solar body and goes far beyond it - to the borders of the solar system and even further. Like the Earth, the sun's north and south magnetic poles are close to the rotational poles, but do not exactly coincide with them. The movements of an electric charge inside the surface of the sun and beyond it lead to the appearance of magnetic fields, and changing magnetic fields inside and outside the sun create electrical currents in plasma (Lang, 2001). Moreover, according to the principles of magnetohydrodynamics, the lines of force of the magnetic field around the sun 'freeze' into the plasma. Charged plasma particles spiral around the field lines, maintaining the magnetization (magnetism) of the lines, and the magnetic field lines, in turn, keep the electrically infected particles moving around the lines of force. Thus, magnetic fields control the movement of the plasma, and the movement of the plasma controls the magnetic fields (Green, 2016). the lines of force of the magnetic field around the sun 'freeze' into the plasma. Charged plasma particles spiral around the field lines, maintaining the magnetization (magnetism) of the lines, and the magnetic field lines, in turn, keep the electrically infected particles moving around the lines of force. Thus, magnetic fields control the movement of the plasma, and the movement of the plasma controls the magnetic fields (Green, 2016). the lines of force of the magnetic field around the sun 'freeze' into the plasma. Charged plasma particles spiral around the field lines, maintaining the magnetization (magnetism) of the lines, and the magnetic field lines, in turn, keep the electrically infected particles moving around the lines of force. Thus, magnetic fields control the movement of the plasma, and the movement of the plasma controls the magnetic fields (Green, 2016).

In the layers of the sun under the photosphere (visible surface), complex convection currents of hot plasma form cellular structures called granules, the number of which on the visible side of the sun exceeds one million.

These granules, in turn, are enclosed within much larger structures called supergranules. All of these moving masses of charged particles create electric currents that lead to the appearance of magnetic fields within the universal magnetic field that engulfs the sun and solar system. In addition to this, electrically charged spicules are ejected above the photosphere; they are also electrically charged and magnetic fields also arise around them (Lang, 2001).

The entire sun experiences acoustic vibrations, rolling out like a spherical bell with a wide range of resonant frequencies. These vibrations are influenced by phenomena occurring on the surface of the sun, such as solar flares and sunspots. By monitoring and analyzing these rhythmic patterns, helioseismologists can determine what is happening on the invisible side of the sun based on vibrations that are reflected throughout the sun's body. These vibrations of electrically charged plasma induce corresponding vibrations in the electric and magnetic fields of the sun (Green, 2016).

Solar activity is cyclical and each cycle lasts approximately 11 years. During the period of greatest activity in the sun, a large number of sunspots are observed, from which extremely strong magnetic fields arise from within the sun, winding the photosphere from above and returning to the sun through sunspots with opposite magnetic polarity. Sunspots arise in pairs and, as is commonly believed, the lines of force of magnetic fields come out of sunspots with north polarity, and return through their companion spots with south polarity. These magnetic fields are so strong that they rule out all normal convective and plasma currents, and for this reason sunspots appear dark. Approximately during the period of maximum sunspot activity, an inversion of the total magnetic field of the sun occurs; the sun's north pole as a whole becomes the magnetic south pole and vice versa (Lang, 2001). Thus, a complete solar cycle, during which the original polarity is restored, takes about 22 years. (On Earth, there is also a magnetic reversal, but much less frequently. The last reversal occurred about 780,000 years ago.)

Sometimes these extremely powerful loops of magnetic energy break and connect again, releasing enormous amounts of energy in the process. Large-scale magnetic 'reunions' create solar flares that shoot electromagnetic energy and charged particles into the solar system. Some of these electromagnetic phenomena lead to coronal mass ejections, during which billions of tons of electrically charged plasma are ejected into space (Green, 2016).

Variations in solar activity are a major contributor to space weather, and the United States National Oceanic and Atmospheric Administration (NOAA) issues regular space weather forecasts because solar activity affects the Earth's magnetic field and also affects the aurora and aurora borealis, radio broadcasts and the frequency of lightning.

If solar flares or coronal mass ejections are directed toward the Earth, they can cause catastrophic failures in electrical power systems; backbone power lines act as antennas for this electricity (Witze, 2016).

If the electromagnetic fields associated with brain activity are the main interface between measurable physical processes and conscious and unconscious minds, then the electromagnetic activity of the sun is quite possibly the main interface between the physical activity of the sun and the solar consciousness / mind (solar mind).

For those who believe that complex electromagnetic fields are conscious, as McFadden argues in his theory of conscious electromagnetic fields, and Murphy in his theory of magnetic fields, the consciousness of the sun is nothing more than the subjective experience of these fields.

In general terms, the sun appears to meet the CII criteria for high Φ , or integrated information. The Sun possesses a high level of information about itself within its electromagnetic fields, and this information is integrated within the universal electromagnetic field that permeates the entire heliosphere. According to TII, the amount of information the system contains about itself depends on the number of possible states. The number of states in which the brain can be is large. This statement is also true for the sun. The mind of the sun, although centered on the sun itself, can integrate information from the entire heliosphere, just as the human mind / our minds, centered in the brain, integrates information coming from our body and the world around us. Likewise, the brain's responses, TII says, are highly dependent on the brain itself, and the sun's responses are highly dependent on the sun itself. Similar principles can be applied to countless other stars and solar systems.

However, in fact, it is not possible to calculate the value of Φ for the sun at the moment. If, using modern methods, it takes billions of years to compute Φ for the tiny nematode nervous system, the enormous complexity of the sun's structure would require a computational computation that would take the time of multiple universes to exist. Nevertheless, TII obligingly focuses on the role of combinations of subsystems in the compilation of integrated information. Millions of granules in the sun can be thought of as systems that can be combined into higher order systems such as supergranules, just as neurons can be combined into groups of neurons.

TII also focuses on causal information that could be classified as consciousness: the past state of the elements limits their current state, which in turn limits their future states.

In the sun, causal information is available. As in the case of the brain, the empirical question is to what extent the future states of the systems and subsystems of the sun, in terms of probability, can be influenced by its current states.

According to TII, larger scales of integrated information will relate to networks where multiple complex feedback loops and dispersed connections are present, leading to non-local communication. Overly measured networks or systems in which communication is carried out only forward along the chain (feed-forward) will have little, if any, integrated information. For example, the cerebellum, which contains 3.6 times more neurons in the human brain than the neocortex, has a repetitive architectural structure; although it has the ability to process more information than the neocortex, the cerebellum is not associated with conscious experience (Oizumi, Albantakis and Tononi,

2014). For the sun, the empirical question is to what extent feedback loops and non-local interactions might generate integrated information. The existence of such large-scale spatio-temporal macrostructures as sunspots or supergranules suggests that the presence of such integrated information is at least possible.

However, whether TII is applied to the brain or to the sun, the bottom-up approach of this theory, from simple elements to complex ones, leads to a combinatorial explosion. The number of possible combinations and interactions of subsystems and systems, as well as individual neurons and groups of neurons, instantly becomes difficult to calculate. Hence the timing of computer computation, measured by the duration of the existence of entire universes. In recent formulations by TII, Tononi and his colleagues openly acknowledge the need to go beyond the standard reductionist assumption that micro-causation is overarching and underlies organizational processes at the macro-level. In their own words, 'Causal power may be stronger rather on the macro, *and etc.*, 2016).

In physical reality, the effects of processes at all levels of the organization are integrated into electric and magnetic fields, the causal influence of which is top-down both in the brain and in the stars. In the currently existing TII formulations, the integration activity of these fields is ignored.

In addition to the computational difficulties, one of the key assumptions of TII looks problematic when considering the activity of the sun. The postulate of exclusion is the principle of "the winner takes everything", according to which the highest level of integration has consciousness, while the subsystems within this level do not have consciousness. The solar system is part of the Milky Way galaxy and, therefore, if the galaxy gains consciousness due to the integration of information in its subsystems-components, then the sun's consciousness disappears. And if the entire Universe becomes conscious, then all galaxies will lose their consciousness. In a holistic, panpsychic worldview, this postulate of exclusion may have to be revisited in order to be able to consider multiple levels of consciousness.

Electric and magnetic fields in and around the sun appear to be a more promising starting point for a discussion of solar consciousness than the current formulations of CII.

6. How could the mind of the sun work?

As long as the sun's mind is operating in its usual mode, it is probably unconscious, just as we are not aware of most of our own habitual patterns of activity. According to Whitehead's general principle of mind and matter (see above), if the sun is conscious, its conscious mind is likely to deal with issues such as possible actions and the choice between them. The actions chosen by the sun may include influencing the number, location, and activity of sunspots, the timing and direction of solar flares and coronal mass ejections, and the coordination of granules and supergranules within the surface layers of the sun, as well as flow patterns in the interior of the solar body. All this activity, in turn,

The sun, which has consciousness, could have the ability to sense what is happening in the entire solar system through the electromagnetic field penetrating the heliosphere, which could act as the primary (primary) sense organ of the sun. Thus, the mind of the sun, in principle, could be aware of all events within the solar system. All electromagnetic patterns in the solar system would integrate into the all-encompassing electric and magnetic solar fields. The sun would also have the ability to sense, through its gravitational field, the position and movement of planets within the solar system whose tidal pulls act on the sun (Stefani, Giesecke and Weiser, 2019).

If the mind of the sun is associated with, or even identical to, its electric and magnetic fields, we can roughly calculate the maximum speed of solar thoughts and sensations. The diameter of the sun itself is about 1.4 million km (Lang, 2001). The maximum speed at which changes in magnetic and electric fields can propagate is the speed of light (about 300,000 km / s). Thus, the effect of a change in the electric and magnetic fields on one side of the sun will reach the other side in at least 4.6 seconds. It will take much longer to feel the change that has occurred at the outer edge of the heliosphere - in the heliopause.

The heliopause is located approximately 120 astronomical units from the sun, or, in other words, at a distance equal to 120 times from the sun to the Earth (*ibid.*); it will take 60,000 seconds, or 16.7 hours, to travel this distance of approximately 18 billion kilometers at the speed of light. Thus, by our standards, the thought and sensation of the sun could be described as slow.

If the sun is conscious, if the sun has sensations, feelings, desires, memories, imaginations and intentions, what can it do?

First of all, the sun is supposedly involved in the regulation and preservation of its own body, the sun itself, and its expanded body, the solar system, to the very borders of the heliopause, the plasma membrane, which is the boundary between the solar wind emanating from the sun and the galactic winds blowing in the galaxy; both winds are made up of charged particles, electric currents and magnetic fields.

Within this electromagnetic boundary - in the entire solar system - in the heliosphere, there is a certain organism, in the center of which is the sun. The sun's mind may be closely engaged in modulating the solar system, influencing it through the intensity of the solar wind, through solar flares of directional action and, in the most radical way, through coronal mass ejections, splashing billions of tons of charged particles on everything that comes in their path ... The sun, possibly, senses what is happening in the solar system and influences it through its electromagnetic fields.

Second, the sun may be aware of its location and is consciously interacting with other stars and solar systems in the immediate vicinity and, ultimately, located throughout the galaxy. These systems, perhaps, in turn, are part of the galactic mind, like the neurons in the galactic brain. They are literally connected to each other by means of plasma that permeates the arms of the galaxy, through which electric currents of enormous strength flow, spiraling around the grandiose lines of force of the magnetic field, radiating out along the arms of the galaxy tens of thousands of light years long. The sun is part of an electromagnetic system of colossal size. Rhythmic patterns of activity in the sun and in other stars, perhaps

At the center of our galaxy is a supermassive black hole that emits a tremendous amount of energy, with a galactic wind sweeping along spiral arms emerging from the black hole (Keeney *and etc.*, 2006). The activity levels of this galactic center change quite rapidly, with several large flares per year (Mossoux *and etc.*, 2020). As the sun and other stars revolve around the galactic center, they are affected by huge waves of interstellar gas (Alves *and etc.*, 2020).

The sun is influenced by patterns of electromagnetic activity within the galaxy as a whole, which, in turn, may be closely connected to the galactic intelligence, whose center is probably located either in the most supermassive black hole located in the galactic center, or around the black hole. The galactic mind could influence what is happening here on Earth by influencing the sun and solar mind.

Assuming that the sun's mind operates within or through electromagnetic fields, it turns out that the thoughts and perceptions of the sun must indeed be very slow by our standards. The radius of the Milky Way is approximately 50,000 light years; so that the galactic center can perceive what is happening at the galactic periphery, it will take at least the above amount of time, and then the same amount of time for the center to be able to affect the solar systems at the galactic periphery.

Our galaxy is part of a 'local group' of over 50 other galaxies, which in turn can affect the mental activity of our own galaxy. These galaxies are connected to each other by magnetic filaments. On an even wider scale, clusters of galaxies are connected to each other by magnetic filaments hundreds of millions of light years long, forming part of the 'cosmic web' of electromagnetic interconnections stretching across the entire Universe (Vacca *and etc.*, 2018).

7. Conclusions

Which point of view to hold is our choice. We can assume that there is no consciousness in the entire Universe, that it is governed by eternal mathematical laws, and that the Universe is evolving through aimless and mindless processes. We can imagine our own mind / mind (our own minds) only in the form of physical activity of our brain and abandon our own experience of making informed decisions, declaring it to be illusory. We can hope that scientific advances in neuroscience will someday solve the 'hard problem' of consciousness in a mechanistic way. In other words, we can completely trust mechanistic materialism or physicalism.

Panpsychism offers an alternative to this mainstream official view. Human brains and animal brains may not be the only conscious structures in the universe. Consciousness (consciousness), perception (awareness) or experiences (experience) can be present in self-organizing systems at numerous levels of the complex structural Universe (complexity).

The possibility that the sun is conscious expands the range of our thinking. We can move beyond the familiar 'hard problem' controversy, whose main focus is on explaining the emergence of human minds from small and less complex systems, and move this discussion into a literal panpsychic context, where 'pan' means 'everything / all- / all '(all), which includes stars, solar systems, galaxies, the cosmic web, and ultimately the entire universe.

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