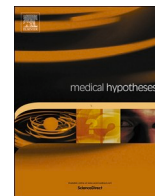




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## What sunspots are whispering about covid-19?

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### ABSTRACT

Several studies point to the antimicrobial effects of ELF electromagnetic fields. Such fields have accompanied life from the very beginning, and it is possible that they played a significant role in its emergence and evolution. However, the literature on the biological effects of ELF electromagnetic fields is controversial, and we still lack an understanding of the complex mechanisms that make such effects, observed in many experiments, possible. The Covid-19 pandemic has shown how fragile we are in the face of powerful processes operating in the biosphere. We believe that understanding the role of ELF electromagnetic fields in regulating the biosphere is important in our fight against Covid-19, and research in this direction should be intensified.

### Introduction

The covid-2019 pandemic is an extraordinary event in the history of our civilization. Billions of people have never been restricted in their homes before.

Self-isolation is conducive to esoteric reflection, and we began to ruminate about Gaia.

Life on earth, once arisen, never completely disappeared, although it survived at least five major extinctions. Isn't that a small (or big) miracle?

Gaia hypothesis suggests that Nature's mercy is neither an accident nor a benevolent deity's work, but instead is the inevitable result of interactions between organisms and their environment [1]. In poetic terms, the Earth with its ecosystem is a gigantic organism that harmonizes itself with the help of many invisible feedbacks.

Unfortunately, human activity causes environmental degradation, which in its destructive effect on the ecosystem rapidly approaches the level of the asteroid impact that end the dinosaur era.

We better stop the destabilization of Gaia, because otherwise either we succeed in this reckless enterprise and destroy the ecosystem and our own existence, or Gaia recognizes our malicious character and invisible feedbacks eliminate us, as a destabilizing element. However, in order to harmonize with Gaia, we must improve our understanding of these invisible feedbacks.

### Solar activity and pandemics

At first glance (and at the second too) there can be no connection between pandemics and solar activity. However, this is exactly what Alexander Chizhevsky discovered [2] many years ago.

Independently, Hope-Simpson observed the same correlation between influenza pandemics and sunspot maximums [3]. Hoyle and Wickramasinghe confirmed these findings [4] indicating that the two phenomena have kept in step over some 17 solar cycles.

Interestingly, the previous two Corona virus epidemics, the severe acute respiratory syndrome SARS-CoV and the Middle-East respiratory syndrome MERS-CoV both occurred at double peaks in the sunspot cycle [5].

A more general result states that most pandemics in the past occurred near the sunspot extrema (maxima or minima) [6,7]. In a sense, the present covid-19 pandemic was predicted based on this idea [8,9].

Of course, such an outlandish idea should be taken with a grain of salt, and not everybody believes in it [10]. However, we think this strange idea cannot be dismissed easily. The correlation in the data is so obvious that different people have noticed it. We already mentioned Chizhevsky and Hope-Simpson. It seems that the first person who linked the sunspot cycle to the malaria epidemics, as early as in 1881, was C. Meldrum [11]. In 1936, Gill noted that the association of malaria epidemics with the epochs of maximum and minimum of sunspots is extremely close [11].

Solar activity can affect biological organisms in various ways. Of particular interest is the influence mediated by geomagnetic and extra-

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low frequency (ELF) electromagnetic fields [12,13].

The Schumann resonance with base frequency of about 8 Hz is a global electromagnetic resonance excited by natural lightning activity within the Earth-ionosphere waveguide [14]. Life evolved on Earth under the constant presence of Schumann resonances, and thus, we cannot exclude that ELF electromagnetic fields played a role in biological evolution.

Human activity has become a source of widespread electromagnetic pollution, which raises concerns about the possible dangerous health effects [15]. Although studies on the possible biological effects of ELF and other artificial electromagnetic fields remain largely controversial, there is a growing evidence that ELF fields cause numerous types of changes in cells [16–18].

### Biological effects of ELF electromagnetic fields

Modern life is not conceived without electricity with its power lines and appliances, without telecommunication devices. A byproduct of this technical revolution is an ever-growing number of sources of artificial electromagnetic fields, both in ELF and radio frequency range, and this circumstance, as already mentioned, elicits public health concerns [15].

The scope of interactions of electromagnetic fields (EMF) with living matter is rich and diverse, requiring simultaneously an unbiased, open-minded, careful and cautious approach when studying the influence of EMF on biological processes.

Despite a large body of literature devoted to biological effects of ELF magnetic fields (in contrast to ELF electric fields, magnetic fields easily can penetrate biological tissues), no coherent picture has emerged so far regarding the plausibility of such effects, or regarding the interaction mechanisms.

Epidemiological studies that have focused on the potential health hazards of EMFs are largely controversial. About half of the studies found such effects, but the other half failed to find them [19]. The reason for these conflicting results is unclear.

Nonetheless, ample and compelling evidence had been accumulated indicating that ELF electromagnetic fields has important effects on cell functioning [17,20–25]. The nature of these effects is not entirely clear. The problem is that such effects are observed for very weak magnetic fields, so weak that any such effect is expected to be masked by thermal noise [26].

Perhaps, the extreme sensitivity of living organisms to weak electromagnetic fields is not completely unexpected from the point of view of evolutionary biology, since life arose and evolved on Earth with the constant presence of natural ELF electromagnetic fields, especially Schumann resonances [27,28].

Remarkably, there is a striking similarity between natural ELF signals and human brain electroencephalograms [29]. Amazingly, many species exhibit, irrespective of the size and complexity of their brain, essentially similar low-frequency electrical activity [30], and it is possible that the dominant frequencies of brain waves may be an evolutionary result of the presence and influence of the resonant ELF electromagnetic background of Schumann [31].

An interesting hypothesis is that ELF background fields played an important role in the evolution of biological systems and are used by them as a means of stochastic synchronization for various biorhythms [28]. The Schumann resonance frequencies are mainly controlled by the Earth's radius, which has remained constant over billions of years. Therefore, these frequencies can play a special role for the regulatory pathways of living organisms, the Schumann resonances providing a synchronization reference signal, a Zeitgeber (time giver) [12].

This hypothesis, while attractive, has a serious drawback: it remains a mystery how living cells can detect a Schumann resonance signal that is so weak (the magnetic component is only several  $pT$ ) compared to the ubiquitous thermal noise. The clue maybe is provided by spatially and temporally coherent interactions of Schumann resonances with a large ensemble of components of the system [32]. For example, the human

body contains about  $10^{14}$  cells and  $10^{10}$  cortical neurons.

If the ELF electromagnetic fields, and in particular the Schumann resonances, really play a regulatory role in biological processes, then the effect of solar activity on living organisms will not look so mysterious, since solar activity changes the geomagnetic field and can lead to geomagnetic storms, as well as to changes in the parameters of the ionosphere, and, consequently, to a change in the parameters of Schumann resonances and ELF radiation background.

There are some indications that abrupt changes in geomagnetic and solar activity, as well as geomagnetic storms, can act as stressors that alter the regulatory processes of organisms, blood pressure, immune, neurological, cardiac and some other important life-supporting processes in living organisms [33]. There are studies that indicate that geomagnetic disturbances can exacerbate existing diseases, can lead to cardiac arrhythmias, cardiovascular disease, a significant increase in hospitalization rates for mental disorders, depression, suicide attempts, homicide and traffic accidents (see [33] and references therein).

There are several hypotheses that could explain this strange connection between solar activity and geomagnetic disturbances and mental health. According to the visceral theory of sleep [34], the same cortical neurons that process exteroceptive information in the waking state switch to processing information from various internal organs during sleep. At the same time, a violation of the switching process, when visceral information is mistakenly interpreted by the brain as exteroceptive, can manifest itself as a mental disorder [35]. If these hypotheses are correct, and if geomagnetic disturbances can influence the brain's switching mechanisms, then the unexpected link between solar activity and mental disorders could be explained.

### Concluding remarks

Scientific progress has greatly expanded the ability of humankind to cause large-scale changes in the environment. Unfortunately, we do not always understand the subtle feedback loops that operate in the biosphere to predict all consequences of such changes. An amusing example of the unexpected outcome of a large-scale human intervention in nature is provided in [36].

For unknown reasons, fish in the Gulf of Mexico position themselves over buried oil pipelines off the shore of Texas, orienting themselves directly above the buried pipeline at a height of 1–3 m above the seabed and perpendicular to the axis of the pipeline. Presumably they are responding to some electromagnetic stimuli, such as remnant magnetism in pipeline sections, voltage gradient induced by corrosion protection devices, or transient signals induced into the pipeline by remote lightnings or solar wind induced magnetic storms [36].

The research of biological effects was intensified at about 1967 as part of an evaluation of the environmental impact of a proposed ELF military antenna (Project Sanguine) [37]. Unfortunately, the presence of military and commercial components in this research makes it politically very sensitive [27]. Nonetheless, in light of the results so far available, it would be too irresponsible to dismiss such effects as being implausible [32].

On the practical side, if ELF fields cause biological effects, whatever the unknown mechanism of this interaction, we can try to use these effects in our fight against SARS-CoV-2 and similar infections. It is known that bioelectric signals generated by the metabolic activity of cells are in an ELF range, therefore by interfering with these signals by external low intensity ELF electromagnetic fields we can suppress microbial or bacterial activities [38–40].

We believe that under the burden of the Covid-19 pandemic, research in this direction should be intensified. Studies of the antimicrobial effects of ELF electromagnetic fields are not expected to be too expensive. If successful, it promises a non-invasive, inexpensive, safe and fast technique to fight infections [39,40].

Is Covid-19 pandemic related to the deepest sunspot minimum for a century we are experiencing now? During sunspot minimum solar

magnetic field gets weaker and, as a result, galactic cosmic rays flux entering the earth increases. There are some indications that an increase in the flux of cosmic rays can lead to an increase in lightning activity on earth [41,42] and thus change the natural ELF electromagnetic background. As noted in [27], changing the electromagnetic background poses a twofold challenge to us: weakening the immune system due to constant stress and more severe illnesses, since electromagnetic fields can stimulate bacterial growth and increase their resistance to antibiotics.

Increased cosmic rays can lead also to appearance of novel virion strains due to induced mutation and genetic recombination events [9,54], especially if viruses spread even beyond the tropopause (new bacteria have been found in the stratosphere and even on the exterior of the International Space Station, orbiting at a altitude of 400 km) [54].

Interestingly, the idea that the flux of galactic cosmic rays can affect the ELF electromagnetic background can be tested using the Forbush effect [43]. During solar flares, the flux of galactic cosmic rays decreases rapidly (over a day or less) due to modification of the near-Earth interplanetary magnetic field. This so-called Forbush decrease is transient and is followed by a gradual recovery over several days [44-46].

Based on the measurements in the Kola peninsula, it was demonstrated that in all ten events of significant Forbush-decreases, the intensity of the ELF-atmospherics decreased (down to their complete disappearance) [43]. It was hypothesized that this phenomenon is caused by a decrease in the intensity of discharges of a special type (sprites and jets) as a result of a decrease in atmospheric ionization at altitudes of 10–30 km during the Forbush decrease in the flux of galactic cosmic rays [43].

Cosmic ray forcing of the climate acts simultaneously and with the same sign throughout the entire globe and operates on all time scales from days to hundreds of millions of years [47]. For this reason, even a relatively small forcing can lead to a large climatic response over time [47]. To unravel the anthropogenic contribution to the current climate change and assess its danger, which is now the subject of much public concern and controversy, we need to understand physical mechanisms underlying the influence of solar and cosmic ray variability on climate and their impact on the biosphere.

It has recently been shown that bats, like many other animals with highly developed magnetosensory skills, use magnetic field for orientation and can sense even very weak magnetic fields [48-50]. Perhaps, this magnetoreception is influenced by ELF electromagnetic background [51,52]. Another source of possible influence is the change in cloudiness due to the increased flux of galactic cosmic rays, as bats have been shown to calibrate their magnetic compasses with sunset cues [53].

So, one can imagine the following scenario<sup>1</sup>. Changes in the ELF electromagnetic background, caused by the increased flux of cosmic rays due to unusually deep sunspot minimum, can cause abnormal movements of the population of bats and affect the time of their arrival and departure. Delayed arrival or departure and longer travel times can increase the population of bats in some areas, thereby increasing competition for limited food supplies, and can also increase the likelihood of interspecies transmission of the virus. Besides, increased level of irradiation increases genetic recombination rates, as was demonstrated in laboratories during the 1950s and 1960s [6]. Finally, under the influence of these circumstances, the new coronavirus successfully recombined and caused the Covid-19 pandemic.

We end this article with a funny observation from [54]. The Italian word *influenza* means influence, meaning the influence of the stars in the case of influenza illness. This etymology reflects the belief of our ancestors that events in the sky and events on Earth are interconnected. It may well be that they were right.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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<sup>1</sup> Suggested by an anonymous reviewer

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