Acceleron Aerospace Journal || AAJ.11.2106-2439
Volume 3, Issue 2, pp (441-445)
Short Review
E-ISSN- 2583-9942 || DOI: 10.61359/11.2106-2439

Assessing the Biomedical Consequences of Cosmic Events on Human Health

Hafia Shafqat*

ORCID: 0009-0007-5610-3315

Department of Space Science, University of Punjab, Pakistan

Abstract: This paper explores the profound relationship between humanity and the universe, examining how celestial bodies and cosmic phenomena influence our lives beyond the familiar effects of sunlight. While significant research has been conducted on the origin and composition of celestial bodies, the potential impacts of cosmic events such as black hole collisions, supernovae, pulsars, quasars, and cosmic radiation remain less understood. By integrating insights from diverse scientific disciplines, this study seeks to broaden our understanding of how these phenomena may shape our existence. The investigation aims to uncover the subtle yet potentially significant ways in which the universe affects the trajectory of human life, thereby expanding the scope of cosmic influence beyond the traditionally acknowledged factors of light and heat.

Table of Contents

1. Introduction

The initial impetus for this comprehensive investigation stemmed from the downing of the Russian satellite "Sputnik," an event initially attributed to aerodynamic drag. However, as technological advancements progressed and our understanding of space dynamics deepened, it became evident that space weather—distinct from terrestrial weather—played a crucial role. Satellites, which are now routinely launched into High Earth Orbit (HEO), operate in an environment shaped by complex and unpredictable phenomena. These include interstellar radiation, variations in the ionosphere's composition, and the influence of Solar Radiation Pressure (SRP). Understanding these influences is critical, particularly as human activities in space continue to expand, necessitating an examination of the potential biomedical consequences for human health [1].

2. The Sun and its Influence

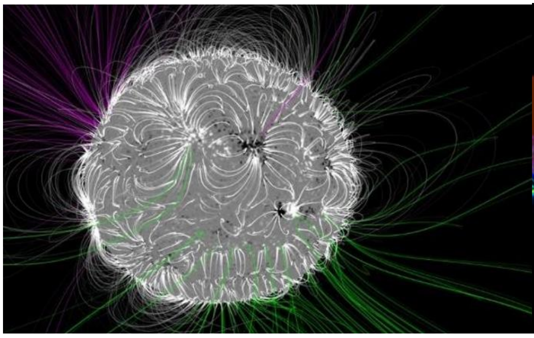
Our Sun, located approximately 151.56 million kilometers from Earth, is a vital source of energy that sustains life by providing light and heat. Despite this distance, the Sun's impact on Earth is profound, extending beyond simple thermal and photonic effects. The Sun's inner layer, known as the photosphere, is a highly energetic region where nuclear fusion occurs, converting hydrogen into helium under extreme conditions. This fusion process releases immense amounts of energy, which travel outward through the chromosphere and into space. These energetic emissions, including ultraviolet (UV) radiation, X-rays, and charged particles, have far-reaching consequences for Earth's atmosphere and living organisms. While the Sun's energy is essential for life, its variability—manifested in solar cycles and sunspots—can have significant impacts on both the environment and human health. The Sun's activity is not constant; it undergoes an approximately 11-year cycle of solar maximum and minimum phases, during which the frequency and intensity of solar events fluctuate. These cycles are closely monitored, as they can influence everything from climate patterns to technological systems on Earth [1].

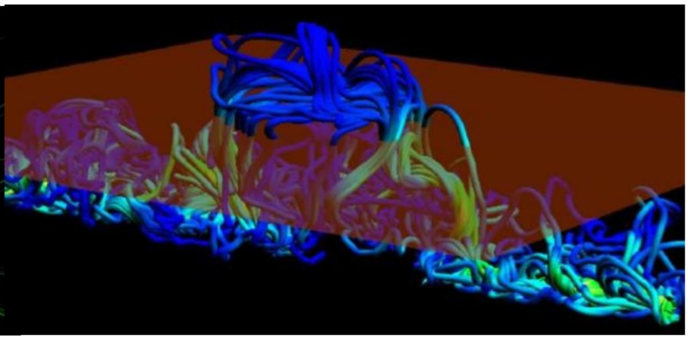
*Space Science Student, Department of Space Science, University of Punjab, Pakistan. **Corresponding Author: hafiashafqat@gmail.com.**
** Received: 16-August-2024 || Revised: 28-August-2024 || Accepted: 28-August-2024 || Published Online: 30-August-2024.

Copyright © AASPL. Published by Acceleron Aerospace Journal (AAJ) with permission. This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). For more info, visit www.acceleron.org.in.

3. Sunspots and Solar Activity

Sunspots are visible indicators of the Sun's magnetic activity, first observed by Galileo in 1610. These dark patches on the Sun's surface result from intense magnetic fields that suppress the convection of hot plasma from the Sun's interior, leading to localized cooling and a reduction in brightness. The Sun exhibits differential rotation, with plasma at the equator rotating faster than at the poles. This differential rotation twists and amplifies the magnetic field, storing energy and creating immense pressure in certain regions. When this pressure becomes too great, it prevents hot plasma from rising, resulting in the formation of cooler, darker sunspots **[2]**.





(Left) **Figure 1 Image of Solar Magnetic Field Captured by NASA;** ***(Right)*** **Figure 2. The figure shows the tangled magnetic field due to the Sun's rotation [Image Courtesy: NASA & Research Community]**

Sunspot activity follows an approximately 11-year cycle, with periods of maximum and minimum activity. Historical records, such as those dating back to February 1755, document these cycles, noting significant peaks in sunspot activity that have coincided with various global events. For instance, the sunspot cycle that began in 1755 and ended in 1766 saw peak activity around 1761, a period marked by significant changes in human society, including the onset of the Industrial Revolution. Such correlations raise intriguing questions about the potential influence of solar activity on historical developments and human behavior.

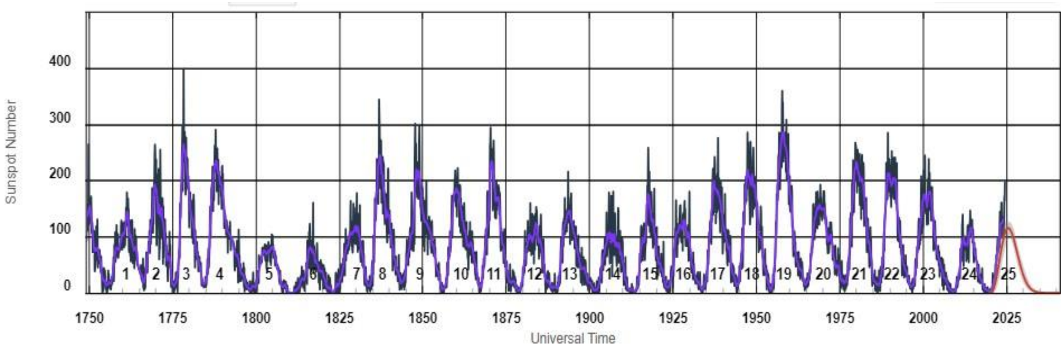


Figure 3. The Graph shows the number of sunspots since 1750. This help scientists to identify the active durations. [Image Courtesy: SWPC.NOAA]

4. Solar Flares and their Consequences

Solar flares are intense bursts of electromagnetic radiation resulting from the sudden release of stored magnetic energy in the Sun's atmosphere. These flares occur when twisted magnetic fields become unstable and release energy across the electromagnetic spectrum, including X-rays, ultraviolet rays, and gamma rays. The size and intensity of solar flares are often correlated with the complexity and magnitude of sunspot activity. For instance, large sunspots are typically associated with more powerful solar flares, which can have significant impacts on Earth **[3]**.

Solar flares are of particular concern because they can affect Earth's magnetosphere, leading to geomagnetic storms that can disrupt communication systems, satellite operations, and power grids. The effects of these storms can be felt globally, with regions closer to the poles being particularly vulnerable due to the direct interaction between solar particles and Earth's magnetic field. Additionally, solar flares can increase the radiation exposure of astronauts and passengers on high-altitude flights, posing a risk to human health **[4]**.

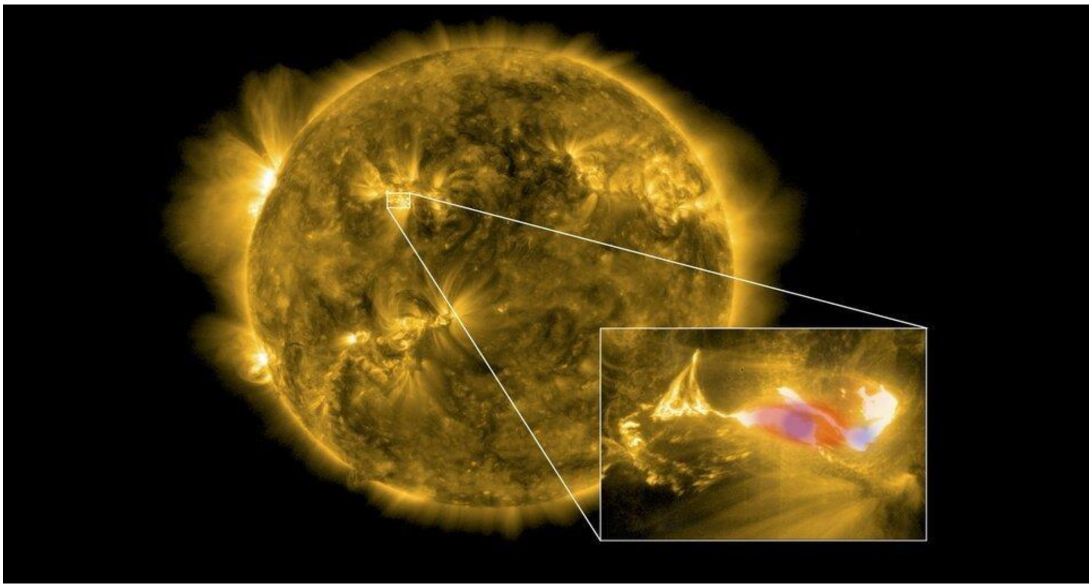


Figure 4. The close up look at solar flares captured by ESA Solar Orbiter. The pink and red color shows the burst of X-rays. [Image Courtesy: ESA Solar Orbiter]

Table-1 Classification of Solar Flares

Solar Flare Type	Associated X-ray flux-I (W/m^2)	Probable Effects on Earth
B	I < 1E-06	No effects
C	1E-06 ≤ I < 1E-05	Possible effects on spacecrafts in orbits
M	1E-05 ≤ I < 1E-04	Blackout in radio transmissions and possible damages to astronauts outside spacecraft
X	I ≥ 1E-04	Damage to satellites, communication systems, power distribution stations, and electronic equipment.

5. Impact of Solar Storms Globally

Solar storms, which encompass phenomena such as solar flares and coronal mass ejections (CMEs), can have significant effects on Earth's technological infrastructure and human health. Satellites in geostationary orbits (GEO) are particularly vulnerable to disruptions caused by increased radiation and charged particles. These storms can induce geomagnetic disturbances, which not only create the beautiful auroras near the poles but also pose serious risks to power grids, communication systems, and navigation technologies.

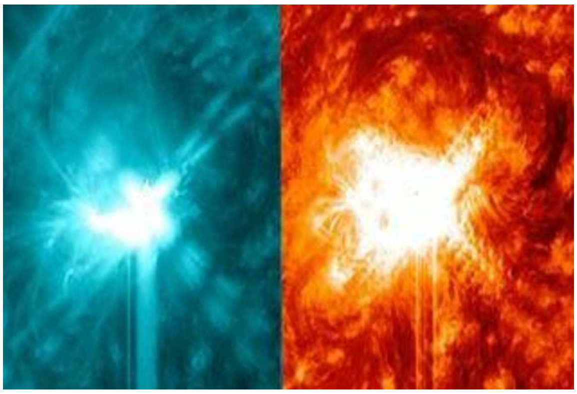


Figure 5. NASA's Solar Dynamics Observatory captured this image of an X1.8-class solar flare on Feb. 21, 2024. (Image credit: NASA/SDO)

The interaction of solar particles with Earth's magnetosphere can generate geomagnetic currents that disrupt electrical systems, damage satellites, and interfere with radio communications. The economic impact of these disruptions can be substantial, affecting everything from global financial markets to emergency response systems. Moreover, the charged particles from solar storms can interfere with cellular networks and electronic devices, highlighting the broad-reaching implications of solar activity on modern technology [5].

6. Solar Storms and Human Cognition

Human cognition relies on the proper functioning of neuronal processes, which involve the movement of ions and the transmission of electrical signals across neural networks. The human brain, a complex organ composed of various regions such as the cerebrum, cerebellum, hypothalamus, thalamus, pons, medulla oblongata, pituitary gland, and brain stem, operates through intricate biochemical and electrical activities. Neurons communicate via neurotransmitters like dopamine, serotonin, norepinephrine, and acetylcholine, which are essential for mood regulation, cognition, and overall brain function. Solar bursts, particularly those releasing high-energy X-rays and gamma rays, interact with Earth's magnetosphere and ionosphere, leading to increased ionization and the presence of charged particles in the atmosphere. These particles can penetrate biological tissues and potentially disrupt atomic bonds and chemical reactions within the human body. Given that neurotransmitter function relies on precise ionic movements and electrical signaling, disruptions caused by cosmic radiation could theoretically influence brain function, potentially altering mood, cognition, and behavior **[6-9]**.

Figure 6. A visual Representation of human brain transferring electrical signals [Image Courtesy: Open Source]

The human body generates its own magnetic fields, but these are negligible compared to the effects of solar phenomena. Exposure to high levels of ionizing radiation from solar bursts could affect neuronal activity, potentially leading to changes in mood, motivation, and cognitive processes. This could manifest as alterations in neurotransmitter levels, impacting psychological states and behavior. Understanding these interactions is crucial for assessing the biomedical consequences of cosmic events on human health **[6-9]**.

7. Conclusion

Solar bursts and cosmic radiation present significant challenges for both planetary exploration and human health. On lifeless planets like Mars, these phenomena primarily pose geological challenges; however, Mars' weak magnetic field makes it particularly susceptible to solar and cosmic radiation, posing serious health risks for future human missions. Increased exposure to ionizing radiation can lead to a range of health issues, from acute radiation sickness to long-term risks such as cancer and cognitive impairment. Beyond Mars, the vast expanse of space is permeated by cosmic radiation, which can be even more intense than solar storms. Understanding the composition and intensity of this radiation is essential for ensuring the safety of astronauts on deep space missions. Additionally, the potential for cosmic radiation to transport biological materials, such as viruses, through space remains an area of concern that warrants further investigation. This review underscores the necessity for comprehensive studies on the biomedical consequences of cosmic events, emphasizing the importance of protecting human health as we advance our presence in space. As humanity looks toward the stars, it is imperative that we not only focus on the technological and exploratory aspects of space travel but also on the potential health risks posed by the cosmic environment.

8. References

[1] Mahmood, S. B. (2006, July). Cosmology and human destiny (2nd ed.).
[2] NOAA / NWS National Weather Service. (n.d.). Sunspots. Retrieved August 16, 2024, from **https://www.weather.gov/sun_and_sunspots**.
[3] ESA / Science Exploration. (n.d.). Solar Flares. Retrieved August 16, 2024, from **https://www.esa.int/What_are_solar_flares**.
[4] NOAA / NWS Space Weather Prediction Center. (n.d.). Solar Cycle Progression. Retrieved August 22, 2024, from **https://www.swpc.noaa.gov/products/solar-cycle-progression**.
[5] Space.com. (n.d.). Solar Maximum Prediction. Retrieved August 17, 2024, from https://www.space.com/solar-maximum-prediction
[6] Harvard Health Publishing. (n.d.). Dopamine: The Pathway to Pleasure. Retrieved August 16, 2024, from **https://www.health.harvard.edu/working_of_dopamine**.
[7] Forbes. (n.d.). This Is What an Epic Solar Storm Looked Like on Mars. Retrieved August 17, 2024, from **https://www.forbes.com/this_is_what_an_epic_solar_storm_looked_like_on_mars**.
[8] ScienceDirect. (n.d.). Does Solar Activity Affect Human Happiness? Retrieved August 16, 2024, from **https://www.sciencedirect.com/effect_of_solar_activity_on_human_mood**.
[9] NASA / SVS Space Visualization Studio. (n.d.). Solar Magnetic Field. Retrieved August 23, 2024, from **https://svs.gsfc.nasa.gov/4623**.

9. Conflict of Interest

The author declares no competing conflict of interest.

10. Funding

No funding was received to support this study.