Wall For All

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Dear Readers

The nostalgic feeling that one experiences while sifting through the dusty old pages of the college magazine cannot be expressed in words. However, very few of us have retained those copies, and most of those precious articles that we wrote during those golden days with enthusiasm are lost forever. With the advent of e-books and other online media, the days of paper-bound college magazines are gone, and the digital platform has paved way to allow retention of such publications without much effort.

Wall-for-All, the e-Magazine published by the Department of Computer Applications, is one such effort that was started with an intent to provide a chance to all students and faculty members to share their thoughts and knowledge, and hone
their skills in creative writing.

I am happy to see the enthusiasm of eminent members of the department to contribute to *Wall-for-All*. This shows the positive and creative energy of the contributors. However, it would be really wonderful if we can see the articles contributed by more students in the next editions, for this e- Magazine is intended to be a writing pad for each member of the department.

I proudly present the current edition of *Wall-for-All*.

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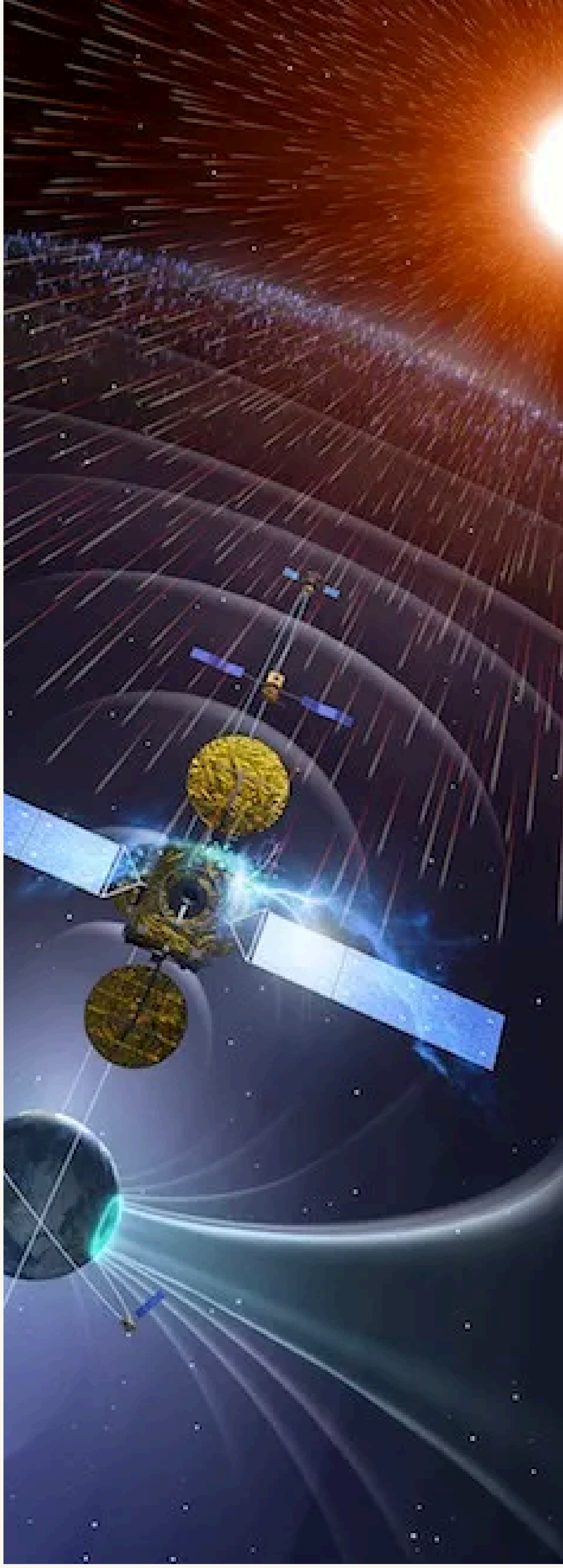
Guardians of the Galaxy: How Space Radiation Affects Astronauts



Space exploration presents numerous challenges, with astronaut health being a paramount concern. Among the various hazards, space radiation stands out due to its potential to cause severe biological damage. This article explores the nature of space radiation, which includes galactic cosmic rays, solar particle events, and trapped radiation belts, and its impact on the human body. Key health risks include DNA damage, acute radiation syndrome, increased cancer risk, cognitive impairments, cardiovascular issues, and other potential effects like cataracts and weakened immunity. The article also discusses current mitigation strategies such as advanced radiation shielding, pharmaceutical countermeasures, careful mission planning, continuous radiation monitoring, and genetic research.

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Introduction

For many years, humankind has been fascinated with space travel, which has propelled technological developments and deepened our understanding of the cosmos. As we get ready for longer missions—like possible trips to Mars and beyond—it is more important than ever to protect the health and safety of astronauts. Radiation is one of the biggest hazards in the space environment. Astronauts are subjected to high radiation levels in space, which can have a significant negative impact on their health, unlike on Earth, where the magnetic field and atmosphere offer significant protection.

Radiation trapped in the Van Allen belts[1], solar particle events (SPEs), and galactic cosmic rays (GCRs) make up most of the complex combination of particles known as space radiation. Because of its great intensity and ability to pierce biological tissues, radiation poses different problems to different kinds of radiation. Creating strong defences requires an understanding of the nature of these radiations and how they affect the human body.

This article explores the several elements of space radiation, looking at how it affects astronaut health and the methods used to lessen the hazards.

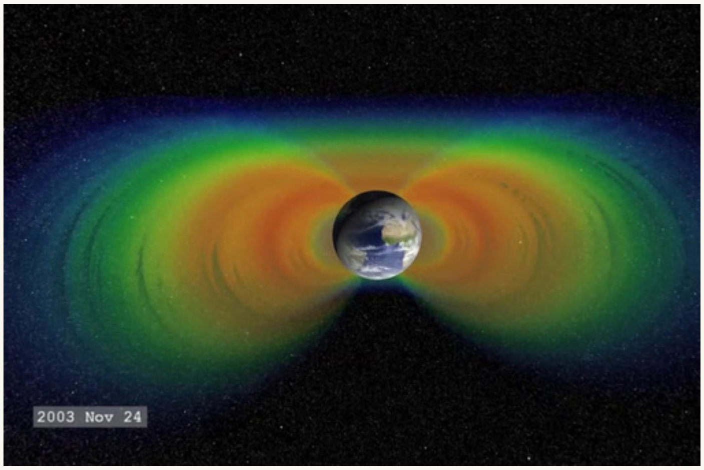

Figure [1] Van Allen radiation belt – Wikipedia

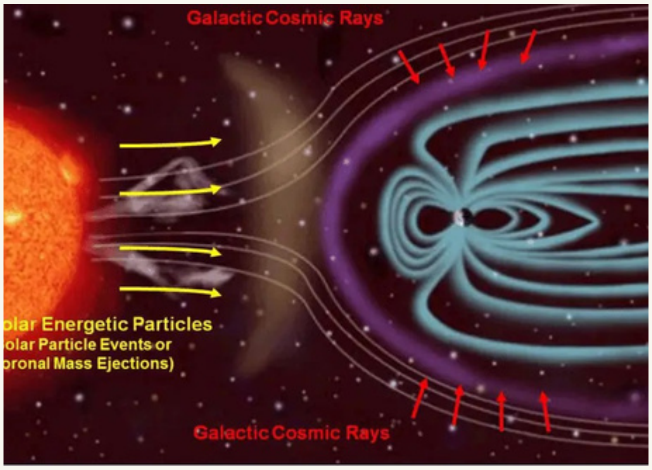

Figure [2] Geomagnetic storm – Wikipedia

Understanding Space Radiation:
The radiation encountered in space differs significantly from that of Earth. It is made up of high-energy particles that come from different sources and each one presents a different risk to astronaut health. Galactic cosmic rays, solar particle events (SPEs), and trapped radiation belts like the Van Allen belts are the main sources of space radiation [1].

Galactic Cosmic Rays (GCRs):
High-energy particles known as galactic cosmic rays originate from sources outside of our solar system, most likely supernova and other high-energy astrophysical events. While protons make up the majority of these particles, they also contain heavier ions like helium nuclei and completely ionised nuclei of other elements[2].

Solar Particle Events (SPEs):
Solar particle events, which include solar flares and coronal mass ejections, are bursts of energetic particles released by the sun, usually during times of increased solar activity. Large amounts of protons and, to a lesser extent, heavier ions can be released during these occurrences. SPEs can result in brief exposure to high levels of radiation, particularly if astronauts are participating in extravehicular activities (EVAs) outside of their spacecraft's shield[2].

Trapped Radiation Belts:
The Earth's magnetic field keeps the trapped charged particles in the Van Allen belts, which surround the planet. The primary elements of these belts are protons and electrons. Although spacecraft that are en route to the Moon or Mars traverse these belts somewhat rapidly, extended exposure on specific missions.

Characteristics and Challenges:
The main problem with space radiation is that these particles have a high energy and can penetrate deep into space. In contrast to radiation on Earth, which is frequently prevented or reduced by rather straightforward barriers, radiation in space necessitates sophisticated shielding methods to properly safeguard humans.

The unpredictability of solar particle occurrences is a serious obstacle. Galactic cosmic rays provide a steady background radiation level, but sudden, variable-intensity SPEs can also happen. Because of this unpredictability, astronaut safety during solar storms depends on reliable monitoring systems and fast response processes.

Biological Effects of Space Radiation:

Space radiation's high-energy particles are extremely dangerous to human health. Space radiation can significantly enter biological tissues, in contrast to the comparatively low-energy radiation seen on Earth, and can have a variety of immediate and long-term negative impacts on health. Understanding these impacts is vital in guaranteeing the security and welfare of astronauts during extended missions[4].

DNA Damage:

The ability of space radiation to harm DNA is one of its most important effects. High-energy particles could neutralise chemicals inside of cells or directly break DNA strands, resulting in indirect damage. Mutations brought on by this harm have the potential to cause cancer and other hereditary illnesses. While some DNA damage can be repaired by the body.

Acute Radiation Syndrome (ARS):

Acute Radiation Syndrome (ARS) can be brought on by brief exposure to high radiation doses. ARS symptoms can appear hours or days after exposure and include nausea, vomiting, drowsiness, and appetite loss. Severe cases may result in burns to the skin, hair loss, and internal organ damage that may be deadly.

Increased Cancer Risk:

Cancer risk rises dramatically with prolonged space radiation exposure. Research on radiation therapy patients and survivors of the atomic bomb provide light on how radiation exposure can increase the risk of cancer. Thyroid, lung, breast, and digestive tract cancers are most common in astronauts. Galactic cosmic ray heavy ions are particularly worrisome because they leave behind extensive ionisation trails in tissues that result in complicated DNA damage that is more challenging for the body to repair may lead to damage of cells.

IV Mitigation Strategies[3]:

Given the significant health risks posed by space radiation, developing effective mitigation strategies is essential for the safety and success of long-duration space missions. Researchers and engineers are working on various approaches to protect astronauts from radiation exposure. These strategies include advancements in spacecraft design, pharmaceutical interventions, mission planning.

Radiation Shielding:

Effective shielding is a primary method for protecting astronauts from space radiation. Several materials and techniques are being explored[4]:

1. Advanced Materials: Materials rich in hydrogen, such as polyethylene, are effective at absorbing radiation. Research is also ongoing into the use of innovative materials like hydrogenated boron nitride nanotubes, which offer superior radiation protection while being lightweight.

2. Water and Fuel: These resources can be used as a radiation shield. Water is excellent for absorbing radiation and can be incorporated into the spacecraft's walls or used to shield sleeping quarters and workspaces.
3. Spacecraft Design: Designing spacecraft with dedicated radiation shelters can provide temporary refuge during solar particle events. These shelters can be strategically placed within the spacecraft to maximize protection using existing mass, such as water tanks and other supplies.

Mission Planning:

Careful mission planning can significantly reduce radiation exposure:

1. Timing Missions: Planning missions during periods of low solar activity (solar minimum) can reduce the risk of exposure to solar particle events.
2. Trajectory Optimization: Choosing flight paths that minimize time spent in high-radiation areas, such as the Van Allen belts, can also reduce exposure.
3. Extravehicular Activity (EVA) Scheduling: Limiting EVAs to periods of low solar activity and monitoring space weather forecasts can help minimize exposure during these high-risk activities[3].

Conclusion

Mitigating the effects of space radiation is a complex challenge requiring a multifaceted approach. Advances in shielding technology, pharmaceutical interventions, mission planning, and continuous monitoring are crucial for protecting astronauts on long-duration missions. As research progresses, these strategies will become more refined, ensuring the safety and health of astronauts as humanity ventures further into space.

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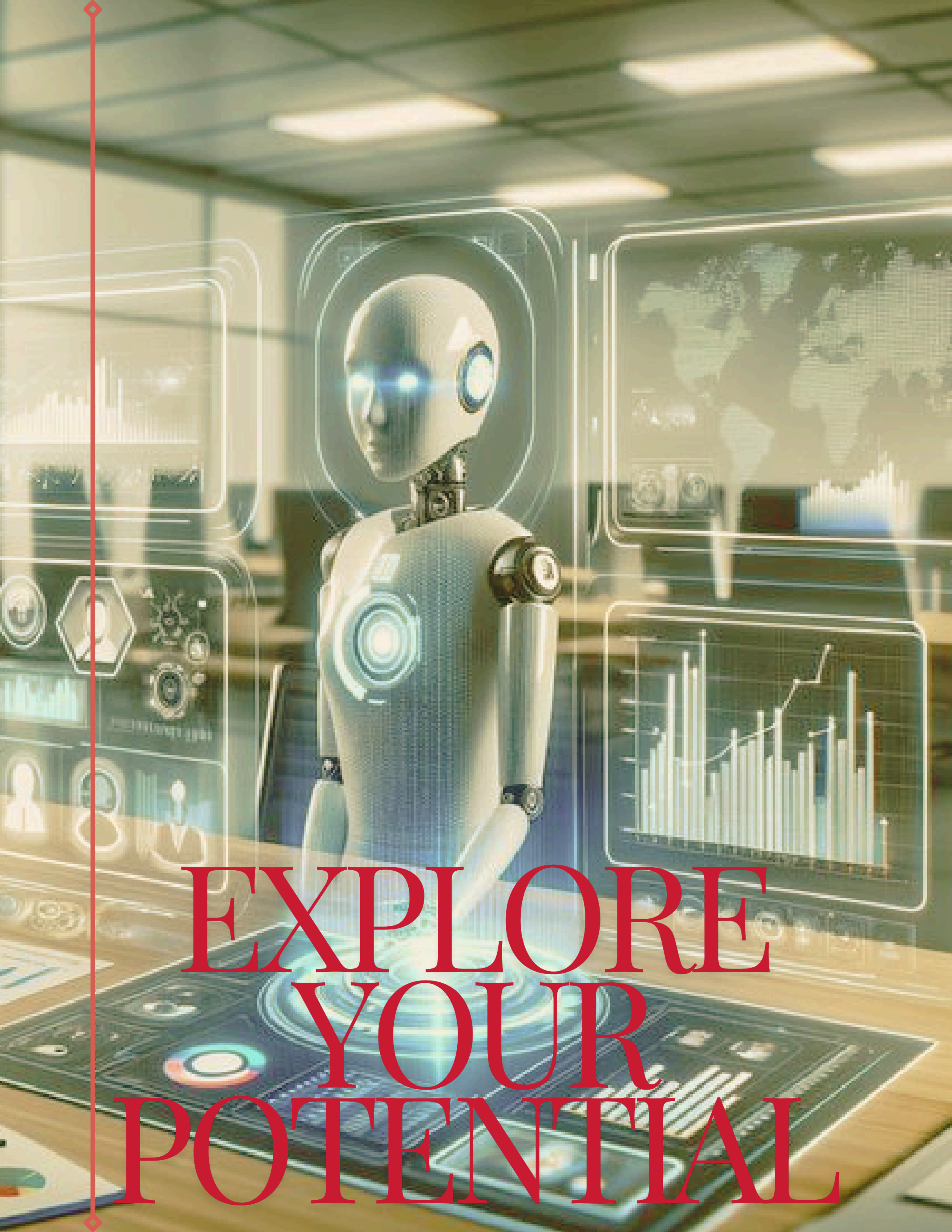
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