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ARTIFICIAL MAGNETIC FIELD AS ACTIVE SHIELD AGAINST COSMIC RADIATION

Abstract

The prospect of establishing a permanent human presence on the Moon and eventually on Mars has gained significant momentum, particularly with the involvement of private entities in space exploration and its economic implications. However, residing beyond our planet Earth brings forth a set of challenges, including temperature fluctuations, vacuum conditions, and constant exposure to cosmic and other radiation types. Addressing these issues not only shapes the structure of extraterrestrial habitats but also has psychological and physiological implications.

On Earth, our protection against cosmic radiation comes from the atmosphere and, crucially, the natural terrestrial magnetic field, which deflects these radiations within its magnetic bands. Ionizing cosmic radiation poses a significant threat, as prolonged exposure can seriously compromise human and animal health by altering DNA chains, increasing the risk of cancer, and damaging eye lenses.

This fundamental research aims to address the challenge of ionizing cosmic radiation exposure. Current state-of-the-art solutions involve creating habitats beneath thick layers of lunar or Martian regolith to passively shield the inhabited space from external radiation. However, this approach results in living essentially underground, raising serious psychological issues, especially for extended stays such as those envisaged for Mars colonization.

The innovative solution proposed in this research is to construct an artificial magnetic shield using a series of electric cables strategically arranged to deflect particles away from the habitat. This design prevents cosmic particles from entering the inhabited zone, allowing for the construction of habitats with large windows, offering panoramic views and reducing psychological stress during the stay.

The project envisions the use of an artificial magnetic field generated by an underground toroidal structure composed of superconducting wires (potentially experimenting with magnesium diboride). The magnetic field lines generated will envelop the settlement, located inside the toroid on the lunar surface, effectively repelling cosmic rays.

This approach necessitates a highly interdisciplinary investigation from the outset, involving expertise in cosmic rays, space radiobiology, superconducting wires, electromagnetic field generation, and characterization, as well as architectural and civil engineering considerations associated with its implementation. This comprehensive approach underscores the complexity of developing active shielding technologies and highlights the need for collaborative efforts across diverse scientific and engineering domains.