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Radiation Fields, Effects and Risks in Human Space Missions (5)

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EVALUATION OF DEEP SPACE EXPLORATION RISKS AND MITIGATIONS AGAINST RADIATION AND MICROGRAVITY

Abstract

Ionizing radiation and microgravity are two considerable health risks encountered during deep space exploration. The latter has deleterious effects on the human body, such as weakening the immune system and delaying wound healing. Microgravity can also disrupt the correct functioning of the musculoskeletal, cardiovascular, and sensorimotor systems. Ionizing radiation, the other predominant health risk faced by astronauts, exists in three distinct forms in space: galactic cosmic radiation, solar particle event radiation and solar winds. In deep space, the radiation-rich environment will affect astronauts critically. Furthermore, inside the spacecraft and inside certain space habitats on Lunar and Martian surfaces, the crew might be exposed to intravehicular radiation, which arises from nuclear reactions between space radiation and matter. The nature and amount of secondary radiation therefore depends on the composition of the vehicle/habitat's materials and can be more harmful than primary radiation.

Besides the approaches already in use, which include radiation shielding materials (such as aluminium, water or polyethylene), alternative shielding materials (including boron nanotubes, complex hybrids and composite hybrid materials and active shielding (using fields to deflect radiation particles) are being investigated for their abilities to mitigate the effects of ionizing radiation.

Furthermore, it can be predicted that exposure to ionizing radiation during missions beyond Low Earth Orbit (LEO) will affect the human body in undesirable ways, e.g. increasing the risks of cardiovascular diseases, carcinogenesis, effects on the central nervous system and on other degenerative tissues effect. Therefore, it is necessary to assess the risks related to deep space exploration and to develop mitigation strategies to reduce these risks to a tolerable level. By using biomarkers for radiation sensitivity, space agencies are developing extensive personalised medical examination protocols to determine an astronaut's vulnerability to radiation. Moreover, researchers are developing pharmacological solutions (e.g. radio-protective agents, drugs) to proactively or reactively protect astronauts during deep space exploration. In conclusion, research is necessary to develop more effective countermeasures for use in future human space missions, which can also lead to improvements of medical care on Earth. This presentation will discuss the risks space travel outside LEO poses to astronauts, methods to monitor astronauts' health, and possible approaches to mitigate these risks.

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