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Radiation Fields, Effects and Risks in Human Space Missions (4)

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LOW MASS RADIATION SHIELDING FOR A MANNED INTERPLANETARY MISSION

Abstract

In the context of the Mars Society International Student Design Competition the possible dangers and counter measures regarding radiation in transit interplanetary flight have been evaluated.

Space radiation mainly consists of particle radiation, which is very dangerous for humans if certain doses are exceeded. The galactic cosmic radiation (GCR) consists of highly energetic particles (up to several TeV) but the fluxes are low. Therefore, GCR is only of concern, if long-term missions are planned like manned flights to Mars in a time range of over 1.5 years. Because of the high energies, GCR cannot be shielded effectively without a significant increase in weight. Solar activity is the source of the second kind of dangerous radiation. Solar particle events (SPE) increase the radiative fluxes by orders of magnitude but only possess energies of a few hundred MeV. This kind of radiation can and has to be shielded effectively since it can result in lethal radiation doses within a short time span (minutes to hours). Therefore, typically storm shelters are used, that possess a high material density and hydrogen content. Using a smart design approach of protective elements, a solar storm-shelter is created with a minimum increase in system weight. Thus, the radiation exposure is kept below the prescribed lifetime doses for astronauts. Since the habitat mass for Trans-Mars-Injection is very limited, the highest level of synergy between different subsystems and radiation protection is necessary. The biggest benefit can be achieved through a smart system layout and recycling. The usage of a system that produces tiles from waste to fortify the shielding is proposed. Furthermore, process water, feces, food and wet wipes can be arranged to result in protective curtains. Polyethylene, due to its high hydrogen content, is a promising material to decrease radiation doses. Several propositions are made for its effective usage. The overall goals are the effective sheltering of the crew from radiation while keeping the increase in mass at a minimum. Both are key requirements to achieve long term manned space flight with currently available technology.