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RADIATION SHIELDING AGAINST SPES AND GCRS WITH PLASMA INDUCED MAGNETIC FIELDS

Abstract

One of the main problems encountered when dealing with interplanetary missions is space radiation such as, Solar Particle Events (SPEs) and Galactic Cosmic Rays (GCRs). SPEs mainly refer to the solar flares coming from the sun. They carry high energy particles such as protons and electrons which range up to several hundreds of MeV. GCRs come from beyond our solar system and are extremely energetic particles. They are composed of protons and highly charged nuclei (HZE particles) up through iron that can reach several GeV. Such radiation is harmful to living organism. Long exposures, as is the case for interplanetary missions, can lead to severe radiation sickness, cancer and even in-flight death.

This study seeks to demonstrate the feasibility of a plasmatic radiation shielding by a first theoretical approach. The concept is to generate plasma inside a tube tightly coiled around the spacecraft. A current flowing through the plasma in the tube induces an external magnetic field. Plasma offers the possibility of passing high current with a very low resistance. This radiation protection system acts both as an active and passive shielding. The induced magnetic field is an active shielding method that protects from the SPEs by deflecting the charged particles. At the same time, the thickness of the plasma surrounding the spacecraft within the tube acts as a passive shield that absorbs the GCRs.

This method has the advantage of preventing both SPEs and GCRs. It is lighter compared to other concepts such as passive bulk shielding or superconductor based active shielding. Passive bulk shields utilize a bulk of heavy material such as iron to absorb and thus reduce radiation exposure. These systems are heavy and can create harmful secondary radiation within the spacecraft from nuclear fragmentation of the shielding material from high speed collisions. Other active shielding strategies employ massive superconductor magnets to obtain sufficiently large currents to deflect radiation particles with magnetic fields. Unfortunately superconductors require cooling systems to reach their superconductive state which increases the overall system mass and size.

In a context where missions to Mars are conceivable, it is very important to consider novel radiation shielding technologies. The goal of this study is to determine the feasibility of this concept. The paper looks at the power required to generate a sufficiently strong field to deflect radiation particle. The mass and size of such a system is also considered for an interstellar mission.