Simulating the charged particle environment in interplanetary space with a small ion accelerator

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Abstract

One of the the many challenges for long-duration manned space science and technology is the radiation dose from charged particles that is deposited in astronauts and other biological matter. Experimental simulation has long been the preserve of large accelerator faculties since the particle energies of cosmic galactic particles and solar protons are very high (100 - 1000 MeV/u). The objective of this presentation is to show that much information can be gleaned from experiments with ion accelerators of just a few MeV by exploiting scaling effects.

The first part of the talk will overview where the radiation comes from and how it interacts with biological matter. In particular the concept of biological scales will be considered with regard to deterministic and acute effects.

Subsequently, prediction of realistic estimates for the interplanetary charged particle flux and its temporal variability will be considered. The effect of spacecraft walls will be considered using LSS theory will be shown and used to demonstrate that low energy ($\leq$ 10 MeV) protons can be used to deposit realistic macroscopic doses into biological tissue on the effect of charged particle radiation.

The spatial distribution of dose of charged particles is extremely localized about the ion track. (within a few 10 of nm–μm). This is important as it can introduce extremely high localized levels of damage into DNA that give rise to deterministic effects. It demonstrated that few-MeV energy protons is also reasonably well matched for the dominant proton fluxes in space.

Finally, ongoing experimental work in a collaboration with researchers at the Louisiana Accelerator Center, Department of Biology and New Iberia Research Center will be presented.