Spacecraft Electrostatic Radiation Shielding

Flight Environment Measurement

This project analyzed the feasibility of placing an electrostatic field around a spacecraft to provide a shield against radiation. The concept was originally proposed in the 1960s and tested on a spacecraft by the Soviet Union in the 1970s. Such tests and analyses showed that this concept is not only feasible but operational. The problem though is that most of this work was aimed at protection from 10- to 100-MeV radiation. We now appreciate that the real problem is 1- to 2-GeV radiation. So, the question is one of scaling, in both energy and size. Can electrostatic shielding be made to work at these high energy levels and can it protect an entire vehicle?

After significant analysis and consideration, an electrostatic shield configuration was proposed. The selected architecture was a torus, charged to a high negative voltage, surrounding the vehicle, and a set of positively charged spheres. Van de Graaff generators were proposed as the mechanism to move charge from the vehicle to the torus to generate the fields necessary to protect the spacecraft. This design minimized complexity, residual charge, and structural forces and resolved several concerns raised during the internal critical review. But, it still is not clear if such a system is cost-effective or feasible, even though several studies have indicated usefulness for radiation protection at energies lower than that of the galactic cosmic rays. Constructing such a system will require power supplies that can generate voltages 10 times that of the state of the art. Of more concern is the difficulty of maintaining the proper net charge on the entire structure and ensuring that its interaction with solar wind will not cause rapid discharge. Yet, if these concerns can be resolved, such a scheme may provide significant radiation shielding to future vehicles, without the excessive weight or complexity of other active shielding techniques.

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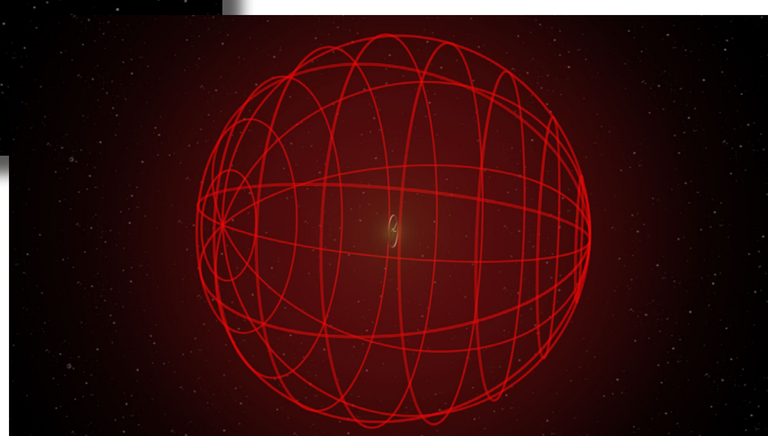
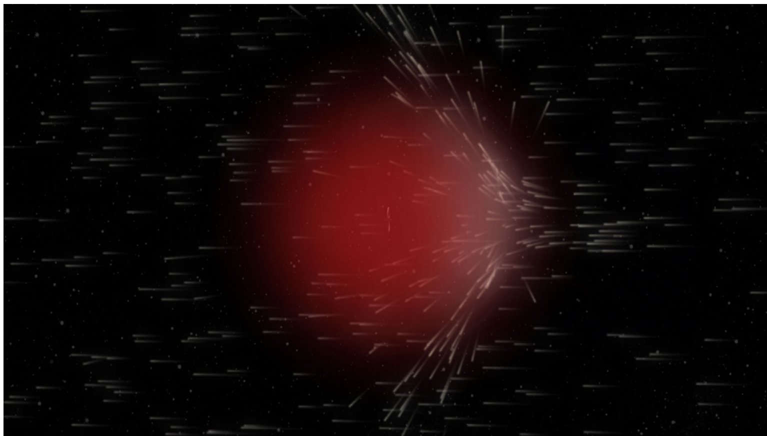
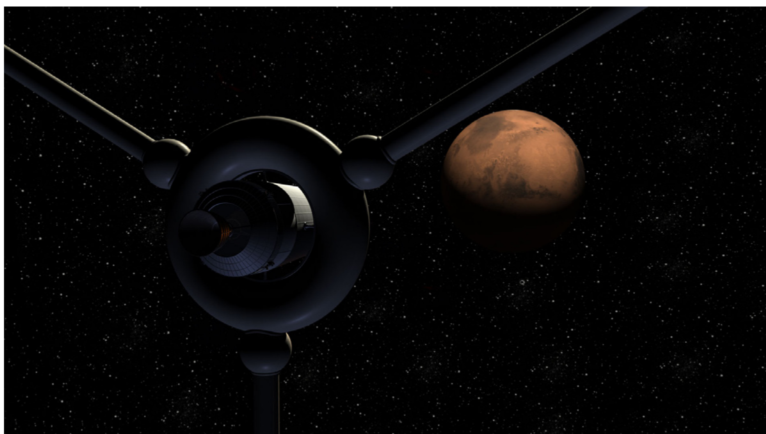
"Spokes" house belts of large Van de Graaff generators.



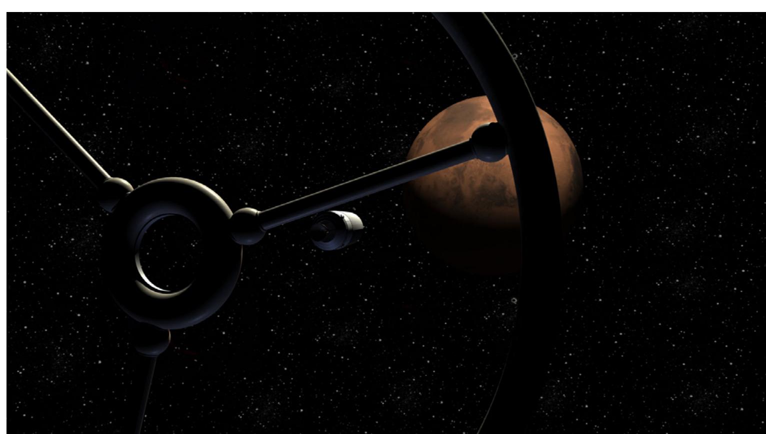
An equipotential electric-field surface at a far-field distance from the shield.



The electrostatic force field in action, repelling charged-particle radiation.



Spacecraft with shield, approaching Mars orbit.



Spacecraft jettisons shield before entering Mars orbit. Shield may be picked up on the return to Earth.