Antiparticle content in planetary magnetospheres and its possible use as fuel for remote heliosphere space missions

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In this presentation we assess the stable and transient antiparticle content of planetary magnetospheres and subsequently consider their capture and application to high delta-v space propulsion. We estimate the total antiparticle mass contained within the Earth's magnetosphere to assess the expediency of such usage. Using Earth's magnetic field region as an example, we have considered the various source mechanisms that are applicable to a planetary magnetosphere, the confinement duration versus transport processes, and the antiparticle loss mechanisms. We have estimated the trapped population of antiparticles magnetically confined following production in the exosphere due to nuclear interactions between high energy cosmic rays (CR) and constituents of the residual planetary upper atmosphere.

The galactic antiprotons that directly penetrate into the Earth's magnetosphere are themselves born in nuclear reactions of the matter component (chiefly protons) of the cosmic rays passing through 5-7 g/cm2 of interstellar matter. Their fluxes are modified, dependent on energy, when penetrating into the heliosphere and subsequently into planetary magnetospheres. In contrast, magnetospherically generated antiprotons are locally produced at a pass-length of several tens grams/cm2 by matter in the ambient planetary upper atmosphere and exosphere. Due to the latter process, magnetically confined fluxes significantly exceed the fluxes of the galactic antiprotons that pass through the magnetosphere by up to two orders of magnitude at some energies.

We present results of a numerical solution of the antiproton diffusive transport equation for the Earth's equatorial magnetosphere in the energy range from 10 MeV to several GeV. The Jovial planets with their strong magnetic fields are reasonably expected to contain an even greater antiparticle concentration within their radiation belt structures. Transient and radiation belt antiparticles can possibly be extracted with an electromagnetic-based "scoop" device. The antiparticles are concentrated by and then stored within the superimposed magnetic field structure of such a device. The feasibility for such uses will depend both on the local availability of antimatter and

the efficiency of the antiparticle capture device. In future developments, it is anticipated that following capture, their energy (both rest energy and kinetic energy) can be adapted for use as a fuel for propelling spacecraft to high velocities for remote solar system missions.