EXTRACTION OF ANTIPARTICLES CONCENTRATED IN PLANETARY MAGNETIC FIELDS

James Bickford
Draper Laboratory
Cambridge, MA

Small quantities of antimatter (nanograms to micograms) have enormous potential in a variety of space, medical, and sensing applications. However, due to the high intrinsic cost of production, such applications have not yet been realized. Antiprotons are currently produced during high energy collisions in large particle accelerators. Based on current capabilities, the electricity cost alone for the process is estimated to be $160 trillion per gram collected. In comparison, high energy cosmic rays bombard the Earth's upper atmosphere and produce the antiprotons naturally through pair production. A fraction of these are subsequently concentrated within the Van Allen radiation belts of the Earth similar to their standard matter counterparts. Satellite and high altitude balloon measurements have confirmed the fractional existences of antimatter in the normal background of ionizing radiation. As particles are lost through diffusion processes, new ones are generated to maintain a quasi-static supply trapped in the near dipole field of the Earth. Based on preliminary calculations, it is estimated that 10 micrograms of antiprotons and 10 milligrams of positrons are locally contained within the Earth's magnetosphere at any given time. The Jovian planets with their strong magnetic fields are expected to contain significantly more within their radiation belts. Draper Laboratory and its collaborators propose to use a magnetic scoop to extract large quantities of these trapped antiparticles. The principles of a Bussard magnetic scoop, first proposed for relativistic propulsion, will be adapted for use on a satellite in a planetary orbit. Particles bouncing between mirror points near the planet's poles will pass through and be concentrated by the superimposed magnetic field. Separation and cooling techniques from particle accelerators will be adapted for extracting and separating the desired particles from the radiation flux near the satellite.