Reaching the Frontier – a Green Approach to Space Travel

J. D. Stets[1], M.R. Peris[1], J.P. Bjerre[1], J. Dubuc[1], D. Tcherniak[1], P. Eysturskard[1], M. Strømsted[1] and M.B. Pedersen[1]
[1]DTU Electrical Engineering, Technical University of Denmark

INTRODUCTION

NASA has recently discovered that the concentration of antimatter particles trapped in the Earth magnetic field is 1000 times larger than previously known. The population of these high energy particles is constantly regenerated by reactions of cosmic rays with particles in the upper part of the Earth atmosphere.

When an antiparticle collides with a normal particle, both particles are converted into pure energy which makes antimatter the most efficient fuel source known. Using antimatter as a rocket propellant would save large amounts of rocket fuel, which is not only known to be highly pollutive, but is also a limited resource on Earth. A few milligrams of antimatter would be enough to send a spacecraft to Mars and back in a month, and provide a step stone for the humanity to enter the interstellar flight era.

ABSTRACT

The discovery made by NASA opens up for a discussion on how the antimatter can be gathered and used. During this project we have done the preliminary design of a small scale spacecraft for antimatter collection.

It is impossible to store or capture antimatter by normal means, which involve physical contact. Therefore, our spacecraft makes use of magnetic and electrostatic fields. A strong magnetic field is generated by superconducting coils, this magnetic field is used to alter the trajectory of the high velocity antimatter particles thereby increasing their flux though the spacecraft. Electrostatic fields in combination with thin foil layers placed around the spacecraft are acting as an energy degrader, which slows down the particles and transfers them into the trapping area around the superconducting coils. The thin foil layers and the direction of the electric field lines are oriented in a special way, which ensures that as big as possible amount of antimatter particles is trapped, while normal matter is filtered away.

The superconducting coils are passively cooled by a system of radiators combined with flexible parabolic heat-shields, which change shape depending on the orbit position of the spacecraft. After the initial charge up of the superconducting coils they go into persistence mode, where the energy is trapped inside the coils. Therefore almost no additional energy is required to sustain the magnetic field. This makes it possible to power the entire spacecraft by a small solar power array.

This project shows that it is possible to create an antimatter collection spacecraft with today's technology. This project concerns a small spacecraft; however, the design is scalable, which allows for larger antimatter collection ships, making green interstellar flight possible within a foreseeable future.