« STUDY OF SPACE PROPULSION BASED ON ANTIMATTER »

CONTEXT

CEA-IRFU and CNES (French National Space Agency) have started a collaborative work to establish the ground of a space propulsion system based on antimatter. This collaboration relies on the Gbar experiment whose purpose is the production of a large number of antihydrogen atoms and the measurement of their free fall in the Earth's gravitational field.

Several schemes of space propulsion have been proposed in the literature, that exploit the properties of antiprotons or antihydrogen atoms. Firstly the high energetic density, 1000 times as high as for nuclear fission, makes antimatter an unsurpassable energetic tank. Compared to a fission reactor, an antimatter reactor would also solve most of the issues related to safety and transport of radioactive matter. Before all, the annihilation properties of antimatter are the most interesting. On one hand antimatter can be used to induce nuclear reaction on very small spatial scale, that would catalyse and control mini or micro nuclear fusion reaction. On the other hand, the product of annihilation of antiprotons onto protons have relativistic velocities. A so called « beamed-core » spaceship ejecting directly annihilation products using a magnetic nozzle could reach a fraction of the speed of light, which is necessary to be capable of traveling beyond the solar system.

The main technological lock to the use of antimatter are its production and storage. It is nevertheless interesting to study and design an antimatter nozzle.

LABORATORY

The internship will take place at the Particle Physics Department (DPhP) within the Institute of Research on the Fundamental laws of the Universe (IRFU) in collaboration with a PhD student based at CERN and his supervisor.

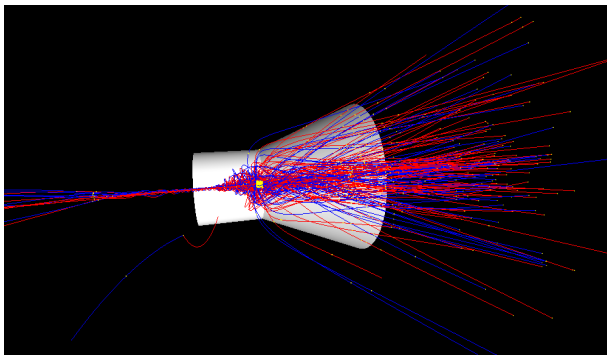

Figure 1 : Simulation of a beamed-core nozzle.

PROPOSED WORK

The study of space propulsion will briefly be dedicated to the question of production and storage before focusing on the production of thrust.

The main goal of the internship is to use simulation software (Geant) to study and optimise a beamed-core nozzle. The parameters to examine will be, the overall geometry, the magnetic system, the radiation shields and the heat sinks.

NEEDED SKILLS

The student should have a good general physics background and basic knowledge in particle or nuclear physics. Computing skills (C++, python, Unix shell scripts) would help.

CONTACTS

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