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SPACE PROPULSION SYMPOSIUM (C4)
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Author: Mr. Yuri Mukai
Research Institute for Sustainable Humanosphere, Kyoto University, Japan

Dr. Ikkoh Funaki
Japan Aerospace Exploration Agency (JAXA), Japan
Prof. Hiroshi Yamakawa
Kyoto University, Japan
Dr. Taketsune Nakamura
Japan
Dr. Hirotsugu Kojima
Japan

GROUND THRUST MEASUREMENT SYSTEM FOR SUPERCONDUCTING MAGNETIC SAIL SPACECRAFT

Abstract

The magnetic sail is one of the next generation spacecraft propulsion systems. An artificial magnetic field around a superconducting coil mounted on the magnet sail spacecraft deflects the charged particles radiated from the Sun, a solar wind. The given momentum from the particles accelerates the spacecraft in the anti-sun direction. The magnetic sail is very efficient thrust system, because it does not need to carry the fuel in the spacecraft to accelerate such as the chemical propulsion system and the electric propulsion system. So, using this system, it makes it possible for the space craft to reach the deep space in a short amount of time. In this paper, we propose the ground thrust measurement methodology firstly using "superconducting coil". First, we designed the thrust measuring experimental system and analyzed the thermal design of the experiment system to keep the superconducting coil at a sufficiently low temperature. The super conducting coil is hanged with the wire in the ultrahigh vacuum chamber which has a freezing capacity of 100K. The superconducting coil is covered by a small freezing box and MLI. We use the MPD arc jet as a simulated solar wind and inject the wind to the coil. The force generated by the interactions between simulated solar wind and coil, is measured by the optical displacement meter. We decided the size of the coil and coil freezing box with MLI based on the estimation of the size of the magnetosphere boundary using Newtonian approximation. The magnetosphere produced by the interaction between the solar wind and the induced magnetic field has to be sufficiently larger than the freezing box, since we cannot inject the solar wind to the coil magnetic field. If the magnetosphere is not sufficiently smaller than the ultrahigh vacuum chamber, we can not simulate the magnetic sail in space. Second, we are going to analyze the local magnet field of the superconducting coil. The superconducting wire has the Meissner effect which is the expulsion of a magnetic field from a superconductor during its transition to the superconducting state. For this effect, the magnetic model is different from that of the normal conducting coil. Through these experimentations and analysis, we show the possibility of the superconducting magnetic sail and the superiority over the previous thrust system.