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| Title | Thrust Analysis of Magnetic Sail Spacecraft with a Superconducting Coil |
| Author(s) | Mukai, Yuri |
| Citation | Sustainable humanosphere : bulletin of Research Institute for Sustainable Humanosphere Kyoto University (2011), 7: 43-43 |
| Issue Date | 2011-09-20 |
| URL | http://hdl.handle.net/2433/182531 |
| Right | |
| Type | Departmental Bulletin Paper |
| Textversion | publisher |

## Thrust Analysis of Magnetic Sail Spacecraft with a Superconducting Coil

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Recently, a new space propulsion system called magnetic sail has been studied for possible application to deep space missions and interplanetary missions. An artificial magnetic field is expanded around a spacecraft by mounting a superconducting coil onboard. The spacecraft magnetic field interacts with the solar wind, which is a plasma flow from the sun, and generates a thrust force to the spacecraft. The magnetic sail produces thrust by imparting momentum flux of the solar wind to the spacecraft, requiring no propellant. This thesis aims at revealing the thrust mechanism of the magnetic sail considering the characteristics of the type II superconductors.

We investigate the interaction between the superconducting coil and the magnetic field by computer simulations and experiments. In the computer simulations, we analyze the magnetic field distribution in the superconducting coil in the condition of the presence of an external magnetic field assuming the Bean model. The external magnetic field is produced by the induced electricity at the boundary region of the magnetosphere around the spacecraft, as a result of interaction between the spacecraft induced magnetic field and the solar wind. The results show a good agreement between the thrust force of the magnetic sail with a superconducting coil and that of an ideal current loop. The current density in the superconductor coil is large. Thus the Lorentz force to drive the thrust becomes large, although the quantized magnetic fluxes penetrating into the coil are very few.

To confirm this result by experiments, we designed a thrust measurement system of the magnetic sail. We made a small superconducting coil and sustained it in a chamber. As a result, the thrust force of the coil becomes 0.19 N when the current in the coil is 80 A in the exterior magnetic field. The thrust in the simulation is 0.20 N. These results indicate that the thrust with the coil is the same as that with an ideal current loop.

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