RECENT RESEARCH ACTIVITIES

Novel Space Environment Monitor, Instrument, and Space Mission Concepts

(Laboratory of Space Systems and Astronautics, RISH, Kyoto University)

Hiroshi Yamakawa, Hirotsugu Kojima, and Yoshikatsu Ueda

Lorentz Force Spacecraft Formation Dynamics

Dynamics and control aspects of a charged satellite using the Lorentz force were investigated. The concept of the Lorentz-augmented charged satellite realizes propellant-less electromagnetic propulsion, using the interaction between an electro-statically charged satellite and the Earth's magnetic field. Charging of satellites can be controlled by devices like ion or electron gun. The devices are smaller and lighter than conventional chemical thrusters and suitable to be carried by small-size satellites. We investigated relative dynamics of two satellites orbiting around the Earth. One is a non-charged satellite called a target satellite, and the other is a charged satellite located near the target satellite on a circular orbit. We studied the effect of the Lorentz force on the relative motion of the chaser satellite with respect to the target satellite on an elliptic orbit or on a circular orbit as a special case.

Magneto-Plasma Sail (MPS) Space Propulsion System

An MPS (Magneto-Plasma Sail) is a unique propulsion system, which travels through interplanetary space by capturing the energy of the solar wind, which inflates a weak original magnetic field made by a super-conducting coil of about 2-10 m in diameter with an assistance of a high-density plasma jet. From our theoretical estimations, momentum transfer from the solar wind to a spacecraft with a coil is large enough if the plasma source is operated to inflate only the magnetic field away from the spacecraft. Our activities in 2006 are as follows: (a) Sizing (mass, dimension, current, etc.) of the super-conducting coil to produce magnetic field around the spacecraft, (b) Preparation of the experiment facility to measure magnetic field, temperature, current etc. around super-conducting coil.

Miniaturization of plasma wave receiver system

To meet the recent requirements on the size, mass and power budgets in constellation missions or planetary missions, the miniaturization of plasma wave receiver is inevitable. The attempt to realize the extremely miniaturized plasma wave receiver have been made using analogue ASIC technology in the lab. The main activity in 2012 is the success in the development of the tiny waveform capture receiver, which is one of the typical types of plasma wave receivers. The size of the developed tiny waveform receiver is about one tenth of the conventional waveform receiver. Moreover, we also succeeded in implementing the preamplifier and the calibration system on the same analogue chip of the waveform receiver.

Use of water containing ultrafine bubbles for remediation of radioactive contamination and in horticultural applications

Recently, ultrafine bubbles (UFBs) have found applications in various fields. We have reported the effectiveness of water containing UFBs (UFB water) of approximately 100 nm diameter for removal of radioactive cesium from soil and gravel conglomerate and nonwoven cotton. In Fukushima, this method of radioactive contamination removal using UFB water is currently under trial. We also investigated the UFB water for its ability to retain freshness and for its coloring effect on cut flowers such as a gentian. The detailed mechanism underlying the performance of UFB in the above-mentioned application is yet not well understood, although the relevance of ions (proton (H^+) and hydroxide (OH^-) ion) in solution has already been discussed by many researchers. Therefore, we are investigating the mechanism underlying the performance of UFB water through electrochemical measurements.