Novel space environment monitor, instrument, and space mission concepts

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Space debris observation, modelling, and mitigation

The space debris problem is tackled from observation (space situational awareness), trajectory evolution, and mitigation points of view. 1) A method to identify the size, shape, and rotation features, and to determine the trajectory of known space debris using range Doppler data of MU (Middle and Upper) Radar, RISH, Kyoto Universiry, is investigated with successful observation results. 2) A study to investigate space debris trajectory evolution focusing on objects smaller than 1 cm has been started to shed light on geomagnetic field effects.

Exploration of electromagnetic space environments

The dominant phenomena in space plasmas are electromagnetic. The medium that transfers kinetic energies of plasma particles in space plasmas is plasma waves, because space plasmas are essentially collisionless. The energy transfer process taking place in space is so-called wave-particle interaction. Exploring electromagnetic environments in space is to investigate wave-particle interactions. The present research focuses on plasma wave observations via scientific satellites. The Exploration of the terrestrial radiation belts by the Arase satellite is the most recent activity. Plasma waves are believed to have significant roles for the generation and loss of high energy particles in the radiation belts. Plasma waves observed by the Arase satellite are extensively analyzed consulting particle measurement data. The results have been showing the detailed and quantitative processes of wave-particle interactions in the radiation belts. Another exploration got started in October 20, 2018. It is the BepiColombo mission targeting the Mercury. Plasma wave instruments onboard the spacecraft will reveal the wave-particle interactions that no one has seen before around the Mercury after 6years' cruising.

Miniaturization of plasma wave receiver system

Plasma wave receiver is one of the essential instruments for space environment exploration; however, conventional receiver has a problem in its large weight and size. In order to overcome this problem, we have been miniaturized plasma wave receiver by developing Application-Specific Integrated Circuits (ASIC) for plasma wave receivers. We succeeded in developing miniaturized plasma wave receiver by realizing analog circuit, which is especially large part of the receiver, using ASIC. This miniaturized receiver will be onboard the SS-520-3 sounding rocket, which will launch in the not-too-distant future to resolve the cause of ion outflow phenomena at the cusp region. In addition, we aim to develop a mixed-signal ASIC chip for one-chip plasma wave receiver. The mixed-signal ASIC chip includes all analog and digital circuits for plasma wave receiver. One-chip plasma wave receiver allows to reduce weight and size of the instruments drastically, and it will contribute for increasing opportunities of plasma wave observation.

Theoretical study of fine bubble and its application research

Fine bubble (FB, less than 1 micro meter) technology is standardized as ISO/TC 281 and its basic and application research is conducted by many researchers. Basic properties and assumed generation mechanisms are now making clear. There is still remained problems of integrated theory of FB such as generation and stabilization. And we also need to apply FB technology to various application field with its detailed theory. As for integrating basic properties, we conduct various measurement such as ultrasonic attenuation of FB water, as measuring electrical potential of FB and as comparison with nano-particles in water. We also try to do application experiment in agricultural field as international collaboration study.