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太陽発電衛星における大電力マイクロ波と電離層プラズマとの相互作用に関する宇宙実験の基礎検討
Space Experiment on Interaction between High Power Microwave and Ionospheric Plasma for Solar Power Satellite

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The Space Solar Power System (SSPS) which converts solar energy into electricity in space, and transmits energy using microwave from space to the ground is a promising candidate for a clean and sustainable energy system. The first solar power satellite (SPS) concept was proposed by Dr. P.E.Glaser in 1968. R & D activities on the SPS have been carried out in US, Japan and Europe. Some key technologies require space experiments in order to realize the SPS. Especially, Wireless power transmission (WPT) is inherent technology of the SPS, and WPT demonstrations on the ground and in space have been performed in Japan. Two rocket experiments, MINIX in 1983 and ISY-METS in 1993 were performed by Kyoto University and ISAS in order to study nonlinear interactions of the high power microwave in the space plasma environment and to demonstrate microwave power transmission. However higher-accuracy evaluation of the effect of the microwave against the ionospheric region is required because the experiments of the sounding rocket are limited in time and mass resources. Microwaves interact with ionospheric plasma. Plasma density gradient and its variation will results the phase shift of the microwave and degradation of the accuracy of the microwave beam pointing. Also, injection of the high power microwave into plasma will cause a change in plasma distribution of ionospheric region or a plasma hole that will affect on communications. There are some interaction mechanism between ionospheric plasma and high power microwave. Plasma heating by the microwave will cause a decreasing of the plasma density and thermal self focusing of the microwave beam. Several potential non-linear interactions between ionosphere and microwave have been identified. These include parametric instability excitation, electron thermal runaway in the lower ionosphere and thermal self-focusing of the microwave beam by the ponderomotive force. Microwave power density around ionospheric region is designed around several hundred W/m2 for the future commercial base SPS. These effects should be confirmed by the space experiments. We are considering a space experiment on the WPT from space to the ground and on the interaction between high power microwave and ionospheric plasma using a small scientific satellite. The total microwave power radiated from the power transmission panel is 0.95 kW for a single antenna panel configuration. This level of microwave power injection will generate a power density above 1000 W/m2 within 50 m, and 100 W/m2 within 100 m in the ionosphere. Effects of interaction between high power microwaves and plasma in ionosphere can be measured. We plan to measure the electron temperature, the electron density and excited waves under the microwave irradiated conditions using plasma probes, wave receiver or some observation equipments. We would like to discuss the on-board instrumentations for the plasma and waves measurement in ionosphere.

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