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Computer experiments on space plasmas perturbation caused by a spatial gradient of intence EM beam intensity

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SPS(Space Solar Power System) has been proposed as one of the solutions for energy and environmental problem. In this system, electric power generated with solar cells installed on the satellite is transferred to the ground by intense microwave beam. In the energy transfer to the ground with microwave beam, the interactions between the electromagnetic (EM) beam and the ionospheric plasmas is one of the issues to be investigated.

In this study, we focus on a plasma cavitation caused by Ponderomotive force which is one of the nonlinear interactions caused by the spatial gradient of the intensity of EM beam.

To investigate the dynamics of plasma cavitations by Ponderomotive force and their characteristics, we performed computer experiments with electromagnetic particle-in-cell model prior to the demonstration of intense microwave energy transmission in the ionosphere.

In the simulations, we could clarify the basic process of a plasma cavitaion by Ponderomotive force. When the EM beam with a radial spatial gradient of its intensity propagates in the plasma, electrons and ions are moved out of the beam by the effects of Ponderomotive force and the electric force by a charge-separation

field. Consequently the plasma density inside the EM beam becomes lower than outside. This phenomenon is called plasma cavitation.

To understand the characteristics of this plasma cavitation more in detail, we performed theoretical analysis by considering the plasma fluid theory. From these considerations, we derived theoretical density variation by Ponderomotive force and revealed the detailed parameter dependencies and characteristics of the temporal and spatial variation of the plasma cavitation, which basically agree with the simulation results. In addition, we revealed the damping of the ion-acoustic waves by the plasma kinetic effects makes the differences between theoretical values and simulation results.

Finally we estimated the density variation by this plasma cavitation with the SPS parameters which are currently proposed. From this estimation, the density variation becomes about 0.001%. Therefore the plasma cavitation isn't likely to be a problem in SPS.