Study on Space Plasma Perturbations Caused by a Spatial Gradient of Intense EM beam Intensity

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Before the realization of SPS (Space Solar Power System) and its prior experiments, we need to understand the mechanism and the extent of interactions between the microwave beam and the ionospheric plasma.
In this study, we particularly focus on the plasma perturbations by Ponderomotive force which is one of the nonlinear interactions caused by the spatial gradient of the electromagnetic (EM) beam intensity. To investigate the dynamics of plasma cavitation by Ponderomotive force and their characteristics, we performed computer experiments and theoretical considerations.

From simulation results, we found out the basic dynamics 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. With this plasma perturbation, electro-static ion waves which propagate radially to the EM beam are enhanced.
In the existence of the external magnetic field, this plasma cavitation has an anisotropy by the effects of Ponderomotive force and the external magnetic field.

To understand the more detailed characteristics of this plasma cavitation, we performed theoretical considerations by 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 a 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 by the cavitation becomes about 10^{-3} % of the initial plasma density. Therefore the plasma cavitation isn't likely to be a problem in SPS.