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

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In SPS(Space Solar Power System), electric power generated with solar cells installed on the satellite is transfered to the ground by intense microwave beam. In the energy transfer to the ground with microwave beam, the effect of the microwave beam on the ionospheric plasma has been concerned in terms of density perturbation.

In the current study, we focused on the plasma perturbation due to the Ponderomotive force which is one of the nonlinear interactions caused by the spatial gradient of beam intensity. We analyze this subject from the view points of both the safety of SPS and space plasma physics.

To investigate the basic process of plasma response and its associated field perturbation by Ponderomotive force, we performed computer experiments with electromagnetic particle code.

By analyzing the simulation results, we found the basic process of plasma perturbation caused by Ponderomotive force. (1)Ponderomotive force pushes electrons toward the weaker region of the field intensity and generates an electron cavity in the stronger region. (2)Electro-static field is enhanced by the charge separation between ions and electrons and the resulting electro-static force balances with Ponderomotive force in the steady state. (3)When the effect of the static magnetic field is concerned, we observe a current flow in the direction perpendicular to the static magnetic field. The plasma perturbation becomes smaller as the intensity of the static magnetic field becomes large. (4)Considering the ion motion, more electrons and ions are pushed out of the stronger field toward the weaker region by Ponderomotive force because the electric field dose not grow large enough to balance with the Ponderomotive force. Therefore, the plasma cavity becomes larger than in the case considering only electron's motion.

The plasma perturbation mentioned above is caused by the electromagnetic wave which has a much larger intensity and a lower freqency than those of SPS. From the simulation results with parameters of the SPS experiment and the theoretical consideration based on these basic experiments, we find out the plasma perturbation by Ponderomotive force is very small (the electron density decrease is about 10^-12%).