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Numerical simulation of plasma acceleration due to Rotating Magnetic Field

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Electric thrusters, characterized with high specific impulse, are considered to be useful for long-term space missions such as those to outer planets. On the other hand, the performance of many of the conventional electric thrusters (e.g., ion engines) is limited by electrode wastage. In order to overcome this difficulty, we have initiated the HEAT (Helicon Electrodeless Advanced Thruster) project [1], in order to pursue research and development of completely electrodeless thrusters.

Among several different types of electrodeless plasma acceleration schemes we propose, in this presentation we discuss the acceleration concept utilizing the Rotating Magnetic Field (RMF), which has been developed primarily for an application to the plasma confinement in the field-reversed configuration [3]. In this scheme, a rotating external magnetic field is applied to the cylindrical helicon plasma [2], in such a way that the external magnetic field drives the azimuthal electron current. If the background magnetic field has a finite radial components, axial Lorentz force is generated. This Lorenz force accelerates ions in cylindrical plasma, producing a thrust [4].

We will show the results of numerical modeling of the interaction between the cylindrical plasma and the RMF. It is very important that we understand situations in cylindrical plasma with the radial magnetic field.   Three essential, non-dimensional (normalized) parameters in the system are the plasma dissipation, driving RMF magnitude, and the radial magnetic field strength. Fraction of the magnetic field penetration into the plasma as well as the penetration time scale will be discussed in detail.

[1] This work was supported by the Grants-in-Aid for Scientific Research under Contract No.(S)21226019 from the Japan Society for the Promotion of Science.
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[4] Inomoto, M., I.E.E.J. Trans. vol. 128, 319, 2008.

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