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Estimate of the pressure profile of the plasma confined in a magnetospheric configuration.

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In a dipole magnetic configuration like a magnetosphere of a planet, a plasma is stably confined by the effect of plasma compressibility although which is surrounded by 'bad-curvature' magnetic surfaces unlike other general nuclear fusion devices. It is actually found that there is very high beta plasma whose local beta-value exceeds unity in the Jovian magnetosphere. We have constructed the RT-1 (Ring Trap-1) device to investigate the physics of the high beta plasma confined in the magnetosheric configuration. We also aim to realize thermal nuclear fusion reactors with the magnetospheric plasma in future.
In the RT-1 experiment, we have achieved to realize the magnetosphere in the laboratory with the super-conducting magnet which is magnetically levitated in the vacuum chamber. The fueling-neutral gas (hydrogen or helium is used) is heated by two frequency of ECRH (2.45 GHz and/or 8.2 GHz) about 1 second. Plasma diamagnetism is measured by four magnetic flux loops which are wounded around the vacuum chamber. The plasma pressure and beta value are roughly estimated by converting the plasma diamagnetic signals with the MHD equilibrium calculation code for the RT-1 configuration. We succeeded to produce high beta plasma, whose pressure is mainly resulted from that of the high energy electron whose Te is about 10 keV. The maximum plasma diamagnetism in RT-1 exceeds 3.4 mWb which corresponds to more than 40% of local beta value.
In this research, we succeeded to measure the magnetic field structure in the neighborhood, sometimes inside, of the high beta plasma by using the multi-channel magnetic Hall probes. This enables us to estimate more precisely the plasma pressure profile of the RT-1 plasma than using only the magnetic flux loops wounded around the chamber. The faster response speed of the Hall element also allows us to observe fast MHD phenomena slower than 0.1 ms, which leads us to evaluate the energy confinement time of the RT-1 plasma. In the experiment, the variation of the pressure profile of the plasma is observed. The pressure profile is changed in response to the discharge conditions such as the frequency of the ECRH, the power of the ECRH and filling gas pressure. These observations are thought to be valuable to discuss a instability of the magnetospheric plasma.

Keywords: magnetospheric plasma, high-beta plsma, magnetic measurement, MHD equilibrium