Contribution ID: **19** Type: **Poster**

Effects of Electron Cyclotron Heating on the Toroidal Flow in Helical Plasmas

Wednesday, 4 September 2019 15:15 (15 minutes)

Recently, spontaneous toroidal flows have been observed in electron cyclotron heating (ECH) plasma in many tokamak and helical devices such as JT-60U, LHD, and HSX. To clarify the underlying mechanism, many experimental [1] and theoretical [2] studies have been undertaken. Particularly, in LHD, when ECH was applied into the neutral beam injection (NBI) heated plasma, the radial profile of the toroidal flow velocity changes drastically and the direction is reversed in the core region. This change of the toroidal flow by ECH has not yet been understood well.

ECH can drive the radial electron current j_e due to the radial motion of suprathermal electrons [3]. The net current in the steady state should be canceled to maintain the quasi-neutrality, so the return current, $j_r(= -j_e)$, must flow by the bulk ions. Therefore, the bulk plasma feels the $j_r \times B$ force due to the return current. On the other hand, the suprathermal electrons drift toroidally due to the precession motion. During the slowing down of the suprathermal electrons, they transfer their obtained momentum to the bulk plasma due to collisions.

In this study, we investigate the behaviors of energetic electrons by ECH, which can generate the radial current making the $j_r \times B$ torque in the LHD plasma. Also, we evaluate the collisional torques, by the collision between energetic electrons and bulk plasma. We apply the GNET code, which can solve a linearized drift kinetic equation for energetic electrons by ECH in 5-D phase space[3]. Then, we calculate the toroidal flow by solving the radial diffusion equation including the toroidal component of the $j_r \times B$ torque, collisional torques, and the NBI torque, which is evaluated by FIT-3D code[4].

The toroidal components of the $j_r \times B$ and collisional torques cancel each other in axisymmetric plasma[5]. We, first, calculate the torques in the axisymmetric magnetic configuration and obtain this cancellation of the toroidal torques. Next, we study the behaviors of energetic electrons and evaluate the torques assuming the LHD plasma. As a result, we find that the obtained torque by ECH is almost the same order as that by NBI, and that its direction is opposite to NBI torque direction in the inner region. Finally, we solve the radial diffusion equation to evaluate the toroidal flow in plasmas with ECH and/or NBI, and compare with the experimental observations.

References:
[1] M. Yoshida, et al., Nucl. Fusion 49 (2009) 115028.
[2] P. H. Diamond, et al., Nucl. Fusion 53 (2013) 104019.
[3] S. Murakami, et al., Nucl. Fusion 40 (2000) 693.
[4] S. Murakami, et al., Fusion Technol. 27 (1995) 256
[5] M. N. Rosenbluth and F. L. Hinton, Nucl. Fusion 36 (1996) 55

Country or International Organization

Japan

Primary authors: Mr YAMAMOTO, Yasuhiro (Kyoto University); MURAKAMI, Sadayoshi (Departement Nuclear Engineering, Kyoto University); YAMAGUCHI, Hiroyuki (National Institute for Fusion Science); Mr CHANG, Ching Chieh (Kyoto University); TAKAHASHI, Hiromi (National Institute for Fusion Science); IDA, Katsumi (National Institute for Fusion Science); YOSHINUMA, Mikirou (National Institute for Fusion Science)

Presenter: MURAKAMI, Sadayoshi (Departement Nuclear Engineering, Kyoto University)

Session Classification: Poster

Track Classification: Effects of Energetic Particles in Magnetic Confinement Fusion Devices