Contribution ID: **56** Type: **Poster**

Modeling of Supra-thermal Electron Flux and Toroidal Torque by ECH in Non-Axisymmetric Toroidal Plasmas

Wednesday 4 September 2019 15:15 (15 minutes)

Spontaneous toroidal flows have been observed during ECH without direct momentum input in tokamak and helical plasmas[1-3]. In LHD, when we applied ECH to the NBI heated plasma, the toroidal velocity profile changed drastically. We assume that the radial flux of supra-thermal electron enhances the bulk ion canceling current. This current generates the JxB torque, which would play an essential role in causing a toroidal flow. We have studied the JxB torque due to the radial current of supra-thermal electrons and the collisional torque by the supra-thermal electrons in the LHD using GNET[4] code, which can solve the 5D drift kinetic equation for supra-thermal electrons. As a result, we have found that the JxB torque generated by ECH is the same order as the NBI torque, and its direction is an opposite (same) direction to NBI torque in the inner (outer) region[5]. Also, we have evaluated the toroidal torque by ECH in the non-axisymmetric tokamaks (finite toroidal field ripples and magnetic perturbations) and have found significant net toroidal torques by ECH due to the radial motion of ripple trapped electrons.
In this study, we study the radial flux of suprathermal electrons assuming a drift convection model and estimate the radial profile of the JxB toroidal torque by ECH in a rippled tokamak. We find that the maximum toroidal torque which is proportional to δ3/2/n, where δand n are the ripple amplitude and plasma density, respectively. We find that the obtained model fluxes show relatively good agreements with the numerical results by GNET. Also, we extend this drift convection model in the case of LHD and HSX. We find that the larger JxB toroidal torques are obtained in helical plasmas than that in the rippled tokamak due to the large fraction of trapped electrons. The drift convection model results are compared with the numerical results by GNET code.

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Session Classification: Poster

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