§7. Investigation of Momentum Transport and Characteristics of Intrinsic Torque in LHD

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Momentum transport and intrinsic rotation/torque attract much attention because of the possibilities of toroidal rotation to control MHD stabilities in tokamak plasmas, and they have been intensively studied in helical plasmas as well as tokamak plasmas. Intrinsic toroidal rotations depending on ion temperature gradient, radial electric field and collisionality have been observed in LHD so far. The characteristics of intrinsic rotation, however, are not understood so well. In order to catch the general properties of intrinsic rotation, the toroidal rotations without any external torque input have been experimentally investigated.

The transition of toroidal rotation has been identified in the collisionality dependence until 16th campaign. At the transition point, the density fluctuation measured by a phase contrast imaging (PCI) changes the characteristics. The rotation of the dominant mode in laboratory frame changes the direction although the locally excited mode near the edge does not.

In the 17th campaign, the toroidal rotations without any external torque input have been investigated, in particular, the dataset of discharges with ECH have been newly obtained. The parameter space of the database expands widely in electron temperature dependence. Four graphs in Fig. 1 show the toroidal rotation observed in this experiment as a function of the central electron and ion temperatures, the line-averaged electron density and temperature ratio at the center. The experimental data is plotted with the information of plasma heating scheme, perpendicular NBI heated plasmas (closed circles), balanced tangential NBIs and perpendicular NBI for diagnostics (open circles) and NBIs and ECH with no external torque (open squares). Some characteristics have been identified in this database. (1) The tendency to rotate in the counter direction was observed when electron heating power is small. (2) The plasma rotates in the co-direction depending on both electron and ion temperatures. (3) The fast rotation in the co-direction is observed in the low density regime (n_e<$2x10^{19}m^{-3}$). These dependencies do not seem to be understood by only neoclassical theory. The quantitative comparison is necessary, which will be available in near future. The significant ctr-rotation in the ion and electron ITBs is also observed, which seems to different characteristics from the database obtained in this study.

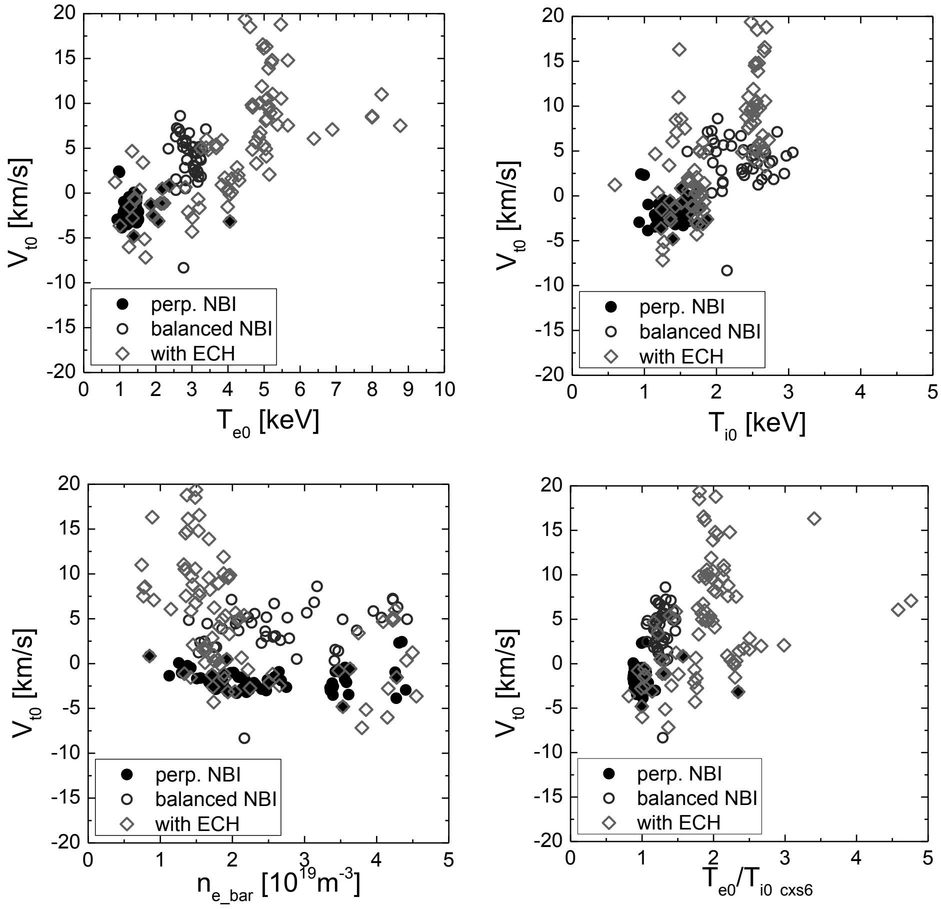

Fig. 1 Toroidal rotation database of plasmas without any external torque input conditions.