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Magnetism of toroidal field in two-fluid equilibrium of CHI driven spherical torus T. KANKI, Japan Coast Guard Academy, M. NAGATA, University of Hyogo — Double-pulsing CHI (D-CHI) experiment has been conducted in the HIST device to achieve a quasi-steady sustainment and good confinement of spherical torus (ST) plasmas. The feature of CHI driven ST such as diamagnetic toroidal field in the central open flux column (OFC) region and strong poloidal flow shear around the separatrix in the high field side suggests the two-fluid effect. The relationship between the magnetism of the toroidal field and the poloidal flow velocity is investigated by modelling the D-CHI (mainly driving the poloidal electron flow along the open flux) in the two-fluid equilibrium calculations. The poloidal component of Ampere's law leads that the toroidal field is related to the difference between the stream functions of ion $\bar{\psi}_i$ and electron $\bar{\psi}_e$for the poloidal flow, indicating that the toroidal field with $\bar{\psi}_e > \bar{\psi}_i$ results in a diamagnetic profile, while that with $\bar{\psi}_e < \bar{\psi}_i$ results in a paramagnetic one. The gradient of the stream function determines the polarity and the strength of the poloidal flow velocity. It is found that the two-fluid equilibrium of CHI driven ST satisfies $\bar{\psi}_e > 0$ and $\bar{\psi}_i < 0$ in the OFC region, and $\bar{\psi}_e < 0$ and $\bar{\psi}_i < 0$ in the closed flux region. The toroidal field is a diamagnetic profile in the OFC region due to $\bar{\psi}_e > \bar{\psi}_i$ and $|u_{ez}| > |u_{iz}|$, where u_{ez} and u_{iz} denote the poloidal electron and ion flow velocities, respectively. It becomes from a diamagnetic to a paramagnetic profile in the closed flux region, because $\bar{\psi}_e(u_{ez})$ approaches $\bar{\psi}_i(u_{iz})$ around the magnetic axis. The poloidal ion flow shear is enhanced in the OFC region due to the ion inertial effect through the toroidal ion flow velocity.

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