Validity of flow velocity estimation of an FRC plasma by the Doppler shift measurement of impurity ion spectra

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The lifetime of an FRC plasma is at most a few hundred micro-seconds. FRC plasmas formed by the field-reversed theta pinch method often suffer from the n=2 rotational instability; it results in disruption of the FRC. Therefore, it is necessary to study in detail the mechanisms of toroidal rotation [1]. The flow velocity is measured by the Doppler shift of impurity ion spectra. At the Nihon University Compact Torus Experiment-III machine, for example, the spectral line of C^{4+} ion is used for estimation of the toroidal flow velocity. Flow velocity estimation is valid in a case that the flow of ions equals the one of impurity ions; it is not always true because the flow is perpendicular to the magnetic field in which large spatial variation is present. In the present study, the particle orbit calculation is carried out to find both ion and impurity ion flow velocities. The particle-in-cell method is employed to calculate the density and particle flux. Resultantly the flow velocity profile can be found. Preliminary calculation shows that the ion flow equals the impurity flows near the field-null point. The friction force between them would equalize the flow velocity. On the other hand, each species has different flow velocities near the separatrix where the magnetic field is relatively strong. A detailed discussion will be given in the poster presentation.

[1] T. Asai *et al*, Phys. Plasmas **13**, 072508 (2006).