1D fluid model of LHD divertor plasma and hydrogen recycling

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One dimensional fluid model of divertor plasma and neutral recycling in Large Helical Device (LHD)[1] is presented. In the previous work[2], plasma profiles in the LHD divertor leg was described by one dimensional fluid equations similar to those of fluid simulation studies[3,4]. The neutral density profile was determined by equation of continuity under the assumption of constant flow velocity. Since the ionization and charge exchange caused by collision between the neutral and the background plasma plays an essential role in the divertor plasma, for instance collisional presheath and recycling, understanding and modeling of the dynamics of the neutral are important issues in the boundary plasma studies.

In this work, the neutral is treated as multicomponent gas to preserve the characteristic of each component. Since the hydrogen mean-free-path in the divertor is longer than the divertor size, each component of the gas is assumed to interact with the ion and the electron only, i.e. collisions between neutral atoms are neglected. Each component reflects on its source such as slow hydrogen molecules released from the wall surface, fast hydrogen atoms generated by Franck-Condon dissociation, high energy atoms generated by charge exchange and reflected atoms at the wall surface. They have different density, velocity and temperature and thus the decay length due to ionization and amount of momentum and energy exchange with the plasma differ from each other. In the actual divertor, the geometry of the plasma and wall also plays an essential role in the neutral dynamics because they are not affected by the magnetic field. Although our model is one dimensional, the geometrical effect is involved in the model as a effective cross field flux.

We develop a calculation code to solve the stationary fluid equations of the plasma and multicomponent neutral gas. In the poster, detailed modeling of the neutral and the physical interpretation of the neutral behavior are presented. Effects of the interactions between the neutral and the plasma on plasma profiles are also investigated.

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