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## In/Out Impurity Density Asymmetries in a Rotating Tokamak Plasma

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As is well known, the centrifugal force due to the impurity toroidal rotation can push the impurity ions to the outboard side of a flux surface (out-in asymmetry). This has been pointed out theoretically by Hinton, Wong and Wesson earlier and observed in the tokamak experiments. But the centrifugal force effect can not explain the experimental phenomenon that the impurity ions accumulate on the inboard side of a flux surface (in-out asymmetry) observed in JET [1, 2], Alcator C-Mod [3-8], ASDEX Upgrade [9, 10] tokamaks. Some explorations have been carried out to understand the mechanism causing this phenomenon, such as the poloidal varying friction force between the impurity and the bulk ions due to the large ion temperature and pressure gradients [11], the poloidal electric field due to the ion cyclotron resonance heating(ICRH) [4, 5]. But the impurity-ion friction force is estimated to be too small to explain the in-out impurity density asymmetry observed in the JET experiments [1] and the in-out impurity density asymmetry is not observed in the Alcator C-Mod I-mode plasma with a large temperature gradient [7]; the out-in impurity density asymmetry still exists in the Alcator C-Mod EDA (Enhanced D-Alpha) H-mode plasma with ICRH[4], while the in-out impurity density asymmetry is observed in the ASDEX Upgrade plasma without ICRH[9, 10].

In the ASDEX Upgrade experiments [9, 10] with the large magnitude of in-out impurity density asymmetry existing, the strong impurity poloidal rotation besides the impurity toroidal rotation is observed. Also the experiments on Alcator C-Mod show that the in-out impurity density asymmetry is strongly related to the impurity poloidal rotation [3].

In this talk, the toroidal Coriolis force due to the combined effect of the impurity toroidal and poloidal rotation is proposed to be the mechanism that can induce the in-out impurity density asymmetry for the first time. With  $qv_{\theta,z}\omega_z > 0$ , the in-out impurity density asymmetry can be induced with the toroidal Coriolis force strong enough to overcome the centrifugal force effect. With  $qv_{\theta,i}\omega_i > 0$ , the bulk ions will accumulate on the outboard side of the flux surface due to the toroidal Coriolis force and the poloidal electric field generated will be beneficial to the in-out impurity density asymmetry formation. The physical mechanism discovered here offers a possibility for an active control of the in/out impurity asymmetries, and thus the impurity radial transport and core accumulation via the plasma rotation controlling.

### References:

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