FAST ION TRANSPORT AND PLASMA ROTATION IN ION-CYCLOTRON HEATED PLASMAS

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Abstract. Minority ion cyclotron heating can produce energetic ions with banana orbits that are finite compared with the minor radius of a tokamak. The radial transport of the fast ions in the presence of Coulomb collisions results in a radial current and a corresponding J×B torque density on the bulk plasma. Collisions between the minority ions and majority ions provide an additional frictional torque that adds to or opposes the magnetic torque. Using a code that follows the particle drift trajectories in a tokamak geometry under the influence of rf fields and collisions, modeled with an rf quasi-linear operator and a Monte-Carlo operator respectively, it is shown that a finite central rotation velocity can result even when the volume integrated torque density is small. This is consistent with the results of [1] for the case of a symmetric toroidal wavenumber (n_ϕ) spectrum. A physical picture emerges explaining the co- and counter-rotation with low- and high-field resonance, respectively, as a consequence of finite orbit width. For an asymmetric spectrum, it is found that when n_ϕ is in the co-current direction, the rf produces a net co-direction torque leading to co-rotation for both low- and high-field side resonance. With negative n_ϕ, the rotation reverses to the counter-current direction. An analysis of antenna coupling has identified conditions when a positive n_ϕ power spectrum is favored, which might partially explain the observations in the C–Mod and JET tokamak.