Prompt toroidal momentum balance with collisionless neutral beam injected torque in DIII-D

J.S. deGrassie, R.J. Groebner, and K.H. Burrell

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

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Abstract. In electron cyclotron heated (ECH) H-mode discharges with neutral beam injection (NBI) pulses short compared with the fast ion scattering or slowing times, it is observed that the plasma stores all the angular momentum delivered by the NBI torque impulse. The pulse length is also much shorter than the momentum confinement time of the plasma. Source computations with the Monte Carlo code TRANSP [20] show that during a pulse approximately 90% of this torque impulse is delivered via the collisionless fast radial current injection process, so that the plasma acquires the balancing toroidal acceleration through ion drift motion in the increasing $\partial E/\partial t$ where E is the electric field normal to the flux surfaces. The measured radial profile of the toroidal momentum increase matches the source, i.e., the computed torque impulse profile. We measure the bulk ion toroidal acceleration in helium discharges, as well as that of the primary impurity, carbon. These two species show a common acceleration, consistent with an incremental velocity due to an electric drift. This process is mediated by the dielectric response of the ions. The acceleration measurements are consistent with this being the neoclassical value of the dielectric constant, as computed from measured quantities.

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