Plasma rotation driven by static nonresonant magnetic fields

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Abstract. Recent experiments in high temperature DIII-D tokamak [J.L. Luxon, Nucl. Fusion **42**, 64 (2002)] plasmas have reported the first observation of plasma acceleration driven by the application of static non-resonant magnetic fields (NRMFs), with resulting improvement in the global energy confinement time. Although the braking effect of static magnetic field asymmetries is well known, recent theory [A.J. Cole, *et al.*, Phys. Rev. Lett. **99**, 065001 (2007)] predicts that in some circumstances they lead instead to an increase in rotation frequency toward a "neoclassical offset" rate in direction opposed to the plasma current. We report the first experimental confirmation of this surprising result. The measured NRMF torque shows a strong dependence on both plasma density and temperature, above expectations from neoclassical theory. The consistency between theory and experiment improves with modifications to the expression of the NRMF torque accounting for a significant role of the plasma response to the external field, and for the beta dependence of the plasma response, although some discrepancy remains. The magnitude and direction of the observed offset rotation associated with the NRMF torque are consistent with neoclassical theory predictions. The offset rotation rate is about 1% of the Alfven frequency, or more than double the rotation needed for stable operation at high β_N above the $n = 1$ no-wall kink limit in DIII-D.

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