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P2.1103 Contribution of the Hall effect to radial electric field and spontaneous/intrinsic rotation in tokamak core plasmas

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The Hall effect, defined as the separation of electric charges of opposite sign when they move in a magnetic field, is suggested to contribute substantially to the observed negative radial electric field E_r in the core plasma in tokamaks and, respectively, to the spontaneous/intrinsic rotation of plasma. A detailed study of the Hall effect in plasmas began with the study in [1] – within the framework of two-fluid magnetohydrodynamics (2FMHD) – of the effect of the frozenness of magnetic field mainly in the electron component of plasma. This effect is important for stationary plasma flows [2], and it plays a dominant role in plasma open switches, Z-pinches, plasma foci, and is widely studied in the literature [3]. In the 2F-MHD, the tokamak poloidal magnetic field compresses only the plasma electrons (the pinch by toroidal electric current), and this separation of electric charges produces E_r which, in turn, generates "spontaneous" plasma rotation in the crossed ExB fields. A simple way to evaluate the Hall effect contribution to the E_r value, using the independently measured space distributions of magnetic field, electron pressure and plasma rotation velocity, is suggested. Application of this procedure to experimental data from the TM-4 [4] and T-10 [5] tokamaks yields high negative values of Er in the core plasma (~ few hundreds of V/cm) which are in qualitative agreement with the measured values (~ 100 V/cm). The data from other tokamaks are considered as well. The results suggest that the contribution of other mechanisms (e.g., neoclassical kinetics) to E_r (and spontaneous/intrinsic plasma rotation) in tokamaks should be treated with account of a strong hydrodynamic effect of the Ampère force, described in the framework of the 2F-MHD.

References

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