Intrinsic Rotation Model Combining Momentum Pinch and Residual Stress: Scaling and Profile Predictions

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There are three vital components in the modeling of anomalous angular momentum transport. These are turbulent diffusion, curvature driven convective flux [1] (i.e. a momentum "pinch", when inward), and the $E \times B$ shear driven residual stress [2]. $E \times B$ shear plays a dual role however, since it also affects these anomalous components by quenching the turbulence that drives them. The effect of the curvature driven pinch to the lowest order is the same as the turbulent equipartition (TEP) pinch encountered in particle transport. Thus, a combined model describing the evolution of plasma density, plasma pressure and angular momentum which incorporates the TEP pinches for density and angular momentum, $E \times B$ shear driven residual stress and $E \times B$ shear driven turbulence quenching has been developed. The model reduces the the Hinton-Staebler model when toroidal momentum and pinch are neglected and predicts a scaling of the non-dimensionalized pedestal toroidal flow velocity with the pedestal width. We also show that this result is in qualitative agreement with the Rice scaling[3, 4] for intrinsic rotation in H-mode. The overall qualitative picture suggestes by the model is that in the H-mode, intrinsic rotation is generated primarily in the pedestal via residual stress, while the inward momentum pinch leads to rotation profile peaking on axis.

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[1] T. S. Hahm, P. H. Diamond, O. D. Gurcan, and G. Rewoldt, Phys. Plasmas **14**, 072302 (2007).

[2] Ö. D. Gürcan, P. H. Diamond, T. S. Hahm, and R. Singh, Phys. Plasmas **14**, 042306 (2007).

[3] J. E. Rice, W. D. Lee, E. S. Marmar, et al., Nucl. Fusion **44**, 379 (2004).

[4] J. S. deGrassie, J. E. Rice, K. H. Burrell, et al., Phys. Plasmas **14**, 056115 (2007).