Thermal Ion Orbit Loss and Radial Electric Field in DIII-D*

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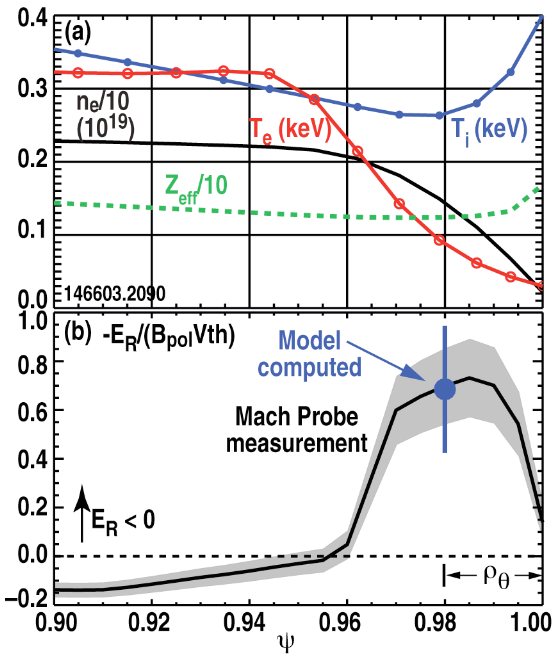

Fig. 1. (a) Edge profiles shortly after L-H transition. (b) Mach probe measure of E_r plotted as $E_r/B_{pol}Vth$ and the model computed value for balance of thermal return and loss currents. The D+ poloidal gyroradius, ρ_θ, is ~7 mm.

A simple neoclassical model for the return current balancing thermal ion orbit loss appears to agree with measurements of the edge radial electric field just inside the outboard last closed flux surface (LCFS), as indicated in Fig. 1. Here, a Mach probe measures the bulk ion toroidal velocity, V_{tor}, and the electrostatic potential in a discharge shortly after the L-H transition with electron cyclotron heating, when the density is up only ~10% of the total rise. It has been found that a simple empty loss cone model of the thermal ion orbit loss agrees surprisingly well with the V_{tor} profile measured [1], and simulations have borne out the existence of a depleted loss cone near the LCFS in low collisionality steady-state conditions [2]. We use this non-Maxwellian, empty loss cone model distribution, to compute the friction-induced return current driven by the co-I_p V_{tor} layer on the trapped ions, which is proportional to the difference in V_{tor} and the toroidal electric precession of the trapped ions, $V_{tor} - E_r/B_{pol}$. The model is applied near the LCFS where the loss boundary in phase space is relatively simple, allowing semi-analytical treatment of the variation of the relevant phase space boundaries with E_r. In the model, as the ion temperature is increased, E_r must become more negative for the return current to balance the orbit loss current [3], equilibrating on the ion-ion collision timescale. This suggests a possible connection with the H-mode trigger mechanism and also any coupling to interior intrinsic rotation which we are exploring further.

[1] J.S. deGrassie *et al.*, Nucl. Fusion **52**, 013010 (2012).
[2] D.J. Battaglia, *et al.*, submitted to Phys. Plasmas (2014).
[3] J.A. Heikkinen, *et al.*, Phys. Rev. Lett. **84**, 487 (2000).

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