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Fusion Alpha Loss in ITER with Local Marginal Stability to Alfven Eigenmodes

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A simple 1D radial transport code predicting the fusion alpha density profiles in an ITER burning plasma unstable to Alfvén eigenmodes (AEs) is illustrated. With the local AE thresholds exceeded only in the mid-core in the baseline case, we find only moderate mid-core flattening of the alpha density (and heating) profile and negligible alpha heating loss. Neglecting "ripple loss,"only microturbulent low energy alpha transport remains at the edge for this baseline case, so escaping alpha particles are best described as very hot helium. Edge energy loss in the alpha channel is then 1000 times smaller than in the thermal channels. This work extends earlier work by Angioni et al. [1] treating the fusion alpha transport from high-n micro-turbulence to include marginal stability (or "stiff") transport from alpha driven low-n Alfvén eigenmodes. The local alpha density gradient AE thresholds are provided by physically realistic linear gyrokinetic GYRO code calculations. The transported alpha density profiles are compared to the (no transport) classical (or collisional) slowing-down alpha profiles. The baseline thermal plasma (and hence fusion alpha source) profiles are taken from the Kinsey et al. [2] ITER performance projection. The distinction between the alpha particle and the much smaller alpha energy microturbulent transport loss is emphasized. Any high-energy alpha losses would both reduce needed plasma heating and increase the risk of material damage to plasma-facing surfaces. We predict no such losses in this baseline case.

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[1] C. Angioni, A.G. Peters, G.V. Pereverzev, A. Botino, J. Candy, R. Dux, E. Fable, T. Hein, and R.E. Waltz, Nucl. Fusion 49, 055013 (2009).
[2] J.E. Kinsey, G.M. Staebler, R.E. Waltz, and J. Candy, Nucl. Fusion 51, 083001 (2011)

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