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TH/P2-09: New Results in the Theory of Non-Diffusive Heat Transport and Anomalous Electron-Ion Energy Coupling

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We present new results in the theory of non-diffusive heat transport, with special emphasis on electron thermal transport. Two foci of this paper are a) the theory of the convective energy velocity (i.e. heat pinch) for both electrons and ions [1], and b) the theory of collisionless electron-ion energy coupling [2]. Both these topics are important for ITER, since in a burning plasma, alpha particles slow down through Coulomb collisions with the electrons. We emphasize that the heat pinch and collisionless transfer are physically distinct and independent processes, which can, in principle, co-exist in low collisionality regimes. For both ions and trapped electrons, an inward heat pinch is predicted for flat density profiles, while outward energy convection is predicted for steep density profiles. An analysis of various energy dissipation channels shows that collisionless energy transfer and the consequent ion heating will occur predominantly by quasilinear processes and through zonal flow dissipation. This implies that any putative ITER transport model must include the effect of turbulent heating and inter-species coupling, in addition to predicting the electron heat flux.

[1] L. Wang and P. H. Diamond, Nucl. Fusion 51, 083006 (2011).
[2] Lei Zhao and P. H. Diamond, U.S. Transport Task Force Workshop, San Diego, California, April 6-9, 2011.

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