Coupled transport in field-reversed configurations

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Coupled transport is the close interconnection between cross-field and parallel fluxes in different regions due to topological changes in the magnetic field. This occurs because perpendicular transport is necessary for particles or energy to leave closed field-line regions, while parallel transport strongly affects evolution of open field-line regions. In most toroidal confinement systems, the periphery, namely the portion with *open* magnetic surfaces, is small in thickness and volume compared with the core plasma, the portion with *closed* surfaces. In field-reversed configurations (FRCs) the periphery plays an outsized role in overall confinement. This effect is addressed by an FRC-relevant model of coupled transport that is well suited for immediate interpretation of experiments. The present focus is *particle* confinement rather than energy confinement since the two track together in FRCs. The interpretive tool yields both the particle transport rate χ_n and the end-loss time $\tau_{\|}$. The results indicate that particle confinement depends on both χ_n *across* magnetic surfaces throughout the plasma and $\tau_{\|}$ *along* open surfaces, and that they provide roughly equal transport barriers, inhibiting particle loss. The interpretation of traditional FRCs shows Bohm-like χ_n and inertial (free-streaming) $\tau_{\|}$. However, in recent advanced beam-driven FRC experiments χ_n approaches the classical rate, and $\tau_{\|}$ is comparable to classic empty-loss-cone mirrors.