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Comparison of the electron thermal transport between tokamaks and the C-2U FRC

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In many magnetic confinement devices anomalous electron heat transport has been found. In tokamaks it arises from the densely spaced and overlapping drift wave eieng modes in the sheared magnetic field, which leads to radially extended streamers and the Bohm-like transport. In reversed magnetic field shear there appears a gap in the radial spectrum and greatly reduced transport[1] as confirmed in reversed magnetic shear experiments. The NBI driven FRC C-2U plasmas[2] have no magnetic shear and show energy confinement times that increase with electron temperature in sharp contrast to tokamaks and stellarators. We present arguments based on drift wave turbulent transport[3] and the FLR-MHD-Alfven wave stability conditions that are consistent with this sharp contrast of energy confinement scaling with electron temperature.

For the C-2U plasmas the following stabilizing elements for dirft waves are found: (1) the large ion gyroradii are stabilizing, (2) electron bounce frequency is high and only a small fraction of the electrons leave the core confinenment region, (3) the direction of the grad-B drift is opposite to the grad-n_e, and (4) the large temperature ratio such as $T_i/T_e > 5$. We use these contrasts between the toroidal confinement systems and the NBI driven closed magnetic fields of the C-2U plasmas to explain the key differences in the scaling of the plasma confinement with electron temperature. For the the C-2U plasmas, the energy confinement time $\tau_E \approx T_e^{\alpha}$ rather than the universal Bohm or gyroBohm toroidal system scaling where $\tau_E \approx 1/T_e^{\beta}$ decreases with increasing electron temperature.

[1] A. D. Beklemishev and W. Horton, *Transport Profiles Induced by Radially Localized Modes in a Tokamak,* Phys. Fluids B **4**, 200-206 (1992) and B **4**, 2176 (1992).

[2] M. Binderbauer et al., Confinement times in the Tri Alpha C-2U plasmas (2015).

[3] W. Horton, *Turbulent Transport in Magnetized Plasmas* (2012) ISBN: 978-981-4383-53-0 pp.172-180 and 188-199.

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