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Impact of electro-magnetic stabilization, small- scale turbulence and multi-scale interactions on heat transport in JET[1]

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Heat transport experiments in JET, based on ICRH heat flux scans and temperature modulation, have confirmed the importance of two transport mechanisms that are often neglected in modeling experimental results, but are crucial to reach agreement between theory and experiment and may be significant in ITER. The first mechanism is the stabilizing effect of the total pressure gradient (including fast ions) on ITG driven ion heat transport. Such stabilization is found in non-linear gyro-kinetic electro-magnetic simulations using GENE and GYRO, and is the explanation for the observed loss of ion stiffness in the core of high NBI-power JET plasmas. The effect was recently observed also in JET plasmas with dominant ICRH heating and small rotation, due to ICRH fast ions, which is promising for ITER. Such mechanism dominates over ExB flow shear in the core and needs to be included in quasi-linear models to increase their ability to capture the relevant physics. The second mechanism is the capability of small- scale ETG instabilities to carry a significant fraction of electron heat. A decrease in T_e peaking is observed when decreasing Z_{eff} T_e/T_i, which cannot be ascribed to TEMs but is in line with ETGs. Non-linear GENE single-scale simulations of ETGs and ITG/TEMs show that the ITG/TEM electron heat flux is not enough to match experiment. TEM stiffness is also much lower than measured. In the ETG single scale simulations the external flow shear is used to saturate the ETG streamers. Multi-scale simulations are ongoing, in which the ion zonal flows are the main saturating mechanism for ETGs. These costly simulations should provide the final answer on the importance of ETG-driven electron heat flux in JET.

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