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Open Theoretical Issues and Solutions for Fusion Relevant Physics Regimes

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New features [1] of the Quasi Coherent Mode (QCM) have been observed in the EDA H-Regime and our theoretical model indicates that: i) the relevant resistive mode driving factor is the edge sharp plasma pressure gradient; ii) a novel mode topology is involved as the usual “disconnected mode approximation” cannot be applied given that the rotational transform $\iota(\psi)=1/q(\psi)=0$ on the LCMS around which the mode is localized; iii) the mode ballooning (poloidally) is related to the limited region [2] around the equatorial plane where the pitch of the magnetic field is about constant. Modes producing reconnection in low collisionality regimes have been observed to have a phase velocity in the direction of the ion diamagnetic velocity [3] contrary to the well accepted drift-tearing mode theory [4]. Then two theoretical lines leading to a mode with this phase velocity direction have been pursued: i) a theory based on the simultaneous effects of classical transport coefficients (plasma resistivity, longitudinal thermal conductivity and transverse ion viscosity) ii) an analysis [5] introducing a “mode inductivity” [6] to represent the electromagnetic coupling of the current channels inside the reconnection layer to other outside it. The “spontaneous rotation” of axisymmetric plasmas is confirmed to be related [7], to the excitation of modes involving the extraction of angular momentum from the plasma column and the recoil of the background plasma in the opposite direction. The features of the drift-tearing mode [4], of the ion-drift reconnecting mode [3] and of $m=1$ internal modes, that are responsible for the “generation” of the experimentally observed angular momentum within the plasma column, are identified. Velocity profiles reproducing the observations are obtained from the angular momentum balance equation [7] with sources associated with both the internal electrostatic and electromagnetic modes.

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