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OV/3-4: Towards an Emerging Understanding of Nonlocal Transport

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In this overview, recent progress on the experimental analysis and theoretical models for non-local transport (non-Fickian fluxes in real space) are overviewed. The non-locality in the heat and momentum transport observed in the plasma, the departures from linear flux-gradient proportionality and the spontaneously and externally triggered non-local transport phenomena will be described in both L-mode and improved-mode plasmas in various devices (LHD, JT-60U, HL-2A, Alcator C-mod, KSTAR, etc.). Non-locality of transport has been observed in the response to perturbations, such as a core temperature rise associated with the cooling at edge by pellet injection, sustainment of the core temperature increase for repetitive perturbations by supersonic molecular beam injection (SMBI), strong coupling of transport at different radii as seen in the curvature transition of ITB, and spatial propagation of ITB regions.

The probability distribution function (PDF) analysis for differences in temperature gradient from steady state values, studies of the fluctuation response during 'non-locality events', and micro-meso scale turbulence coupling studies are discussed as new approaches to investigate the mechanism of non-local transport. The experimental observation of meso-scale fluctuation with long range correlation during non-local phenomena is reviewed as a possible agent causing the non-locality of transport. The turbulence with long correlation, which is one of the strong candidates for causing the non-locality of the transport, was confirmed experimentally and the coupling between the different turbulence scales has also been identified in various devices (LHD, HL-2A, TJ-II, TJ-K, PANTA, etc.).

Theoretical models of non-locality fall into two categories, namely models which are intrinsically local but which support fast front propagation (e.g. for turbulence spreading, barrier propagation etc.) and those which are intrinsically non-local (i.e. relate heat flux to temperature gradient by a non-local kernel). The intrinsically non-local models link the Kernal scale to the interval between steps in the 'staircase'zonal flow pattern. Radial propagation of turbulence and barrier fronts models have had some success in explaining phenomena such as fast response to cold-pulses and profile rigidity in response to off-axis heating perturbations.

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