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Finding the Latent Structure in Non-local Electron Heat Transport Event[1]

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Latent structures in electron heat transport in stationary, magnetically confined plasma are unmasked by dynamic transport experiment in LHD. An edge perturbation induced by a trace impurity pellet (TESPEL) injection in LHD evokes a non-local transport phenomenon (large scale transport event, LSTE, such as a core electron temperature rise in response to edge cooling). The LSTEs are not peculiar to helical plasmas nor to plasmas with an impurity pellet injection, but are a very common characteristic. At the onset of the LSTE, a first-order phase transition of the electron heat transport, which is characterized by a discontinuity of the electron temperature gradient, is found to take place over a wide region (at least 6 cm wide) in the periphery of the plasma. At about the same time, over a wide region (about 10 cm wide) in the plasma core, a second-order phase transition of the electron heat transport, which is characterized by a discontinuity of the time derivative of the electron temperature gradient, appears. Both transitions involve coherent structures of a scale much larger than a typical micro-turbulent eddy size (a few mm in this case). In order to evaluate how the local heat transport properties change during an LSTE in LHD, a new transit time distribution analysis is applied to the temporal behavior of the electron temperature gradient. The analysis results show that two large-scale coherent structures in the electron heat transport exist, and are qualitatively different from each other. Recently, we found a long distance correlation of electron temperature fluctuation of the order of 30 eV, with a size corresponding to the plasma minor radius. Therefore the non-local transport phenomenon observed in LHD is evoked by the interaction of those structures via a long distance radial correlation of electron temperature fluctuations.

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