Change of fluctuation properties during non-local temperature rise in LHD from 2d phase contrast imaging

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Since the reduction of the total outward flux due to modification of turbulence characteristics is important for achieving improved confinement regimes, turbulence measurements can be helpful to explain this improvement. We present an example where confinement improvement through reduction of outward heat flux is associated with an *increase* of the density fluctuation amplitude and change of the radial wave-vector spectrum, which we interpret to mean that an inward-directed anomalous heat flux is generated.

It has recently been observed in LHD that the core electron temperature can rise after edge cooling induced by TESPEL (tracer encapsulated solid pellet) impurity pellet injection or argon gas puff [1]. The core temperature rise, unexplainable by a local diffusive transport model, implies that the total outward heat flux reduces, or in other words that there must be an inward directed perturbation to the total heat flux. An example of the temporal evolution of the perturbed part of the heat flux, normalized to density at the edge is shown in the figure below.

The 2d phase contrast imaging diagnostic can measure the spatial profile of a quantity closely related to the density fluctuation amplitude with wave-numbers in the range 1-10cm^{-1}, which is generally hollow. Fluctuation properties are measured at 2 points on each flux surface, above and below the mid-plane. As shown below, the edge fluctuation amplitude decreases during the initial phase when the perturbed flux is outwards, then increases beyond the initial level as the inwards directed perturbed flux manifests. This suggests that the confinement improvement is not due to fluctuation suppression, rather an increase of inwards-directed anomalous heat flux. Moreover, the sign of the difference between the top and bottom amplitude is also seen to correlate closely with the sign of the perturbed heat flux. This may be indicative of the imbalance of inward/outward radial fluctuations.

A systematic summary of the behavior at different collisionality will be given and the implications of these results for explaining the non-local temperature rise will be discussed.

[1] N. Tamura et al, Nuclear Fusion, 2007.