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Dynamics of thermal turbulence during non-local transport in a gas-puffing experiment on HL-2A

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One of the worldwide conundrums is the nonlocal transport which has been observed and studied a lot in many devices[1-3]. These observations suggest that the edge plasma could influence the deeper core. Turbulence theories of multiple scale nonlinear and statistical dynamics are research highlights recently[4-7]. However, the mechanism and theory models of nonlocality are still open problems nowadays. Validation of theories is the neccessary work but usually ristricted by experimental observations. The comprehensive action mechanism of particle, momentum and heat transport is still not conclusive. It should be carried out to more clearly understand the existence and significance of long range transport processes in confined plasmas.

Non-locality is still to be solved in the heat transport channel since the thermal turbulence had not been well analyzed. Recently, a correlation electron cyclotron emission diagnostic (CECE) is installed in HL-2A [8], assisting to reveal profound physics of the non-local phenomenon. In this talk, we will present analytical details in thermal turbulence and first time findings.

Dynamic behaviors of broadband electron temperature fluctuations on the coverage of normalized radial range $\rho = 0 \sim 0.9$ during non-local transport are observed for the first time. After the feeding, amplitudes of ˜ Te/Te within the radii of $0 < \rho < 0.38$ drop promptly and significantly. On the contrary, the peripheral($0.65<\rho<0.9$) amplitudes increase sharply in a time scale of 2 ms, as shown in Figure 1. Further in this region, long radial coherency in macro- and meso-scale turbulence is proved which could be a candidate responsible for the transient transport. While the disappearance of the long coherency inside the inverse radius would end this effect and finally lead to core heating.

The evidence shows that the E × B shearing rate would be a potential inducement which plays an important role in the turbulent dynamics(Fig.2). Turbulence may be stabilized by the increment of shearing rate in the core. Oppositely, the shearing rate drops in the peripheral, where instabilities grow and long radial coherency forms.

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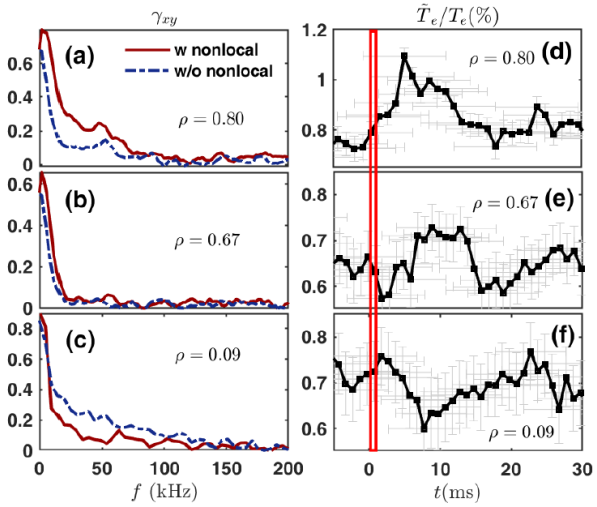

Figure 1 (a-c)CECE coherency with and without nonlocal period at different radii and(d-f)Time sequences with ˜ Te/Te

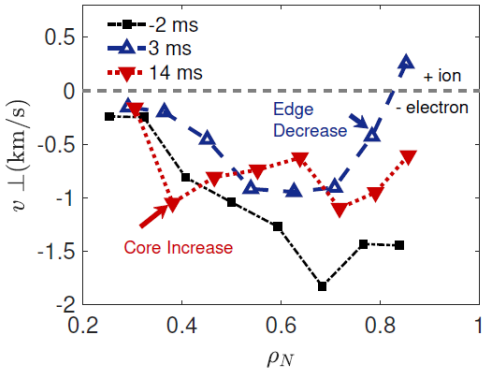

Figure 2 Profile of perpendicular velocity before(-2 ms) and during(3 ms, 14 ms) nonlocal transport period. The sign ”+” represents ion diamagnetic direction. ”-” is the electron diamagnetic direction.

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