Characteristics of electron temperature profile stiffness in electron heating dominant plasmas on EAST

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In future fusion plasmas, since the birth energy of alpha particles is typically 2 orders of magnitude higher than the temperature of the DT fuel ions, they will be predominantly slowed down on electrons, so the core alpha particle heating of electrons is expected. Therefore, electron heat transport characteristics in plasmas with a core electron heating dominated are crucial for the study of magnetic confinement fusion.

Recently, a very high core electron temperature (T_e~10 keV) has been achieved using pure radio frequency (RF) waves heating in a low density plasma (central line averaged density $<n_e>$ = $1.8\times10^{19}m^{-3}$) on EAST. Due to the strong synergistic effect between two on-axis ECRH (2 × 0.4 MW) and LHW (1.8 MW), the core T_e profile becomes rather peaked. The ratio of $T_{e0}/T_{e0.8}$ after the second ECRH injection is by a factor of 2 larger than that with LHW heating only. The dependence of electron heat flux (q_e^{GB}) on the normalized electron temperature gradient (R/L_{Te}), which yields the slope of straight line to represent the profile stiffness, has been investigated. The result shows that the increase of ECRH power can increase significantly of the normalized T_e gradient at the plasma core region ($\rho < 0.6$), but does not change the T_e profile stiffness. Furthermore, a slow density ramp-up from $1.5\times10^{19}m^{-3}$ to $3.3\times10^{19}m^{-3}$ has been performed in the target plasma dominated by LHW and ECRH synergistic electron heating on EAST. According to the plasma transport analysis, three distinguishable stages, characterized with different T_e profile stiffness, in the time evolution of the plasma density climb can be identified. A stronger T_e stiffness at $\rho=0.3$ has been observed in the second stage, where the LHW power deposition moves away from the plasma core region following the n_e increases. A formation of internal plasma density transport barrier at $\rho=0.6$, accompanied by a sudden drop in core T_e and a rise in both of core density and ion temperature, has been observed for the first time during the transition from the second stage to the third stage when the central line-averaged plasma density reaches a threshold of $2.2\times10^{19}m^{-3}$. It also turns out that the density transport barrier at $\rho=0.6$ can be stably sustained even with a higher plasma density of $3.3\times10^{19}m^{-3}$.