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Role of magnetic topology on core transport in TJ-II stellarator

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The influence of the magnetic topology, and rational surfaces in particular, on core transport has been an area of increasing interest in the recent years. In tokamak plasmas, a correlation between the appearance of rational surfaces (as the q profiles evolves) and the formation of the ITBs has been seen on several devices[1]. Local transport enhancement together with different types of central relaxation of the central electron temperature have been observed in ECH heated low density plasmas in TJ-II stellarator ($B_0 < 1$ T, R = 1.5 m and $a \leq 0.22$ m). Recent work in TJ-II has shown that there is a clear link between the perturbations of the electron temperature profile and the presence of a rational surface close to the plasma centre[2]. In this paper, emphasis is placed on the analysis of the temporal evolution of electron temperature (as measured by ECE) and SXR data in order to identify possible mechanisms underlying the observed behaviour. This study can contribute to understanding the influence of the rational resonances on the observed transport changes.

Fast drops ($t \approx 0.1$ ms) of the central temperature followed by a longer period (0.5 ms) of reheating are observed in plasmas with iota(0) ≈1.5[3]. This activity stops after a few crashes and then the temperature stays at the saturated level. These sharp transitions are clearly seen in the SXR and interferometer data, indicating an increase of the central density. Periods with several pronounced forward and back transitions can also be seen: the plasma alternately takes two discrete temperature values with a repetition frequency of about 1 ms. The transition pattern changes when the line averaged increases while the ECRH power is constant. The modification of the electron temperature profile is restricted to a small region of $\rho/a \leq 0.25$ in the plasma core. The increase of the temperature gradient by a factor of 1.5 during the transition indicates a local change of the transport coefficients. The clear separation between the two plasma states in these conditions allows us to estimate the changes in the thermal diffusivity from power balance analysis.

Similar behaviour has also been reported in two toroidal helical plasmas, CHS[4] and W7-AS[5]. In both devices, these phenomena have been explained in terms of improvement of the neoclassical transport and/or changes in the anomalous transport induced by sheared electric fields. However, the possibility of varying the magnetic configuration in TJ-II significantly, shows us that the appearance of these phenomena in the TJ-II case is restricted to certain magnetic configurations, suggesting the important role played by the magnetic structure.

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