Parallel SOL transport regime in tokamak COMPASS

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The topic of parallel SOL transport regimes is of great interest for future fusion devices, as the detached or partially detached regimes allow to reduce heat fluxes incident on the divertor targets by dissipating a substantial part of the energy carried by plasma particles. Tokamak COMPASS is well suited for SOL transport studies, possessing an advanced system of diagnostics such as a divertor probe array capable of measuring heat fluxes with high temporal resolution [1]. However, due to its short connection length ($R \approx 3$ m) and open divertor configuration, it is not clear which transport regime tokamak COMPASS operates in. This study addresses the question based on an analysis of electron temperature profiles.

Using the vertical and horizontal reciprocating probe, the divertor probe array, and the High Resolution Thomson Scattering diagnostics, electron temperature profiles are measured at three poloidal locations: the plasma top, the outer midplane, and the divertor. Position of the separatrix, whose accurate knowledge is crucial for the analysis, is discussed in depth. The resulting profiles are compared in the view of the two-point model [2], providing an estimate of parallel temperature gradient and plasma collisionality. By processing the database of tokamak COMPASS discharges, a scan over plasma parameters such as plasma current or line-averaged density is performed, yielding operational space in which partial detachment plays a role.

COMPASS Scrape-Off Layer is shown to be typically in the sheath-limited regime or in the transition region between the sheath-limited and conduction-limited regimes. This has implications on the behavior of both the upstream and downstream temperatures. While in the conduction-limited regime the upstream separatrix temperature is expected to be largely insensitive to plasma conditions [2] [3], in the sheath-limited regime it decreases with increasing plasma density. Since at low collisionalities the downstream temperature closely follows the upstream one, a significant drop of target temperatures at high density, observed on COMPASS in [4], must be treated with great care before it can be considered as a sign of detachment.

References

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