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## **Transport, Stability and Plasma Control Studies in the TJ-II Stellarator**

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Recent improvements in TJ-II plasma diagnostics and operation have led to a better understanding of transport, stability and plasma control in fusion plasmas. Impurity transport: Observations of asymmetries in impurity parallel flows in TJ-II ion-root plasmas have been interpreted as an indication of the compressible variation of the impurity flow field and hence of in-surface impurity density asymmetries. In addition, first-time observations of electrostatic potential variations within the same magnetic flux surfaces are presented which are reproduced by neoclassical Monte Carlo calculations. The dependence of impurity confinement time has been also studied as a function of charge and mass. Momentum transport and isotope physics: TJ-II has provided evidence that three-dimensional magnetic structures convey significant impact on plasma confinement and L-H transitions. Recent observations on the temporal ordering of the limit cycle oscillations at the L-I-H transition show the leading role of the plasma turbulence. Comparative studies in tokamaks and stellarators have provided direct experimental evidence of the importance of multi-scale physics for unravelling the physics of the isotope effect on transport. Power exhaust physics: Novel solutions for plasma facing components based on the use of liquid metals like Li and alloys have been developed on TJ-II. The TJ-II programme on liquid metals addresses fundamental issues like the self-screening effect of liquid lithium driven by evaporation to protect plasma-facing components against heat loads and tritium inventory control, using Li-liquid limiters (LLL) recently installed. Plasma stability studies: Experiments with magnetic well scan on TJ-II suggest that stability calculations, as those presently used in the optimization criteria of stellarators, might miss some stabilization mechanisms. Fast particle control: The TJ-II results show that, upon moderate off-axis ECH power application, the continuous character of the Alfvén eigenmode (AEs) changes significantly and starts displaying frequency chirping. This result shows that ECH can be a tool for AE control that, if confirmed, could become ITER and reactor-relevant.

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