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Results of a model of interchange turbulent transport on the correlation between scrape off layer width and core confinement in tokamaks

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Turbulent transport has two critical impacts on the operational domain of tokamak reactors: it sets the core confinement performances through limitation of kinetic gradients from the very centre of the confined plasma to the magnetic separatrix, and it sets the condition of power exhaust by the tokamak wall, through the size of the heat flux wetted area. Experiments across a variety of magnetic configurations tell us that improvement of confinement is correlated with a reduction of the heat flux wetted area, as clearly established by the comparison of low and high confinement mode experiments. In that respect, research on advanced divertor concepts has to find a way to disentangle power exhaust conditions from that of confinement, for instance by optimizing both turbulent spreading of the wetted area and dissipation performances of the boundary plasma volume. A key aspect of this research is to understand the transport mechanisms taking place from the core to the plasma periphery, and how they correlate.

A model of transport by interchange turbulence was recently derived to propose a physical basis of the experimental scaling on scrape off layer width. The model is found to accurately predict global and local properties of scrape off layers in circular limited geometries: width of the wetted area, fluctuation levels of density and electrostatic potential, scale of the dominant turbulent modes, etc. Even though the model overpredicts the scrape of layer width of divertor configurations, suggesting missing physical ingredients from a magnetic X-point, sensitivity with global control parameters is well recovered. In addition, the model is able to recover recent experimental findings from the TCV tokamak where the width of the wetted area was found to increase significantly with the geometrical length of the outer divertor leg. These results suggest that the model contains the ruling physics of scrape off layer transport even in diverted geometry. Another striking result from the model is the capability to predict a global energy confinement time that is accurately matching the trend of the multimachine scaling, apart from a multiplication factor. As found in experiments, the model therefore predicts a close correlation between global confinement performances and power exhaust conditions, principally driven by the plasma current. But it also offers an interesting physical basis to optimize power exhaust at least through geometrical considerations: Can we expect a given advanced divertor geometry to efficiently enhance interchange spreading of the heat flux wetted area?

Country or International Organization

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