

P2.1041 Role of filaments in setting the SOL width in tokamaks

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See full abstract here

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Understanding the plasma transport at the boundary of magnetic confinement devices is needed to improve both confinement & power exhaust. Low to high confinement mode transition relates to the reduction of transport across flux surfaces near the separatrix, and transport in the scrape off layer (SOL) directly sets the width of heat load areas (WHL). Transport across the plasma edge is often associated with the intermittent convection of plasma filaments, driven by interchange mechanisms. A few key questions still pending are to know if this filamentary transport can explain, at least qualitatively, the dependences of WHL and confinement properties from current experiments, and if such models can provide predictions through scaling laws for future reactors (ITER and DEMO).

In this contribution, a generic model of 2D interchange turbulence is considered. Numerical simulations applied to simple SOL geometries feature exponentially decaying density profiles & intermittent convection of filaments as the main radial transport mechanism. Both filament velocities & SOL widths from the simulations are consistent with experimental measurements made in the SOL of Tore Supra circular plasmas. A predictive model of the turbulent flux associated with this filamentary transport is then exposed. To overcome the difficulty of modelling the filament intermittency, a new point of view is adopted: filaments are decomposed on poloidal wave numbers, where the flux is a simple convolution of density and potential spectra. A model of time average spectra is deduced from the conservation equations, following similar approximations made for isolated filaments. The model agrees with spectra from nonlinear simulations. The result is an analytical model of turbulent flux & fluctuation levels. Applied to SOL configurations, it translates into an analytical model for the SOL width. Quantitative agreement is found against a wide database from Tore Supra, regarding both SOL width & fluctuation levels. The sensitivity of the SOL width model with engineering parameters is very close to scaling laws built from international data bases for (1) startup limiter (2) L-mode diverted & (3) H-mode diverted conditions; although the model over predicts the absolute SOL width values in diverted configurations. Inclusion of specific geometrical features from diverted configurations is probably needed to generalize the model. A second important extension of the model is the inclusion of turbulence mitigation by sheared flows. Results from simulations with a background shear will be discussed. Last, a striking conclusion is drawn regarding global confinement. The analytical model of turbulent flux leads to a scaling of the energy confinement time close to the multi-machine trend. It suggests a certain genericity between core & edge transport, and confirms a close correlation between core confinement and SOL width as shown in experiment. Keywords : edge tokamak plasmas, turbulent transport, scrape-off layer width, shear flows

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