Turbulence and Transport in Magnetically Confined Plasma

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Transport mediated by turbulent is the dominating mechanism for plasma transport across a confining magnetic field in hot plasmas. The turbulent fluctuations arise spontaneously due to pressure gradients perpendicular to the magnetic field. Low frequency plasma turbulence is well described by the fluid model for plasma dynamics, and it is essentially quasi two-dimensional, i.e., the turbulence is strongly anisotropic with the main dynamics in the plane perpendicular to the magnetic field.

In toroidal magnetically confined plasmas the scrape-off layer, SOL, is the outer region of the plasma, where the magnetic field lines ends on material surfaces. It has the function of "scraping off" the plasma that is transported out through the edge region. The dynamics and transport in the edge region is essential for the global plasma dynamics, since all plasma has to leave through the edge. In addition, the character of the transport in the edge/SOL is essential for estimating the power deposition on the plasma facing components. It is well established from both experiments and models that the turbulence and transport in this region is inherently intermittent and involves large outbreak of hot plasma. These structures appear as filaments aligned with the magnetic field; they are often termed “blobs” and propagate far out in the SOL. The dynamics of these blobs, which resembles raising plumes in thermal convection, is well described by a two-dimensional convection model. The ensuing turbulent transport cannot be parameterized in terms of a simple diffusion coefficient (in the sense of Ficks law), but is characterized by strongly skewed Probability Density Functions (PDF) with broad (exponential) tails.

In this presentation results from numerical modelling of the transport in the Edge/SOL region of magnetically confined plasmas in toroidal devices will be reviewed and discussed in terms of experimental findings [1-4].

References

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