Impurity screening in RFX-mod RFP plasmas


Consorzio RFX, Associazione EURATOM-ENEA sulla Fusione, Padova, Italy

Impurity transport and particle confinement are important issues in plasma physics. In many experiments it has been observed that in high confinement regimes the radial profiles of impurity density tend to be more peaked than those of the main ion density. This phenomenon, ‘impurity accumulation’, has the immediate consequence of increased radiative losses and radiative instabilities which, in an ignited plasma, would result in a lower fusion power. The experimental evidence in RFX-mod RFP is that impurity core penetration is prevented. Such finding has been documented for intrinsic (C, O) and injected (Ne, Ni) impurities in various experimental conditions [1]. Recent W LBO experiments confirmed that W doesn’t progress into the plasma core.

1-dim impurity transport simulations showed that the impurity flux convective term is positive (outward) over the whole plasma radius, with a large velocity barrier at the plasma edge. This outward convection acts to prevent the impurity access to the core. Impurity accumulation is avoided even in the improved confinement self-organized helical regimes (SH) occurring at high plasma current (I>1 MA). Moreover, in the enhanced confinement SH regime the impurity screening is more effective, being the outward convection barrier stronger and wider.

In SH conditions, the main gas shows just a reduction of the particle diffusion inside the thermal barrier [2]; the velocity is outward in the region of the high internal temperature gradients, of the order of 10 m/s, lower than the velocity predicted by the theory of transport in a stochastic magnetic field [3].

A coherent impurity transport theoretical frame is still missing: with the present knowledge of the RFX-mod ion temperature profile, the found impurity outward convection cannot be ascribed to a classical ‘temperature screening’ effect.

Gyrokinetic calculations (GS2 code) of turbulent transport, to evaluate the effect of electrostatic and electromagnetic turbulences on impurity fluxes, are compared with the ‘experimental’ impurity convection.