Impurity transport : fluid simulations and comparison to quasilinear theory

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Impurity transport is an important issue for fusion plasmas. It is indeed planned to seed impurities (e.g. Ar) at the edge of the plasma in a next step device. The aim is to produce an edge-localized radiation belt for continuous heat exhaust. However, impurity accumulation in the core may lead to detrimental radiated power losses (from high Z impurity) and fuel dilution (for high and low Z impurities, including He). Therefore, it is crucial to predict whether impurity accumulation will take place or not.

In order to study impurity turbulent transport, an impurity species has been implemented in the 3D fluid code TRB [1]. This allows parametric scans of impurity transport. Quasilinear theory [2] predicts that the impurity pinch velocity contains two contributions: one called curvature pinch, always directed inward, and a thermodiffusion term that changes sign with the average phase velocity of turbulence. The thermodiffusion pinch velocity is found to be directed inward for dominant TEM (Trapped Electron Modes) turbulence and outward for dominant ITG (Ion Temperature Gradient) modes. Also the thermodiffusion coefficient decreases with the charge number. TRB simulations show that a turbulent pinch exists. Indeed impurity profiles are peaked even when the ionisation source is peripheral. This pinch is mainly due to curvature effect, as thermodiffusion effects (induced by v_*) decrease as 1/Z. Moreover, thermodiffusion trends to flatten impurity density profile for ITG-dominated turbulence (the opposite holds for electron density); this is coherent with quasilinear theory.

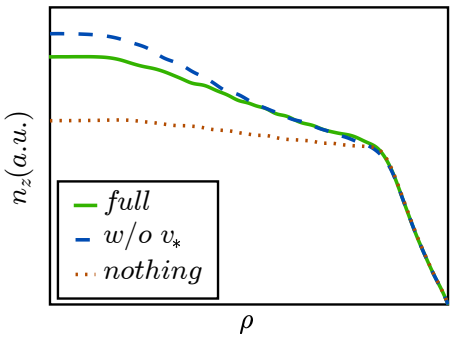

Figure 1: Impurity pinch : thermodiffusion (ν_*) and curvature effects.

References

[1] X.Garbet and R.E.Waltz, Phys. Plasmas **3** (1996) 1898.

[2] X.Garbet, N.Dubuit, E.Asp, Y.Sarazin, C.Bourdelle, P.Gendrih, G.T.Hoang, submitted to Phys. Plasmas