Neoclassical transport with non-trace impurities in density pedestals

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By increasing the global energy confinement edge transport barriers are of crucial importance for the viability of the tokamak concept in becoming an energy source. Changing from carbon to metallic plasma facing components (PFCs) in major fusion devices was accompanied by a reduction in the pedestal performance (JET [1, 2], ASDEX [2]). The performance representative of carbon PFC operation could in some cases be recovered using nitrogen seeding, pointing to a possible impact of impurities on pedestal confinement.

We investigate the effect of non-trace impurities on collisional transport and flows in a sharp density pedestal (characterized by an ion orbit width scale density variation and subsonic flows), using the global, δf, Eulerian neoclassical solver PERFECT [3]. We show that the fluxes are significantly altered by the presence of the sharp density pedestal: most notably, the coupling between different flux-surfaces allows for non-ambipolar particle fluxes and non-zero transport of parallel momentum. We find the mass and momentum transported by the main ions to be significantly affected by going from trace to non-trace impurity content. In the sharp gradient region the friction of ions on electrons can compete with that on impurities leading to ion and impurity particle fluxes with the same sign, making the temperature screening effect on impurity transport unreliable.

References

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