Modelling investigation of the recycling effects on the upstream SOL density profile for tokamak divertor plasmas

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Towards the physical understanding on the formation of flattened upstream SOL density profiles, namely 'density shoulders', a self-consistent one-dimensional radial transport model has been developed to estimate the upstream profiles covering both core plasma and SOL region at tokamak midplane. For the core plasma, the energy confinement time in the model is calibrated by the experimental scaling, where the radial diffusion coefficient in the SOL is in a reasonable range with the typical order of $\left(1\ \mathrm{m^2 s^{-1}}\right)$. For the SOL region, the effective density and temperature profiles used to simplify the ionization process are obtained by weighted averaging of the upstream and downstream profiles, which can distinguish the open target operation (OTO) from the closed target operation (CTO) by a weighting factor. Compared with enhanced turbulent convective transport, it is complementary for the model to study the competition between the effective source S_{eff} and the parallel particle losses L_{SOL} ,which indicates the algebraic sum of $S_{eff}+L_{SOL}$ is necessary to be significantly greater than a critical value in a certain region to flatten density profile, which is triggered by a positive feedback in the OTO-like regime where the effective source term S_{eff} are dominant.

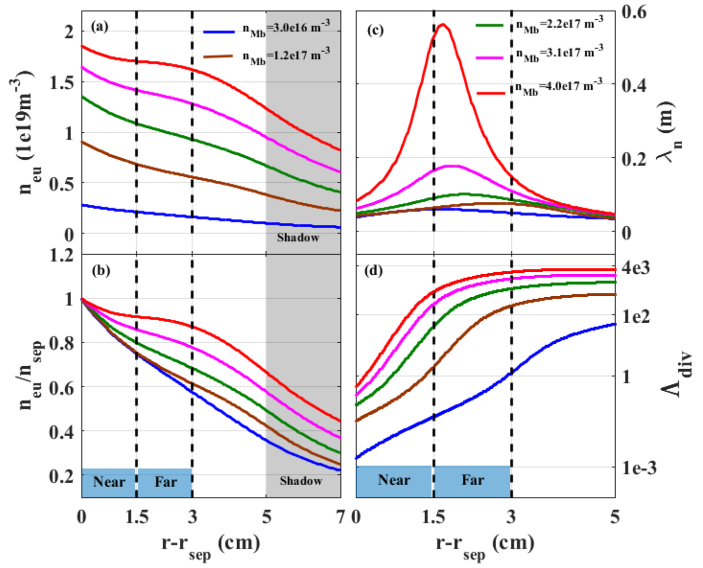

Figure. (a) Example density profiles during edge molecular density n_{Mb} ramp showing characteristic flattening. (b) The same density profiles normalized to upstream separatrix densities. (c) The radial distributions of density e-folding length. (d) The radial distributions of the effective divertor collisionality by the downstream parameters.