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Can the H-mode be sustained by neoclassical mechanisms?

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It is conjectured that the L to H mode transition is associated with the turbulence suppression by the self-organized ExB flow shear and the associated transport reduction in the pedestal region. However, after the turbulence suppression, the self-organization driver is also suppressed. Hence, the question how the turbulence is kept suppressed during an H-mode has been a burning topic for some time. There are possible answers within the nonlinear turbulence physics (e.g., predator-prey model). However, there is a growing suspicion that the neoclassical ExB flows may be able to claim a significant responsibility for the sustainment of H-mode.

Gyrokinetic simulation using the edge particle code XGC shows that there are robust neoclassical/classical boundary layer mechanisms to drive strongly sheared ExB rotation in the tokamak edge plasma if there is a sharp pedestal profile. The ExB shear exists not only in the pedestal (H-mode layer), but also throughout the scrape-off layer. Thus, if the neoclassical/classical driven ExB shearing is responsible for H-mode sustainment, it is most likely that the turbulence is kept suppressed not only in the H-mode layer, but also in the whole edge region.

The same boundary mechanism also drives co-current toroidal rotation in the pedestal top, which can be the boundary condition for a core rotation transport equation. Sources of sheared edge electric field and rotation will be discussed. Relevant experimental measurements will be suggested. Due to the non-validity of the conventional Maxwellian-based force balance equation in the edge, and the significant cancellation between the ExB and diamagnetic drift, it is not trivial to have a meaningful comparison between the simulation results and the experimental measurement.

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