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Effects of nonambipolar transport on confinement transition

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The development of external resonant magnetic perturbation (RMP) is to mitigate/suppress giant edge localized mode (ELM), thus ease the heat loads to the magnetic fusion devices. While, the increment of power threshold for L-H transition due to application of external coils like RMP has been widely reported. Motivated by this, we present a new theory on studying the effects of nonambipolar transport on the L→H transition in a stochastic magnetic field.

From the radial force balance equation, it can be clearly seen that the effects of stochastic field on $\langle E_r \rangle$ can be embodied in the gradient of ion pressure, and poloidal as well as toroidal rotation, and the latter two are both directly drive by $\langle J_r \rangle$. Besides, from Ohm's law, $\langle E_r \rangle$ and $\langle J_r \rangle$ are related and self-consistent based on Ampere's Law. The ambipolarity will be broken by the magnetic stochasticity, and thus affects the turbulent transport. By using the mean field theory, we found novel features include a Maxwell stress on poloidal rotation V_θ induced by the stochastic magnetic field. This tends to work against V_θ, since it has the same phase as, but sign opposite to, the Reynolds stress. More importantly, the magnetic stress on V_φ can reverse the toroidal rotation on the stochastic layers. Stochastic magnetic fields induce a non-diffusive, multi-component particle flux, which can explain RMP-induced pump-out. In addition, stochastic magnetic fields can degrade the coherence of $\tilde{V}_r$ and $\tilde{V}_\theta$ in the Reynolds stress, thus weakening the L→H trigger mechanism. Finally, stochastic fields necessarily carry a portion of the ion and electron heat fluxes.

Reference
1. Weixin Guo, Min Jiang, Patrick H. Diamond, Chang-chun Chen, Mingyun Cao, Hanhui Li and Ting Long. Theory of mean E×B shear in a stochastic magnetic field: ambipolarity breaking and radial current. PPCF submitted.