Gyrokinetic theory of turbulence-driven intrinsic rotation and intrinsic current

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A new mechanism for turbulent acceleration of parallel rotation in electrostatic ion temperature gradient (ITG) is discovered from electrostatic gyrokinetic theory [1]. The turbulent acceleration acts as a local source/sink, which cannot be written as a divergence of the parallel Reynolds stress. It has different physics from the residual stress, which enters the rotation equation via its divergence. Via comparison between the cases for ITG and collisionless trapped electron mode, a possible connection of our theoretical results to the experimental observations of ECH effects on toroidal core rotation is discussed [2].

Recent experimental results show that the fluid Reynolds stress cannot explain the rotation profile [3], and kinetic stress can drive parallel rotation [4]. Therefore, we extended our previous work to electromagnetic turbulence [5]. The quasilinear intrinsic parallel flow drive including parallel residual stress, kinetic stress, cross Maxwell stress and parallel turbulent acceleration by electromagnetic ITG turbulence is calculated analytically using electromagnetic gyrokinetic theory. The possible implications of our results for experimental observations are discussed [5]. To clarify that turbulent acceleration does not contradict the momentum conservation, we also present the relationship between turbulent acceleration and momentum conservation in electromagnetic turbulence [6]. Our ongoing works focus on intrinsic toroidal rotation by taking toroidal effects into account and intrinsic current drive by electromagnetic turbulence.

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