Transport of Parallel Momentum by Collisionless Electromagnetic Turbulence

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An electromagnetic gyrokinetic formulation is utilized to calculate the turbulent radial flux of parallel momentum for a strongly magnetized plasma in the large aspect ratio limit. A parallel momentum conservation theorem is proven, such that the exchange between, and the momentum flux induced by, resonant particles and waves are both accounted for. Specifically, we show that the total flux of parallel momentum can be written as a resonant particle momentum flux plus a radial flux of parallel wave momentum. We distinguish two distinct cases from the generalized theory for electromagnetic gyrokinetic modes developed. The first case considered corresponds to drift-Alfven waves. For the low beta regime, we recover diffusive, convective, and residual stress terms consistent with the electrostatic calculations performed in Refs. [1,2], but with the addition of finite beta corrections. As beta increases past a critical value, the magnitude of the residual stress term passes through zero, possibly producing a change in the direction of the off-diagonal momentum flux. The second limit considered is that of kinetic shear Alfven waves (KSAW). Here we find that dispersion due to finite Larmor radius corrections, coupled with the mean profile gradients allow for a radial flux of KSAW momentum. A net imbalance in the parallel propagating KSAW populations (i.e. unequal Elsasser populations N_+, N_-), can thus induce a net radial transport of parallel momentum, carried by waves. Discussion of applications to experiments will be given. In particular, we consider ways of producing imbalances in Alfven wave Elsasser populations via external drives.

[1] O. D. Gurcan, P. H. Diamond, T. S. Hahm, and R. Singh, Phys. Plasmas **14**, 042306 (2007)

[2] P. H. Diamond, C. J. McDevitt, O. D Gurcan, T. S. Hahm, and V. Naulin, Phys. Plasmas **15**, 012303 (2008).