Drift-Wave Turbulence: a Heating Mechanism for the Solar Corona

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Abstract

The solar corona is a highly filamentary environment with density gradients occurring on diverse scales, which can give rise to unstable drift waves, leading to plasma heating as well as particle, heat, and momentum transport. By means of nonlinear gyrokinetic simulations, density-gradient-driven drift-wave turbulence is explored in the solar corona, to ascertain whether this mechanism may contribute substantially to the observed coronal heating. To ensure relevance for the solar corona, realistic parameters such as hydrogen mass ratio and coronal plasma beta are used, and a range of gradient scale lengths are explored; for this study, coronal loop geometry is reduced to a sheared slab.

Drift waves with frequencies between 0.1 mHz and 10 Hz arise, consistent with stochastic heating due to perpendicular motion becoming relevant. Furthermore, particle acceleration via parallel electric fields is measured and may account for observed volumetric heating rates, albeit only in regions with high density gradients. Notably, fluctuations in the parallel electron current are produced by the drift-wave turbulence, implying that secondary magnetic reconnection can be driven that in turn may be able to account for further heating. Notably, typical lifetimes of coronal structures are consistent with the erosion time of density filaments due to particle fluxes in these simulations.

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