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An Effective Collision Operator for Heat-Flux-Generated Whistler Turbulence

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A large proportion of galaxy clusters contain an ICM which supports temperature gradients that are inconsistent with the classical coulomb scattering rate. Turbulence has long been cited as a possible mechanism for enhanced scattering. In particular, the role of the whistler instability in limiting electron heat flux has been a recent area of interest. Numerical results have demonstrated the saturated heat flux scales as 1/beta_e (Roberg-Clark 2016 and Komarov 2018) and a quasi-linear form for the whistler scattering operator has been proposed (Drake 2021). In this work, we run numerical simulations of the whistler instability and confirm the heat flux scaling in a setup similar to previous work as well as a stratified setup with gravity. We then recover the form of the turbulence collision operator using a Fokker-Planck method as well as a Chapman-Enskog method and discuss in detail the comparative strengths of each method. We then use this information to construct a collision operator for whistler turbulence and compare with existing models. Finally, we discuss preliminary results from our simulations of an analogous ion heat flux instability.

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