6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Quantifying nongyrotropy of proton-electron heating in turbulent plasmas

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An important aspect of energy dissipation in weakly collisional plasmas is that of energy partitioning between different species. Instead of identifying specific models for this preferential heating, here we adopt pressure-strain interaction to quantify the fraction of isotropic compressive, gyrotropic and nongyrotropic heating for each species. Analysis of kinetic turbulence simulations is complemented by analogous observational results from the Magnetosphere Multiscale mission in the magnetosheath. In assessing how the two species (i.e., ions and electrons) respond to different parts of the pressure-strain interaction, we find that the compressive heating is stronger than the incompressive heating in the magnetosheath for both electrons and ions, while the incompressive heating is stronger than the compressive heating in our kinetic plasma turbulence simulations. Concerning the incompressive heating, the gyrotropic contribution for electrons is dominant over the nongyrotropic contribution, while for ions the nongyrotropic heating is enhanced. Variations with plasma β are also discussed.

References

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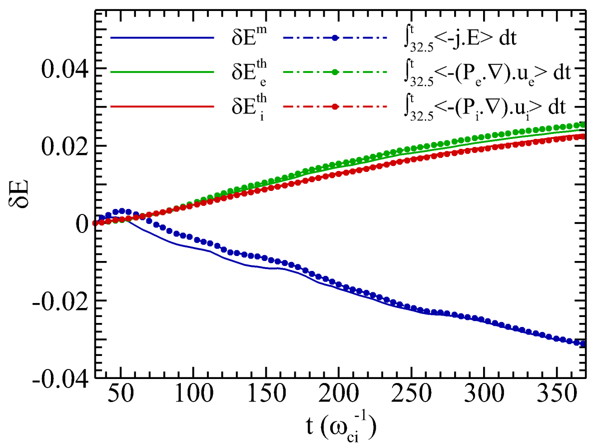

Figure 1: Time evolution of the changes of the electromagnetic energy and the internal energy of each species vs. cumulative time-integrated electromagnetic work and pressure-strain interaction for a 2.5D kinetic simulation.

Figure 2: Percentages of regional averaged gyrotropic and nongyrotropic contributions relative to the pressure-strain interaction for electrons and ions at different β’s in the magnetosheath.