SH32A-06 Learning closure of fluid equations from kinetic simulations of reconnection using machine learning

Wednesday, 13 December 2023
20:14 - 20:24
213-214 - South (Level 2, South, MC)

Abstract

A classic problem in space plasma theory is how to represent the complex behaviour of electrons and ions that include complex non Maxwellian velocity distributions within fluid models. Fluid models are based on a closed set of moments of the velocity distributions function, for example in MHD density, velocity and pressure. However this set is not complete as the equations for the moments selected always include higher order terms not present in the fluid model. For example in the study of reconnection, the generalised Ohm's law includes the full pressure tensor that is not available within a MHD model. If an equation is added for the pressure tensor then the third order moments (energy fluxes) are needed and so forth. The solution is to introduce the so-called closure relations. These are equations that express the higher order moments in terms of the available moments. The most classic example is the ideal equation of state to express pressure via density and temperature. In r plasmas, however, obtaining accurate working relationships is very complex, especially in regions where reconnection takes place. Here we will see how progress can be made using machine learning to learn closure relations for the pressure tensor and the heat flux using massively parallel particle in cell (PIC) simulations to train neural networks [1].

[1] Laperre, B., Amaya, J., Jamal, S., & Lapenta, G. (2022). Identification of high order closure terms from fully kinetic simulations using machine learning. *Physics of Plasmas*, *29*(3).

First Author

Giovanni Lapenta
KU Leuven

Authors

Brecht Laperre
Katholieke Universiteit Leuven

Jorge Amaya
Katholieke Universiteit Leuven

George Miloshevich
ENS de Lyon

View Related

SH32A - Energy Transfer and Dissipation in Space Plasmas: Kinetic to Global Scales III Oral

Yan Yang[1], ***William H Matthaeus***[2], ***Paul Cassak***[3], ***Nishtha Sachdeva***[4] *and* ***Rohit Chhiber***[2,5], *(1)University of Delaware, Newark, DE, United States(2)University of Delaware, Department of Physics and Astronomy, Newark, DE, United States(3)Department of Physics and Astronomy, West Virginia University, Morgantown, United States(4)University of Michigan, Climate and Space Sciences and Engineering, Ann Arbor, United States(5)NASA Goddard Space Flight Center, Heliospheric Science Division, Greenbelt, United States*

Wednesday, 13 December 2023
19:20 - 20:50
213-214 - South (Level 2, South, MC)

SPA-Solar and Heliospheric Physics