CD-I13 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Mapping Turbulence and its consequences around a reconnection region

Giovanni Lpenta[1,2]

[1] Department of Mathematics, University of Leuven, Belgium

[2] Space Science Institute, Boulder, USA

e-mail (speaker): giovanni.lapenta@kuleuven.be

Reconnection is often accompanied by turbulence. The two seem to be disjoint only in the ideal world of 2D models and simulations but in 3D their relationship becomes stronger. An example from a massively parallel simulation with iPic3D is reported below [1].

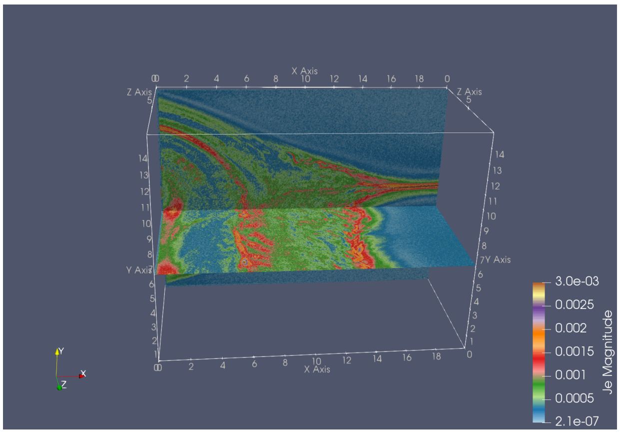

Figure 1: Two sections that show the turbulent outflow originating from the right end of the domain shown (it is only half of the computational box) at x=20. The false colours show the current density. Turbulence is clearly present in the outflow.

Turbulence alters the evolution of reconnection and reconnection causes flows that shape the regions of turbulence and further promote turbulence. To understand these processes, we need to design methods that can measure quantitatively the processes of reconnection and turbulence in 3D [1-2]. This is far from trivial. In 3D even defining what is and what isn't reconnection can be a challenge.

Within the project European Commission funded Horizon 2002 project AIDA (www.aida-space.eu), we have recently developed a combination of deterministic physics-based methods and statistical machine learning techniques to investigate turbulence and reconnection.

We report here the combined use of physics-based methods (e.g. topological indicators, agyrotropy, distribution functions, structure functions) and unsupervised machine learning methods (e.g. DBSCAN [2-3], Gaussian Mixtures [4], SOMs [5]) to identify the role of turbulence and that of reconnection in the energy transformations developing in regions of reconnection characterized by varying degrees of guide filed, representative of conditions in the tail, in the dayside and in the solar wind.

References

1. Lapenta, G., Pucci, F., Goldman, M. V., & Newman, D. L. (2020). Local regimes of turbulence in 3D magnetic reconnection. The Astrophysical Journal, 888(2), 104.

2. Patway, Md Mostofa Ali, et al. "BD-CATS: big data clustering at trillion particle scale." *SC'15: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*. IEEE, 2015.

3. Sisti, Manuela, et al. "Current structures and reconnection events analysis in hybrid-kinetic turbulence simulations using unsupervised machine learning." EGU General Assembly Conference Abstracts. 2020.

4. Dupuis, R., Goldman, M. V., Newman, D. L., Amaya, J., & Lapenta, G. (2020). Characterizing magnetic reconnection regions using Gaussian mixture models on particle velocity distributions. The Astrophysical Journal, 889(1), 22.

5. Amaya, J., Dupuis, R., Innocenti, M. E., & Lapenta, G. (2020). Visualizing and Interpreting Unsupervised Solar Wind Classifications. arXiv preprint arXiv:2004.13430.