Plasma turbulence in the interstellar medium

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The interstellar medium (ISM) is a multi-phase, magnetized, and highly turbulent medium. In this talk, I will address both theoretical and observational aspects of plasma turbulence in the ISM. After setting the general interstellar context and introducing the relevant parameters of the turbulent ISM, I will tackle interstellar plasma turbulence from two different perspectives.

In the first part of the talk, I will focus on the (collisionless) plasma aspects of the ISM and address three important effects of radio wave propagation through a plasma, which make it in principle possible to trace back to some properties of the traversed plasma. The first, lowest-order, effect is the dispersion of pulsar signals, which gives access to the spatial distribution of the free-electron density. A second, more subtle and more complex, effect is interstellar scattering, which enables one to diagnose fluctuations in the free-electron density down to the smallest scales. The third, higher-order, effect is Faraday rotation, which leads to the line-of-sight component of the magnetic field. This part of the talk will pertain mainly to the warm ionized phase of the ISM, which encloses most of the free electrons.

In the second part of the talk, I will focus on the magnetic aspects of the ISM and discuss radio polarized emission, which carries information on the magnetic field projected onto the plane of the sky. I will first present existing studies of interstellar synchrotron emission, showing how the synchrotron total intensity and complex polarized intensity lead to the strength and the orientation of the plane-of-sky magnetic field. I will then describe the novel and promising technique of rotation measure synthesis, also known as Faraday tomography. This part of the talk will concern the entire magnetized ISM, including its neutral and ionized phases.

Throughout the talk, I will be careful to make the connection between basic plasma equations and available observations. This will enable me to interpret the existing observational signatures of plasma turbulence in the ISM and to explain what astronomers have learned from them regarding the nature, the sources, and the dissipation of turbulence in the ISM.

References

Ferrière, K., "Plasma turbulence in the interstellar medium", Plasma Phys. Control. Fusion 62 (2020) 014014 -- https://doi.org/10.1088/1361-6587/ab49eb.

Illustration of Faraday tomography

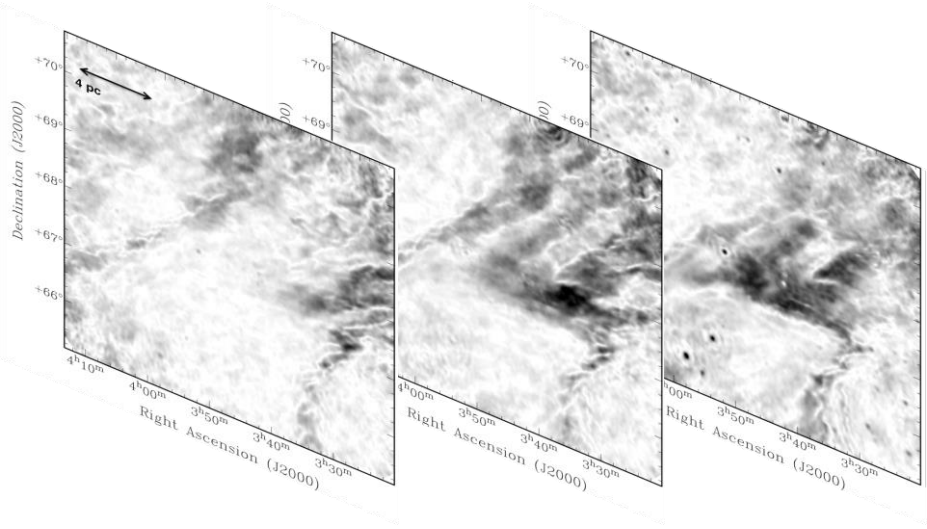

Figure Credit: Marta Alves