Turbulence and Shocks

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In a first part, I will review and succinctly demonstrate some of the known statistical properties of homogeneous incompressible turbulence: the Reynolds number, the Kolmogorov power spectrum and its first intermittency corrections. I will give observational examples relevant to the interstellar medium in our galaxy, and I will point the interested students towards the more advanced textbooks and papers needed to connect turbulence to the complex physics of the interstellar medium. If time allows, I will give a general introduction to intermittency and how it connects to the coherent strong dissipation structures, such as the shocks. This first part will not require any knowledge of hydrodynamics.

In a second part, I will briefly introduce the interstellar matter cycle to show shocks have a role to play everywhere. I will attempt to give estimates on turbulence driving for supernovae shocks, outflows and jets as well as galactic differential rotation. I will briefly introduce fluid dynamics, the concept of linear wave, wave steepening and how shocks are born. I will then examine the Rankine-Hugoniot relations, present the various dissipation processes pertinent to the interstellar medium and show the equations governing the profiles of steady states shock fronts. If time allows, I will discuss various shock types and their stability. Finally, I will present the Paris-Durham shock code and review some of its observational applications in 1D and 3D.

Although no a priori knowledge is required for this lecture, I will try to give hints at where we stand on some the alleys in both these vast subjects. However, I will be far from exhaustive given the short time available. Therefore, and since I am going to be one of the first lecturer, I advise the students to come to me after the lecture if they would like to have more details on some the subjects I will leave aside. I will try to put as much effort as I can to satisfy their curiosity within the boundaries of my own limited knowledge.