Observational properties of the turbulence in interstellar molecular clouds.

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The interstellar medium (ISM) is a mixture of gas and dust filling the space between the stars. The ISM exists under extremely different thermodynamical conditions, both in terms of density and temperatures. The most tenuous phase of the ISM contains $\sim 10^5$ particles per cubic meter, while the dense regions where all stars form, have densities at least a million times larger. The equation of state of the ISM is such that these extreme phases are in approximate pressure equilibrium.

The dense ISM, which is structured in molecular clouds, will be the subject of this talk. All stars form in these molecular clouds, where the gas motions are supersonic and extremely turbulent, with Reynolds number probably larger than a million. If this turbulence were not dissipated, its energy density would be large enough to slow down the gravitational collapse responsible for star formation to unacceptable rates. Questions related to the dissipation of this turbulence support are of the most important in the physics of the ISM: how, where, and at which rate is the turbulence in molecular clouds dissipated. Currently, this remains essentially an observational problem. But observation facilities are growing, and new instruments with spectacular performances are becoming operational. At some points, observational limits will meet with theoretical issues. Observations are inevitably confronted to theoretical and numerical predictions, so I will refer, with the ignorance of an observer, to these developments.

In this talk, I will review the observational methods which are used to determine some of the properties of the turbulence in these clouds. In particular, the statistical properties of turbulence in molecular clouds may be derived from usual tools developped for terrestrial and laboratory turbulence analysis, e.g. based on structure functions of the velocity fields. Molecular clouds are also magnetized, but direct measurements of the magnetic fields (both the intensity and morphology) are extremely difficult. Yet, the statistical properties of the turbulence may be promising tools to disentangle between hydrodynamical and magnetohydrodynamical models of turbulence dissipation. All along the talk, I will try to pinpoint the strengths and caveats of the various observational methods, and will present the perspectives in this field.