Gravitational collapse: magnetohydrodynamics and turbulence.

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Several observations have revealed the complexity of the internal constitution and dynamics of Galactic molecular clouds, the sites of star formation. The infrared satellite Herschel, for example, has shown that molecular clouds are made by intricate networks of intertwined filaments. These structures are shaped by interstellar turbulence and magnetic fields. It has been also possible to compare the morphology of the Galactic large-scale magnetic field (deduced from the polarized emission of interstellar dust), revealing the close connection between the two components [1]. According to the current picture, when the individual filaments composing a molecular cloud accumulate enough mass per unit length (by accretion from the ambient medium), they become gravitationally unstable and fragment into condensations called *cores*. Each *core* is then subject to further fragmentation and collapse, ultimately forming in a few million years one or more stars [2].

Turbulent shear motions and magnetic stretching are plausibly at play, yet both processes are poorly understood [3],[4]. If turbulent motions are responsible for the filamentary structure of the cosmic clouds, their nature is profoundly affected by the compressibility and magnetization of the interstellar medium. Turbulence in the interstellar medium is compressible, magnetized and multi–phase. Understanding its origin and dissipation is therefore a key process to find out how the formation of molecular clouds, star formation and Galaxy evolution work. [5]

Current numerical simulations of supersonic turbulence usually consider a gas cloud in a static volume, whereas astrophysical gases often expand or contract. In order to study the physics of this puzzling problem increasingly elaborate magnetohydrodynamical codes are required. We will study the time evolution of a fluid element in a magnetized cloud undergoing gravitational collapse. In particular, starting from a spherically symmetric free-fall collapse, we will follow the evolution of the turbulent velocity of a fluid element in a contracting volume [6].

We will use a magnetohydrodynamical code (ECHO code [7]) in order to solve the equations of magnetohydrodynamics (MHD) using a particular system of coordinates, the expanding box model [8]. It is designed to follow the evolution of non linearly interacting fluctuations within a given, mean uniform radial flow, with interactions at widely different scales. Our goal is to follow the evolution of the quantities characterizing the turbulent field (rms velocities, spectrum, dissipation rate, etc.) during gravitational collapse and determine the conditions for amplification or quenching of the turbulent fluctuations.

References

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