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Magneto-gravitational fragmentation of quiescent and turbulent layers

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Molecular clouds exhibit a hierarchical density structure with stars forming in their densest regions. Often, these star-forming complexes have an elongated, filamentary shape[1]. Herschel observations of such filaments show a column density profile that deviates from hydrostatic equilibrium[2]. Several explanations have been proposed, but none have elucidated the formation process completely. I will discuss the formation of filaments in self-gravitating layers by gravitational instabilities. Self-gravitating layers are unstable to perturbations if the exciting modes are of sufficiently long wavelength[3] and fragment into clumps or thin filaments. When the layers are threaded by magnetic fields, fragmentation is still possible[4]. Depending on the initial magnetic field, the resulting filaments form either a spiderweb-like structure (for weak magnetic fields) or a network of parallel filaments aligned perpendicular to the magnetic field lines (for strong magnetic fields) as can be seen in Fig. 1.
Numerical simulations of the gravitational instability in magnetised quiescent layers produce density structures similar to observed ones[5]. Depending on the initial magnetic field, the resulting filaments form either a spiderweb-like structure (for weak magnetic fields) or a network of parallel filaments aligned perpendicular to the magnetic field lines (for strong magnetic fields). Although the filaments are collapsing, the central region of the filament can be perfectly described by an equilibrium density distribution. Excess mass accumulates at radii larger than the scale height resulting in a density and column density distribution that is flatter than for an equilibrium cylinder. The models do not reproduce the quasi-constant filament width because no additional support is provided, not even by the magnetic fields.
Turbulent motions are an important ingredient of the ISM and are thought to provide additional support to the filaments. They also have the potential to modify the fragmentation process due to the gravitational instabilities. We apply isotropic turbulence to the self-gravitating layer and, even though the wavelength of the driving modes is below the critical wavelength for fragmentation, the layer still fragments. In thin layer turbulence the flow is in essence two dimensional. Then, rather than having an energy cascade from larger to smaller scales, an inverse cascade is present transferring energy from small to larger scales[6]. Also, I will show how the properties of the turbulence affect and change previously obtained results.
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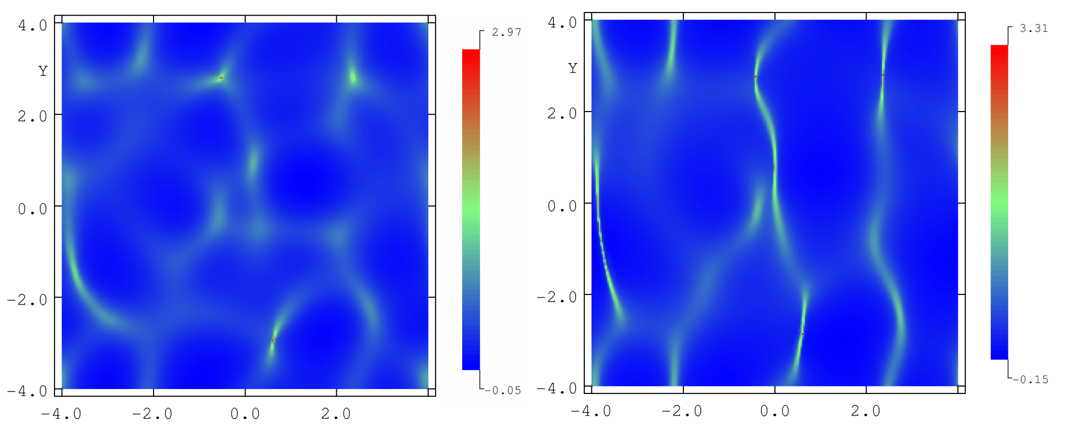

Figure 1: Logarithmic surface density for gravitational layer treated with a weak-magnetic field of β = 10 (left) and a strong magnetic field of β = 0.1 (right). The magnetic field is orientated along the x-axis.