Q24a Nonlinear Hydromagnetic Wave Support of a Stratified Molecular Cloud

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We performed a numerical simulation of nonlinear MHD waves in a stratified molecular cloud and studied the relation between the strength of the turbulence and various global properties of a molecular cloud, such as the line-width-size relations, within one-dimensional approximation.

We found that the cloud was lifted up by the pressure of MHD waves we input in the cloud. Though it is oscillating according to the inward self-gravity and the outward wave pressure gradient, the time average of the size of the cloud becomes larger than the size of the initial Spitzer (1942) equilibrium cloud. For the various strengths of the input energy, the size of the cloud have a following relation with the strength of the velocity dispersion of the cloud; $\sigma \propto H^{0.5}$ where σ is the velocity dispersion of the cloud and H is the size of the cloud. This relation is consistent with observational results of molecular clouds (Larson 1981; Solomon et al.1987; Myers 1983). The velocity dispersion is also proportional to a mean Alfvén velocity of the cloud, which is also consistent with observations (Crutcher 1999; Basu 2000).

At the surface of the cloud, where waves are reflected, the relation between velocity dispersion and the wave component of the magnetic field is not like a relation predicted by a linear theory. This means that the Chandrasekhar-Fermi formula would break down at the surface of the cloud. The outer region of the cloud undergoes oscillations like standing waves whose effective wavelength is very long because of the low density in the outer part of the stratified cloud.