FRAGMENTATION OF ISOTHERMAL SHEET-LIKE CLOUDS

Shoken M. Miyama
Department of Physics, Kyoto University, Kyoto 606, Japan
Shinji Narita
Department of Electronics, Doshisha University, Kyoto 602, Japan
Chushiro Hayashi
Momoyama Yogoro-cho 1, Fushimi-ku, Kyoto 612, Japan

Growth of perturbations and fragmentation of isothermal sheet-like clouds are computed three dimensionally. An initial cloud is a self-gravitating equilibrium gas layer with small fluctuations, which have the form $e^{i(k_x k+k_y y)}$. The simulations of models with various values of k_x and k_y are performed.

The results show that the growth rate of perturbations is determined essentially by the value of $k(=\sqrt{k_x^2+k_y^2})$ only, while the characteristic of growth is determined by the ratio k_y/k_x and k. In the case of an unstable mode, a cloud breaks in to many fragments.For $k_y/k_x < 1.2$, one fragment contracts to form a disk-like configuration with density profile r^{-2}. For $k_y/k_x \geqq 1.2$, one fragment contracts to form a filamentary structure. It will collapse and refragment, because a filamentary cloud is usually unstable to fragmentation. We also compute the evolution of sheet-like clouds with initially random perturbations in Figure 1, where column densities of clouds are shown as particles' distribution. There filamentary structure is very clear.

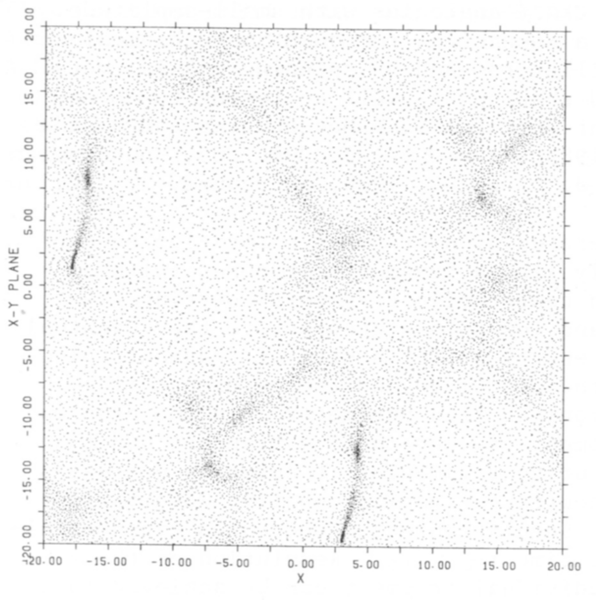

Fig. 1. Fragmentation of isothermal sheet-like clouds with initially random perturbations. The column densities of the clouds are shown as particles' distribution.

https://doi.org/10.1017/S0074180900096236 Published online by Cambridge University Press

If a sheet-like cloud is made by some triggering mechanism in interstellar region, the probability that the ratios of k_y/k_x of perturbations are greater than 1.2 may be large. Therefore the sheet-like cloud will fragment to form many filamentary structures and each filamentary cloud will collapse further and refragment. This scenario is very suggestive for interpretation of observed cloud's morphology such as TMC.

Simulations of fragmentations of isothermal sheet-like clouds with uniform rotation or uniform magnetic field are also computed.

RESOLUTION OF THE ANGULAR MOMENTUM AND MAGNETIC FLUX PROBLEMS DURING STAR FORMATION, AND OBSERVATIONAL CONSEQUENCES

Telemachos Ch. Mouschovias
Dept. of Phys. and Astron., U. of Illinois, Urbana, IL 61801, USA

Detailed calculations show that the two most important dynamical problems in the formulation of a theory of star formation (namely, the angular momentum and magnetic flux problems) can be resolved in that order by magnetic braking and ambipolar diffusion, respectively, relatively early during the collapse of an interstellar cloud or fragment. Although the physical processes involved are complicated and highly nonlinear and the formal solutions are mathematically nontrivial, they can often be elucidated by *exact* analogies with small-amplitude, transverse waves on strings, by a mechanical (or quantum mechanical) "leaky" system of N coupled oscillators, and by spinning coaxial metal disks joined by rubber bands and sharing (as well as losing to an external medium) energy and angular momentum (see Mouschovias and Morton 1985a, Astrophys. J. 298, 190; 1985b,Astrophys. J. 298, 205, Mouschovias and Paleologuo 1979, Astrophys. J. 230, 204; 1980, Astrophys. J. 237, 877).

Torsional Alfvén waves generated by a fragment's rotation bounce back and forth among magnetically linked fragments or cores (with a crossing time $\tau_0 \cong 10^6$yr between consecutive fragments) setting the fragments into successive high and low spin states before they eventually carry the rotational kinetic energy of the system of fragments plus interfragment medium away into the medium beyond the outermost fragments. There is only one dimensionless free parameter σ in the problem, namely, the ratio of half the moment of inertia of a fragment and that of the medium between two consecutive fragments; it normally decreases as a fragment of constant mass contracts gravitationally. Observations suggest that $\sigma < 1$. A fragment's angular momentum decreases exponentially in time with a characteristic time $\tau_{11} = \sigma\tau_0$. Resolution of the angular momentum problem for an individual fragment can be achieved in a