fragments, with different ranges of mass. A proto-galactic evolution model, using our new theory, predicts that the first stars are created in the third generation of fragments. These can represent the "zero-metal" population.

Mass functions for various objects are elaborated from observational data. Their shapes are compared among themselves quantitatively. A striking similarity suggests the hypothesis that all the different kinds of astrophysical objects examined were formed by essentially the same process. The theoretical mass functions predicted by the evolutionary models and the fragmentation rate are quantitatively compared with the observations, yielding a remarkably good agreement.

STRUCTURE AND FRAGMENTATION OF MOLECULAR COMPLEXES

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We propose a hierarchical model of large molecular complexes (mean density $\sim 10\ cm^{-3}$, masses larger than $10^5\ M_\odot$ relevant to their "cold phase") which preceeds the formation of massive stars and H II regions, and investigate the gravitational stability of the different scales.

The parameters of the hierarchy are mostly derived from observations: its building blocks are clouds of well defined characteristics (mean density 200 cm^{-3} masses $\sim$ a few hundreds solar masses), virialized in the potential well of the complex. They may form subgroups of all sizes up to that of the largest scale.

The volume filling factor of the clouds in the parent complex is low ($f_V \sim 10^{-2}$), the bulk of its volume being filled with a low density gas: the warm H I phase.

First, we propose and investigate an efficient mechanism to transfer kinetic energy from the orbital motions of the clouds to their internal random motions. The large perturbations of the magnetic field induced, at the clouds boundaries, by their interactions with their neighbours, excite systems of hydromagnetic waves trapped inside the clouds. The internal velocity dispersion of the clouds computed in this way is comparable to the values deduced from observed linewidths.

The pumping rate allows the cloud internal velocity dispersion which has a short hydrodynamic timescale ($\tau = 2R/V \sim 3\times10^6$ yr) to be fed over more than several 10^7 yr. In addition the energy supply is such that in a cloud contraction its internal energy increases at fast as the gravitational potential energy: the clouds are therefore stable against radius perturbations.

Second, we investigate the evolution of such a system and we discuss the implications for fragmentation: the origin and structure of dense cores of a few solar masses. We show that, for steep enough power spectrum of the supersonic turbulence which supports the clouds, a range of small scales may be gravitationally unstable when others are still stable: larger scales being supported by turbulence, smaller scales being thermally supported.

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STAR FORMATION INDUCED BY SUPERSONIC TURBULENCE

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Supersonic turbulent motion of gas plays a significant role in the dynamics and physics of a cosmic gas cloud. One of the most important effects of the supersonic turbulence is a strong compression of the gas by shock waves, that may trigger the gravitational instability of the shock-compressed layer leading to the formation of stars.

We studied fragmentation processes in the interstellar molecular cloud and the protogalactic gas cloud, which are dominated by supersonic turbulence, with special emphasis in the stability of the compressed layer formed by receding shock waves as a result of a collision of the turbulent gas elements.

The interaction of the turbulent gas elements is simply modeled by a head-on collision of a pair of supersonic gas flows. Since the compression of the gas parallel to the direction of the gas flow dominates, the gas dynamics is essentially one dimensional. The propagation of the shock waves and the evolution of the shock-compressed layer are followed by a one-dimensional gas dynamical simulation until the self-gravity becomes significant.

Because of the one-dimensional nature of the shock compression, if the compressed layer becomes gravitationally unstable, a gravitational instability is expected for a perturbation normal to the collision axis. The stability of the shock-compressed layer is examined for the parameters obtained by the numerical simulation.