THE GEM OB1/IC443/S249 COMPLEX: A CASE HISTORY OF STELLAR EVOLUTION

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The extended cloud complex containing members of the Gem OB1 asso-ciation, the supernova remnant IC443, and the H II region S249 has been studied with IRAS observations at 12,25,60 and 100 microns and WSRT ob-servations at 327 and 1400 MHz and in the 21-cm H I line. A skeleton-like framework of cool dust delineates the boundaries of the region, and physical parameters have been derived for the entire complex, individual H II regions and the shocked and recombined gas within IC443 using the radio and infrared data. IC443 is shown to consist of three intercon-nected, roughly spherical subshells of vastly different radii and centroids. The geometry is fully constrained by the structural and kinematic data. Two of the subshells together define the usually assumed boundaries of IC443, while the third includes the optical filaments which extend beyond the northeastern rim and which are shown to have well-correlated nonthermal radio components. The available evidence implies that the SNR shock has encountered a pre-existing high density shell. It is shown that the system of subshells is fully consistent with formation by stellar wind driven bubbles generated by association members within the inhomogeneous environment of the complex.

A NEW THEORY OF STAR FORMATION: ANALYTICAL MASS FUNCTION AND STAR FORMATION RATE

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An analytical, theoretical, time-dependent initial mass function is derived for the objects created in the fragmentation of a gravitational-ly unstable gas protocloud. The mass spectrum depends on the chemical-dynamical-radiative evolution of the protocloud and it peaks at a mass slightly greater than the minimum Jeans mass attained throughout the evolution. A fragmentation rate mass spectrum is also analytically derived.
By using an evolutionary model presented here, it is shown that the fragmentation process implies the existence of several generations of

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 ~ 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 observa-
tions: 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 trans-
fer kinetic energy from the orbital motions of the clouds to their in-
ternal 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.