PROPAGATING STAR FORMATION INDUCED BY SUPERBUBBLES

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A supernova explosion in the galactic disk creates a hot, low density cavity which persists much longer than typical lifetimes of supernova remnants. McCray and Snow (1979), Bruhweiler et al.(1980), Tomisaka, Habe and Ikeuchi (1980) and Kafatos et al. (1980) pointed out that repeated supernovae from a stellar association will produce an expanding shell of gas ($R \gtrsim 100$ pc) and offered extensive evidence for such shells -primarily in the form of H I shells.

A young association imparts mechanical power to the interstellar medium (ISM) via ionizing photons from O stars, stellar winds-primarily-from O stars and supernova explosions from O and early B-type stars. The input from B stars dominates after a few million years. An association typically contains $\sim$ 30 stars earlier than B3 (Humphreys 1978; Garmany, Conti and Chiosi 1982). We find that typically 20% of the total energy available from the association is delivered during the first 10^7 years of its lifetime.

A supershell will expand with its radius given by the relation

$$R_S = 100 \text{ pc } (N_* E_{51}/n_0)^{1/5} \; t_7^{\;3/5} \qquad (1)$$

(cf. Weaver et al. 1977) where N_* is the number of stars formed by the association earlier than B3, E_{51} is the supernova energy in units of 10^{51} egrs, n_0 is the ambient number density of the ISM and t_7 is the age in 10^7 years.

When a supernova explodes inside a supershell its ejecta expand freely for $\sim 10^4$ years. Then an adiabatic blast wave is established (for $r \gtrsim 30$ pc) until the supernova shell encounters the supershell at which time it rapidly deaccelerates and merges with the supershell. The supershell itself expands adiabatically until radiative cooling becomes important (typically after $\sim 10^7$ years). Moreover, if the radius of the supershell is greater than the density scale height z_0, the supershell will burst through the H I medium and equation (1) is no longer valid.

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Multiple supernovae from OB associations can accelerate the formation of gravitationally bound clouds. This happens because of the packing of the interstellar gas into dense supershells. Such clouds could be the sites of new star formation. Following the theory of Ostriker and Cowie (1981) we find that progressively smaller fragments become gravitationally unstable. Typically such fragments have a mass of 3 x 10^4 $M_\odot$ for timescales of a few tens of millions years. The minimum mass of the fragments depends strongly on the value of the magnetosonic speed in the shell a_S (to the 29/8 power of a_S). This is likely reduced in the supershell as result of the elevated density ($a_S \lesssim 1$ km s^{-1}). The development of the supershell accelerates the formation of gravitationally unstable fragments.

There is abundant evidence for giant shells in the Milky Way galaxy (cf. Heiles 1979). Such structures are also found in M31 and the Magellanic Clouds. In the irregular galaxies-such as the Magellanic Clouds-the metallicity is lower and radiative cooling would set in much later. Equation (1) would then be valid for values much larger than a few hundred parsecs. Moreover, the scaleheight in the irregulars is probably much greater than the corresponding scaleheight in a large spiral. We expect much larger supershells to be found in irregular galaxies than typically found in the Milky Way. Such a structure is loop IV which surrounds Constellation III in the LMC (Davies, Elliott and Meaburn 1976). It contains about 700 O stars as well as a number of supernova shells around its rim. There is probably extensive star formation associated with this supershell. Discussion of the detailed theory and some relevant observations is carried out elsewhere (McCray and Kafatos 1985, submitted).

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