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MASTER

TITLE RADIATION-HYDRODYNAMICS OF HII REGIONS AND MOLECULAR CLOUDS

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RADIATION-HYDRODYNAMICS OF HII REGIONS AND MOLECULAR CLOUDS

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ABSTRACT

Two-dimensional calculations of ionization-shock fronts surrounding neutral cloud clumps reveal that a radiation-driven implosion of the clump can occur. The implosion of a cloud clump results in the formation of density enhancements that may eventually form low mass stars. The smaller globules produced may become Herbig-Haro objects, or maser sources.

INTRODUCTION

The details of two-dimensional radiation-hydrodynamics calculations leading to our conclusion that radiative implosion is a possible mechanism for star formation are given in Klein et al. (1980) and in Sandford et al. (1981). Briefly, a consequence of the interaction of O-B star radiation with nearby neutral cloud gas can be the compression of cloud clumps to densities significantly greater than is achieved by planar compression as suggested by Elmegreen and Lada (1977). Two-dimensional compressions occur on a timescale of 10^4 years and produce central densities $10^4 - 10^5$ cm^{-3}. Calculations to date have demonstrated that radiative implosion is capable of forming objects of at least $1M_{\odot}$ from cloud clumps initially only about twice as massive. This paper presents a pictorial summary of a star formation hypothesis that includes the radiative implosion mechanism, and which requires further observational and theoretical study.

STAR FORMATION HYPOTHESIS

The sequence of events leading to the radiation implosion of cloud clumps is shown schematically in Figures 1-3. Star formation of a few massive objects in a molecular cloud is initiated by passage of a shockwave (Woodward, 1976), by the collision of clouds, or by the Elmegreen-Lada mechanism. Once formed, O-B stars disrupt the cloud by forming "blisters" of HII near the cloud edges (Bodenheimer et al. 1979, and Whitworth 1979). As a result of this process molecular cloud-HII complexes form which we postulate to be characterized by an irregular interface such as is observed in many regions, and is schematically illustrated in Figure 4. The irregular interface can result from the interaction of stellar winds with the neutral material (Schneps et al. 1980), the propagation of the ionization front into the cloud (Guiliani, 1980), or the existence of internal cloud structure (Larson, 1981).

During the 10^5 year lifetime of the exciting star, radiation-driven implosions form neutral condensations of various masses near the edge of the HII region, within the molecular cloud material. These are postulated to be observable in CO and HI and would be surrounded by ionized material observable in the radio continuum (Figure 5). The larger globules are expected to self-gravitate to form stars of B0 and later classes. In particular, we propose that smaller globules (not self-gravitating) may be visible as H-H objects when subject to the winds of T-Tauri stars, and as dark globules when viewed in projection (Figure 6).

Finally, the last stage of star formation is viewed as the dissipation or disruption of the smaller globules and the formation of a few main sequence stars (Figure 7). This picture of the star formation process is qualitative and necessarily simplistic, but is presented to indicate the potentially important role of radiation-driven implosion.

SUMMARY

The principle features of the radiation implosion model for star formation can be stated as follows:

- O-B stars are necessary to form condensations on short timescales,
- parent clouds in which O-B stars form must be disrupted to leave cloud inhomogeneities exposed to ionizing radiation,
- radiation implosion compresses irregularities to $/_{o}$ 100-1000,
- Jeans' limit is reduced by the presence of a velocity field in the neutral gas (Hunter, 1979),
- low mass objects are formed by this mechanism,
- globules are formed near the edges of HII regions,
- H-H objects and dark globules may result from radiation implosion of cloud clumps.

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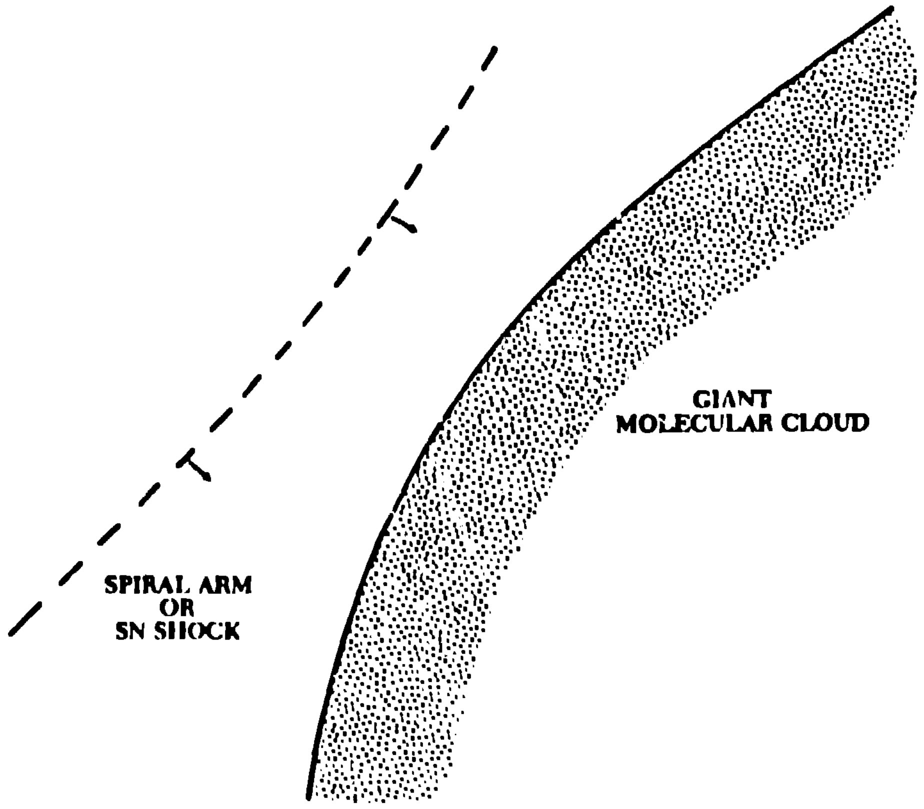
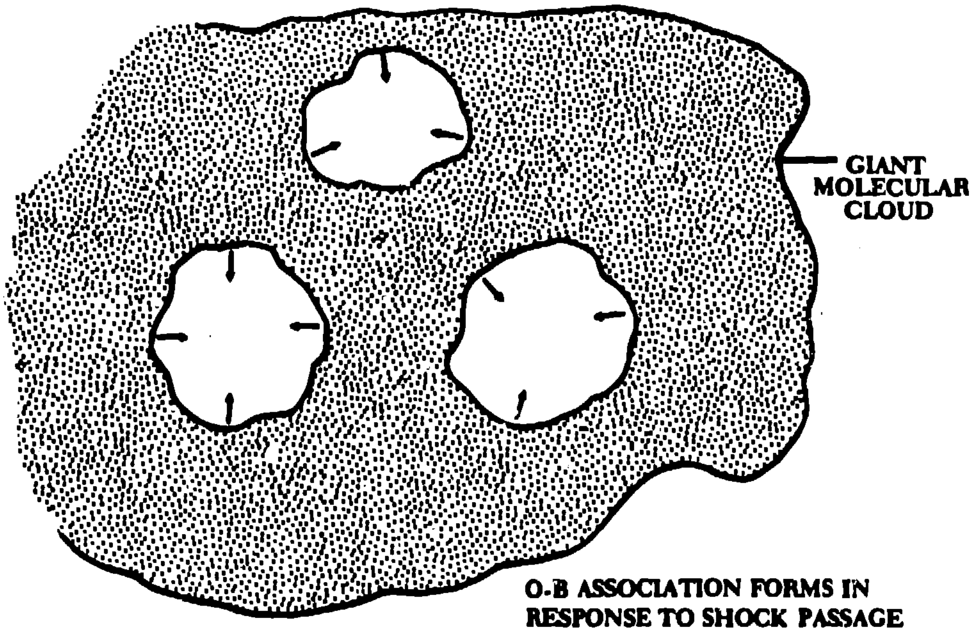
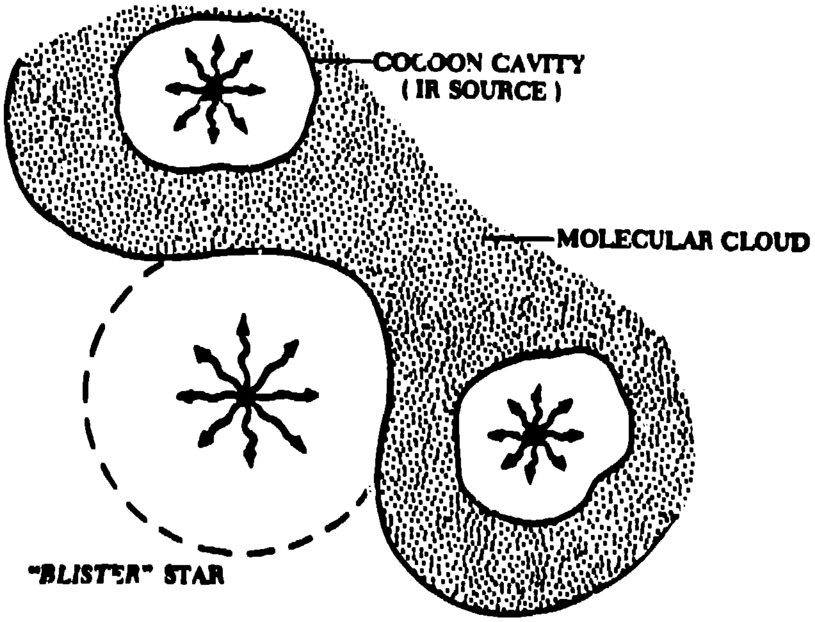


FIGURE 1



O-B ASSOCIATION FORMS IN RESPONSE TO SHOCK PASSAGE

FIGURE 2



O-B STAR FORMATION DISRUPTS CLOUD

FIGURE 3

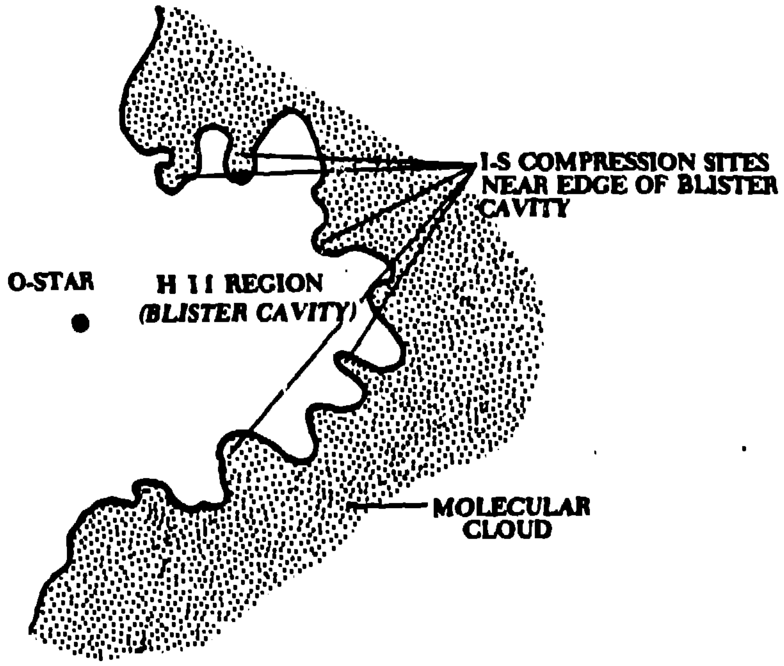


FIGURE 4

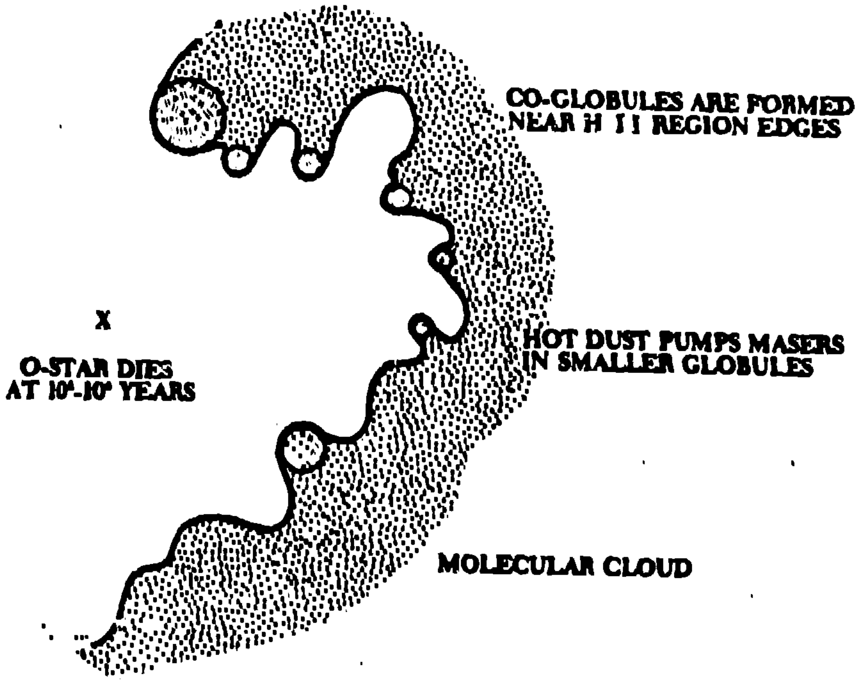


FIGURE 5

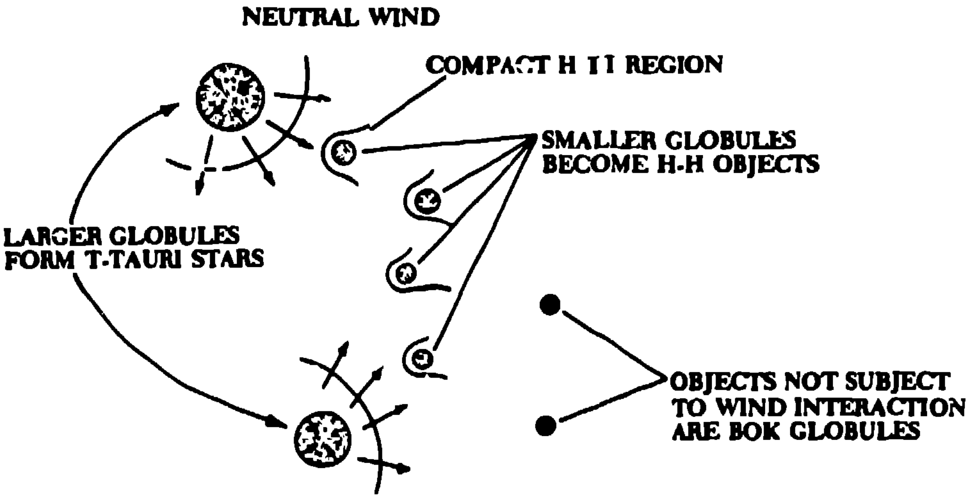


FIGURE 6

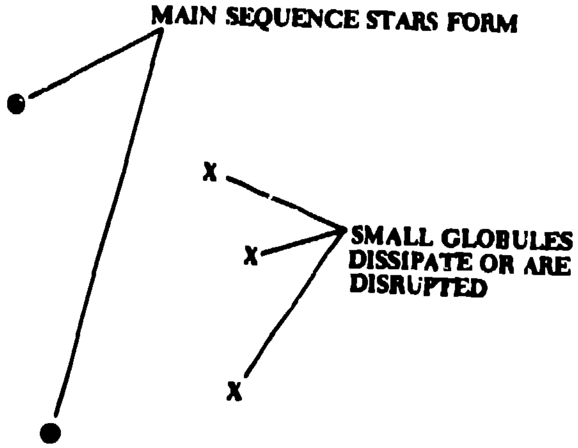


FIGURE 7