envelope, the centroids of the radio recombination lines move progressively to lower velocities with increasing value of the principal quantum number, n. This shift is caused by the free-free absorption on the near side of the envelope combined with non-LTE radiative transfer effects.

We have observed the H66α, H76α, and H110α lines towards W3(OH) with the VLA. The measured line velocities of -49.1±0.3, -50.5±0.3, and -68.3±4 km s^{-1}, respectively, and other line parameters were analyzed with a non-LTE radiative transfer model. Preliminary results suggest an expansion velocity of about 20 km s^{-1} and a stellar velocity of about -46 km s^{-1}. The H66α and H76α lines show significant departures from Gaussian profiles due to pressure broadening, and the H110α line has a nearly Lorentzian profile, requiring a mean density of about 2×10^5 cm^{-3} independent of the excitation temperature. We also observed the recombination lines towards W49S and G10.6-0.4 in the H66α and H76α lines but detected no shift in velocity between the lines in either source, presumably because of smaller expansion velocities.

HOLLOW H II REGIONS: FROM GIANT TO ULTRACOMPACT

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1. PROBLEM AND RECENT DEVELOPMENTS

H II regions around OB associations have a thick-shell structure (see, *e.g.*, the Carina and Rosette nebulae), and yet the standard "Hot Interstellar Bubble" model (*e.g.*, Weaver *et al.* 1977) predicts thin H II shells around a large X-ray emitting volume, when associated with stellar winds. Observations suggest that strong dissipation must occur at the edge of the wind cavity: (i) expansion velocities there are much smaller than predicted by the standard model (*e.g.*, Chu, 1983); (ii) in bubbles around WR stars, overabundances of N, He, etc., are seen, hence the need to cool these WR-produced elements down to observable temperatures (Kwitter, 1981). Also, two theoretical developments are important: (i) new stellar evolution models for massive stars, including mass loss and overshooting in convective cores (*e.g.*, Doom, 1985); (ii) a non-linear theory for heat conduction with steep temperature gradients (Luciani *et al.* 1985).

2. EFFECTS OF STELLAR EVOLUTION

The new models allow to compute the total ionizing flux and mass loss as a function of time (including WR stars). Note that the birth of the O and B stars is spread over several Myrs (see Doom *et al.* 1985). Assuming entire dissipation of the wind energy in a thin layer at the wind shock (see below), one then computes the (standard) evolution of the hollow H II region. For actual OB associations, with measured molecular cloud densities (Rosette, Carina), the results agree well with observations, and are very different from those of the standard model (see Figures 1 and 2).

3. WIND ENERGY DISSIPATION: HOW?

Heat conduction must be non-linear when $(T/\nabla T)/\lambda_0 < \alpha$, λ_0 = standard m.f.p. for 90° scattering; $\alpha \cong 500$ (Gray and Kilkenny, 1980). This is the case for the standard model, since at the wind shock $[(T/\nabla T)/\lambda_0]_{st}$ is always smaller than $[(T/\nabla T)/\lambda_0]_{adiab} = 380$. Then, Luciani *et al.* (1983, 1985) have shown that the classical Spitzer-Härm flux q_{SH} must be replaced by

$$q = \int_0^\infty dr\, q_{SH}\, W,$$

where W is a "delocalization" kernel. We suggest that energy dissipation is a conductive-radiative process: (i) ~ 1 keV electrons (from wind shock thermalization) suffer friction (Coulomb losses) with ambient, $\sim 10^4$ K post-shock H II region electrons; (ii) they heat these up near the shock to the maximum of the radiative cooling curve (taking photoionization into account) at some temperature $T_c \sim 10^5$ K; all the wind energy is eventually lost at $T \lesssim T_c$.

4. SOME RESULTS AND APPLICATIONS

Our calculations (Dorland *et al.* 1986) show that the dissipation layer is a few percent of the thickness of the H II shell, as assumed above. Observations of the electron density profile in the Rosette nebula (Celnik 1985) support this result. The dissipation layer also emits X-rays (from hot conduction electrons). The calculated X-ray luminosity is shown to match the *Einstein* IPC fluxes (and overall morphology) of the Rosette (Leahy, 1985) and Carina (Seward and Chlebowski, 1982) nebulae within better than a factor of 2. In a different context, these calculations may also be applied to ultracompact H II regions, for which the same discrepancy with the standard model seems to exist (see Turner and Matthews, 1984). Work is in progress in that direction.

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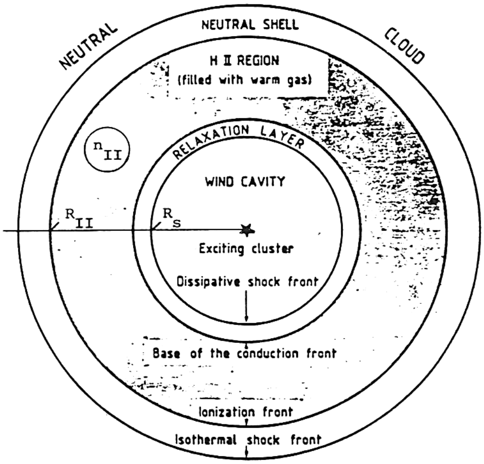

Fig. 1. Structure of an H II region with stellar winds.

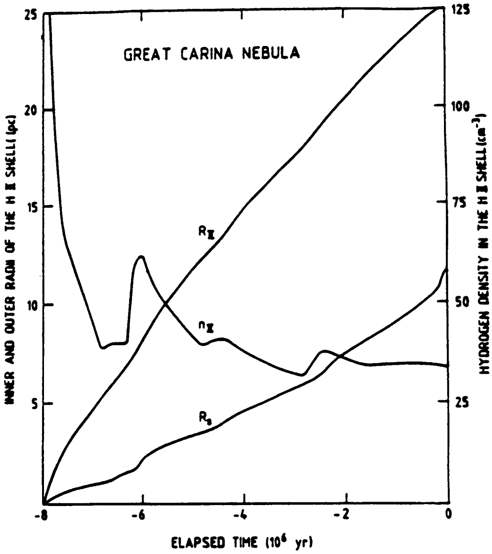

Fig. 2. Time evolution of the Carina nebula.

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STELLAR ASSOCIATIONS AND REGIONS OF STAR FORMATION

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The genetic nature of the OB and T-Tau stars connection with stellar associations is at present beyond any doubt. They present the characteristic population of the latter. From this important observational fact follows that all young objects connected with OB and T-Tau stars also originated in stellar associations, and hence, are genetically connected with them.

In this paper the observational data on star forming regions are