THE DENSE STELLAR CORES OF GIANT HII REGIONS

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ABSTRACT. We explore the bright central diffuse objects of the closest visible giant HII regions 30 Dor (LMC) and NGC 3603 (Galaxy), with the aid of CCD imagery in 1" seeing. Both central objects are interpreted as dense cluster cores composed of normal stars with masses ranging up to $\approx 100\ M_\odot$. Each object appears to contain at least one close massive binary. Being significantly denser, the core of NGC 3603 seems to be dynamically more evolved than the core of 30 Dor.

1. CCD IMAGERY OF 30 DOR AND NGC 3603

The closest visible giant HII regions with total mass $> 10^5\ M_\odot$ are 30 Doradus in the LMC and NGC 3603 in the Galaxy. Both of the accompanying broadband blue CCD images are shown on the same angular scale (Fig.1); a linear scale of 2 pc is shown for each. At the center of 30 Dor is a fuzzy, luminous object known as R136, which has recently been argued to be or to contain a supermassive star (Feitzinger et al. 1980,Astron.Ap.84,50; Cassinelli et al. 1981,Science 212,1497; Ebbets and Conti 1982,Ap.J.263,108; Savage et al. 1983,Ap.J.273,597; Chu et al. 1984,Ap.J. in press). Our data do not support this hypothesis; they favor the alternative interpretation that both central objects represent dense cluster cores, composed of normal stars ranging up to $\approx 100 M_\odot$ (Moffat, Seggewiss and Shara 1984, preprint, = MSS). Similar conclusions have been reached by Melnick (1983,ESO Messenger 32,11), Moffat and Seggewiss (1983,Astron.Ap.125,83) = MS, and Walborn (1984,IAU Symp. 108,p.243).

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2. THE WOLF-RAYET POPULATION: MASS SEGREGATION ?

Many if not all extragalactic giant HII regions exhibit weak, broad emission lines, indicating the presence of WR stars (Rosa 1983,Highlights of Astronomy 6,625). 30 Dor and NGC 3603 are no exception, as the accompanying net HeII 4686 Å emission images show (Fig.2). While the ~ 15 WR stars in 30 Dor (only ~ half of these are seen in Fig.2) are spread out much like the overall light distribution (R136a itself even contains several WR stars), the ~ 3 WR stars in NGC 3603 are located only in its core. Thus, since WR stars probably represent the advanced evolutionary stage for the most massive stars, it appears that NGC 3603 may have succeeded in concentrating its more massive members in its core, i.e. it may be relaxed (see below). Furthermore, both central WR components reveal diluted, low-amplitude, periodic radial velocity variations (cf. MS and MSS for 30 Dor, and Moffat and Niemela 1984,Ap.J. in press, for NGC 3603), showing that (hard) binaries are present in the cores.

3. RADIAL SURFACE BRIGHTNESS DISTRIBUTION

The overall surface brightness distribution over two orders of magnitude in radius nicely fits a King profile for either case (MSS), with formal core radii:

r_c = 0.26 pc (1".02) for 30 Dor, and

r_c = 0.026 pc (0".76) for NGC 3603.

Since these values are very close to the seeing radius (HWHM ~ 0".7), the true core radii could be considerably smaller.

We now compare best estimates of the central star density and relaxation times of the core regions of each cluster, defined by a radius r_i = 1".5 (~ 2 seeing radii):

	r_i(pc)	$\rho_c(M_\odot pc^{-3})$	t_{rh}(yr)
30 Dor	0.38	~ 10^5	~ $20 \cdot 10^6$
NGC 3603	0.051	~ 10^7	~ 10^6

Since each region contains early O-stars, the evolutionary ages are 2-3·10^6 years. Thus, while the core region of 30 Dor is still far from being relaxed, the core of NGC 3603 is well relaxed (as suspected above) and may be entering a core collapse stage.

4. CONCLUSIONS

NGC 3603 seems to be dynamically more evolved than 30 Dor, with more of its massive stars concentrated in its core, whereas the 30 Dor cluster shows no apparent differences in stellar content between its core and its halo. The fate of the collapse stage for NGC 3603 may depend on the presence of the central hard binary.

The 30 Dor cluster is possibly the youngest among the populous clusters in the LMC. Although NGC 3603 verges on being a populous cluster in the LMC sense, it is a rare type of object in the Galaxy and indeed may not survive for long in its present state.

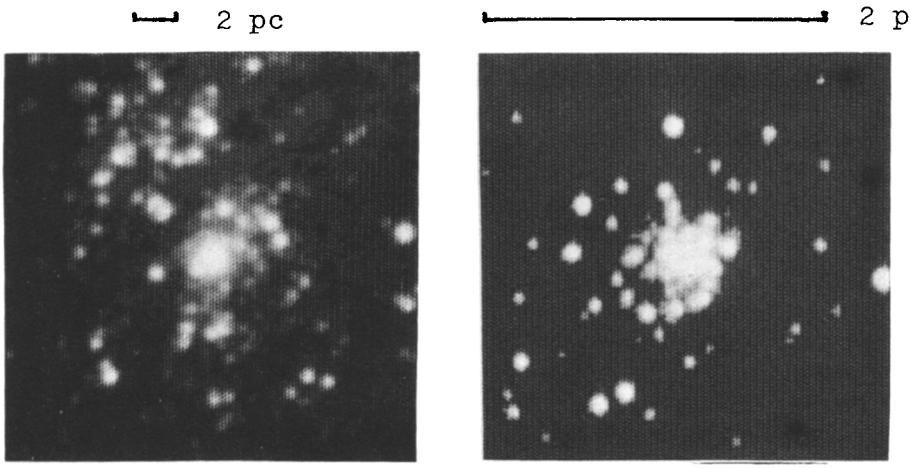

Fig.1: Broadband blue images of the central 80" of 30. Dor (left) and NGC 3603 (right).

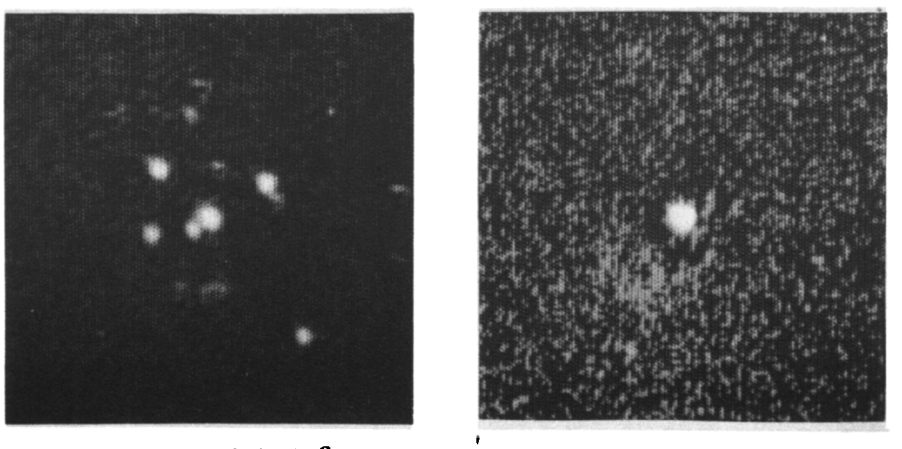

Fig.2: Net HeII 4686 Å CCD images of the central 80" of 30 Dor (left) and NGC 3603 (right).

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