NGC 604 - A GIANT H II REGION DOMINATED BY MANY WR STARS

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NGC 604, the largest H II region in M 33, is comparable in many respects (eg. ionized mass, total extent of a few hundered pc) with the giant H II complex 30 Doradus of the LMC. Recently D'Odorico and Rosa (1981) discovered broad WR emission features at 4640 Å, 4660 Å, He II 4686 Å and 5812 Å in a number of the bright knots in the core of NGC 604. In that paper it was concluded, that about 50 WR stars, mainly of the transition type WN 7 but WC characteristica seen as well, are present in the H II region. These findings were confirmed by the observations by Conti and Massey (1981).

The velocities of the stellar winds produced by these WR stars can be evaluated from the P Cygni profiles of the lines of eg. N V, Si IV and C IV in the IUE UV spectrogram of NGC 604 discussed by Rosa (1980). Mean values of v(edge) = -2700 km s^{-1} and v(abs) = -1800 km s^{-1} are derived for the blue edge and the center of the absorption components respectively. These values agree fairly well with the mean terminal velocities observed in late LMC WN stars ($\sim$ 2000 km s^{-1})(Willis 1980), so that mass loss rates similar to those of the LMC WN stars ($\sim 6 \times 10^{-5}$ $M_\odot$ yr^{-1}) may be expected.

The impact of the mechanical luminosity of about 3×10^{39} erg s^{-1} in the wind of 50 WR stars, or their superluminous equivalents, onto the ambient medium in NGC 604 is evidenced by the numerous shells and filaments of ionized gas seen in the nebula (cf. photographs in Benvenuti et al 1979). The radii of 12 prominent shell structures group very closely around a mean of 25 pc, suggesting a common origin. About 50 percent of the nebular emission is emitted in these shells, two of which form the bright core of the nebula. The supersonic motions (25 km s^{-1}) observed in NGC 604 (Smith and Weedman 1970, Melnick 1980) can therefore be attributed to the space velocities of these stellar wind driven shells. Assuming an efficiency of 20 percent in the conversion of the mechanical energy in the stellar winds into the kinetic energy of the ionized and neutral mass of NGC 604, the presence of the WR stars can easily explain the amount of 6×10^{51} ergs of kinetic energy contained in the nebula. The observable properties of the shells, eg. diameters, velocities,

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electron densities, can be explained within the framework of the theory of stellar wind driven shells as outlined by eg. Dyson (1977). Thus, the WR stars in NGC 604 appear to dominate the kinetic energy balance and the formation of large scale structures in that particular giant H II region.

These findings suggest that more detailed investigations of the properties of the stellar wind driven shells and the distribution of various evolutionary states of stellar evolution across the entire area of NGC 604 may offer observational tests for the theoretical evolutionary tracks of massive WR stars, tentatively scetched as follows: Recent models of WR stars by Maeder (1981) for example require high mass loss rates over long periods of time for a star to become a WR object. The observable properties of the shells in NGC 604 combined with the theory of stellar wind driven shells may be used to estimate such 'historical' mass loss rates of the involved WR stars. In addition there are some indications that massive stellar objects of different evolutionary status are present in NGC 604, namely the WR stars, O stars ionizing individual small H II spheres embedded in the core of NGC 604 (cf. Smith and Weedman 1970 and photograph therein) and IR sources possibly representing compact H II regions (cf. Israel et al 1981). These objects are distributed in the sense of radially decreasing distance towards a large H I cloud. This distribution suggests that the strong mass loss phenomena of the WR stars and their main sequence progenitors may induce star formation according to the mechanism discussed by Elmegreen and Lada (1977).

This contribution will be presented in a more detailed form (Rosa and D'Odorico 1981). *M.R. has been supported in part by the Deutsche Forschungs Gemeinschaft, SFB 132.*

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