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HIGH-VELOCITY GAS IN THE LUMINOUS H II REGIONS OF NGC 1530

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We are carrying out a systematic study of the Hα emission line profiles from the H II regions in NGC 1530 (Knapen et al. 2001) based on a data cube from the TAURUS Fabry–Perot scanner, on the 4.2m WHT, La Palma. The data are of high S:N ratio, high spatial resolution (seeing ∼ 0.6″) and velocity resolution, FWHM, of 18 kms^{-1}. The observations reveal, from the luminous regions, high velocity components forming low intensity wings to the intense emission peak. We cannot tell whether they are absent in the less luminous regions, or below the noise level. We detected similar high velocity features from M100, NGC 3359, and NGC 6951 (see e.g., Rozas et al. 1998).

Figure 1 shows the integrated Hα spectrum from a luminous region. The "narrow" feature has a line width, σ, of $\sim$ 31 km s^{-1}, while the high velocity component has a $\sigma \sim 74$ km s^{-1}. Assuming that the broad component is due to emission from gas swept up by stellar winds from the ionizing stars, we are exploring models which can account for this. We have examined two limiting optical cases:

(a) An optically thick expanding shell. As shown long ago by Beals (1931) as the emission intensity is independent of the shell thickness projected along the line of sight, the intensity will not depend on the Doppler velocity. The result is a box–car profile, which does not reproduce the expanding feature.

(b) An optically thin expanding shell. Here intensity depends on projected shell thickness; the integrated line from the shell has a sharp central peak. The resulting "Lorentzian" profile does not fit well the observed high velocity feature. An optically intermediate solution will give a fair fit to the data.

Using a simple model from Dyson & Williams (1980) and an electron density of ~ 100 cm^{-3} we find the kinematic luminosity of a representative O star

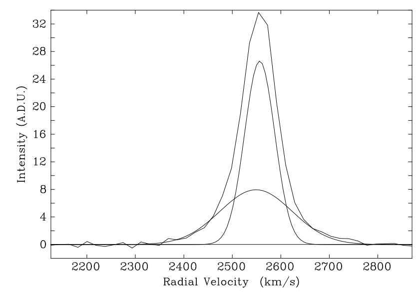

Fig. 1. High velocity features in the emission spectra of H II regions in NGC 1530.

to be 6×10^{39} erg s^{-1}; taking a 20% wind coupling efficiency to the external medium, also from Dyson & Williams (1980), and a wind lifetime of 2×10^6 yr (Chu & Kennicutt 1986, CK) the kinetic energy in the high velocity swept up shell is $\sim 7 \times 10^{52}$ ergs. From the observed profile in Figure 1, comparing the emission measure of the "narrow" feature, EM$_{\rm reg}$ with that of the broad feature, EM$_{\rm sh}$ we have:

$$\mathrm{EM_{sh}/EM_{reg}} = \frac{\langle N_{\rm sh}\rangle^2 \, \Delta R_{\rm sh}}{\langle N_{\rm reg}\rangle^2 \, R_{\rm reg}} \qquad (1)$$

$N_{\rm sh}$ and $N_{\rm reg}$ are electron densities, R are the region radius (300 pc) and ΔR the shell thickness ($\sim$ 1 pc; CK). Values of $N_{\rm reg} \sim 3$–5 cm^{-3} (Rozas et al. 2000) yield, from Equation (1), $\langle N_{\rm sh}\rangle \sim 60$ cm^{-3}. The expanding shell velocity, $\sim$ 90 km s^{-1}, then gives a shell kinetic energy of 4–8 $\times 10^{52}$ erg. The agreement between wind and shell energies encourages us to explore such models, including mass loading in isothermal wind shocks as proposed by Williams et al. (1995).

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