THE O6.5IIIf STAR BD +60°2522 AND ITS INTERACTION WITH THE SURROUNDING INTERSTELLAR MEDIUM

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The luminous O-type star BD +60°2522 is embedded in the extended H II region S 162. Part of S 162 is NGC 7635, the striking spherically symmetric bubble nebula surrounding BD +60°2522. This star itself is unique in that it is the only known O star apparently associated with warm dust.

In an attempt to study the interaction of the central O star with the surrounding H II region we obtained flux calibrated narrow-band CCD frames (H_α, H_β, O III, N II) and highly resolved coudé spectrograms.

Fig. 1 shows the northern part of NGC 7653. This figure underlines the sharp boundary between the bubble nebula and the nearby H II region. This boundary represents a drop in density, since the output of stellar Lyman photons suffices to ionize the whole S 162 complex (i. e. NGC 7653 is density bounded). A marked peculiarity within NGC 7635 is the comet-like condensation west of BD +60°2522.

The H_α/H_β ratio is found to be very uniform all over the bubble nebula, E(B-V) ≃ 0.5, except for the bright westward condensations, E(B-V) ≃ 1.0.

The density structure is derived from the S II 6716/6731 ratio obtained from the long-slit spectrograms. The maximum density in the knots is about 10^5 cm^{-3}, whereas the average density outside the knots is 10^2 - 10^3 cm^{-3}.

The dereddened H_β flux integrated over the bubble nebula without immersed stars is about 5 x 10^{-10} erg sec^{-1} cm^{-2}. The corresponding total mass of NGC 7653 including the knots turns out to be ~3 $M_\odot$. An estimate of the nitrogen abundance (relative to sulfur) can be obtained from the I(6548 + 6584)/I(6717 + 6731) ratio. From this ratio we derive $N(N^+)/N(S^+) \approx 7.3$ for slit position 0 to 35 and $N(N^+)/N(S^+) \approx 15$ for slit position 55. These values can be converted to total abundances using the ionization correcting factors. We find $(N(N)/N(S))/N(N^+)/N(S^+)) \approx 0.3$ for the average bubble region and approximately 0.18 for slit position 55. Thence within the limits of uncertainty the N/S abun-

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dance is the same, 0.4.

The velocity field can be investigated from our coudé long-slit spectrograms. We did not find significant radial-velocity variations from line to line eastward of the star (slit position 0 to 35). We derived a mean LSR velocity of (-39 ± 7) km sec^{-1} for NGC 7635. On the other hand the bright knots show a significant radial-velocity difference of (+12 ± 1) km sec^{-1} (slit position 50 to 75) relative to slit position 0 to 25.

Moreover, a significant difference in the line width (FWHM) between the bubble nebula and the bright knots is observed: At slit positions 0 to 25 we find for the forbidden lines as well as for H_α line widths of 30 km sec^{-1}. In contrast, the line widths of the forbidden lines at slit positions 50 to 75 are 20 km sec^{-1}, whereas H_α shows a line width of 50 km sec^{-1}, indicating an origin of H_α and the forbidden lines in different regions in the knots. This interpretation is supported by the different radial velocity behavior of H_α and the forbidden lines.

The significant line-width and radial-velocity differences cast serious doubts on the physical association between the bubble nebula and the bright knots. The bubble nebula itself can be interpreted as a stellar-wind blown shell caused by the stellar wind of BD +60°2522 interacting with the ambient ISM. The mechanical power of the stellar wind, $L_W \sim 3.4 \times 10^{36}$ erg sec^{-1}, is transferred to the ISM leading to an expansion of the swept-up matter by $v_{EXP} \approx$ 20 km sec^{-1}, then the age of the bubble is of the order $10^4 - 10^5$ yr.

Our derived nitrogen supports the wind-blown shell model, since if the bubble nebula were due to an explosive stellar event, an overabundance of processed matter should be expected.

We conclude that the molecular cloud and the dust detected at the knots and around BD +60°2522 is not physically associated with the bubble itself but is (together with BD +60°2522) part of the large star-forming region S 162: The existence of the molecular cloud and the dust ($M_{dust} \approx$ 0.2 $M_\odot$) close to BD +60°2522 within the bubble is highly improbable due to (i) the destructive stellar UV radiation and (ii) the gas-to-dust ratio which would be of the order ~0.13.

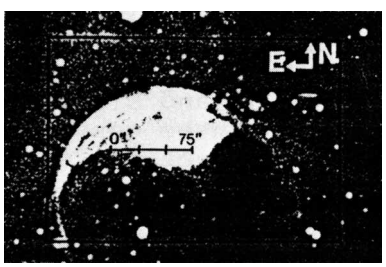

Fig. 1: The H II region S 162 with the bubble nebula NGC 7635. CCD orientations and slit positions are shown.

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