Bull. Astr. Soc. India (2002) 30, 643–645

A near-infrared study of the massive young star IRAS 02230+6202 and its surroundings

Surendra Mishra[1] *, B.G. Anandarao[1] and D.K. Ojha[2]
[1] *Physical Research Laboratory,Ahmedabad-380009*
[2] *TIFR, Mumbai-400005*

1. Introduction

High-mass stars play an important role in the evolution of galaxies, by depositing significant amounts of energy and momentum into the interstellar medium through stellar winds, molecular outflows, UV radiation, and supernova explosions. They also dictate the formation of nearby low-mass stars, usually in dense clusters. By far the most complete survey for embedded clusters has been on the Orion molecular cloud(Strom et al. 1989; Lada et al. 1992). These studies strongly suggested that in the Orion molecular cloud the dominant mode of formation of massive stars is through the formation of clusters (Carpenter et al. 1993). IRAS 02230+6202 ($W3N$) represents the northern-most object in the western boundary of the giant H II region $W4$(Churchwell et al. 1997). Earlier studies showed this object to be a diffuse H II region powered by a single or a group of stars with an equivalent luminosity of an $O7$ ZAMS star (Thronson et al. 1984). There is a large discrepancy between the fluxes measured by KAO(Thronson et al. 1984) and IRAS in the 60 and 100 μm bands. This may be attributed to the different aperture sizes used in the two observations. This casts a doubt as to the estimate of spectral class of the central star from the FIR fluxes by Thronson et al. We present here some preliminary results of new near-infrared observations made on the source.

2. Observations

The observations were made at the Gurushikhar 1.2m IR telescope in Mt. Abu, using 256 × 256 HgCdTe array *NICMOS3*. Broad band imaging photometry was performed in the $J, H, \& K'$ bands in $4' \times 4'$ field of view. Narrow band images were also taken

*e-mail:smishra@prl.res.in

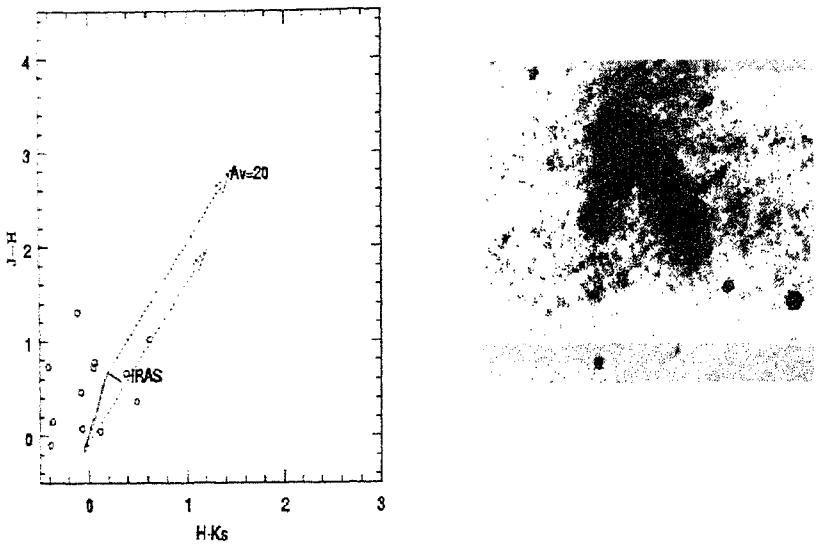

Figure 1. The color-color(left) diagram of IRAS 02230+6202 and its surroundings. The solid line in the figure represents the mainsequence. The dashed line represents the extinction vector for A_v=20. Brγ image of the region(right)

in FeII(1.65μm), H_2(2.12μm), Continuum(2.14 μm), Brγ (2.16μm), Continuum(2.24μm) and CO(2.37μm) filters(2%).

The source was observed along with two standard stars *AS40* and *AS06* on 10 Dec 2001. In J filter 20 frames of integration time 30 sec each, in H filter 30 frames of 20 sec each and in K' filter 120 frames of 4 sec each were taken. In the case of the narrow band images the total integration time given was 1500 sec for each filter. The analysis was done with *IRAF* using the *DAOFIND* and *PHOT* tasks. The photometric uncertainties in the J, H and K' bands are $\pm$0.15, $\pm$0.15, $\pm$0.20 and the limits of detection are 13.5, 13.5 and 13.0 mag respectively.

3. Results & Discussion

Fig 1 (left) shows the $(J-H)$ vs $(H-K_s)$ Color-Color diagram for 12 stars detected in our broad band photometric images. Also shown in the figure is the position of the IRAS source and the reddening vector for A_v=20. The solid line represents the non-reddened mainsequence stars(Koorneef 1983). All the observed stars show$A_v \leq 10$. Most of the observed stars lie in the upper part of the color-color diagram, i.e., in 'forbidden region' (Lada et al.1992) for Young Stellar Objects(YSOs). The position of the IRAS source

corroborates with the earlier inference that it is a massive star. Our results show that the extinction towards its direction is $A_v \leq 7$. According to the expected colors we find only a single Class II type YSO near the massive star. The Brγ image, shown in Fig 1(right) brings out clearly the extent and the morphology of the H II region surrounding the massive YSO. From the Brγ image, we can infer the maximum extent of the H II region to be 18 arcsec. Assuming a distance of 2.2 kpc and a typical expansion velocity of 10 km/s, we can obtain the kinematic age of the H II region to be 2.0×10^5 years. This is close to the expansion age of the cloud estimated by Thronson et al.(1984) from a different consideration. The estimated kinematic age nearly matches also with the evolution age for a massive (O type) star to reach $ZAMS$ stage (Myers & Fuller 1992).

4. Conclusions

New near-infrared observations were made on the $W3N$ region of the giant H II region $W4$. The embedded IRAS source was found to be a high mass $ZAMS$ star. One Class II YSO has been identified in this otherwise well-evolved region. The kinematic age derived from our observations matches with the evolutionary age of a late O type star which is driving the H II region.

References

Carpenter, J.M. et al., 1993, *Astrophys. J.*, **407**, 657.
Churchwell, E. et al., 1997, *Astrophys. J.*, **479**, L59.
Hillenbrandt, & Hartmann , 1998,
Koorneef, J., 1983, *A&A*, **128**, 84.
Lada, C. et al., 1992, *Astrophys. J.*, **393**, 278.
Myers, P.C. & Fuller, G.A., 1992, *Astrophys. J.*, **396**, 631.
Strom, K.M. et al., 1989, *Astrophys. J.*, **346**, L33.
Thronson, H. et al., 1984, *A&A*, **128**, 84.