

Ultraviolet Variability of HD 62001 – The Central Star of the Missing Nebula V-V 1–7*

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Abstract. IUE observations of HD 62001 do not confirm the ultraviolet variability of 0.15 mag seen from the ANS observations. These intriguing variations in ANS observations seem to be caused by a nearby (~ 70 arcsec away) B star getting in and out of the field of view of the telescope, which had a jitter of 20 arcsec. There seems to be no evidence for the presence of a hot companion, either from the energy distribution or from UV variability. However, visual light variations are present. This, coupled with the radial velocity variations, indicates a binary nature probably of Algol type.

Key words: variable stars – photometry – ultraviolet spectroscopy

Recently the star HD 62001 has attracted considerable attention because of the disappearance of the nebula V-V 1–7 which it was supposed to illuminate (Gilra, Wesselius & Rao 1980; Méndez *et al.* 1980; Rao & Gilra 1981). Originally V-V 1–7 was classified as a planetary nebula by Vorontsov-Vel'yaminov (1961) from the appearance on the Palomar Observatory Sky Survey (POSS) blue prints. However Kohoutek and Wehmeyer (1975) thought it to be a reflection nebula because of its absence on the POSS red print and they also determined the spectral type of the central star HD 62001 as A0 V. Interest in this object was revived by the discovery of the ultraviolet (UV) photometric variability from the Astronomical Netherlands Satellite (ANS) observations (Gilra *et al.* 1978). Gilra *et al.* found variations of 0.15 mag over a timescale of 3 hours. One of the suggestions made by these authors is that HD 62001 could be an old nova with a small hot companion. Spectroscopic observations in the blue region by Méndez *et al.* (1980) and by us, showed variations in radial velocity. This again led Méndez *et al.* to suggest that HD 62001 has a small hot companion. Further in 1978 we have also observed photometric variability in blue light (see below). To follow these intriguing ultraviolet variations, we have obtained observations with the Interna-

* Based on observations obtained with IUE satellite at the Villafranca Satellite Tracking Station of the European Space Agency.

tional Ultraviolet Explorer (IUE) satellite (Boggess *et al.* 1978) on different occasions using both the low- and high-resolution mode. Because of their higher photometric accuracy, the large-aperture, low-resolution observations were used to compute the magnitudes in the ANS filter bands and these are presented in Table 1, along with the range in magnitudes (Gilra *et al.* 1978).

All the observations obtained so far with IUE do not show any photometric variability over and above that which can be ascribed to photometric errors ($\sim \pm 0.05$ mag). The $\lambda 1500$ magnitude of 1980 May 30 also agrees with the rest, once corrected for the exposure effect (Bohlin, Holm, & Lindler 1981). It can also be seen from Table 1, that all the IUE magnitudes agree with fainter magnitudes observed by ANS (*e.g.* 1975 April 22.001). It appears from these observations, that only on a few occasions during the ANS observations the star has brightened in UV. However there was one other possibility, as originally indicated by Gilra *et al.* (1978) namely contamination of the UV photometric measurements by a star which lies on the edge of the field of view of ANS ($2.5 \text{ arcmin} \times 2.5 \text{ arcmin}$) and gets in and out of the diaphragm due to the jitter of the telescope by about 20 arcsec. Fig. 1 shows the star field with the position of the diaphragm plotted at the time of the ANS observations. It shows the two 11th magnitude stars situated near the edge of the field. The star ~ 70 arcsec away in SW direction seems to be the bluer of the two. We have measured the *UBV* colours of these stars with the 40-inch telescope at Kavalur. The magnitudes of the bluer star are as follows: $V = 11.05$, $B - V = 0.15$ and $U - B = -0.37$. The second star is too red ($B - V = 1.18$) to cause any effect in the UV photometric bands. Assuming the bluer star is on the main sequence and the standard reddening relations, the estimated $E(B - V)$ is 0.30 and the corresponding spectral type is B5-B6. This spectral type seems to be consistent with a low-dispersion objective-grating spectrum of the star obtained with the 40-inch telescope. From the colours and extinction law given by Wesselius *et al.* (1980), the magnitudes are calculated in ANS photometric bands with this field star in and out of the diaphragm. These are given in Table 1. We assumed that the IUE magnitudes (also ANS magnitudes when faint) represent the magnitudes of HD 62001 alone. As is evident from the table, the calculated magnitudes match the ANS observations within the photometric accuracy (± 0.03 mag), when the system is supposed to be bright in UV. Thus UV variations indicated by the ANS observations seem to be caused by this nearby field star.

A comparison of the IUE low-resolution spectra of HD 62001 with IUE ultraviolet spectral atlas (Wu *et al.* 1981) indicates the spectral type as A0 (Fig. 2), consistent with the spectral type from blue region and also with the energy distribution in the visual region observed in 1976 February by Méndez *et al.* (1980) and in 1979 December by us.

However, the high-resolution, long-wavelength-range IUE spectra obtained in 1980 October and 1981 February show absorption components in the Mg II resonance lines. Also there seem to be some changes in the strength of some of the features (*e.g.* Mn II resonance lines *etc.*).

Although there do not seem to be any brightness changes in UV, HD 62001 seems to show visual light variations. Our photometric observations in blue light on consecutive nights in 1978 April show a variation of 0.3 mag (Fig. 3). Later, when observed in 1979 January the star was bright and showed a constancy of light (within ± 0.1 mag). We have made extensive photometric observations from that time and no further light minima have been detected. Even during IUE observations, the FES counts (visual

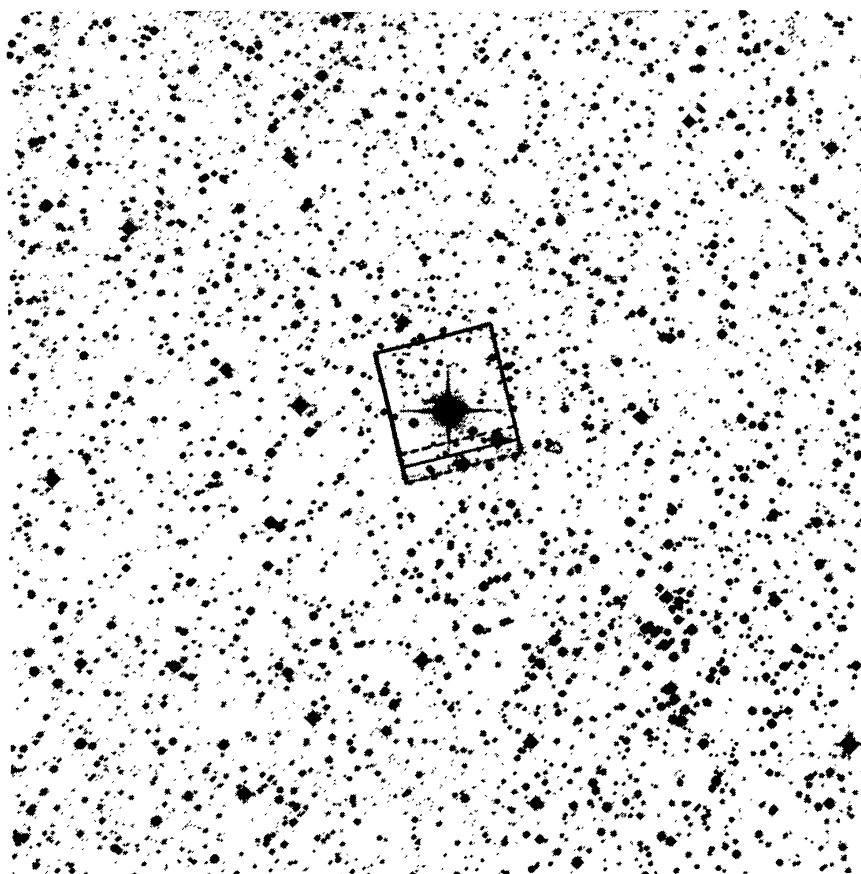


Figure 1. The field of HD 62001. The entrance slot of ANS ($2\frac{1}{2}$ arcmin \times $2\frac{1}{2}$ arcmin) is shown. The jitter of 20 arcsec in one direction is marked by the dashed lines. The blue star ~ 70 arc sec away sits on the edge of the field.

Table 1. Ultraviolet magnitudes of HD 62001.

Filter Å	IUE (date, image, exposure)				ANS†	
	1979 Oct 25	1980 May 30	1980 Oct 5	1981 Feb 7	1976 Apr 22.0 - 1976 Apr 21.8	HD 62001 + field star
	SWP 6992 17 min	SWP 9153 3 min	SWP 10288 6 min	SWP 11257 7 min		
1500 W	8.38	8.50 (8.44*)	8.42	8.45	8.419 - 8.268	8.42 - 8.22
1500 N	8.44		8.47	8.44	8.467 - 8.303	
1800	...	...	...	...	8.181 - 8.066	8.18 - 8.03
	LWR 5936 6 min	LWR 7891 2 min	LWR 8954 2 min			
2200	8.53	8.48	8.51		8.536 - 8.451	8.54 - 8.44
2500	8.59	8.54	8.55		8.586 - 8.433	8.59 - 8.45
3300	...	...	...		8.472 - 8.343	8.47 - 8.34

Notes:

* after correcting for exposure effect (Bohlin, Holm & Lindler 1981).

† only the range in ANS observations are given.

 $m_1 = 0.0$ corresponds to 3.62×10^{-9} erg cm⁻² s⁻¹ Å⁻¹.

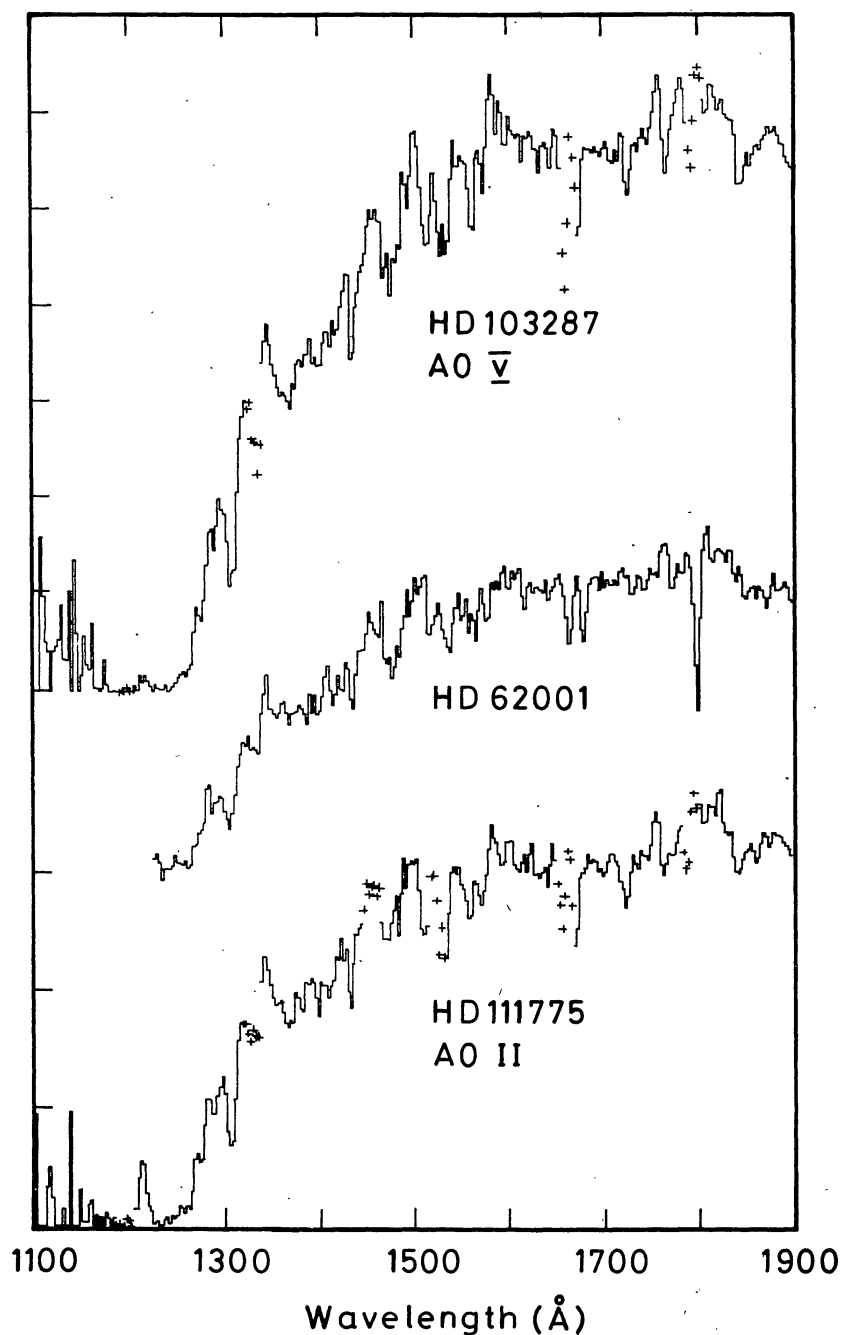


Figure 2. The low-resolution IUE spectrum of HD 62001 (SWP 10288) shown along with two standard stars from the atlas of Wu *et al.* (1981).

light) indicate a change of 10 per cent. All these photometric variations, coupled with radial velocity changes indicate a binary nature of HD 62001, but there is no evidence for the presence of a hot companion from our UV observations. Probably the system might be more like an Algol type.

Assuming the image of V-V 1-7 was real and not a photographic defect the disappearance of the nebula has been discussed by Rao and Gilra (1981) in the context of the central star HD 62001 being an Algol-type binary. Further analysis is in progress.

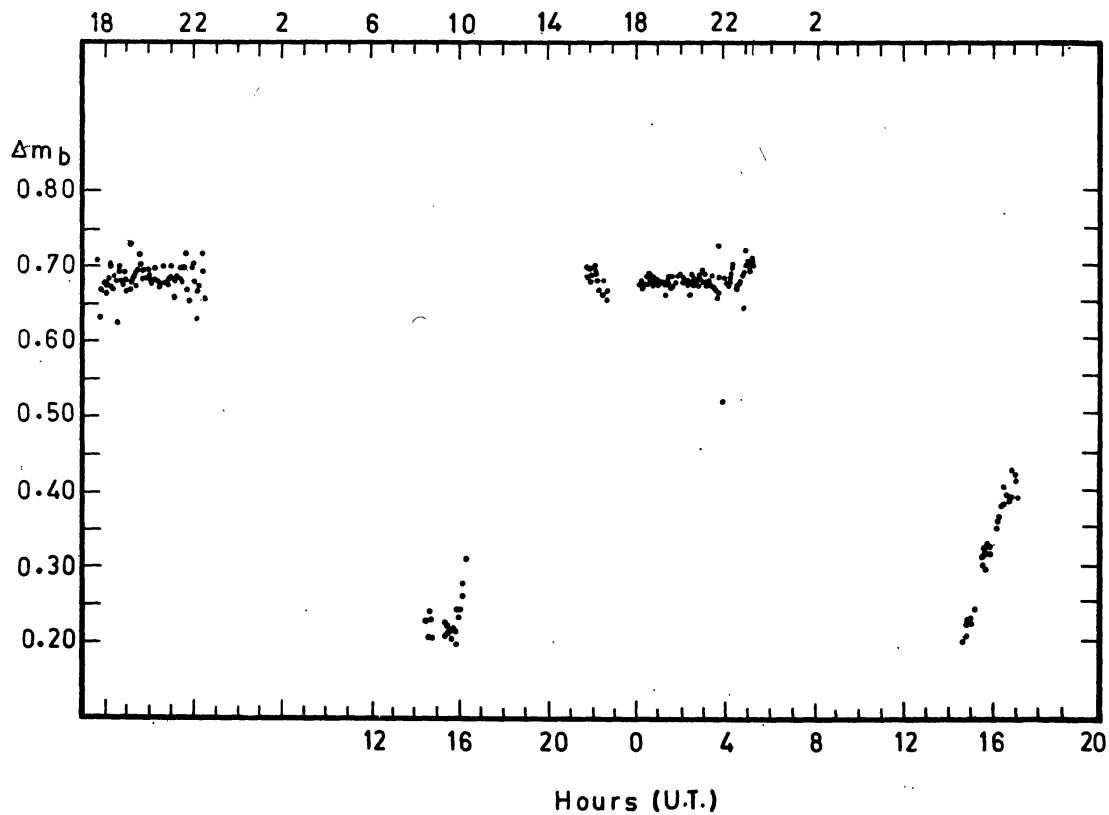


Figure 3. Differential magnitudes in blue filter (HD 62001 – HD 62002) plotted for four separate nights, 1978 April 14 and 15 (lower), and 1979 January 8 and 9 (top). The time marked in hours (U.T.) is continuous for two successive nights.

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