INFRARED PHOTOMETRY OF SAKURAI'S OBJECT (V4334 Sgr) IN 1996-2000

A.M. Tatarnikov[1], V.I. Shenavrin[1], P. A. Whitelock[2], M.W. Feast[3], B.F. Yudin[1]
[1] Sternberg Astronomical Institute, Universitetsii pr. 13, Moscow; 119899 Russia *yudin@sai.msu.ru*
[2] South African Astronomical Observatory, South African Republic
[3] Cape Town University, Cape Town, South African Republic

ABSTRACT The results of the photometric observations of V4334 Sgr and characteristics of its evolution after outburst are presented.
Key words: Stars: variables and pecular; stars: individual: V4334 Sgr.

On the 20, 1996, the Japanese amateur astronomer Sakurai discovered a novalike variable in Sagittarius; it was designated as V4334 Sgr and is commonly referred as Sakurai's object. It happened one year after its outburst. The observations of V4334 Sgr by Duerbeck and Benetti (1996) immediately after its discovery show that the star is similar to an F supergiant whose atmosphere is depleted of hydrogen and enriched with carbon and oxygen. They also detected an old planetary nebula of low surface brightness around the star. All these findings led them to suggest that V4334 Sgr was a star that underwent the final helium flash at the stage when it was already a planetary nebula nucleus. After the flash, the star returns to the Post AGB track, initially moving backward along it, i.e., gradually cooling down through it expansion. Such novalike stars were called born again AGB stars, which include FG Sge, V605 Aql, and V4334 Sgr.

The photometric $JHKLM$ observations of V4334 Sgr are being carried out with the 1.9-m SAAO telescope (South Africa) and with the 1.25-m telescope at the Crimean Station of Sternberg Astronomical Institute.

Figure 1 shows V, K magnitude and $B-V$, $H-L$ color variations in V4334 Sgr, as well as variations in its bolometric magnitude and in the optical depth of its dust shell at the wavelength of $1.25\mu m$ (Tatarnikov et al. 2001, and references therein). Before calculating m_{bol} the magnitudes were corrected for interstellar reddening with color excess $E(B-V) = 0.^m54$. In this way, the bolometric light curve differs from the remaining light curves in Fig. 1, which were not dereddened. The arrows mark the times when the bolometric flux reached its maximum and when the first profound visual fading of the star began.

After outburst V4334 Sgr has passed already through four well-defined stages as it moved backward along Post AGB track. At the first stage (1996), there was not dust in the star's shell. Its visual brightness slightly increased, as the bolometric flux, and it reddened (Fig. 1). At the second stage (1997), an optically thick dust shell condensed around the star, which, however, essentially did not manifest itself at optical wavelength ($V \approx const$, Fig.1). The bolometric flux continued to rise though an increase in the star's IR brightness alone; the rate of its rise also increased.

At the third stage (1998-March 1999), V4334 Sgr entered the R CrB phase. First two shallow minima and then two deep minima were observed in optical wavelength. Before the first deep minimum (July 1998) the bolometric flux had reached its maximum value and began to gradually fall in the second part of 1998.

At the fourth stage (since March 1999 up till now), V4434 Sgr has been at a protracted deep minimum, which is typical of the R CrB stars. The total amplitude of the bolometric flux variations was about 0.5 mag, and they did not correlate with the variations of the optical depth of the dust shell.

Until the mid-summer of 2000, the optical depth of the dust shell had increased gradually, but nonmonotonically to its maximum $\tau(J) \approx 11.3$, which was reached in July. The model of a two-layer dust shell, in which each layer is formed with a constant rate of dust condensation at the inner boundary of the dust envelope, satisfactory reproduces the rate of increase in its mass, at least until the mid-summer of 2000. The second, denser layer began to form in July 1998 through an approximately fivefold increase in dust production, from $\sim 3.5 \times 10^{-8}$ to $\sim 2.0 \times 10^{-7} M_\odot$/yr (Tatarnikov et al. 2001). The fraction large ($a_{gr} = 0.2 - 0.3\mu m$) grains were increasing remarkably during its formation.

References

Duerbeck H.W., Benetti S.: 1996, *Ap. J.*, **468**, L111.
Tatarnikov A.M., Shenavrin V.I., Whitelock P.A., Feast M.V., Yudin B.F.: 2001, *Astron.Lett.* **27**, 534.

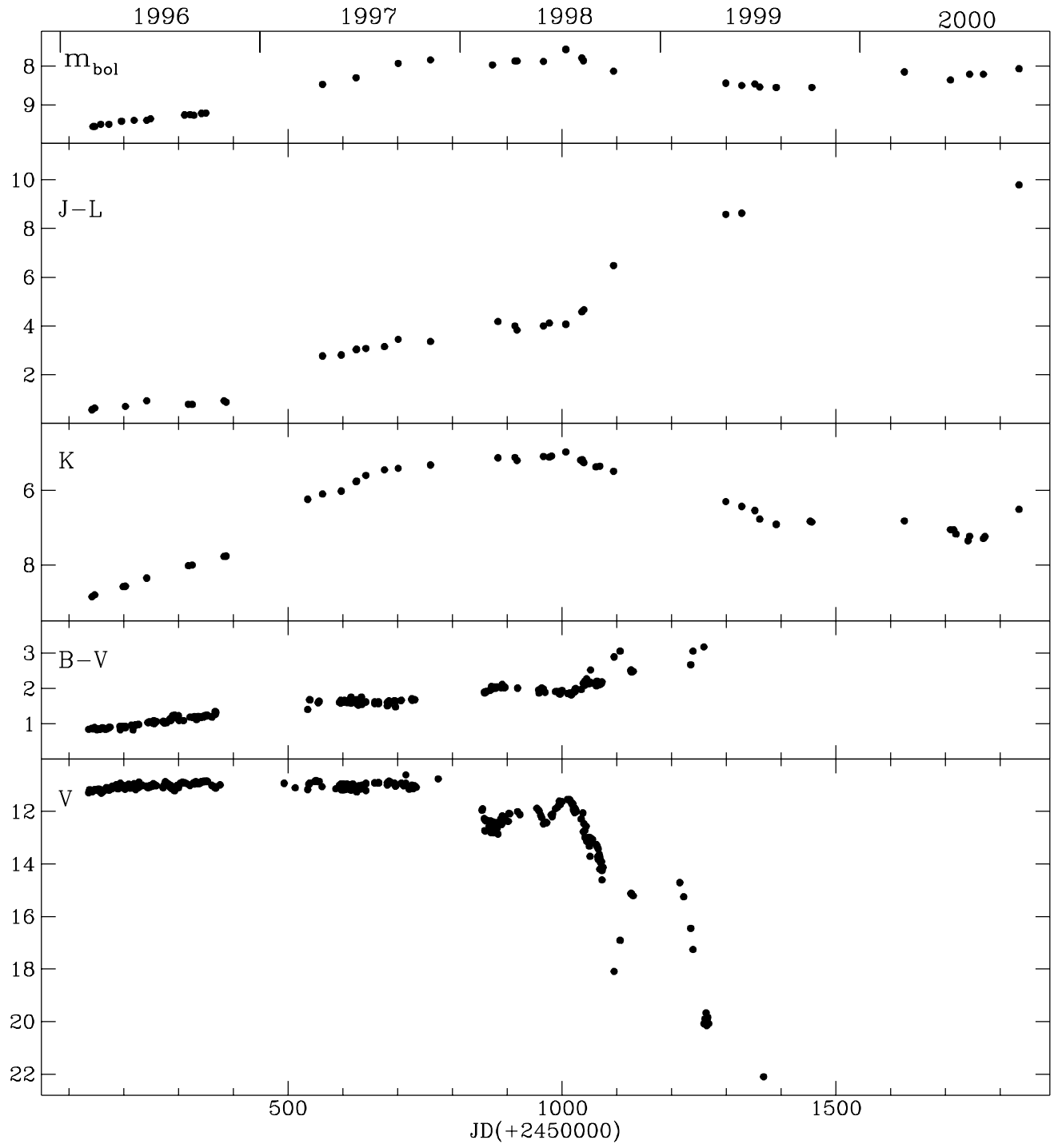

Figure 1: Variations in the V and K magnitude, $B-V$ and $H-L$ color, and bolometric magnitude m_{bol} of the V4334 Sgr and in the optical depth $\tau(J)$ of the dust envelope during 1996-2000.