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THE RECENT OPTICAL DECLINE OF V1057 Cyg

The pre-main sequence star V1057 Cyg was discovered as the second FU Orionis variable in 1970 (Herbig 1977). The star brightened by ~ 5 mag in less than one year and reached B ~ 10 in 1972 (see Figure 1). The optical spectrum also changed significantly, evolving from a T Tauri-like spectrum into an A-type supergiant with P Cyg-type emission lines. The star also developed large near-infrared and near-ultraviolet excesses over the spectral energy distribution expected for a normal supergiant. The large broadening of optical absorption lines further indicated significant rotation, in excess of 30–40 km s^{-1} at 0.5–0.6 μm.

Following the eruption, the brightness and spectrum continued to evolve. The spectrum cooled from an A-type to an F-type to a G-type supergiant in roughly a decade. The optical brightness declined by nearly a factor of ten during this time and then leveled off at B ≈ 13. The system also declined at all other wavelengths. The magnitude of the decline decreased monotonically from 4 mag at 0.36 μm to 0.5 mag at 3–5 μm. Kenyon & Hartmann (1991) interpreted this evolution in terms of a changing color temperature of a central accretion disc surrounding a low mass pre-main sequence star. Larger declines at wavelengths exceeding 5 μm followed the overall decline in bolometric luminosity of the optical source. This radiation is optical light absorbed and reradiated by a surrounding dust cloud (see Kenyon & Hartmann 1991).

During the past decade, we have acquired UBV photometry of V1057 Cyg to follow the continuing decline of this interesting system. We acquired these data with the 60-cm Zeiss reflector at the Crimean Laboratory of the Sternberg State Astronomical Institute (see Kolotilov 1990; Kenyon et al., 1991). Most observations were made through a $13''$ aperture; a $27''$ aperture was used on nights of poor seeing. We reduced the data using Landolt's (1975) star N9 as the comparison and star N13 as the control. The probable errors are ± 0.01–0.02 mag in V and ± 0.02–0.03 mag in B–V.

Figures 1-2 show our B light curves. The complete light curve in Figure 1 illustrates the ~ 1 mag irregular variability prior to the eruption, the 5 mag rise itself, a roughly 15 yr decline (~ 0.2 mag yr^{-1}), a nearly 10 yr period of constant brightness, and the recent, relatively rapid, decline of nearly 2 mag (see also Kenyon & Hartmann 1991 and references therein). The optical source varies irregularly, ~ 0.1–0.3 mag, on time scales of days to weeks throughout the optical decline. The amplitude of these irregular variations increases towards blue wavelengths and may reach ~ 0.5 mag at U (Kolotilov 1990; Kopatskaya 1984).

Figure 2 shows the recent activity on an expanded scale. The system declined ~ 1 mag in 8–10 months, recovered by ~ 0.25 mag in 1 yr, and then faded by ~ 0.75 mag in the past year. The B–V color increased by $\delta(B-V) \approx 0.35$ mag as the optical brightness declined. The B–V color changed very little during the increase in B brightness during Year 27 (compare Figures 2 and 3).

In addition to the obvious decline, the B light curve contains a wave-like fluctuation with a period of $\sim$ 2 yr and an amplitude of $\sim$ 0.5 mag. This variation was *not* visible shortly after maximum and has developed in the past decade. The variation maintained its 'coherence' through approximately one cycle during the recent 1.5 mag decline. Future data will yield better estimates for the period and amplitude of this variation.

The recent evolution of the light curve, with a total decline of 1.5 mag in nearly 3 yr, resembles the rapid fading of V1515 Cyg in the 1980's (Kenyon et al. 1991). The evolution of V1515 Cyg was comparable in magnitude but slightly faster, with a decline of $\sim$ 1.5 mag in slightly less than one year. The change in the B–V color was identical in both systems. Neither system showed much spectroscopic evolution during the decline: both continued to show G-type absorption features at minimum light.

The simplest explanation for the optical minimum in V1057 Cyg is a dust condensation event in the outflowing wind from the inner accretion disc. Kenyon et al. (1991) showed that the decline of V1515 Cyg can be explained with this interpretation. In V1057 Cyg, the reddening of the B–V color is consistent with a 1.5 mag decline in B brightness for a standard extinction law (Mathis 1990). The lack of significant changes on optical spectra of V1057 Cyg suggests an external event – rather than a sudden cooling of the central source – caused the brightness decline.

Future optical photometry will provide a test of this simple picture. The brightness of V1515 Cyg recovered from the 1.5 mag decline in several years. We expect a similar time scale for recovery in V1057 Cyg once it has reached a definite minimum.

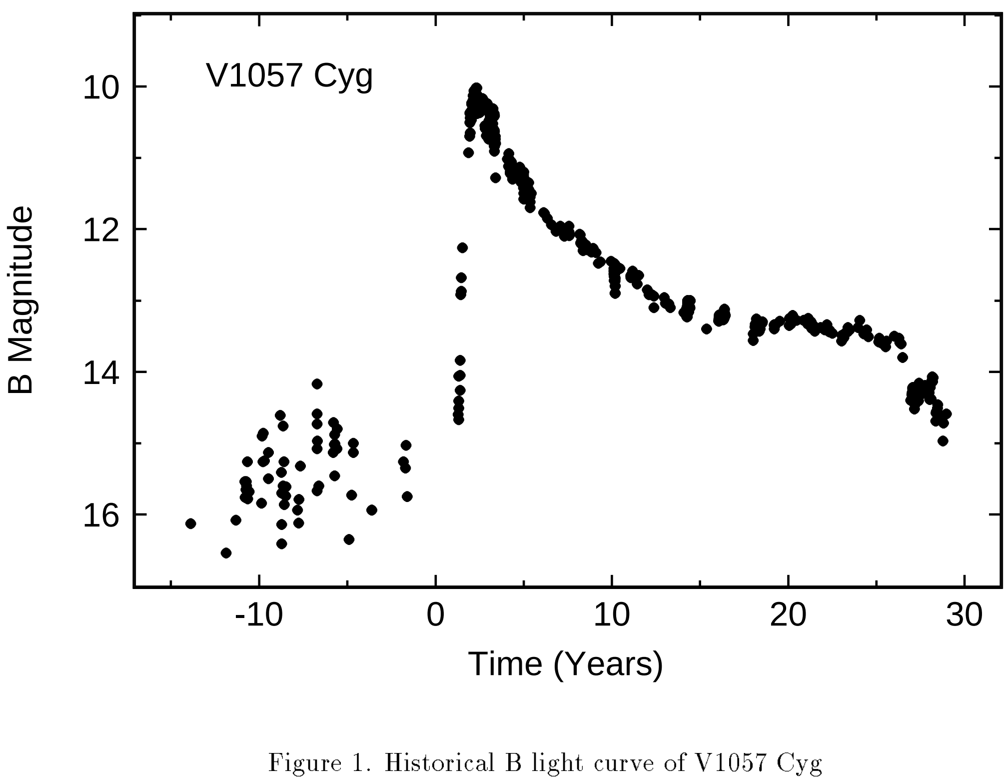

Figure 1. Historical B light curve of V1057 Cyg

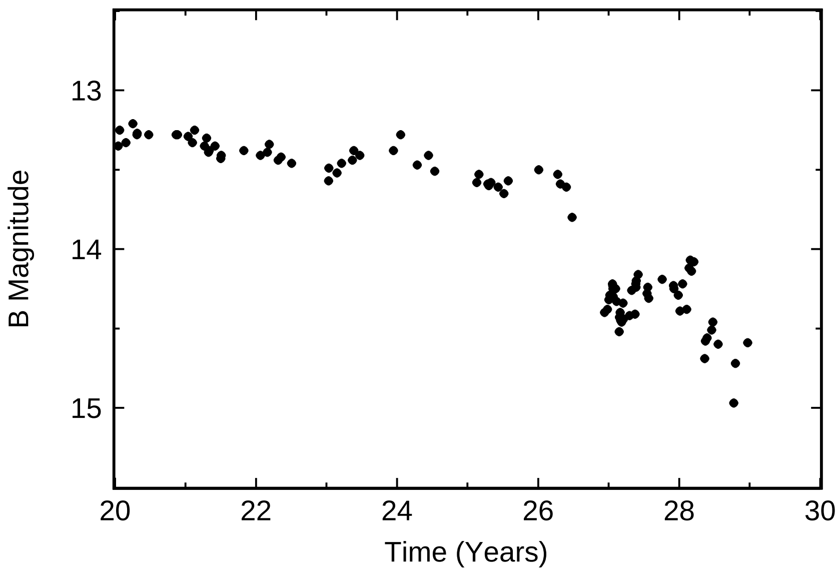

Figure 2. Recent B light curve of V1057 Cyg

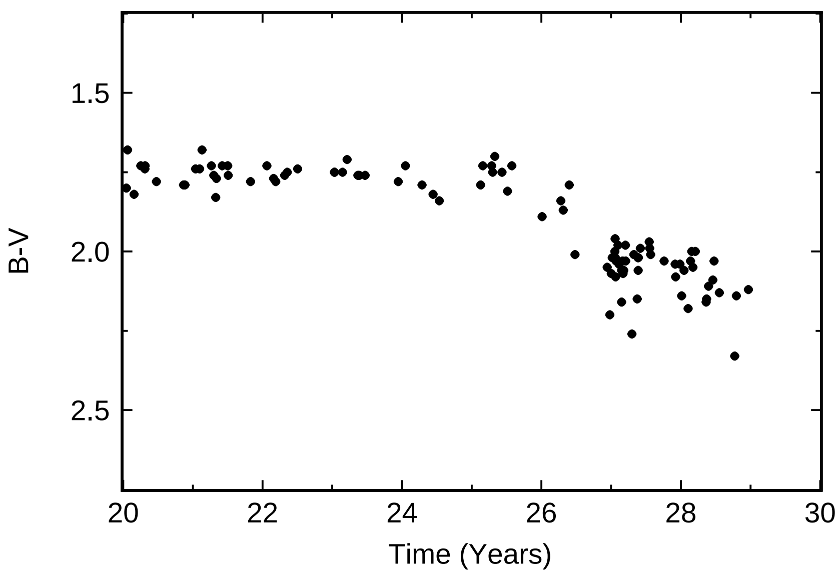

Figure 3. Recent B–V evolution of V1057 Cyg

E.A. KOLOTILOV
Crimean Laboratory
Sternberg State Astronomical Inst.
p/o Nauchny, 334413 Crimea
e-mail: kolotilov@sai.crimea.ua

S.J. KENYON
Smithsonian Astrophysical Obs.
60 Garden Street
Cambridge, MA 02138 USA
e-mail: skenyon@cfa.harvard.edu

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