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NOTES ON THE SPECTRUM OF U SCORPII AND ON ITS POSITION AMONG THE RECURRENT NOVAE

A spectrogram (dispersion 132 Å mm^{-1}, emulsion IIa-O) of the recurrent nova U Sco during its recent outburst was taken on 1979 June 28.95 (UT) with the Cassegrain spectrograph of the 1.06 m telescope of the Hoher List Observatory. While the blue part of the spectrum is underexposed due to the faintness of the object and the strong atmospheric extinction, some features in the region between Hδ and 5050 Å can be studied.

The nova had at that time a magnitude of about 11.5, and was nearly 3^m below maximum. Simultaneous high speed photometry has been reported by Warner (1979). Spectroscopic observations on 1979 July 2 and 3 are briefly described by Hill et al. (1979).

At the time of our observations, the most prominent feature is a broad blend of emission lines of Fe II , N III , C III , and He II at 4580 - 4690 Å, which is much stronger than the Balmer lines Hβ and Hγ . The tracing of the spectrum with some (often tentative) identifications is shown in Fig. 1. As already suggested by Hill et al. (1979) the spectrum bears some resemblance to that of T CrB 3^m below maximum (see, e.g., Herbig and Neubauer 1946). However, it is also similar to that of RS Oph 3^m below maximum (see, e.g., Dufay et al. 1964). While the lines of RS Oph are much more diffuse than those of T CrB, the lines of U Sco are by far the most diffuse at this stage, making line identifications very uncertain.

Fast recurrent novae show a tendency of decreasing line width with time:
T CrB : 570 → 270 km s^{-1} in 7 days (Herbig and Neubauer 1946)
RS Oph: 1600 → 950 km s^{-1} in 10 days (Folkart et al. 1964)
U Sco, however, seems to show very broad emission lines also in later stages of the outburst. We derive half-widths of ± 2800 ± 200 km s^{-1} (m.e.) 5.5 days after outburst. Hill et al. report 10 000 km s^{-1} zero-intensity line widths 9 days after outburst.

An attempt is made to estimate the interstellar extinction in the direction of U Sco. Unlike ordinary novae, recurrent novae do not show dramatic changes in the B - V index during decline from maximum. T CrB had B - V = 0.1 around

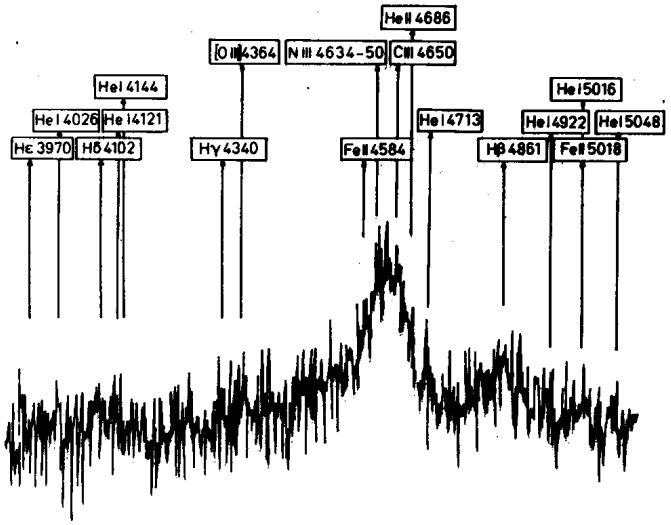

Fig. 1. The spectrum of U Sco, 1979 June 28.95 (UT)

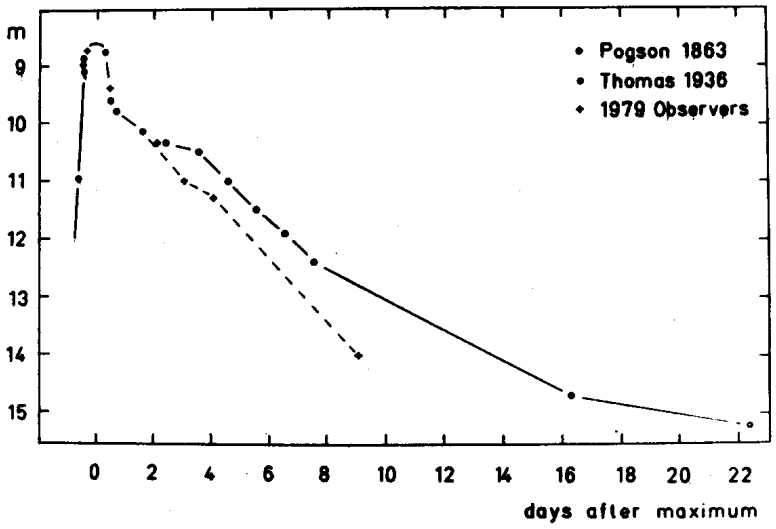

Fig. 2. A composite light curve of the outbursts of U Sco. The 1979 outburst appears to have a more rapid decline

maximum (Gordon and Kron 1979) and suffers no noticeable reddening. RS Oph had $B-V = 0.74$ (Connelley and Sandage 1958); Svolopoulos (1966) derived $(B-V)_o = -0.02$. For U Sco, the visual and photographic observations of Narumi and Kuwano (Kosai 1979) indicate $m_{pg} - m_{vis} = 0.1$ at maximum, and Whitney (1979) observed $B-V = -0.13$ 2.5 days after maximum. It appears that U Sco is very little reddened. Unfortunately, there is no clear distance - reddening relationship in this region (see, e.g., Neckel's (1967) field No. 194). $E_{B-V} = 0.3$ should be present if U Sco is not closer than 250 pc, but the extinction does not increase up to a distance of 3 kpc and likely more, since the line of vision at that distance has left the Galactic plane.

Let us assume that U Sco has reached an absolute magnitude at maximum equal to that of T CrB and RS Oph. T CrB has shown some nebular whisps that may have been ejected during the 1946 outburst (Williams 1977). They yield an expansion rate of $0''.33$ year^{-1}. Due to the ambiguity of our knowledge of the principal expansion velocity (radial velocities of 4 000 ... 1 000 km s^{-1} have been observed), the absolute magnitude is only coarsely determined: $M_V = -8.5 \pm 1.5$. Svolopoulos' study of the reddening and distance of RS Oph yields $M_V = -8.7$. With an apparent maximum brightness of U Sco of $m_v = 8.7$, an estimated A_V of 1^m, and an absolute magnitude $M_V = -8.5$, a distance of the order of 17 kpc is derived. This brings U Sco 6 kpc above the Galactic plane !

If we assume that the minimum V magnitude is only due to the late type companion, then $M_V = -0.5 \pm 1.5$ for T CrB, and -2.5 (variable; Tempesti 1975) for RS Oph indicate that the secondaries are in the range of M giants and semiregular variables. The estimated brightness and colour of U Sco at minimum, as derived from the POSS charts (Webbink 1978) make it more likely that the secondary is an F or G giant with $M_V = +1.5$, if the distance of 17 kpc is correct.

Spectroscopic observations of U Sco at minimum would be highly desirable, since they could settle the question whether all *fast* recurrent novae have indeed giant secondaries. For the *slow* recurrent nova T Pyx, the colour at minimum light (Webbink 1978) and the nebular expansion parallax (Duerbeck and Seitter 1979) put severe restrictions on the size of the secondary. It is very likely a dwarf star.

The knowledge of the colour of U Sco also allows a construction of the combined light curve for all well-observed outbursts. While the visual light curve of Pogson et al. (1908) and the photographic light curve of Thomas (1940) appear to be very similar, the new observations (Bortle 1979, Kosai and Mattei 1979, Whitney 1979) indicate a more rapid decline.

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