V745 Sco – a New Member of the Elusive Group of Recurrent Novae

H. W. DUERBECK, ESO and Astronomisches Institut der Universität Münster, F. R. Germany

Up to late July, 1989, the six novae which have shown repeated outbursts in the last 130 years, are: V394 CrA, T CrB, RS Oph, T Pyx, U Sco and (likely) V1017 Sgr. On July 30, William Liller, a regular visitor to La Silla and owner of a private observatory in Viña del Mar (a sea resort on the coast of Chile), discovered on a sky patrol film a 10th-magnitude star that was not there the night before. Its position coincided, as was found after some re-examination of old photographic plates, within an arcsecond of the position of a nova that had flared up on May 10, 1937. This poorly known nova, V745 Sco, thus became the seventh known recurrent nova.

The writer, who has a continuous interest in novae, had just begun a three-month stay on La Silla as the first astronomer of ESO's newly instituted Senior Visitor Programme. While recent outbursts of U Sco and V394 CrA were studied by astronomers at the South African Astronomical Observatory, joint efforts made this nova an ESO nova: There was Thomas Augusteijn, who informed me in time of the discovery, Hugo Schwarz, who offered some joint observing time at the 1.4-m Coudé Auxiliary Telescope/Coudé Echelle Spectrometer, and the TRS people, who were so kind to postpone the aluminization of the CAT mirror for a few weeks to rearrange some test nights. Finally, there was the possibility to make fairly regular observations with EFOSC2 at the 3.5-m New Technology Telescope which was undergoing a series of astronomical tests in August/September. While the observations and reductions of the CES spectra were relatively straightforward, those of EFOSC2 were improvized: there was no guiding possibility, no calibration lamps, but much enthusiasm and expertise from the other users. Finally, using the lines of a planetary nebula for establishing the dispersion curve, and some spectral standards and the cool component of the recurrent nova itself for calibration, a series of composite spectra of V745 Sco were obtained, covering the range 3620–8270 Å. It was fortunate that the evolution of the outburst proceeded very rapidly, so that, when the engineering staff took over again, the most interesting phases had been covered.

So much for the observations. What about the results? As already mentioned, the group of recurrent novae is not only small, but also inhomogeneous, and poorly understood. It is still unclear whether the outbursts are caused by thermonuclear runaways in degenerate hydrogen-rich matter accreted on the surface of a massive white dwarf (some authors evoke accretion events on main-sequence stars to explain the outbursts of T CrB and RS Oph). Both these objects have, as well as V1017 Sgr, late giants as mass-donating components, while the cool components of V394 CrA, T Pyx and U Sco appear to be dwarf stars, whose absorption lines can hardly be detected against the continuous background of light produced in the accretion disk.

As can be clearly seen in the later spectra obtained with EFOSC2 (Fig. 1), V745 Sco has a giant companion as mass-donor: the strong TiO bands indicate a spectral type of M6 III. This object has a strong wind (and likely the white dwarf accretes its fuel from it). Indications for this wind are, first, the narrow emission lines observed in the early outburst phases. They clearly showed up in the CES spectra taken in the first days after outburst, and obviously are emitted by the wind material, which was photoionized by the flash of the nova explosion. Especially interesting is the region around the line [OIII] 5007: At this early phase, no forbidden oxygen emission is expected from the expanding shell, while it clearly is present in V745 Sco (Fig. 2). Near to it is an FeII line at 5018 Å: it has a weak narrow component originating in the slowly moving wind material, and also a broad component formed in the rapidly moving nova shell. In the third night following the outburst, the broad component is only noticeable as a slight bending in the stellar continuum, while in the fifth night, when a deceleration had taken place, it is clearly visible. Such narrow emission lines were discovered before in only one other recurrent nova, in RS

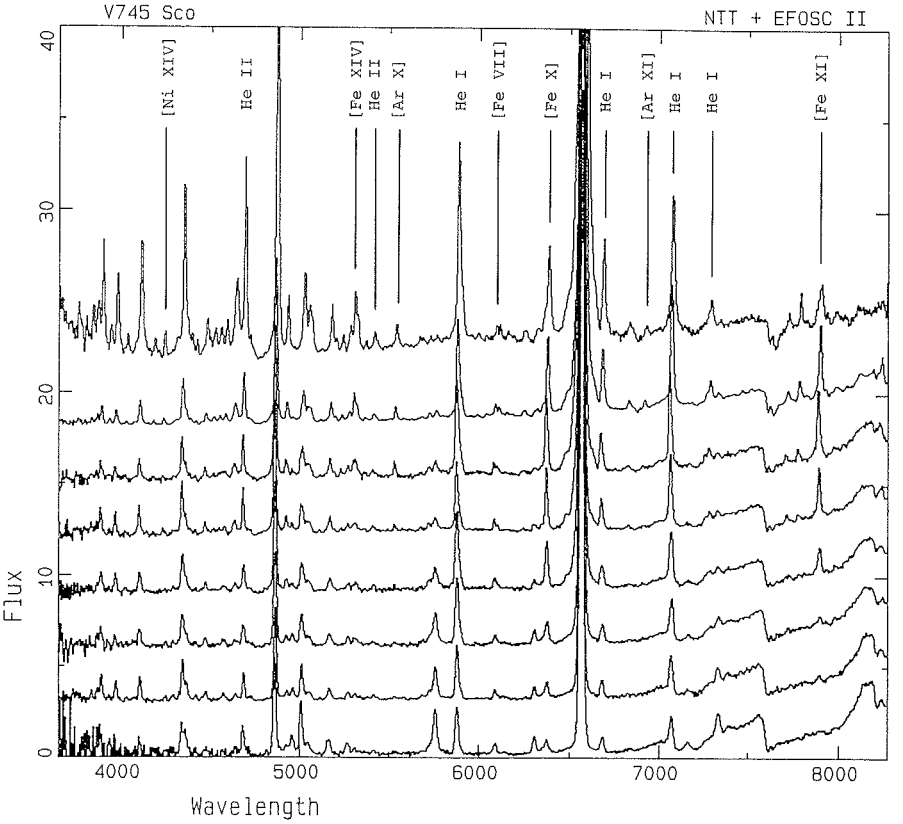

Figure 1: *The later phases of the outburst of V745 Sco, shown in spectra taken by T. Augusteijn, J. Melnick, H.E. Schwarz and the writer with EFOSC2 attached to the 3.5-m New Technology Telescope. The spectra were taken (from top to bottom) on August 9, 11, 13, 15, 17, 24, 28 and September 9, and are separated by 3 (arbitrary) flux units to avoid overlapping. While the first spectrum still shows emission lines typically found in classical novae, the coronal lines reach maximum strength in the following days and decline afterwards. In the later phases, medium and low-excitation lines of [NII], [OI], [OII] and [OIII] increase in strength. Note also the TiO bands of the giant M6 companion in the infrared.*

Oph during its 1958 outburst (and subsequent ones).

A few days later, when the rapidly expanding shell ejected from the white dwarf had time to strongly interact with this slowly moving material, its kinetic energy became thermalized by collisions: "coronal" lines of high excitation potential are formed in the surrounding shell: lines of [FeVII], [FeX], [FeXI] and [FeXIV], as well as those of [NiXII], [AX] and [AXI] rapidly increased in strength and reached maximum intensity around August 12. Again, there is a similarity with RS Oph, however, while the coronal spectrum in RS Oph took six weeks to acquire maximum strength, this process took hardly two weeks in V745 Sco. Three weeks later, when the last spectrum was taken, hardly a trace of them remained.

What else was found? V745 Sco is quite faint, even at maximum, and obviously very distant. The interstellar sodium lines show 11 components, produced by distinct interstellar clouds of different radial velocity, as do the calcium lines (the strong interstellar extinction, however, makes the latter ones difficult to observe). We estimate that the interstellar visual extinction is 3^m, and that the distance to V745 Sco is of the order of 10 kpc; it likely belongs to the galactic bulge.

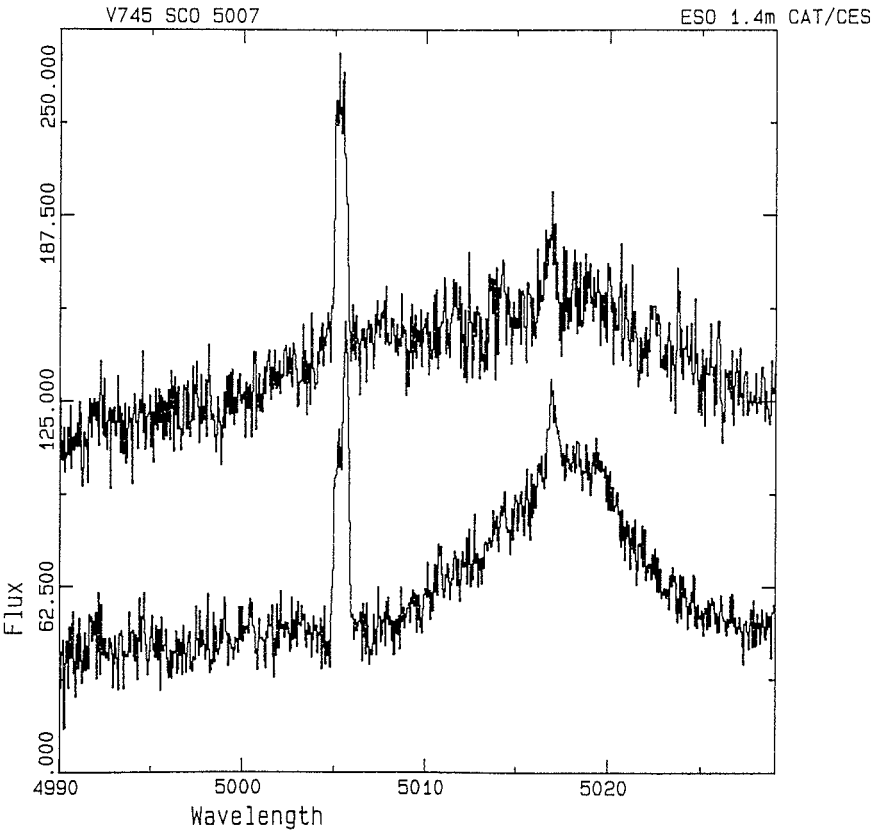

Figure 2: *The region of the [OIII] line at 5007 Å in V745 Sco, observed on August 2 and 4, three and five days after outburst, with the Coudé Echelle spectrometer at the 1.4-m Coudé Auxiliary Telescope by H.E. Schwarz and the writer. Note the different appearance and temporal development of the [OIII] line at 5007 Å and the FeII line at 5018 Å. While the first formed in the wind of the companion, the second arises mainly in the expanding nova shell.*

Photometry and High Resolution Spectroscopy of Two Southern T Tauri Stars

C. CHAVARRIA[1,2], E. COVINO[3], M. FRANCHINI[4], R. STALIO[5] and L. TERRANEGRA[1]

[1] *Instituto de Astrofísica, Optica y Electrónica, Puebla, México*
[2] *Instituto de Astronomía, UNAM, México, D.F., México*
[3] *Osservatorio Astronomico di Capodimonte, Napoli, Italy*
[4] *Osservatorio Astronomico di Trieste, Trieste, Italy*
[5] *Dipartimento di Astronomia, Università di Trieste, Trieste, Italy*

Introduction

In an attempt to determine rotational velocities, photometric rotational periods and possible correlations with chromospheric activity, a sample of southern T Tauri or suspected T Tauri stars was monitored in May 1989 with the CAT+CES 1.5-m and the 50-cm ESO telescopes at La Silla. Unfavourable weather conditions limited our original goals. Nevertheless, some interesting results were obtained. Here we report some preliminary results for two stars from our sample: T Cha and CoD −33° 10685.

T Cha: According to the catalogue of Herbig and Bell (1988), no spectroscopic observations of T Cha exist; its T Tauri nature is suggested only by the RW Aurigae-Type variability, and by its location in a dark cloud. The star has a probable photometric period of 3.2 days (Mauder and Sosna 1975). There is also a discrepancy of about $2^m.5$ in the data for the apparent visual brightness of the star given by Mauder and Sosna (1975), and by Mundt and Bastian (1980 and references therein).

CoD −33° 10685: This is a fairly well-studied T Tauri star of spectral type K2 (Herbig, 1967), with a rotational velocity $v \cdot \sin i$ = 48 km/s and a visual magnitude of 10.3. It is also a suspected linear polarization variable (Drissen et al., 1989). All these properties make CoD −33° 10685 a good candidate for BY Draconis-type variability.

The Observations

Owing to the prevailing weather conditions, we decided to limit our observations to the spectral range of the NaI D lines in order to study the outer and colder parts of the stellar atmosphere. Three spectra of each star were taken on three different nights, and the spectra of a number of reference stars were obtained as well. The latter were convolved with different synthetic rotational profiles in steps of 5 km/s over the ve-