Long-term optical studies of cataclysmic variables

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DETECTION OF A BRIEF OUTBURST FROM THE INTERMEDIATE POLAR V1223 SGR*

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Summary

We report the detection of an outburst from the intermediate polar V1223 Sgr, which lasted between ~6 and ~24 hours and during which the optical flux increased by at least a factor 3. With respect to duration, amplitude, and spectral development this outburst is very similar to outbursts previously observed from the intermediate polar TV Col. These brief outbursts may be caused by the same instability that gives rise to dwarf nova outbursts, in a system where the inner parts of the disk are absent.

*Based on observations made at the European Southern Observatory

1 Observations

As part of a long-term investigation of intermediate polars we have made spectroscopic observations of V1223 Sgr, to study possible spectral variations (line strength, radial velocities) at the white-dwarf rotation period of 13.2 minutes [see Warner (1985), Watson (1986), and Van Amerongen et al. (1987) for references on V1223 Sgr]. The observations were made by one of us (SvA) on six consecutive nights between August 28 and September 2, 1984, using the Boller and Chivens spectrograph and Image Dissector Scanner at the Cassegrain focus of the 1.52 m telescope of the European Southern Observatory.

During each night V1223 Sgr was observed for typically 4.5 hours, i.e. at least one orbital period (3.4 hours) was covered. Spectra were taken once every minute; they had a dispersion of 172 Å/mm, and covered the wavelength range between ~4000 and ~7000 Å. A total of 1360 spectra were collected. These data were reduced at ESO (Garching) using the IHAP data analysis system. The reduction procedure included sky background subtraction, wavelength calibration, and flux calibration. For each reduced spectrum we have derived estimates of the position and integrated flux of Hα, Hβ, and the He II line at 4686 Å(all three are in emission), and of the continuum flux near these lines.

A detailed description of the spectral variations of V1223 Sgr will be reported elsewhere (van Amerongen and van Paradijs, in preparation). We here report the detection of a brief outburst of V1223 Sgr.

2 Results

In Fig. 1a we show the variation of the continuum flux of V1223 Sgr near Hα, during the six nights of observing (similar results have been obtained for the continuum fluxes near the two other emission lines).

From this figure it appears that during five of these nights V1223 Sgr was at approximately the same brightness level (it showed a 0.15 mag brightness modulation at its 3.4 hr orbital period). During the fourth night we observed V1223 Sgr during what appears to be the decline of a brief event ('outburst') during which the flux was higher than the average, as observed during the other five nights, by a factor ~3.

Throughout this night the flux decreased, with an average rate of

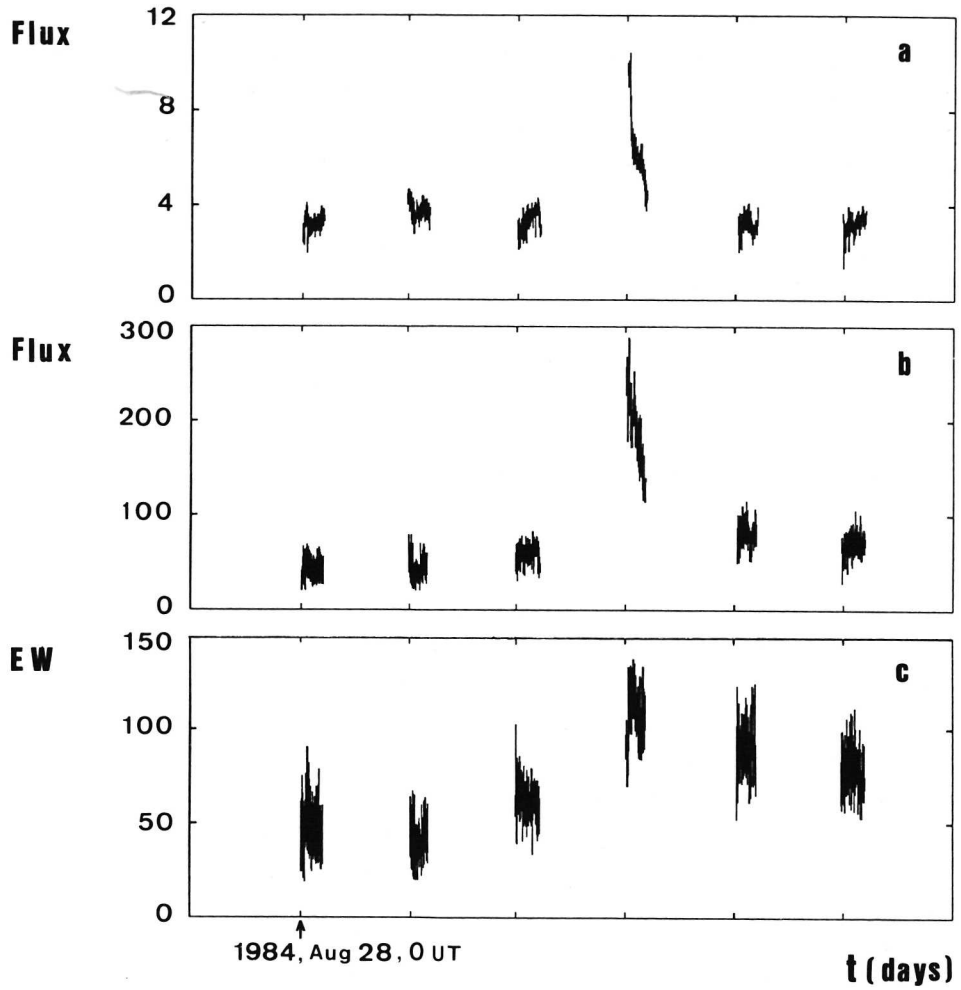

Figure 1.
Variations of characteristics of Hα in the intermediate polar V1223 Sgr between August 28 and September 2, 1984. (a) the continuum flux around Hα (units $10^{-14} erg/cm^2/sec/Å$; (b) the integrated line flux (units $2.5 \times 10^{-14} erg/cm^2/sec/Å$); (c) the equivalent width (units: Å). Time is given in days. On August 31, the source was on the decline of a flaring event, in which at the beginning of the night the flux was approximately 3 times higher than on the other nights of observations.

decline of 0.20 mag/hr. The decline rate was not constant; it showed a temporary slowdown which reflects the maximum of the underlying orbital light curve, whose expected time of maximum light it coincides with the slowdown. By the end of the night the flux had more or less returned to the normal level observed during the other nights.

The Hα, Hβ, and HeII λ4686 lines, which were in emission before and after the outburst, remained in emission during the outburst; their integrated fluxes increased by about twice as much as the corresponding continuum fluxes (see Fig. 1b), leading to an increase of their equivalent widths by a factor $\sim$2.

In Fig. 1c the variation of the equivalent width of Hα is shown. It appears that after the outburst has disappeared the equivalent widths of this emission line remained somewhat higher than before the outburst (the same is the case for Hβ and HeII λ4686).

3 Discussion

The outburst we observed from V1223 Sgr is similar to a number of brief events observed by Schwarz et al. (1988) from the intermediate polar TV Col (see also Szkody and Mateo 1984). For both sources the outbursts are absent a day before and after they are detected. The rate of decline of the continuum flux near Hα (on average 0.20 mag/hr) is not very different from the corresponding value of 0.35 mag/hr observed for TV Col in the V band (Schwarz et al. 1988). For both sources the emission lines are stronger during the outbursts than during the normal (quiescent) state.

With respect to the post-outburst behaviour of the emission lines V1223 Sgr differs somewhat from TV Col: in the latter source the equivalent widths were found to be slightly smaller after the outburst than before (Schwarz et al. 1988).

If we make the assumption that the optical outbursts observed for V1223 Sgr and TV Col have the same temporal profile (i.e. duration, and maximum brightness above the quiescent level) we can make an estimate of their total duration by lining them up. We then find that they probably last between $\sim$6 and $\sim$12 hours.

The detection of an outburst from V1223 Sgr suggests that these brief events, which are very different from dwarf nova outbursts with respect to duration, amplitude, and spectral development, may be characteristic

for intermediate polars.

Since the emission from intermediate polars is totally dominated by energy release due to accretion onto a magnetized white dwarf, there is little doubt that these outbursts are the result of an accretion instability. As suggested by Schwarz et al. (1988) the mechanism of this instability may be the same as that which gives rise to dwarf-nova outbursts; the small amplitude of the outbursts, their much shorter rise time and duration, and the different behaviour of the spectral lines, as compared to dwarf-nova outbursts, may be due to the fact that the inner part of accretion disks is absent when the magnetic field of the accreting white dwarf is strong.

This idea is supported by the detailed calculations of the outcome of accretion instabilities in intermediate polars by Angelini and Verbunt (1988).

Acknowledgments

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