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THE OPTICAL SPECTRUM OF LUYTEN'S VARIABLE GM SAGITTARII

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I obtained several long-slit spectra of V4641 Sgr, the optical counterpart of the fast X-ray transient and superluminal radio source SAX J1819.3-2525, in mostly marginal conditions on 2000 June 2–6 using the FORS1 instrument on the first 8.2-m telescope at ESO's Paranal Observatory (ESO visitor program 65.H-0360). Most of the observations were done with the grism #600B, which covers the wavelength range 3500–5700 Å with 4 Å resolution. A few additional spectra were obtained with the grism #600R, which covers the region near Hα with similar resolution. The VLT has a good atmospheric dispersion corrector, so the slit position was left in the default north-south position.

While inspecting the first few two-dimensional spectra, I noticed a bright star about 1 arcminute south of V4641 Sgr which had narrow Balmer lines in emission and strong molecular absorption bands. The object was not exactly centered on the entrance slit of the spectrograph, so I executed a telescope offset in order to have the unusual object centered. I took a single 2 minute exposure using the blue grism #600B. See Figure 1 for the finding chart and Figure 2 for the extracted spectrum. The strong absorption bands seen at $\approx$ 4762, 4956, 5168, and 5450 Å (where the wavelengths refer to the deepest part of the band just redward of the steep drop) are most likely due to TiO. I crudely estimate a spectral type of M3-M5 III (Jaschek & Jaschek 1987).

It turns out that the emission line object is Luyten's variable GM Sgr (Luyten 1927), which is listed in the GCVS as an LB type star (long period, irregular) of spectral type M6. The coordinates based on the astrometric solution included in the image header agree with those given in IAUC 7277. This object also appears to be the star marked in Kato & Uemura's (1999) finding chart, although the mismatch in the filters used makes a comparison difficult.

Table 1 lists the line centers and equivalent widths of the emission lines seen in the blue spectrum. I estimate an error of $\approx$ 5% in the equivalent widths, mainly due to uncertainties in the flux calibration. All of the Balmer lines up to H15 can be seen, with the curious exception of Hε. A weak Hα emission line is evident in the red spectrum (not shown) obtained when the slit was centered on V4641 Sgr. All of the lines listed in Table 1 are blueshifted by about 130 km s^{-1}, and all are unresolved (FWHM $<$ 4 Å).

The spectrum of GM Sgr resembles that of a Mira type variable star. The Balmer emission lines are thought to arise in the parts of the photosphere which have been heated by an outward moving shock (e.g. Fox, Wood, & Dopita 1984; Gillet 1988). The emission lines are visible over most of the pulsational cycle, and are strongest near the time of

Table 1: Wavelengths and equivalent widths of the emission lines in the GM Sgr spectrum.

Line	Central wavelength (Å)	Equivalent width (Å)
Hβ	4858.82	−6.6
Hγ	4338.63	−18.2
Hδ	4099.95	−35.0
Hε	...	...
H8	3887.21	−19.6
H9	3833.52	−16.8
H10	3796.03	−11.4
H11	3768.71	−10.8
H12	3748.28	−5.2
H13	3732.16	−4.7
H14	3721.17	−4.5
H15	3710.65	−5.9

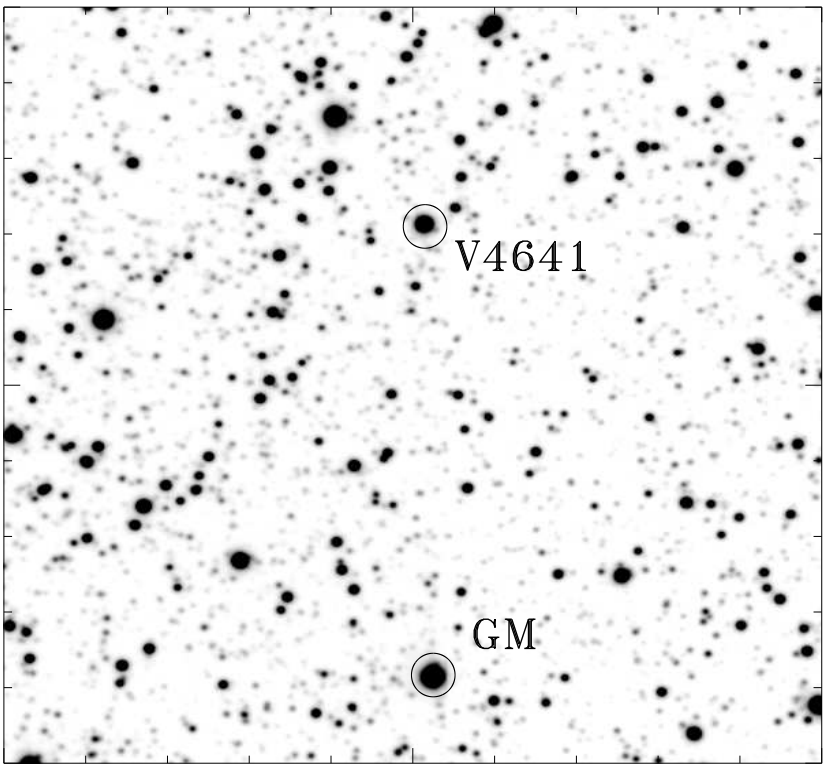

Figure 1. The finding chart for V4641 Sgr and GM Sgr. The field is $2' \times 2'$. North is up, and east is to the left. This is a section of an R band image obtained with the VLT Unit Telescope 1.

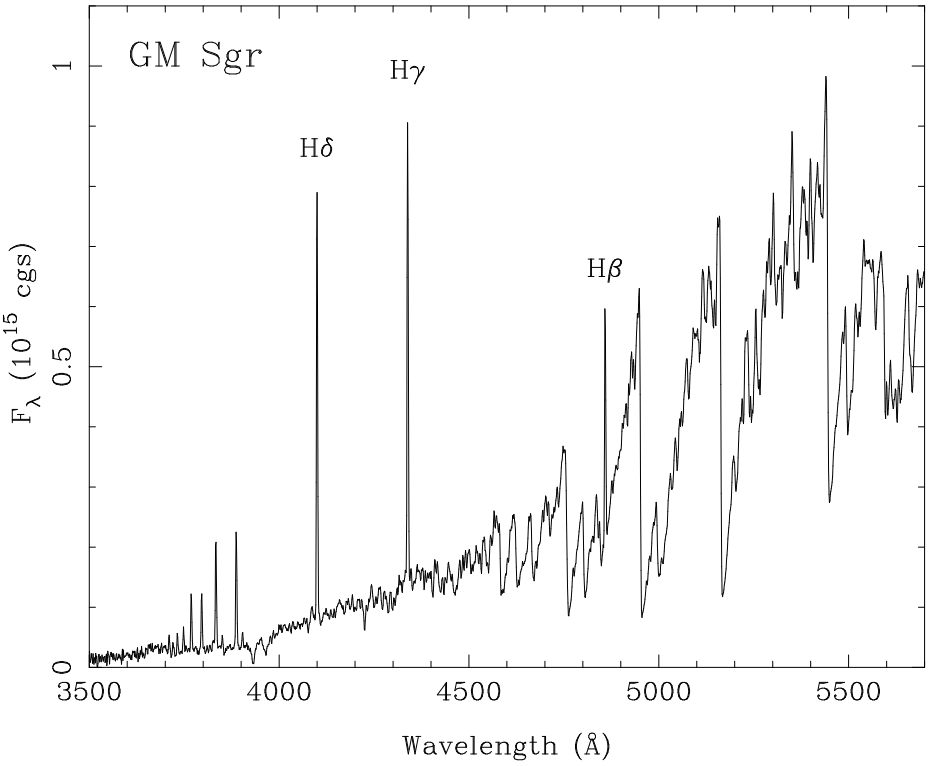

Figure 2. The flux calibrated spectrum of GM Sgr. Owing to clouds, the flux calibration is only approximate.

maximum light. The weak or absent Hε emission line is fairly typical in Mira variables near maximum light (Castelaz et al. 2000). According to Kato & Uemura (1999), a peak in the optical light curve occurred about October, 1999, although coverage subsequent to that was sparse. The pulsational period could be several hundred days, so a long-term photometric monitoring program will be needed to establish whether the variability is in fact periodic. Any CCD images of GM Sgr that also contain V4641 Sgr would of course be of extra value, since the latter source (which most likely contains a black hole—Orosz et al. 2000) seems to be prone to flaring behavior.

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