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PHOTOMETRY OF NOVA MUSCAE 1983

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RESUMEN. Presentamos observaciones fotométricas de GQ Mus en su estado quieto que revelan una fuerte modulación orbital. Se discuten observaciones espectroscópicas recientes las cuales indican un período corto orbital (85 min) en fase con el período fotométrico. Basándonos en los resultados, argumentamos que el sistema pertenece a la clase de variables cataclísmicas magnetizadas.

ABSTRACT. We present photometric observations of GQ Mus at quiescence which reveal a strong orbital modulation. We also discuss recent spectroscopic observations which reveal a very short orbital period (85 min) phased with the photometric period. On the basis of the results we argue that the system belongs to the class of magnetized cataclysmic variables.

Key words: PHOTOMETRY — STARS-BINARY — STARS NOVAE

INTRODUCTION

GQ Mus is a classical nova that erupted in January, 1983 (Liller, 1983). Its tburst and decay were well covered by multiple wavelength observations from satellites (IUE, OSAT and IRAS) and in the visible, near infrared and ultraviolet from the ground. Some portant properties of the system were established in the last five years: The observation of near polarization (~3%) increasing to the infrared (Cropper, 1985) and the presence of soft Ray emission (Ögelman et al. 1985). At the time two possible mechanisms were proposed explain this detection; the first was the occurrence of a hydrostatic burning process in e white dwarf surface and the second was the emission from a shock wave formed by the panding envelope into the interstellar medium. The reddening ($E_{(B-V)}$=0.45) and distance 800 pc) were found by Krautter et al. (1984) based on the interstellar feature at 2200Å and e absolute magnitude versus decay time relation.

An increase in the degree of ionization of the ejected envelope was found and the nizing mechanism was identified as photoionization by a central high temperature radiation urce. (Krautter and Williams, 1988). An overabundance of helium, nitrogen and oxygen and obably of iron was found by Pacheco and Codina and by Krautter and Williams.

. OBSERVATIONS AND RESULTS

The photometric observations were made in 1988 and 1989 using the 1.6m telescope the Laboratório Nacional de Astrofísica at Brasópolis MG, Brazil. A single-channel otometer with a S11 response phototube was used to obtain the light curves with resolution 25 seconds. These data show a remarkable high amplitude asymmetric modulation (fig. 1). No her highly significant peaks were found in a power spectrum calculated using a 6 hours ght curve in the range 50-1800 seconds.

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Summary of photometric observations:
Photometric period: 0.05923 ± 0.00017 days.
T_{min} = HJD 2,447,241.5635 ± 0.0010
T_{max} = 0.33 ± 0.03
Amplitude: 0.6^m (B).

Intrisic colors: (at photometric maximum)
(U-B): -1.1
(B-V): -0.3
(V): 17.5

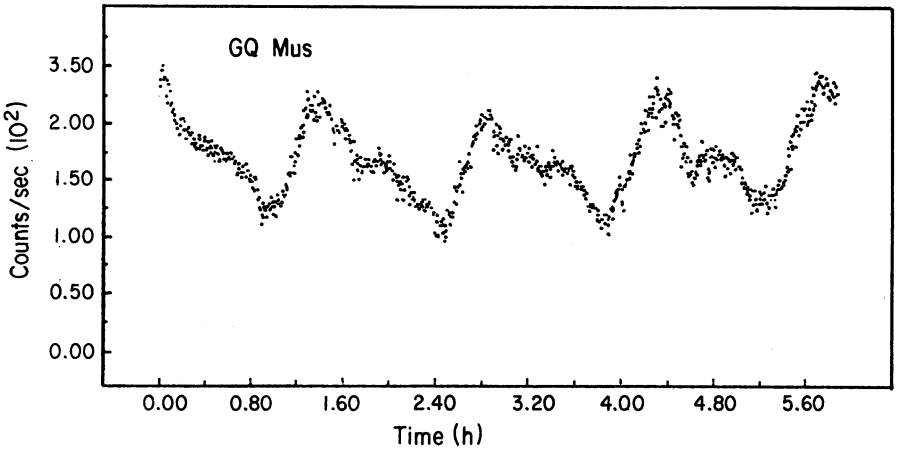

Fig. 1. Fast photometry of GQ Muscae.

The spectroscopic observations were made using the 2D-Frutti detector at the 4m telescope of CTIO on May, 1989. The spectra have a resolution of 3Å, a spectral coverage from 3450Å to 5300Å and have a time resolution of five minutes. The spectrum of GQ Mus on May, 1989 shows a large number of lines including lines of highly ionized atoms (fig. 2). Some lines such as HeII λ4686, OVI λ3411 and NIII λ5270 have a radial velocity modulation with a period which is, within the errors, equal to the photometric period (fig. 3). In these lines a periodic variation in the line profile with orbital phase is seen, a blueshifted structure appears near to the phase of maximun redshift (see the arcs in fig. 4). Some strong nebular and coronal lines formed in the nova ejecta do not show any periodic shift phased with the orbital period.

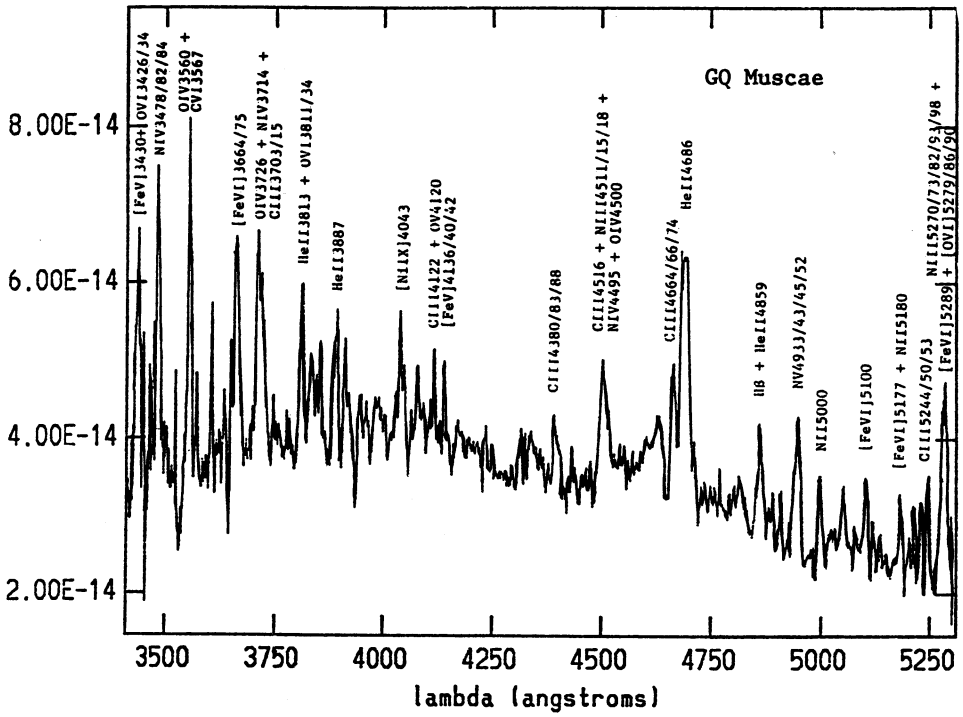

Fig. 2. Optical spectrum of GQ Muscae on May, 1989.

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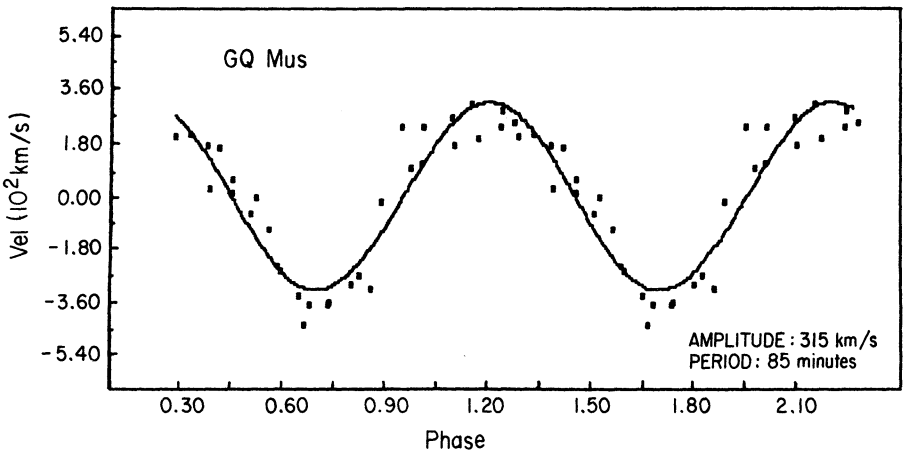

Fig. 3. Radial velocity curve for the OVI λ3811 emission line.

ımmary of spectroscopic observations:

nplitude of continuum shape modulation*: $0.30^m \pm 0.15^m$
:W) HeII λ4686: 25Å.
:W) OVI λ3811 + HeII λ3813: 8Å.
(HeII λ4686): 400 km/s (peak).
(HeII λ4686): 180 km/s (centroid).
(OVI λ3811 + HeII λ3813): 310 km/s (centroid).
ax. reddening of the continuum: $\Phi = 0.0 \pm 0.1$.
ax. V (HeII λ4686): $\Phi = 0.35$.
ax. V (OVI λ3811 + HeII 3813): $\Phi = 0.20$.
ax. EW (HeII λ4686): $\Phi = 0.90$.

n(3500Å)-m(5100Å)

II. DISCUSSION

Using the value for the period and the relations of Patterson (1984) we roughly stimate: $\dot{M} \sim 10^{-11}\ M_\odot \cdot year^{-1}$ and $M_2 \sim 0.1\ M_\odot$ for the system at quiescence. The possibility of strong outburst sets the lower limit to the white dwarf mass down to $0.6\ M_\odot$ (Livio and Shara)87).

It is interesting that the large pulse fraction in the visible spectral range $\Delta M_V=3.3$) limits the size and temperature of a blackbody emitting region to $R^2T=6\times10^{24}$ K.cm^2. ıe to this condition, the modulation cannot arise from a hot white dwarf which is radiating :low the Eddington limit and it should be produced in larger regions of the binary system Lke the heated surface of the red dwarf or the accretion stream. This fact allows us to :cognize the zero phase with the photometric minimun and calculate the observed phases seen ı fig. 4.

The asymmetry, the amplitude of the photometric modulation (Diaz and Steiner)89), the modulation in the shape of the continuum and the profile variation of emission lnes (Diaz and Steiner 1990) strongly suggest that the system may belong to the class of 1 Her stars. Other characteristics of the system agree with this identification: the value of ıe orbital period, the relatively high absolute magnitude at quiescence, the low accretion ate, the intense soft X-ray luminosity and the presence of an unusually strong HeII4686 ıission line.

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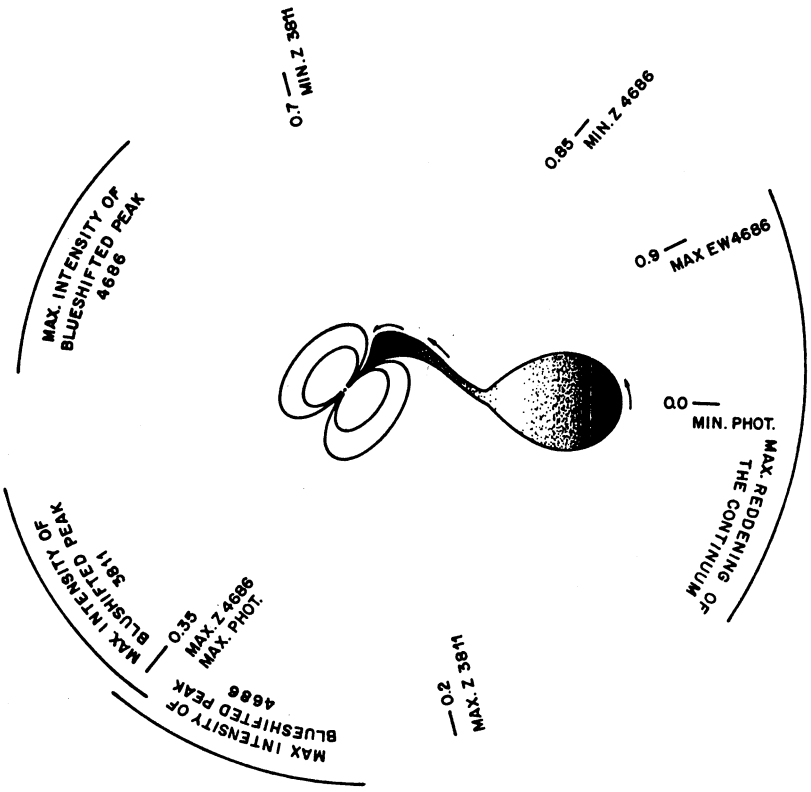

Fig. 4. A possible scenario for the emission line and continuum sources in GQ Muscae. The phases were calculated using the spectroscopic ephemeris.

IV. CONCLUSION

We have found a short orbital photometric modulation in GQ Mus and the system is proposed as a new AM Her system. GQ Mus is the nova with the shortest orbital period known, is the second object in this class with orbital period below the period gap and is the second nova with observed characteristics of polars.

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