1. Publication Nº	2. Version	3. Date	5. Distribution
INPE-4756-PRE/1428		Dec. 1988	☐ Internal ☒ External ☐ Restricted

4. Origin	Program
DAS	EXTRA

6. Key words - selected by the author(s)

PHOTOMETRY; STARS: NOVAE

7. U.D.C.: 524.337

8. Title INPE-4756-PRE/1428

THE PHOTOMETRIC PERIOD OF NOVA MUSCAE 1983

10. Nº of pages: 13

11. Last page: 12

12. Revised by

Francisco Jablonski

9. Authorship

M.P. Dias
J.E. Steiner

Responsible author

13. Authorized by

p/ Marco Antonio Raupp
Director General

14. Abstract/Notes

We report the discovery of a photometric period of 85.5 minutes in CQ Mus (Nova Muscae 1983). Such a value for the orbital period is the shortest known for classical novae and the second falling below the period gap. Based on the photometric and spectroscopic behaviour, we suggest that star may belong to the class of AM Her objects.

15. Remarks

Submitted to Astrophysical Journal Letters

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO DE PESQUISAS ESPACIAIS

PROPOSTA PARA PUBLICAÇÃO

- ☐ DISSERTAÇÃO
- ☐ TESE
- ☐ RELATÓRIO
- ☒ OUTROS

IDENTIFICAÇÃO

TÍTULO: The photometric period of Nova Muscae 1983

AUTOR(ES): Diaz, M.P.
Steiner, J.E.

ORIENTADOR:

CO-ORIENTADOR:

DISS. OU TESE

LIMITE: __/__/__ | DEFESA: __/__/__ | CURSO: | ORGÃO: DAS

DIVULGAÇÃO: ☒ EXTERNA ☐ INTERNA ☐ RESTRITA

EVENTO/MEIO: ☐ CONGRESSO ☒ REVISTA ☐ OUTROS

REV. TÉCNICA

NOME DO REVISOR: F. Jablonski

RECEBIDO: __/__/__ | DEVOLVIDO: __/__/__ | ASSINATURA: F. Jablonski

APROVAÇÃO

NOME DO RESPONSÁVEL: Hugo Capelato

APROVADO: ☐ SIM ☐ NÃO | DATA: __/__/__ | ASSINATURA:

REV. LINGUAGEM

Nº | PRIOR. | RECEBIDO: __/__/__ | NOME DO REVISOR:

PÁG. | DEVOLVIDO: __/__/__ | ASSINATURA:

DATILOGRAFIA

OS AUTORES DEVEM MENCIONAR NO VERSO INSTRUÇÕES ESPECÍFICAS, ANEXANDO NORMAS, SE HOUVER

RECEBIDO | DEVOLVIDO: __/__/__ | NOME DA DATILÓGRAFA:

Nº DA PUBLICAÇÃO: 4756PRE/1428 PÁG.:

CÓPIAS: Nº DISCO: LOCAL:

DIRETOR

AUTORIZO A PUBLICAÇÃO

☐ SIM
☐ NÃO __/__/88

OBSERVAÇÕES E NOTAS

Submitted to Astrophysical Journal Letters

APÓS A PUBLICAÇÃO, ESTA FICHA SERÁ ARQUIVADA JUNTAMENTE COM A VERSÃO ORIGINAL

INPE 106

THE PHOTOMETRIC PERIOD OF NOVA MUSCAE 1983[1]

M. P. Diaz and J. E. Steiner[2]

Departamento de Astrofísica
Instituto de Pesquisas Espaciais - INPE/MCT

Abstract

We report the discovery of a photometric period of 85.5 minutes in GQ Mus (Nova Muscae 1983). Such a value for the orbital period is the shortest known for classical novae and the second falling below the period gap. Based on the photometric and spectroscopic behaviour, we suggest that this star may belong to the class of AM Her objects.

Subject headings: photometry - stars: novae

[1] The observations reported in this paper were made at Laboratório Nacional de Astrofísica - CNPq/LNA.

[2] On leave from Instituto Astronômico e Geofísico da Universidade de São Paulo.

I. Introduction

GQ Muscae is a classical nova that erupted in 1983 January (Liller 1983) with large amplitude ($\Delta m_V \geq 14$) and fast early evolution ($t_2 \sim 18$d) followed by a long period with roughly constant brightness at $m_V \sim 11$. A distance of 4.8±1 kpc was obtained and the prenova was identified in the SRC-*J* sky survey as an object with $m_V \geq 21$ (Krautter *et al.* 1984). Observations at multiple wavelength ranges were made during two years after the outburst (Ögelmann *et al.* 1985; Krautter *et al.* 1984; Whitelock *et al.* 1984; Dinerstein 1986) and an analysis of abundances in the nova ejecta by Pacheco and Codina (1985) shows an enhancement of nitrogen and oxigen in the expanding envelope.

Polarization measurements in the UBVRI bands by Cropper (1986) indicate a linearly polarized fraction of about 3% increasing to the infrared. At that time no circular polarization was detected. More recently Duerbeck (1987) took a spectrum when the object was at $m_V = 16.55$ in the nebular phase; the strongest feature seen in the range from 3900Å to 7100Å except for Hα, was HeII λ4686Å. This fact and the lack of a time resolved photometric measurement at quiescent state motivated the inclusion of GQ Mus

in our program aiming the identification of magnetized systems.

II. Observations and Results

The observations were made in 1988, March 21 and May 9 and 10, the latter in poor atmospheric conditions, using the 1.6 meter telescope of the Laboratório Nacional de Astrofísica at Brasópolis MG, Brazil. A single channel offset-guided photometer with a thermoelectrically cooled S11 response phototube was used in the three nights. Pulse counting integrations were taken without filters using a 9 arcsec diaphragm to optimize photon statistics and to avoid nearby field stars.

The light curves, corrected for sky background and atmospheric extinction, show a remarkable modulation with a period of 85.5±0.4 min. and an amplitude of 63% (Fig. 1,2). Mean times for the maximum and minimum light are:

$$T_{min} = \text{HDJ } 2{,}447{,}241.5635 \pm 0.0010 \text{ and}$$

$$T_{max} = \text{HDJ } 2{,}447{,}241.5806 \pm 0.0015.$$

The asymmetric oscillation was subtracted from the March 21 data, which have a time resolution of 25 seconds and a FFT algorithm was applied to the residuals to search for coherent pulsations with

periods in the range 50-1800 seconds. No highly significant peaks were found in the power spectrum, the most conspicuous period being 950 s, with a amplitude of ~4%.

On March 21 the UBV magnitudes of GQ Mus were: $\langle V \rangle$ = 17.5, $(U-B)_{max}$ = -0.75 and $(B-V)_{max}$ = 0.15 (the uncertainties in both colors are less than 0.1^m). Using the interstellar reddening found by Krautter *et al.* (1984) we estimate the intrinsic colors at maximum: $(B-V)_o$ = -0.3 and $(U-B)_o$ = -1.1.

III. Discussion

The value obtained for the photometric period as well as the large amplitude, strongly suggest that it is an orbital one. Intermediate polars present neither such amplitudes nor asymmetric periodic light curves. Nevertheless this value for the orbital period is not uncommon among cataclysmic variables (Morris *et al.* 1987). The light curve characteristics concerning amplitude, asymmetry and flickering resemble those of AM Her systems. Such a hypothesis is strenghtened if we remember that 11 among the 15 confirmed polars have periods in the range of 81-127 minutes and that the HeII(λ4686Å) emission line in

GQ Mus is unusually strong (Krautter and Williams 1988) like it is often seen in polars.

Recently the detection of circular polarization from V1500 Cyg (Nova Cygni 1975) was reported and the object was confirmed to be an AM Her type system (Stockman *et al.* 1988). DQ Her, GK Per and perhaps V533 Her are also magnetized systems (Intermediate Polars cf. Warner 1983), which suggests that the association of magnetized white dwarfs with the nova phenomena is not unusual. It is interesting that both GQ Mus and V1500 Cyg are fast novae (t_2 equal to 18 and 2 days) with very large amplitude ($\Delta m \geq 14$ and ~19, respectively).

The failure in detecting circular polarization in 1985 (Cropper 1986) does not disagree with a possible classification of the system as a polar. Those observations had not enough time resolution, and a significant dilution of the polarized fraction could be produced by the shell and by the emission from the heated surface of the red dwarf (Stockman *et al.* 1988; Patterson 1979). To characterize the system as an AM Her star, circular and linear polarizations has to show up. However, if GQ Mus is not an AM Her binary, then it belongs to an unusual class of objects, unlike any other classical nova.

The large amplitude observed could be partially explained if the outburst occured in a cataclysmic variable with low accretion rate and, therefore, intrinsically fainter (Patterson 1984). In fact, the prenova magnitude mentioned above sets a lower limit to the absolute magnitude at quiescent state of $M_V \geq 6.2$, which is at least two magnitudes fainter than the mean value for novae at minimum (Warner 1987). The values of the outburst amplitude and decay time also agree with the theoretical thermonuclear runaway calculations which predict that low accretion rates, such as expected for polars (Patterson 1984), over massive white dwarfs produce faster and stronger outbursts (Kutter and Sparks 1980; Prialnik *et al.* 1982; Livio *et al.* 1988*a*,*b*).

IV. Conclusion

We found a short photometric period for Nova Mus 1983 and the data suggest this is the binary period. A value of 85.5 minutes for the orbital period is the shortest one found for novae and is the second, among 12 well-defined periods for this class, found below the period gap. The other object is CP Pup (Duerbeck *et al.* 1987), another fast nova with very large amplitude (t_2=5 days and Δm=14.8).

Based on the observed characteristics, the system is proposed as a new AM Her type candidate; the facts that lead to this conclusion are: (1) the strong HeIIλ4686Å line in emission; (2) period in the range 81 - 127 minutes; (3) large photometric amplitude; (4) asymmetric modulation; (5) moderate flickering.

Acknowledgements

We acknowledge CNPq, FINEP, and FAPESP for financial support and F. Jablonski for interesting discussions and valuable help in the data reduction.

References

Cropper, M. 1986, *M.N.R.A.S.*, **222**, 225.

Dinerstein, H. L. 1986, *Astr. J.*, **92**, 1381.

Duerbeck, H. W. and Seitter, W. C. 1987, *Ap. Space Sci.*, **131**, 467.

Duerbeck, H. W., Seitter, W. C. and Duemmler, R. 1987, *M.N.R.A.S.*, **229**, 653.

Krautter, J., Beuermann, K., Leitherer, C., Oliva, E., Moorwood, A. F. M., Deul, E., Wargau, W., Klare, G., Kohoutek, L., van Paradijs, J. and Wolf, B. 1984, *Astr. Ap.*, **137**, 307.

Krautter, J. and Williams, R. E. 1988, preprint.

Kutter, G. S. and Sparks, W. M. 1980, *Ap. J.*, **239**, 988.

Liller, W. 1983a, *IAU Circ.*, No. 3764.

Liller, W. 1983b, *IAU Circ.*, No. 3768.

Livio, M., Shankar, A. and Truran, J. W. 1988*a*, *Ap. J.*, **325**, 282.

Livio, M., Shankar, A. and Truran, J. W. 1988*b*, *Ap. J.*, **330**, 264.

Morris, S. L., Schmidt, G. D., Liebert, J., Stocke, J., Gioia, I. M. and Maccacaro, T. 1987, *Ap. J.*, **314**, 641.

Ögelman, H., Beuermann, K. and Krautter, J. 1985, *Proc. ESA Workshop: Recent Results on Cataclysmic Variables*, ESA SP-236, 177.

Pacheco, J. A. F. and Codina, S. J. 1985, *M.N.R.A.S.*, **214**, 481.

Prialnik, D., Livio, M., Shaviv, G. and Kovetz, A. 1982, *Ap. J.*, **257**, 312.

Stockman, H. S., Schmidt, G. D. and Lamb, D. Q. 1988, *Ap. J.*, **332**, 282.

Warner, B. 1983, *in IAU Colloquium 72, Cataclysmic Variables and Related Objects*, ed. M. Livio and G. Shaviv (Dordrecht:Reidel), 155.

Warner, B. 1987, *M.N.R.A.S.*, **227**, 23.

Whitelock, P. A., Carter, B. S., Feast, M. W., Glass, I. S., Laney, D., Menzies, J. W., Walsh, J. and Williams, P.M. 1984, *M.N.R.A.S.*, **211**, 421.

Author's Address

M. P. Diaz and J. E. Steiner
INPE - Instituto de Pesquisas Espaciais
Ministerio da Ciência e Tecnologia / MCT
Caixa Postal 515
12201 - São José dos Campos - SP
Brazil

Figure Captions

Figure 1. Fast photometry of GQ Mus on 1988 March, 21 with a integration time of 25 seconds. The count rate was corrected for the background and atmospheric extinction effects.

Figure 2. Phase folded curve for March data. The error bars are $2\sigma/\sqrt{n}$ where n is the number of measurements in a 1/30 phase bin.

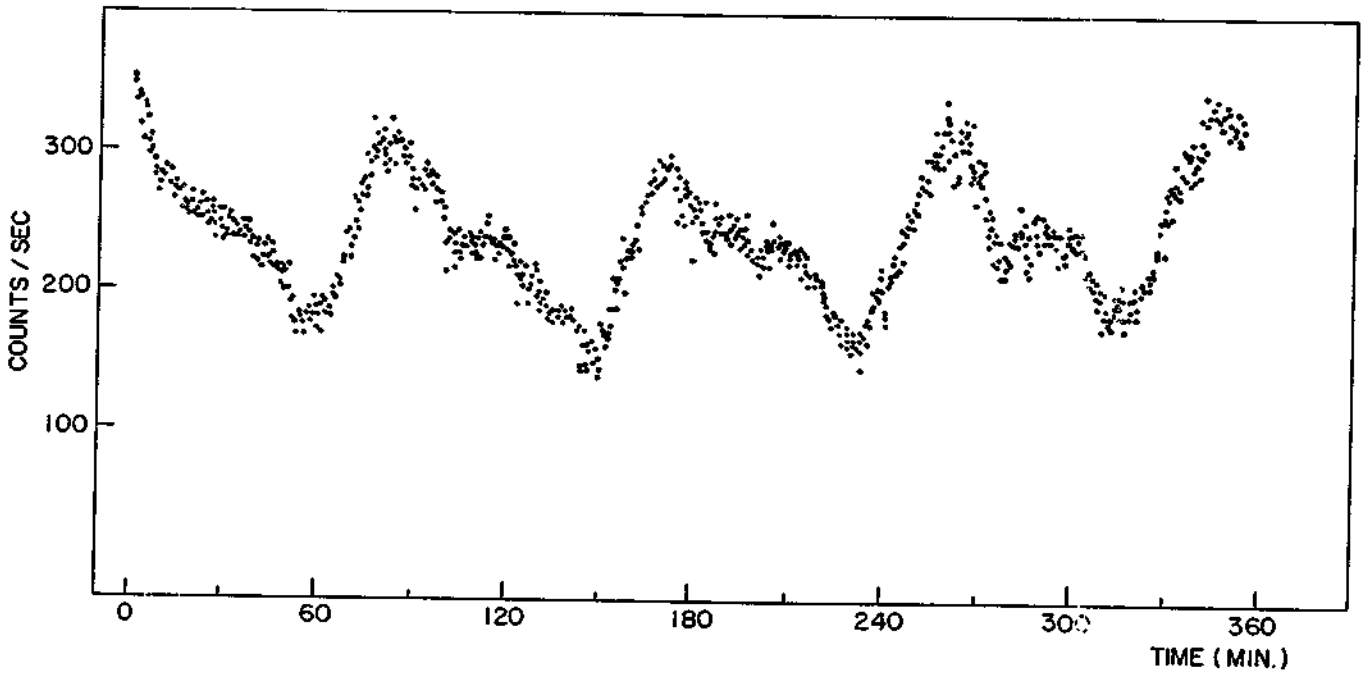

Figure 1

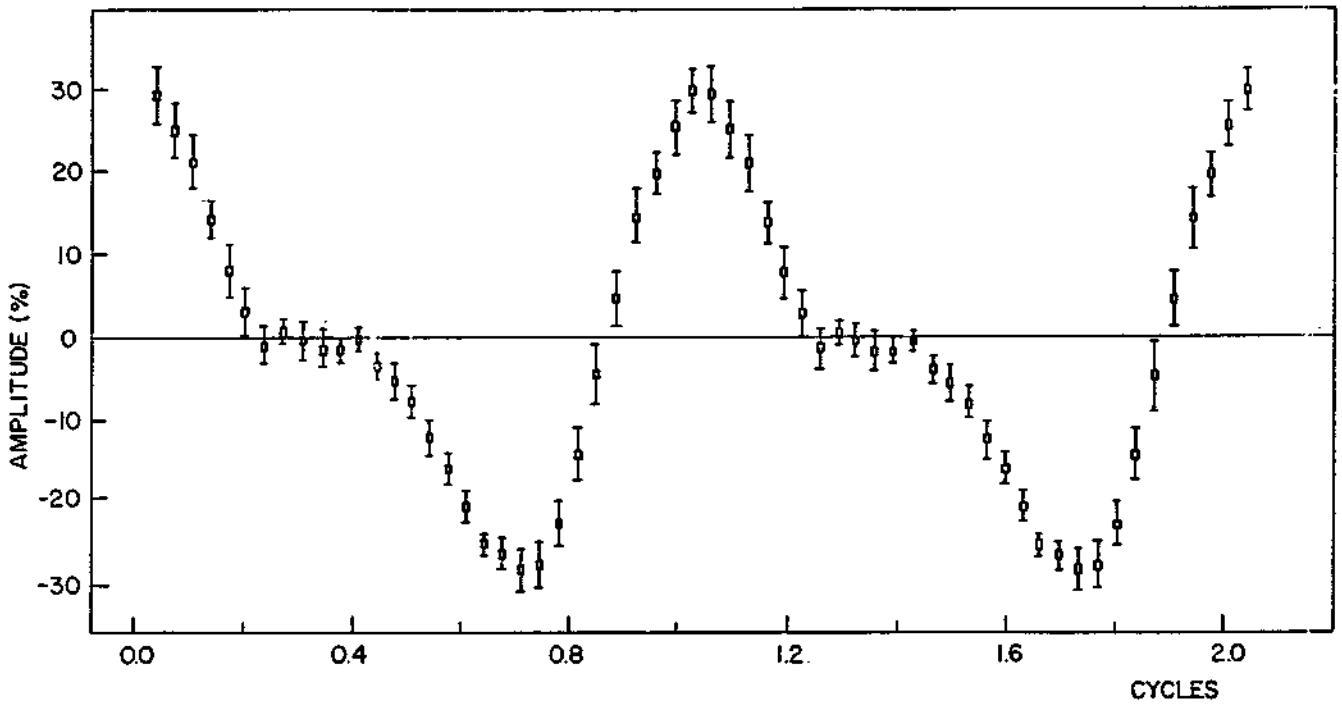

Figure 2