Name of Article

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[1] *First work place*

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Abstract

.... The goal of this paper is to objectively discuss the problems connected with the controversial nature of SS Cyg by using all the different interpretations of its multifrequency data in order to demonstrate undoubtedly its intermediate polar nature.

Keywords: Cataclysmic variables - Dwarf novae - Intermediate polars - Optical - Spectroscopy - Photometry - sub-mm - IR - Radio - UV - X-rays - individual: SS Cyg ≡ BD+42° 4189a.

1 Introduction

Historically, the classification of CVs was based on the optical outburst properties, by which one may distinguish four groups of CVs: (i) classical novae; (ii) recurrent novae; (iii) dwarf novae; (iv) nova-like objects (e.g., Giovannelli & Martinez-Pais, 1991 and references therein; Ritter, 1992; Giovannelli, 2008).

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1.1 Optical outbursts

The optical outbursts of SS Cyg are not always the same. Howarth (1978) discussed about the three possible kind of outbursts, long, short and anomalous with average periodicity of 50.21 days. Giovannelli et al. (1985), Lombardi, Giovannelli & Gaudenzi (1987), Gaudenzi et al. (1990; 2011) and Giovannelli & Martinez-Pais (1991) discussed about such outbursts that originate different optical, UV and X-ray behaviour of the system.

On the base of its optical light curves, SS Cyg was classified as a dwarf nova (Bath & van Paradijs, 1983), with the white dwarf mass equal to Chandrasekhar's limit (Patterson, 1981). On the contrary, we will discuss about its intermediate polar nature analyzing its multifrequency behaviour and the different interpretations of data coming from the literature. Moreover, on the basis of more realistic values of its orbital parameters, we will try to reconcile all experimental multifrequency data with the magnetic nature of SS Cyg.

$$E = mc^2 \tag{1}$$

Text, text.

$$\begin{aligned} x &= 1+3 \quad (2)\\ y &= 1+4 \quad (3)\\ z &= 1+1 \quad (4) \end{aligned}$$

text, text.

1.2 On the Controversial Nature of SS Cyg

With the historical classification of CVs based on the optical outburst properties, SS Cyg (α_{2000} = $21^h42^m48^s.2$; δ_{2000} = +43° 35' 09".88 with the galactic coordinates l_{2000} = 090.5592, b_{2000} = -07.1106), whose distance is 166.2 ± 12.7 pc (Harrison et al., 1999), is a dwarf nova and of those the brightest one. Its optical magnitude ranges from ∼ 12 to ∼ 8.5 during quiescent and outburst phases, respectively.

Because of these characteristics, it is the most observed CV, not only in the optical, where measurements are available from the end of the 19th century to the present, but also in other wavelength regions.

Figure 1: Name of figure 1

Text, text.

Table 1: Name of table 1

column 1	column 2
column 1	column 2

Table 2: Comparison of the characteristic parameters of EI UMa – a well established IP (Reimer et al., 2008) – and SS Cyg (Giovannelli et al., 1983; Lombardi et al., 1987; Gaudenzi et al., 1990, 2002; Giovannelli & Martinez-Pais, 1991; Schreiber & Gänsicke, 2002).

EI UMa	SS Cyg
$\mathrm{P_{orb}} = 6.434$ h	$\mathrm{P_{orb}} = 6.603$ h
$\mathrm{P_{opt}} = 745$ s ($\sim \mathrm{P_{XMM}}$)	$\mathrm{P_{opt}} = 745$ s ($\sim \mathrm{P_{XMM\ UV}}$)
$0.81\ \mathrm{M_\odot} < \mathrm{M_{WD}} < 1.2\ \mathrm{M_\odot}$	$\mathrm{M_{WD}} = 0.97\ \mathrm{M_\odot}$
$\mathrm{R_{WD}} = 7 \times 10^8$ cm	$\mathrm{R_{WD}} = 5 \times 10^8$ cm
$\mathrm{M_R} = 0.81\ \mathrm{M_\odot}$	$\mathrm{M_R} = 0.56\ \mathrm{M_\odot}$
$\mathrm{R_R} = 0.76\ \mathrm{R_\odot}$	$\mathrm{R_R} = 0.68\ \mathrm{R_\odot}$
$\mathrm{L_X} \sim 10 \times 10^{32}$ erg cm^{-2} s^{-1}	$\mathrm{L_X} \sim (6.6 - 9.8) \times 10^{32}$ erg cm^{-2} s^{-1}
$\dot{\mathrm{M}} = 3.6 \times 10^{17}$ g s^{-1}	$\dot{\mathrm{M}} \simeq (1 - 4) \times 10^{17}$ g s^{-1}
$\mathrm{M}_V = 5.4$	$\mathrm{M}_V = 5.9$
f = Rd/a = 0.2 – 0.3	f = Rd/a = 0.2
UBV Orbital modulations of continuum	UBV & UV Orbital modulations of continuum & emission lines EWs

Text, text.

2 The Intermediate Polar Nature of SS Cyg

In our opinion there are several incontestable arguments in favour of the IP nature of SS Cyg, namely: ....

Text, text, text, text, text, text, text, text, text, text.

3 Discussion

Text, text, text, text, text, text, text, text, text, text.

4 Conclusions

Text, text, text, text, text, text, text, text, text, text.

5 Discussion and Conclusions

Text, text, text, text, text, text, text, text, text, text.

Figure 2: Big figure

Acknowledgement

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DISCUSSION

WHITE BUTTERFLY's Comment: I have noted how pleasant has been my flight over the multicolor field of Cataclysmic Variables. Thank you.

LINDA SCHMIDTOBREICK: You have discussed several arguments in favour of SS Cyg being magnetic but all reflex indirect ones. What about direct measurements of optical polarization? Was done never an attempt?

FRANCO GIOVANNELLI: as far as I know, direct positive detections of optical polarization do not exist. Gnedin et al. (1995, Astr. Lett. 21, 118) performed UBVRI polarization measurements of SS Cyg. No appreciable intrinsic linear polarization was detected. However, during a radio flare simultaneous with an optical outburst, upper limits of linear polarization (3.2 ± 2.7)% and circular polarization (−3.2 ± 2.7)% have been published (Körding et al.: 2008, Science, 320, 1318).

SIMONE SCARINGI: i) hard X-ray detection of SS Cyg is NOT a proof of magnetic nature; ii) Radio emission associated with jet is NOT a proof of magnetic nature; iii) failures of spectral fits to accretion disk is NOT a proof of magnetic nature. Is there a better magnetic model fit?

FRANCO GIOVANNELLI: As I clearly discussed, the proofs I gave for supporting the magnetic nature of SS Cyg are circumstantial. However, if we consider that the circumstantial proofs are numerous, it is very reasonable to support the magnetic nature of SS Cyg. Specifically: i) only accretion onto magnetic poles (B $\approx$ 1 MG) justify the hard X-ray emission in quiescence (Ricketts et al.: 1979, MNRAS 186, 233; Cordova et al.: 1980, ApJ 233, 163; Heise, et al.: 1978, ApJL 63, L1). A detailed analysis of simultaneous X-ray, UV, and optical data from SS Cyg needs the presence of a magnetic field of B$\leq$ 1.9 MG (Fabbiano et al.: 1981, ApJ, 243, 911). This conclusion is even more valid on the light of the INTEGRAL detection in a harder X-ray region. Moreover, the CVs detected by the INTEGRAL observatory are all IPs with the exception of SS Cyg (classified as dwarf Nova). Thus, if SS Cyg should be non magnetic, why INTEGRAL does not detect other dwarf novae?

iii) Accretion disk models do not fit the multifrequency data of SS Cyg, that are very similar to those of AM Her (e.g. Fabbiano et al., 1981). Models with the presence of a magnetic field for SS Cyg do not exist in the literature. But this is probably the obvious consequence of considering SS Cyg, by definition, non magnetic. Some results could be available in the near future using the results of 3D MHD numerical simulations (Bisikalo & Zhilkin, these proceedings).

IRINA VOLOSHINA: You state that one of the arguments supporting the idea that SS Cyg is an IP is the detection of the 12-m period. However, I have obtained many photometric light curves of this system and none of them demonstrates the variability with the period that you report. Besides, I have not managed to find any confirmation of this period in papers published by other authors who performed photometric measurements of SS Cyg.

FRANCO GIOVANNELLI: It is true that the 12-m periodicity has not been reported by other authors. However, such periodicity has been found in the R band by Bartolini et al. (1985), and by Tramontana (2007), and in 10 ks XMM–OM UV observations by Braga (2009). On the contrary, this periodicity is not present in 10 ks XMM X-ray data analyzed by my group. However, the behaviour of SS Cyg fulfill most of the characteristics of an IP, such as orbital modulations of continuum and fluxes of emission lines, like discussed.

DMITRY BISIKALO: What are the recent estimates of the magnetic field values in SS Cyg?

FRANCO GIOVANNELLI: The variations in the mid-IR (11.7 μm) emission from SS Cyg could be due to coherent emission during flares. This would probably requires very powerful magnetic field of $\sim 10^7$ G (Dubus et al.: 2004, MNRAS, 349, 869). Our evaluation gives B = 1.6 ± 0.7 MG in agreement with the value (B$\leq$ 1.9 MG) deduced by Fabbiano et al. (1981).