AN OBSERVATION OF THE QUIESCENT CLASSICAL NOVA CP PUP

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ABSTRACT

We present preliminary results of a very recent observation of the quiescent nova CP Pup at quiescence. The X-ray spectrum is best fit with a cooling flow model and shows lines of high ionization stages. The light curve is modulated with the orbital period.

Key words: binaries: close–novae, cataclysmic variables – X-rays: stars.

1. INTRODUCTION

Cataclysmic Variables (CV) in general, and classical novae in particular, are relatively faint but interesting X-ray sources at quiescence, because the X-rays originate from the accretion region. Important details still have to be investigated to understand how accretion occurs in the secular evolution of these systems. *XMM Newton*, thanks to its large effective area, is the ideal instrument to study accreting systems. Non magnetic cataclysmic variables, like all dwarf novae and probably most classical novae, have quiescent X-ray luminosities in the range $10^{30} - 10^{32}$ erg s^{-1}. Only very few quiescent classical novae reach 10^{33} erg s^{-1} (see Orio et al. 2001a). Mukai et al. (2003) showed that *Chandra* grating spectra of non-magnetic CV, including V603 Aql, can be modelled as cooling flows. The parameters that fit the spectrum are the mass accretion rate $\dot{m}$, the width of the emission lines (assuming a constant velocity broadening for all lines) and the maximum plasma temperature. If a line spectrum is detected, we can derive a reliable range for the most crucial parameter in CV secular evolution, the mass accretion rate $\dot{m}$. Only one classical nova and few dwarf novae are accessible for high S/N spectra obtained with X-ray gratings (see also Orio et al. 2001). A handful of other objects are in the luminosity range in which a few lines can be detected with the RGS, and the continuum level and the iron line complexes close to 7 keV are detected with EPIC-pn (e.g. Ramsay et al. 2001). Unlike other CV, most classical novae are more than 1 kpc away from us, so they are always faint X-ray sources at quiescence, and seldom observed. CP Pup is the third brightest classical nova in X-rays at quiescence.

CP Pup had an outburst in 1942, and it was very fast and luminous. It is thought to be a non-magnetic, disk accretor system with a inclination of $30{\pm}5^o$ (Szkody & Feinswog 1988). CP Pup is quite closer than mopst classical novae, at ≈700 pc. The only quiescent nova which is bright enough for a high S/N X-ray grating spectrum is V603 Aql (Mukai & Orio 2005). CP Pup was observed with ROSAT (Balman et al. 1995). In that observation, its X-ray spectrum appeared harder than other accreting novae, with a possible modulation of the flux of the orbital period, which for CP Pup is unusually short, only 88.4 minutes.

2. THE XMM-NEWTON OBSERVATION: THE SPECTRUM

CP Pup was observed for 14 consecutive hours with XMM-Newton in June of 2005. The results illustrate how even observations of low luminosity cataclysmic done variables with XMM-Newton yield very useful results of good quality (the X-ray luminosity of CP Pup is only about 10^{33} erg s^{-1}). Very little is known about accretion in novae, so these data are very new and very valuable. The EPIC-pn spectrum (Fig. 1) is best fit with cooling flow model, typical for disk accreting CV (see Mukai et al. 2003), as opposed to a photoionization model, which is appropriate for several magnetic CV. The iron K-α complex is observed in the pn spectrum (see Fig. 2). The He-like line is the most prominent, and the fluorescence line is higher than the H-like complex. This complex ap-

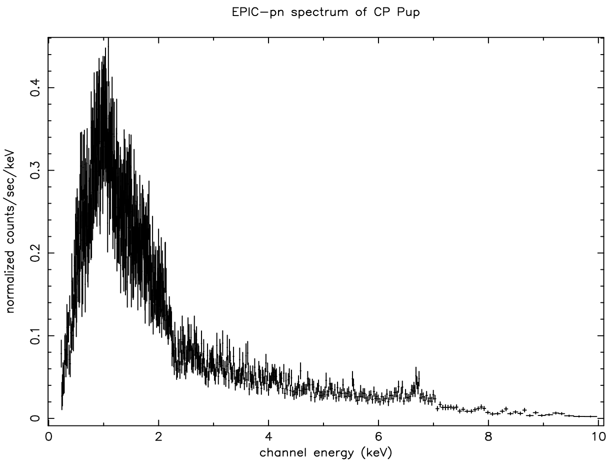

Figure 1. The EPIC-pn spectrum, fit with a cooling flow model with N(H)=1.5 $\times 10^{21}$ cm^{-2}, and a maximum temperature of 80 keV.

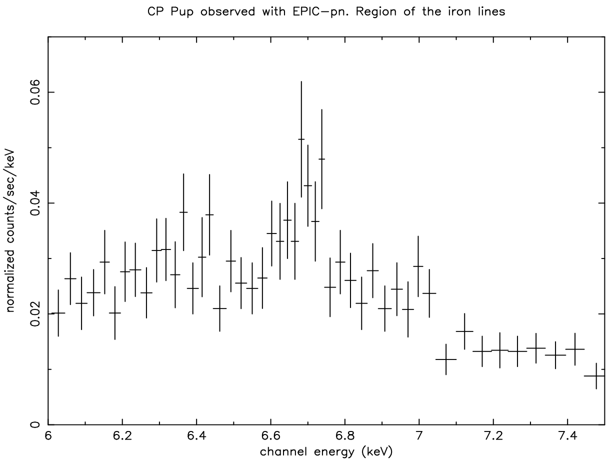

Figure 2. Close up of the iron lines region.

pears to have a strong satellite component, an indication of temperature below 3 million K.

There is evidence of emission lines in the low S/N RGS grating spectra: H-like emission lines of Ne, Si and O are prominent enough to be detected, and they are all lines that were observed in the grating spectrum of V603 Aql (see Fig.3). Overall we notice a striking similarity with V603 Aql, the brightest old nova at quiescence, (see Mukai and Orio 2005). Especially prominent neon lines are detected like in V603 Aql, suggesting high neon abundance also in CP Pup.

3. THE X-RAY LIGHT CURVE

The X-ray light curve is a puzzle: There is a clear modulation (≈40%) of X-ray flux with the orbital period (see Fig. 4). This would be much more easily understood if the system were magnetic, yet there is additional evidence at other wavelengths that it is not. However, if

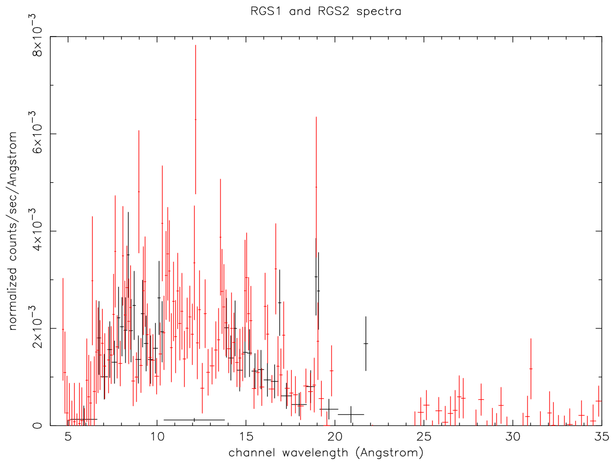

Figure 3. RGS1 (in black) and RGS2 (in red) spectra.

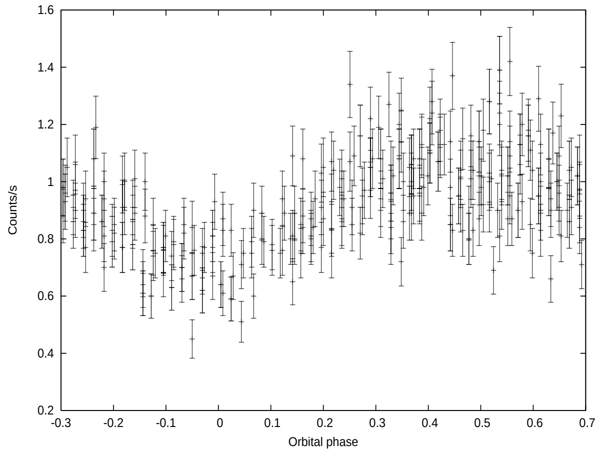

Figure 4. The EPIC-pn light curve of CP Pup, binned every 10 seconds and folded with the orbital period.

CP Pup is indeed a low inclination system, this modulation is not well understood in a standard boundary layer model. New optical observations with large telescopes may be very useful to clarify the issues concerning the inclination, which needs to be confirmed in order to try and build a physical model.

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