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LETTER

Letter to the Editor

Jets from the galactic supersoft X-ray source RX J0019.8+2156

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Abstract. We present evidence from high resolution optical spectra for the presence of bipolar jets in the bright super soft X-ray source RX J0019.8+2156, the second such discovered case after RX J0513.9-6951. The jets seem to appear and disappear over a time scale of several months. No jet precession is observed. From the velocity separation of the emission lines produced by the jets a lower limit of $\sim 79^\circ$ is posed to the orbital inclination. This gives support to the interpretation in terms of eclipses for the periodic features in the RX J0019.8+2156 lightcurve.

Key words: binaries: close – stars: mass loss – stars: individual: RX J0019.8+2156 – X-rays: stars

1. Introduction

The galactic supersoft X-ray source RX J0019.8+2156 was discovered in the course of the ROSAT All-Sky Survey and its optical counterpart was identified by Beuermann et al. (1995, here after B95). It is the optically brightest (V$\sim 12\overset{\mathrm{m}}{.}5$) of all the galactic and extragalactic supersoft X-ray sources (SSSs). One of the favoured explanations for SSSs is nearly stable burning of hydrogen-rich material accreted by a white dwarf from an orbiting, Roche–lobe filling companion.

RX J0019.8+2156 shows variability in the optical, UV and X-rays, with time scales from hours to several years (B95; Greiner & Wenzel 1995; Gänsike et al. 1996). From photometry and radial velocities B95 derived an orbital period of 15.85 hours. Will & Barwig (1996) have presented time resolved UBVRI photometry of RX J0019.8+2156 and have suggested that it is an eclipsing binary showing primary and secondary minima. Similar BVRI observations have been secured by Matsumoto (1996), and Meyer-Hofmeister et al. (1997) have argued for eclipses of an accretion disk with a high rim.

The optical spectrum of RX J0019.8+2156 shows strong Balmer and He II emission lines on a hot continuum and according to B95 the hydrogen lines have P-Cygni profiles with terminal velocities $\sim$1000 km s^{-1}.

It has been recently found that SSSs may exhibit jets. Spectroscopic observations of the LMC source RX J0513.9-6951 by Crampton et al. (1996) and Southwell et al. (1996) show emission components of Hα, Hβ and He II 4686 Å shifted by $\sim$3800 km s^{-1}, which arise in a collimated bipolar outflow. There are some hints that the SSS CAL 83 may present a collimated jet outflow too. According to Crampton et al. (1987) He II 4686 Å line in CAL 83 exhibits extended emission wings, alternatively on the red and blue sides.

In this note we report on the discovery in RX J0019.8+2156 of emission components on both sides of main emission lines that we argue to originate in a bipolar jet outflow.

2. Observations and results

High-resolution CCD spectra of RX J0019.8+2156 have been secured with the Coudé-spectrograph of the 2 m telescope of the National Astronomical Observatory of Bulgaria at Rozhen (resolution $R \sim 0.35$ Å) and with the Echelle spectrograph ($R \sim 0.30$ Å at Hβ) mounted on the 1.82 m telescope of the Padova & Asiago Astronomical Observatories. A low-resolution spectrum ($R \sim 18$ Å) has been obtained with the Boller & Chivens+CCD spectrograph at the same telescope. The journal of the observations is given in Table 1. The reduction and analysis of the spectra has been performed using the IRAF software package.

The low-resolution spectrum of RX J0019.8+2156 is shown in Fig. 1. The emission lines of Hα, Hβ and $\lambda\lambda$ 5412 4686 Å He II stand out on a hot continuum.

The surprise comes from the high resolution observations of emission lines. The Balmer and He II emission line cores are double peaked (separation $\sim$120 km s^{-1}) with a relatively broad bases (FWZI $\sim$1000 km s^{-1}). The radial velocity of these emission cores trace the orbital motion (cf. Table 1). On both sides of the main emission cores at $|\triangle \mathrm{RV}_\odot| \sim$885 km s^{-1}, two broad lines are present (indentified with S$^-$ and S$^+$ in Fig. 2 and Table 1). We interpret these simmetrically placed emission components as the spectral signature of collimated bipolar

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Table 1. Journal of observations. Radial velocities ($RV_\odot$) and equivalent widths (EW_λ) of the Hα central emission (C) and jets components S^- and S^+ are given.

Date	HJD 2400000+	spectrograph	spectral region	Hα $RV_\odot$ (km s^{-1})			Hα EW_λ (Å)		
				S^-	C	S^+	S^-	C	S^+
Jul 18, 1997	50647.577	coudé	Hα	−900	−67	+747	4.3	14.3	4.5
Jul 31, 1997	50660.617	echelle	4330–6690 Å	−1057	−66	+733	3.0	13.4	4.3
Aug 14, 1997	50675.508	coudé	Hα	−1009	−88	+782	3.5	15.6	5.3
Aug 15, 1997	50676.549	coudé	Hα	−1000	−103	+793	3.0	12.1	3.1
Sep 14, 1997	50706.473	coudé	Hα	−1001	−37	+887	2.8	14.4	2.7
Nov 13, 1997	50766.327	echelle	4415–6690 Å	−1009	−96	+887	4.0	17.3	4.6
Nov 13, 1997	50766.470	echelle	4800–6690 Å	−834	−68	+839	4.2	20.6	4.4
Nov 15, 1997	50768.441	echelle	4160–6690 Å	−869	−54	+807	3.6	17.1	4.4
Nov 21, 1997	50774.374	B&C	3500–7700 Å						

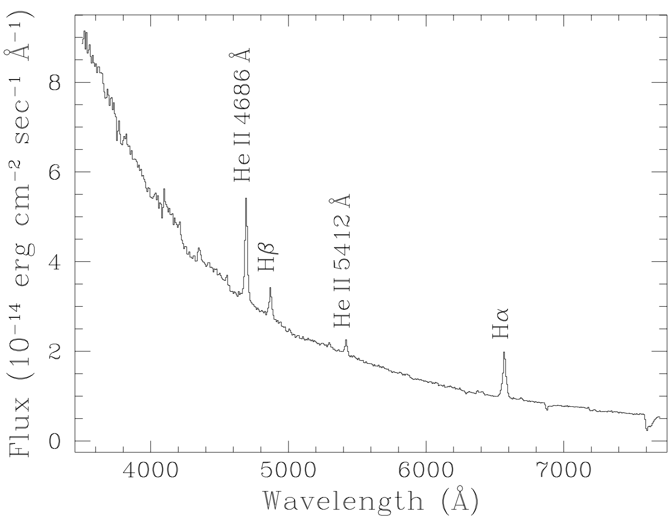

Fig. 1. Low-resolution Asiago B&C spectrum of RX J0019.8+2156 obtained on 21 November 1997.

jets ejected by the hot component in RX J0019.8+2156. It is worth noticing that RX J0513.9-6951 (Crampton et al. 1996; Southwell et al. 1996) and T Pyx (Shahbaz et al. 1997) show very similar spectral features. To the best of our knowledge, this is the first time that spectral detection of jets is reported for RX J0019.8+2156.

3. Discussion

After the LMC source RX J0513.9-6951 (Crampton et al, 1996; Southwell et al. 1996), RX J0019.8+2156 is the second SSS to show the spectral imprinting of bipolar jets. In RX J0513.9-6951 the jet emissions reach ∼5% of the central core, in RX J0019.8+2156 this ratio jumps to ∼30% (cf. Table 1). The presence of jets may be a wide-spread characteristic of the SSSs as a class, CAL 83 showing subtle evidences of jets as well (Crampton et al. 1987). Since apparently the $|\triangle RV_\odot|$ ∼885 km s^{-1} velocity difference of the jets relative to the main central emission does not change with time, it seem adequate to conclude that the jets in RX J0019.8+2156 do not precess and therefore they are emitted perpendicularly to the disk plane.

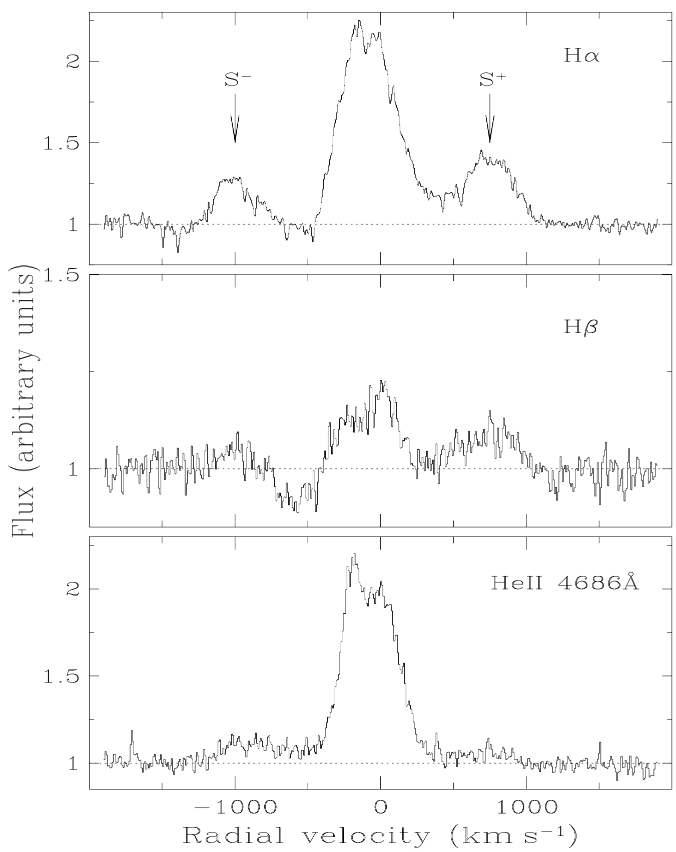

Fig. 2. The Hα, Hβ and He II 4686 Å profiles in the Asiago Echelle+CCD spectrum of RX J0019.8+2156 obtained on 31 July 1997. The spectrum is normalized to the local continuum.

B95 commented about the presence in RX J0019.8+2156 of a stellar wind with a terminal velocity of about 1000 km s^{-1}. Strong P-Cygni components to the Hβ, Hγ and Hδ line profiles are evident in their spectra (Fig. 2 of B95). The spectral signature of a wind is visible on our spectra as well. Hβ (Fig. 2) shows an absorption component centered at −560 km s^{-1}, its wing extending to about −800 km s^{-1} (similarly to the B95 results). A P-Cygni feature can be traced in the Hα profile too, but not in the He II 4686 Å one (cf. Fig. 2). It is worth noticing

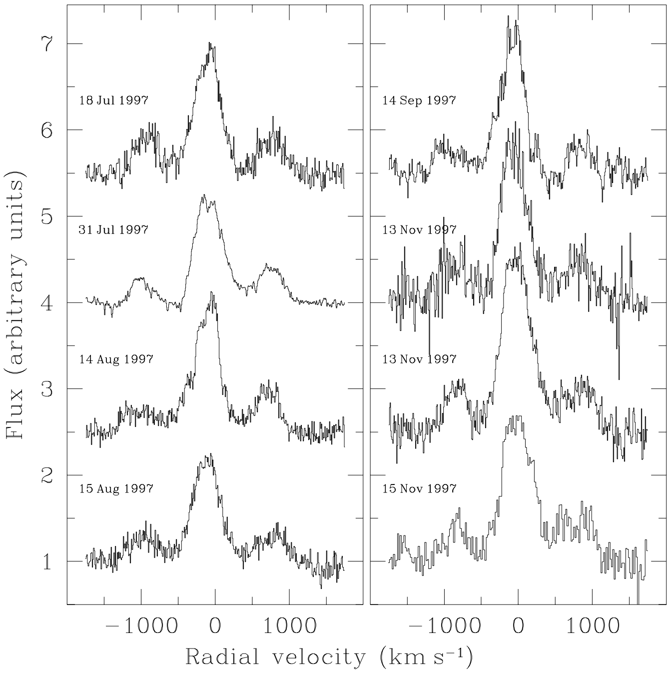

Fig. 3. Hα profile of RX J0019.8+2156 from July to November 1997. The jet emissions are permanently visible.

that Livio (1997) has recently pointed out that powerful jets are produced by systems in which in addition to an accretion disk, there is an energy/wind source associated with the central object. RX J0019.8+2156 thus seems to offer a strong support to this scenario.

Our observations cover a period of about 5 months and the emissions by jets have always been present (cf. Fig. 3). Comparing with the available literature on RX J0019.8+2156, we are lead to conclude that the jets may appear and disappear with time. In support to this possibility come the observations by Crampton et al. (1996) and Southwell et al. (1996) of large variability of the emissions by jets in RX J0513.9-6951, with time scales of several months.

4. Orbital inclination

B95 estimated $i \simeq 20°$ as the orbital inclination of RX J0019.8+2156. Such a value is in contrast with the detection of primary and secondary eclipse-like minima in the folded light-curve of RX J0019.8+2156 reported by Will & Barwig (1996) and Matsumoto (1996). Meyer-Hofmeister et al. (1997) have modeled the orbital light curve of RX J0019.8+2156 with a much higher orbital inclination ($\sim 60°$).

We may estimate a *minimal* orbital inclination by confronting the velocity of the emission components related to the jets with the escape velocity from the central source taken to be a white dwarf (see also Shahbaz et al. 1997). According to Livio (1997) jet velocity in accreting systems is generally of the order of the escape velocity from the central object, and therefore

$$i \sim \arccos\,(V_{jets}/V_{escape}) \qquad (1)$$

The outflows observed in the CVs are in the range 3000–6000 km s^{-1} (cf. Drew 1997). The projected velocity of the jets in RX J0019.8+2156 is ∼885 km s^{-1}, from which it follows

$$i \sim \arccos\,(885/4500)\ \sim\ 79°$$

This high value for the inclination supports the eclipse scenario summarized at the beginning of this section and seems to definitively rule out the low inclination proposed by B95.

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