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V842 Cen: high energy modulations hidden by a false negative

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Abstract. V842 Cen, which was Nova Centauri 1986, has been thought anomalous in showing a 56.8 s optical modulation but not a similar periodicity in X-rays or the FUV, which would be expected if it is an intermediate polar. We find optical evidence that the rotation period of the white dwarf primary is twice that observed (i.e. 113.6 s), so the X-ray emission consists of two signals which are out of phase, masking the high energy modulation, but not the (reprocessed) optical signal.

Key words. Stars: binaries, close – Stars: oscillations – Stars: individual: V842 Cen – Stars: novae, cataclysmic variables

1. Introduction

V842 Cen was a bright moderately fast nova in 1986. High speed photometry fifteen years after maximum showed no coherent modulation (Woudt & Warner 2003) but by 2008 an optical period at 56.825 s with an amplitude of ~ 4 mmag was evident (Woudt et al. 2009). XMM-Newton observations in 2011 showed no such modulation in the 0.5–10 keV range nor at optical wavelengths (the latter only to amplitude < 140 mmag), though the spectral energy distribution is characteristic of accretion onto a white dwarf (Luna et al. 2012). A more comprehensive study, using HST, showed the 56.8 s modulation at 9 mmag in the optical, but none larger than ~ 4 mmag in the FUV/COS region (Sion et al. 2013).

The current interpretation of the optical modulation has been that V842 Cen is an intermediate polar (IP) with primary (white dwarf) spin period 56.8 s. Accretion via a truncated accretion disc is through two accretion curtains that impact onto the primary as shock zones in the form of arcs that are alternately obscured by its rotation (see figure 9.10 of Hellier 2001). X-Rays are generated in these shock arcs; modulated optical contributions come from the rotating luminous accretion curtains and/or from reprocessing of X-Rays.

The puzzling aspect of V842 Cen is the absence of X-Ray and FUV modulation despite the existence of optical modulation. This is not quite unique in IPs – the type specimen, DQ Her, has a strong 71 s optical variation, but has barely detectable X-Rays, caused by its very high orbital inclination which causes blocking of X-Rays by the accretion disc. V842 Cen has a low inclination (Schmidtobreick et al. 2005).

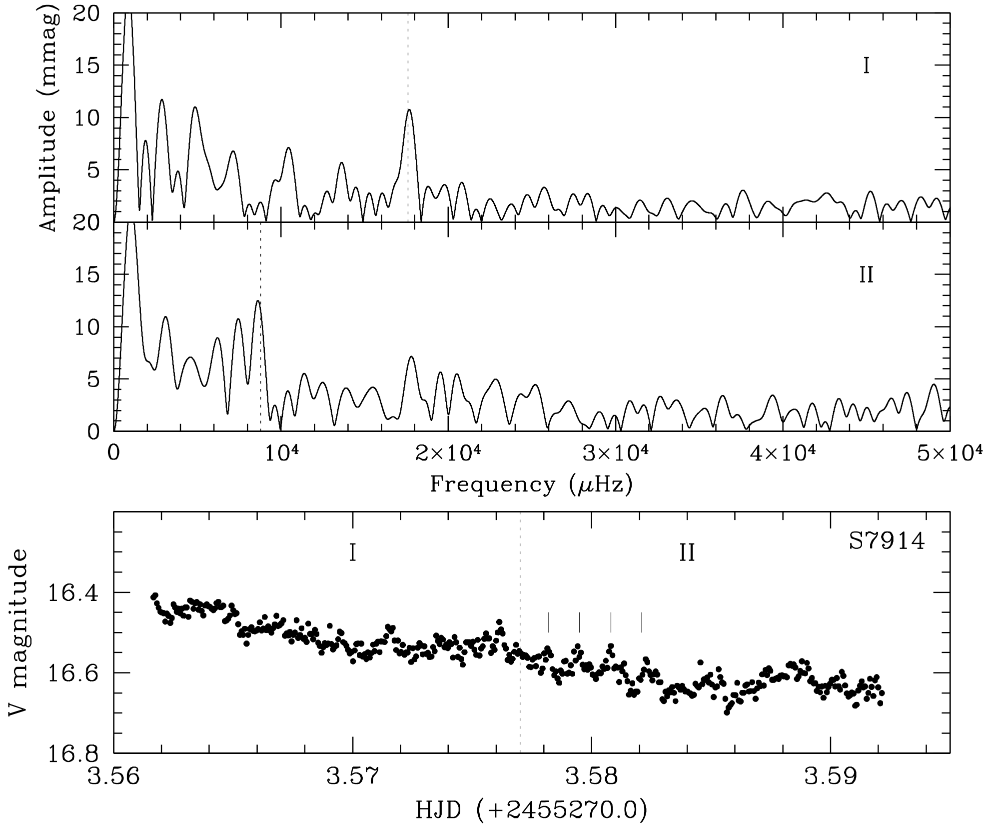

Fig. 1. Light curve and Fourier transforms of its first and second halves, for the observation made on 2010 March 18 (run S7914). The four modulations at 114 s are marked.

2. An explanation in terms of a false negative

It has long be realised that some IPs have possibly been overlooked because of absence of detectable rotational modulation of their X-Rays. At least two different geometries could be responsible: a magnetic field axis that coincides with the spin axis, so that there are no asymmetries during rotation, or accretion arcs so symmetrically situated that the emergence of one around the limb of the primary is counterbalanced by the obscuration of the other arc behind the opposite limb, leaving an unmodulated flux. The latter almost occurs in the IP (and dwarf nova) XY Ari, where in quiescence its 206 s X-Ray modulation has very low amplitude, but in outburst, when the inner edge of the truncated disc is forced inwards and obscures one of the accretion arcs, the amplitude becomes very large (figure 9.9 of Hellier 2001).

We propose an analogous explanation for the behaviour of V842 Cen. Our high inclination view happens to lead to no nett modulation of the X-Ray and FUV flux, but the accretion disc views the X-ray flux differently, producing a varying reprocessed component. There is currently much concern about false positives in wide area searches for transients, but here we propose a false negative that hides what otherwise would be a modulated signal at high energies.

A consequence of our proposal is that the true rotational period of V842 Cen must be

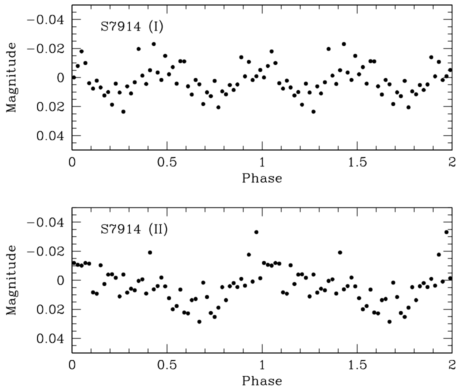

Fig. 2. Average light curves for the first (top) and second (bottom) parts of run S7914 (as shown in Figure 1), co-added on the emphemeris (at twice the 56.8 s = 0.0006577 d period) given in Equation 1.

$2 \times 56.825 = 113.65$ s. An aspect of the optical light curves of IPs is large variations of rotational amplitude from cycle to cycle, showing variations of the rate of mass transfer in along the accretion curtains. The Fourier transforms (FTs) of rotational modulations do not usually show a sub-harmonic at twice the rotational period, and we do not see any in the FTs of V842 Cen, but there is one piece of light curve that reveals a $\sim$ 114 s modulation, which is diluted in an overall FT. In Figure 1 our light curve for run S7914 (2010 March 18) is shown, with FTs of its first and second halves. Despite the low amplitude of the 56.85 s modulation in the first half (hardly evident to the eye) it shows sufficiently strongly to derive a period and phase. The FT of the second half does show low and not statistically significant peaks in the FT at 56.85 s and 114 s, but the marked four peaks at the latter period (Figure 1) which are in phase with the 56.85 periodicity in the first half (Figure 2), are positive proof of its brief existence. The ephemeris on which the data were co-added is

$$\mathrm{HJD} = 245\,5273.5782 + 0.00131539\,E. \qquad (1)$$

None of our other extensive light curves of V842 Cen show this effect – evidently for just those few rotations of the primary mass transfer had ceased through one of the accretion curtains.

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