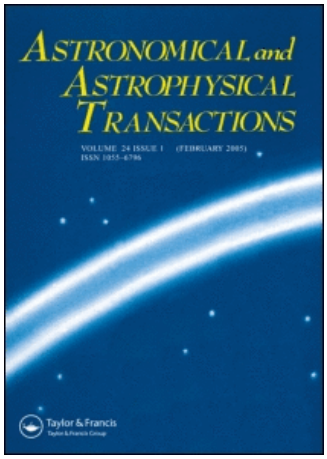

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Detection of a 3.353 h coherent oscillation in the supersoft source RX J0019.8 + 2156 (QR And)

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In this paper we report the detection of a strictly periodic oscillation in QR And which is made on the basis of observations obtained with a multichannel photometer and a 70 cm telescope.

Keywords: Supersoft sources; Cataclysmic variables; Oscillations

Supersoft X-ray sources are binary stars consisting of a donor star and a white dwarf on the surface of which continuous thermonuclear burning of the accreted hydrogen occurs [1]. One of these, RX J0019.8 + 2156 (QR And), shows periodic brightness oscillations with an orbital period of 15.85 h. In addition, this object shows quasiperiodic oscillations with characteristic periods of a few hours [2]. Short preliminary observations obtained by us with a multichannel photometer and a 70 cm telescope revealed that these quasiperiodic oscillations can mask a strictly periodic oscillation with a period in the range of a few hours. To detect this periodic oscillation, we performed long observations of QR And (14 nights; 87 h) in the autumn of 2005. Figure 1 presents the two longest light curves obtained by us.

The power spectrum of QR And (figure 2(b)) shows distinct features of the strictly periodic oscillation with a period of 3.353 ± 0.003 h and with an amplitude magnitude of 0.016. The highest peak is accompanied by 1 day aliases. The location and width of the principal peak and the 1 day aliases, which are characteristics of the window function, are visible in the power spectrum of an artificial time series (figure 2(a)) and completely agree with the location and width of the corresponding peaks for QR And. The presence of the 1 day aliases means that the detected oscillation is phase coherent. This is evidence of the reality of the oscillation. However, these narrow peaks are found to be surrounded by chaotically located noise peaks of comparable height that are caused by non-coherent quasiperiodic oscillations. As mentioned, these quasiperiodic oscillations are well known in QR And [2]. Seemingly the presence of these quasiperiodic oscillations was the reason that the strictly periodic oscillation with a period of 3.353 h was not detected by other observers earlier. We managed to find a sine wave which, when subtracted from the observations, excluded the strictly periodic oscillation from

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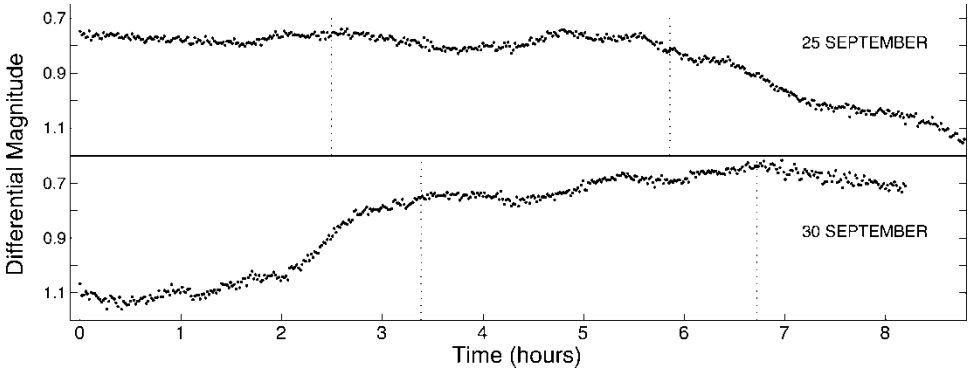

Figure 1. The two longest differential light curves of QR And.

the data. This is also evidence of the reality of the oscillation. This sine wave allowed us to find an ephemeris of the oscillation:

$$T_{\max}(\mathrm{HJD}) = 2\,453\,595.389(7) + 0.139\,71(13)E \tag{1}$$

where HJD means the heliocentric Julian date. The vertical dotted lines in the light curves (figure 1) show the locations of maxima according to this ephemeris. The coincidence of the most prominent maxima seen in the light curves with the maxima of the ephemeris directly testifies to the reality of the detected oscillation although random quasiperiodic oscillations on a similar timescale worsen the impression.

It is considered that some cataclysmic variables originate from supersoft X-ray sources. The well-known intermediate polar AE Aqr is thought to be such a cataclysmic variable. This object shows the shortest rotational period of the white dwarf, which equals 33 s. In the past, this system in the state of a supersoft X-ray source had a more massive secondary star which had transferred approximately 30% of its mass and greatly accelerated the rotation of the white

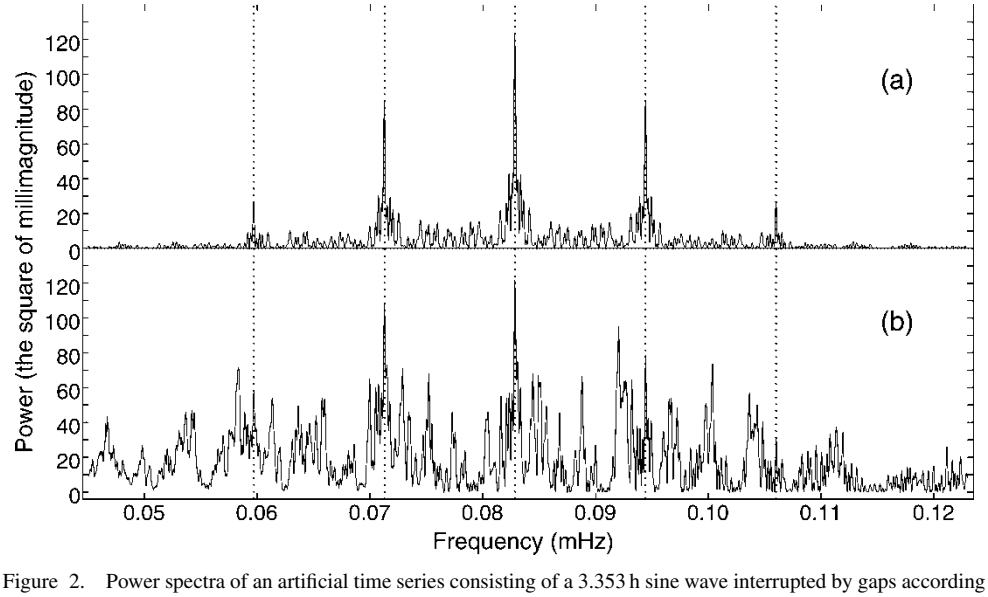

Figure 2. Power spectra of an artificial time series consisting of a 3.353 h sine wave interrupted by gaps according to (a) the observations and (b) the data of QR And.

dwarf [3]. We can then suppose that the strictly periodic oscillation with a period of 3.353 h in QR And may be caused by the rotation of the white dwarf. QR And may also be a progenitor of an intermediate polar.

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