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Two-period variability of the intermediate polar FO Aqr

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We present results of CCD photometric study of the intermediate polar FO Aqr based on observations obtained at the Baja Astronomical Observatory, Hungary, and at the Vihorlat Astronomical Observatory, Slovakia. We analysed variability of the spin period of the white dwarf in FO Aqr using our observations and previously published minima timings. The spin period is significantly shorter than before 2000.

Key words: stars: novae, cataclysmic variables; stars: individual: FO Aqr

INTRODUCTION

We obtained two colour CCD observations of the intermediate polar FO Aqr in the Baja Astronomical Observatory, Hungary, in 2009 using 50-cm telescope with alternatively changing filters V and R (Fig. 1). The CCD frames were processed using the program `WinFits` written by V. P. Goranskij (Goranskij V. P., private communication). Additionally, we analysed VR observations obtained in the Vihorlat Astronomical Observatory, Slovakia. The final time series were obtained using the `MCV`[1] software package [2] taking into account multiple comparison stars with iteratively defined weights.

PERIODOGRAM ANALYSIS

The periodogram analysis was carried out using the sine fit (`FOUR-1` software package [1]. For the intermediate polar FO Aquarii the highest peak at the periodogram for the R data (Fig. 2) corresponds to the photometric period of $0.^{d}014312(5)$. This is a daily alias of the spin period of the white dwarf published before. So we conclude that the period during our observations was $0.^{d}014521(3)$ with an initial epoch for the maximum brightness of 2455068.72430(36). The best fit value of the orbital period of the system is $0.^{d}2120801$. This value corresponds to our lightcurve better than the published earlier value of $0.^{d}2020596$ [4] (Fig. 3), although the difference is significant. Thus new observations are needed to improve the value of the orbital period consistent with the old compiled and our new data.

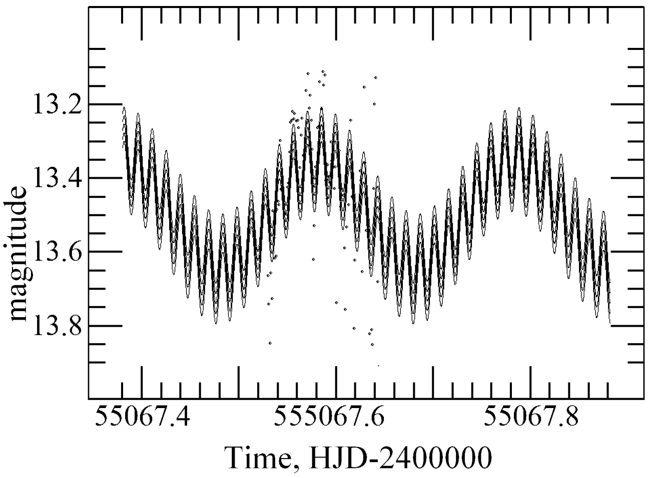

Fig. 1: Lightcurve of the FO Aqr with a two-period ("spin+orbital") approximation for one night of observations. The original observations are in the middle of the figure, but the fit is extended out of the interval of data to show both components of the periodicity.

PERIOD VARIATIONS

The previous published values of the spin period were $0.^{d}01451905$ [4] and $0.^{d}01451718$ [5]. The period variations of FO Aqr are complicated. From 1981 to 1987, the white dwarf showed a spin-down, then it changed to a spin-up, and data from [3] argue for a continuation of decrease of the spin period reported

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[1]`http://uavso.pochta.ru/mcv`

in [5]. We have analysed all available time series using two-period "spin+orbital" approximation to determine timings using the `MCV` software package [2].

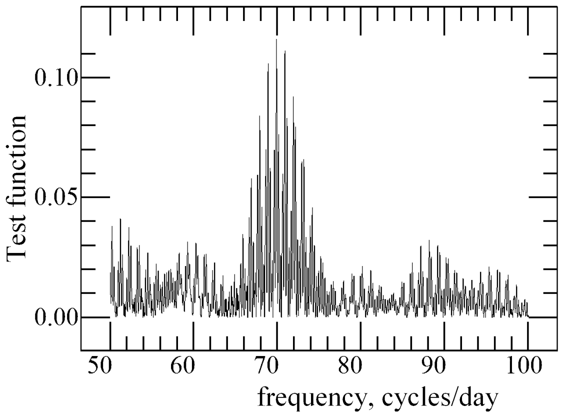

Fig. 2: Periodogram of the R observations of FO Aqr near the spin period.

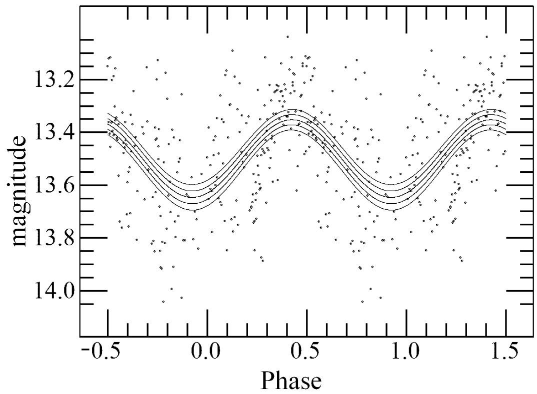

Fig. 3: The orbital phase curve of the FO Aqr in the filter R (T_0 = 2455068.83506, $P = 0\overset{d}{.}2120801$). Lines show a sine-like fit, and 1σ, 2σ corridors. Large scatter is mainly due to a spin variability.

At the beginning the observations were regular and so no cycle miscount was done (Fig. 4). Later on, there was a gap in the observations for almost 6 years (or $\sim 147,000$ cycles) after which we have started our own monitoring. So, practically we have 2 branches on the O-C diagram, which are separated with a gap and there is no published information which could help in filling this gap with points to restore the cycle numbering. This shows a very high importance of regular studies of such short period objects. Without knowing the true cycle numbering, any approximations are guesses.

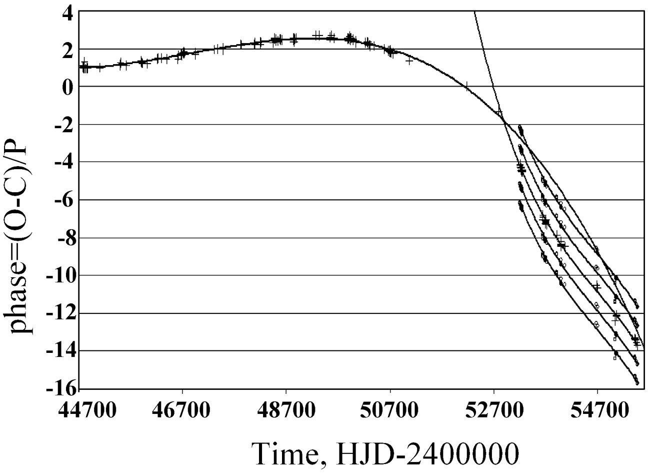

Fig. 4: The O-C diagram of the FO Aqr with 2 branches – based on own (right) and compiled (left) observations. Best fit polynomials of the 3rd order are shown for different cycle difference between the branches.

RESULTS AND CONCLUSIONS

We discuss period variations of the white dwarf in FO Aqr based on our own and previously published maxima timings. For recent years, the period is shorter than in 1980-s. For both branches of the O-C diagram, 3rd-order polynomial fits are optimal. However, there is no good solution of this order to fit all the data. So period variations are more complicated. We expect that new maxima in the 6-year gap, if published by other authors, may allow to determine a correct cycle numbering and to study period variations.

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