OBSERVATIONS AND INTERPRETATION OF THE PHOTOMETRIC VARIABILITY OF TT ARI

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ABSTRACT. Simultaneous WBVR photometric observations of TT Ari during 94/95 years are presented. The periodogram analysis of the obtained light curves and colours are curried out. The photometric period equal 3.2 h and its one day aliases are found from light curves, but the period equal spectroscopic (3.3 h) are found from B-V colours in the observations, performed in 1994. The quasi-periodic oscillations (QPO) with period from 47 to 16 minutes, changing from night to night are found too. A new model of the tilted precessing accretion disk together with reflection from secondary or hot spot is suggested to explanation of the photometric variability of TT Ari. It is proposed that QPO is possibly connected with orbiting blobs in the accretion disk.

Key words: Stars: cataclysmic variables - individual: TT Ari, photometry - accretion, accretion disk

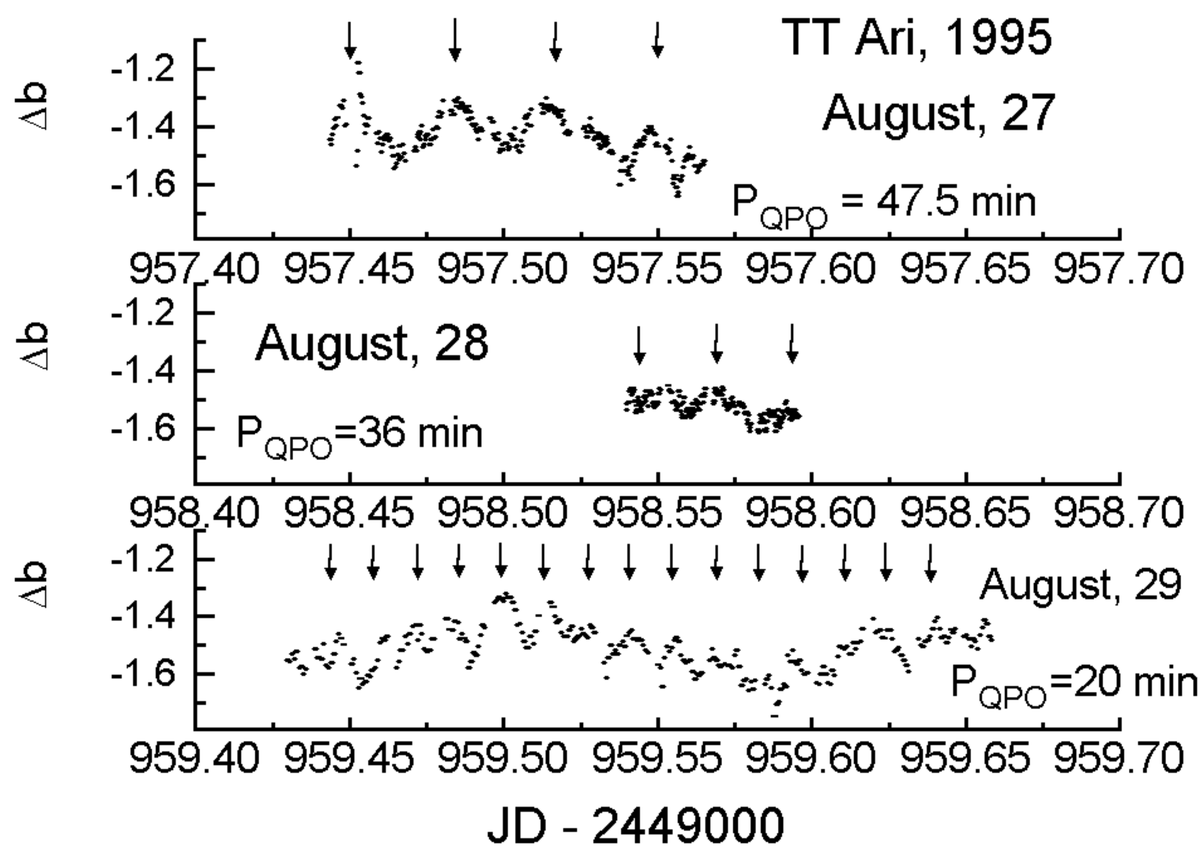

Figure 1. The light curves of TT Ari in August 27, 28, 29, 1995.

I.Introduction

The bright (V $\sim 10^m.5$) cataclysmic variable TT Ari (BD+14°341) has photometric period equal 3.2 h (Smak and Stepien, 1975) with the amplitude about $0.^m2$ - $0.^m3$. The orbiting period (3.3 h, Cowley et al, 1975) is non equal photometric one and this fact is usually connected with the precessing accretion disk (Whiterhurst, 1988).

Moreover, TT Ari shows a quasi-periodic oscillations (QPO) on time scales decreasing from 27 minutes in 1962 to 15 minutes in 1988 (Semeniuk et al, 1987; Hollander and van Paradijs, 1992; Tremko et al., 1996). A reason of this oscillations is not found and further observations and theoretical investigations of this binary are necessary.

II. Observations

Simultaneous multicolour photometric observations of TT Ari were obtained during 6 nights in October 6,7,8 1994 and August 27,28,29 1995. The observations were carried out with the 60-cm reflector of Special Astrophysical Observatory (Russia). The telescope was equipped with 4-channel photometer of Kazan State University.

Duration of individual runs was from more than 6 hours to 2.5 hour. Integration time was 10 s. Object observations were interrupting by observations of background and comparison star (d star from Götz (1985)) every 15–20 minutes. The observations were reduced in the standard way and were obtained the instrumental magnitudes in four bands, which are close to bands of WBVR system. The error of individual observation not exceeded $0.^m01$ in B and V bands and $0.^m03$ in W band. Red observations did not analyzed because signal at R channel was low.

III. Results.

The periodogram analysis was performed using program (based on Fourier analysis) writen by Yu.Kolpakov (SAI, Moscow).

The photometric period equal 3.2 h was obtained from light curves in **w**, **b** and **v** filters as in 1994 as in 1995 years. Most grate amplitudes are in **w** filter.

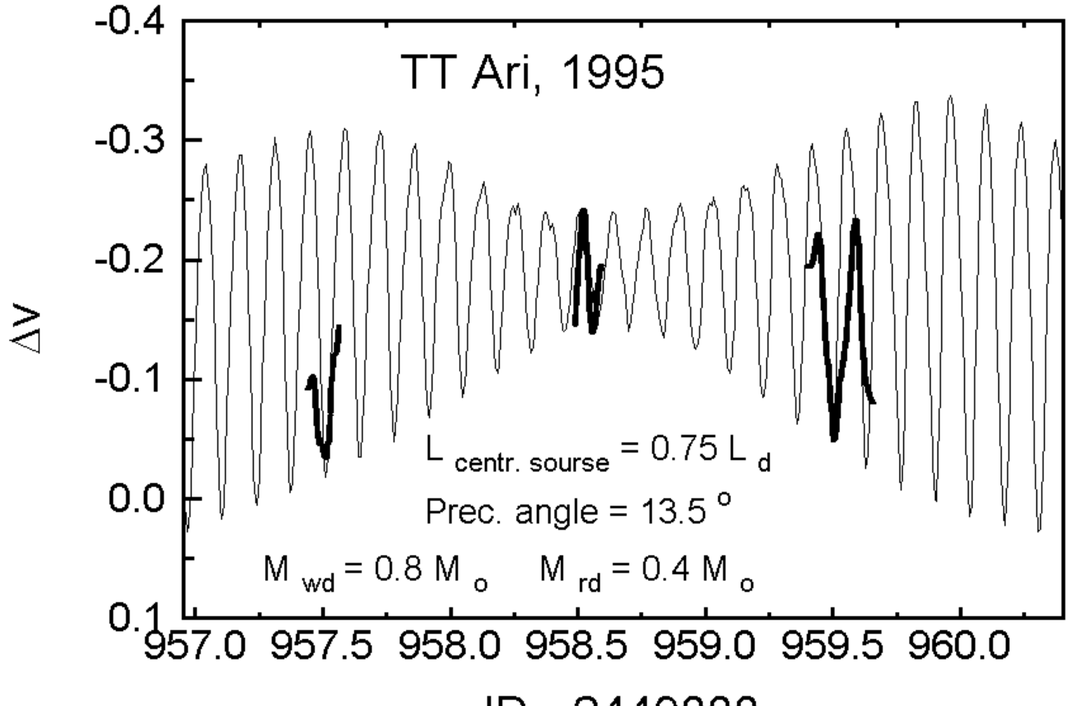

Figure 2. The theoretical and averaged over 200 points observed light curves of TT Ari.

However, in 1994 year **w-b** colour demonstrate rather half photometric period (1.6 h), and in 1995 it is obvious (1.68 h). The variation of **b-v** colour have period (3.28 h) in 1994 close rather to spectral period than to photometric.

The most significant QPO period in 1994 is 16.7 min (October, 7 and 8). In October 6 there are not significant oscillations. The most interesting change of QPO periods was during 3 consecutive nights on August 1995. The QPO period decreases from 47.5 min at August 27 to 36 min at August 28 and to 20 min at August 29 (see Fig.1). Sometimes the QPO periods in colour light curves are the beat periods between half orbital period and QPO periods in filters, as **w-b** QPO period (16.7 min) in August 29, 1995.

IV. Interpretations and discussions.

For interpretation of the photometric behaviors of TT Ari we suggest the improved model of the precessing tilted accretion disk (Barrett et al,1988) completed by reflection effect from a secondary or a hot spot and we calculate the theoretical light curves of TT Ari (reflection from secondary, see Fig.2). Details of the radiation flux calculations from disk and secondary was described by Suleimanov (1996) and Suleimanov and Shakura (1994). The colour variability with spectral period confirmed our model.

Consecutive decreasing of QPO period during 3 successive nights at August, 1995 suggests that QPO are connected with Kepler periods of any inhomogeneities (blobs) of the disk, and that the change of QPO period is connected with the diffusion of these blobs along the radius of the disk. Simple evaluations give the Kepler period on outer disk radius of TT Ari about 50 min, and diffusion time about 0.1 - 1 day.

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