PERIODICAL VARIATIONS OF THE BRIGHTNESS OF T TAURI

G.V. ZAJTSEVA
State Sternberg Astronomical Institute, USSR

1. INTRODUCTION

T Tauri-type stars are characterized by the fast irregular variability. It is possible to select several components in brightness variations: slow components with timescales of years and fast ones with timescales of days and tens of days. Besides, up to 1 mag flares in the ultraviolet part of the spectrum occur during some nights. The overall change of the brightness may reach 2-3 mag.

Periodical light variations have been discovered in a number of T Tauri stars with amplitudes of several hundredths of the stellar magnitude and periods of several days. Periods are determined with different degrees of accuracy using observations concentrated on restricted time intervals. Only for V410 Tau the period of 1.8 days was confirmed by Vrba et al.(1988) from observations at different epochs. Periods are thought to be axial rotation periods and observations are interpreted taking the hypothesis of the presence of temperature inhomogeneities (spots) on star surface in analogy with BY Dra-type stars.

2. OBSERVATIONS

The photoelectric observations of T Tau obtained at the Crimean Station of the State Sternberg Institute from 1971 are plotted in Figure 1. One can note that the light variability is more quiet than for other stars of this type. Nevertheless three components of variations are quite noticeable: two 2000 days waves of the slow component, variations from night to night of the order of 0.1-0.2 mag and ultraviolet flares reaching sometimes 0.8 mag.

The period of 2.8 days was discovered by Herbst et al. (1986) from cooperative observations obtained in the season of 1985-86. This period was confirmed by Zajtseva (1989) using numerous observations obtained in Crimea. Also, observations by Zajtseva et al. (1988) in 1987 and Herbst and Coret (1988) in 1988 have shown the presence of the periodical component in light variations of T Tauri.

Amplitudes A_V and phases φ_{max} derived from 4 series of observations of T Tau are compared in Table 1. For each series the number of nights n and the number of observations N are given. Phases are computed with a period of 2.80 days and the initial epoch is JD 2440000.0. Corresponding phase diagrams are presented in Figure 2.

L. V. Mirzoyan et al. (eds.), Flare Stars in Star Clusters, Associations and the Solar Vicinity, 173–176.

Table 1. A comparison of amplitudes and phases of the periodical comp.

	Season	J.D.	n	N	A_V	φ_{max}
I	1976–77	2443049–43232	41	88	0.038	0.10
II	1985–86	2446323–46526	203	206	0.037	0.60
III	1987	2447099–47102	4	44	0.070	0.93
IV	1988	2447162–47174	13	13	0.048	0.53

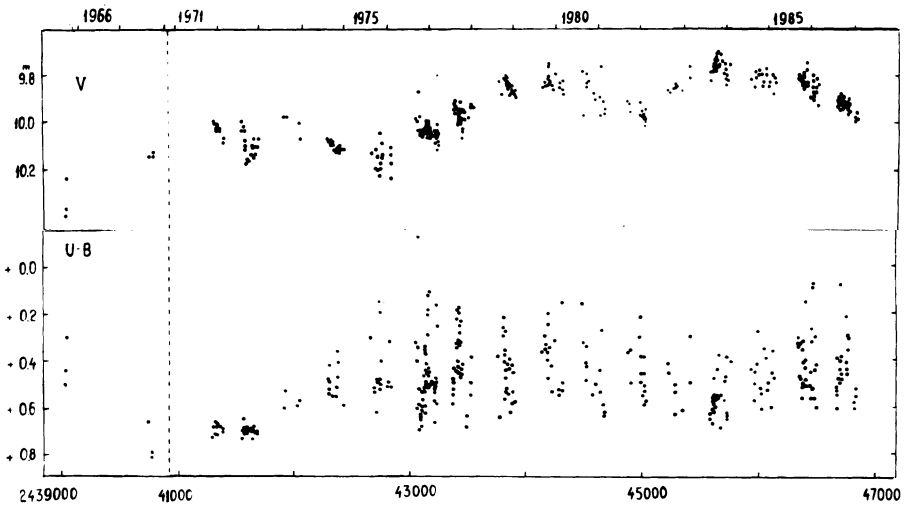

Figure 1. Variations of V and (U–B) for T Tauri.

One can see that the amplitude is the largest for series IV when 44 observations were distributed over 4 nights. The amplitude is smallest for series II with 206 observations over 203 nights. This result indicates that the effect of irregular variations is to decrease the amplitude of the periodical component. Noteworthy are the phase changes which are obviously irregular and could be hardly explained by variations of the period. Especially high is the phase difference between series III and IV, which are separated by two months. Probably the change is due to the longitude shift of an active area (spot).

3. DISCUSSION

Let us suppose that a spot exists on the surface of T Tau and the spot is characterized by the relative area f and the temperature T_s. The amplitude of the light variations due to the spot appearance can be evaluated as

$$\Delta m(\lambda) = -2.5 \log(1 - f(B_\lambda(T_s)/B(T_*)))$$

where λ is the wavelength, B(T) is the Planck function, T_* is the temperature of the unspotted part of the star's surface. The temperature

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adopted for T Tau is T_*=5500 K. The observed amplitudes for the 1987 observations of T Tau are ΔU=0.123, ΔB=0.084, ΔV=0.070, ΔR=0.057. These correspond to the values of T_*, T_s and f given in Table 2. Thus dark and bright spots in equal measure obey observations.

Table 2. Computed temperatures and areas of the spot and amplitudes of the light variations

T_*(K)	T_S(K)	f	ΔU	ΔB	ΔV	ΔR
5500	6500	0.065	−0.107	−0.101	−0.075	−0.058
5500	5000	0.170	+0.100	+0.086	+0.073	+0.060

We have demonstrated the presence of the rotational modulation of the brightness using series of photoelectric observations of T Tau differing in length and number. From these the evolution of spots and other information can be derived. Assuming a constant rotation period of 2.8 days we have found phase changes which probably indicate spot migration.

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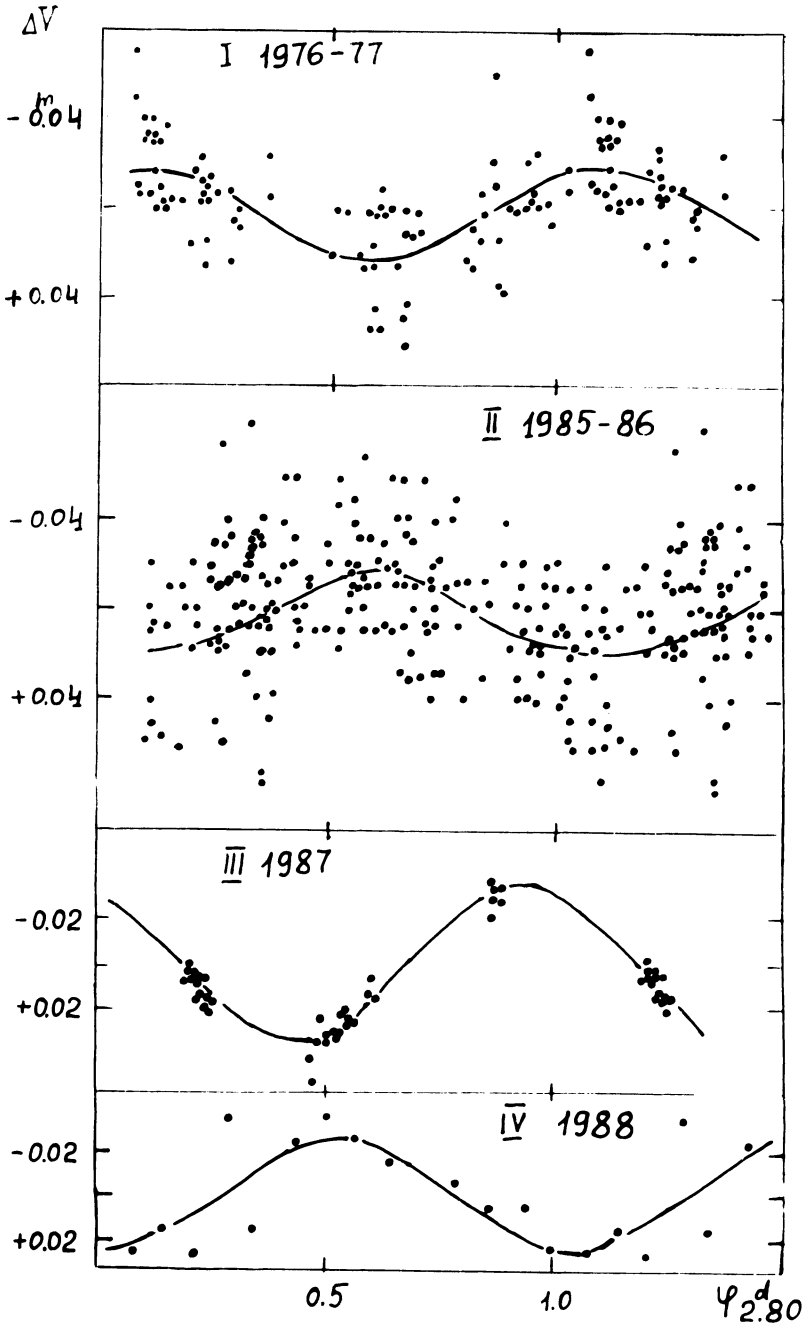

Figure 2. Phase diagrams for 4 seasons of observations of T Tauri.

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