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A NEW POSSIBLE LONG PERIOD IN THE OPTICAL VARIABILITY OF T TAURI

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T Tauri is a well-known prototype of pre-main-sequence variable stars. Its photometric behavior can be studied for a time interval exceeding one century, and it shows a rather unusual feature: whereas the star was quite active before 1920ies, its variability became rather low-amplitude and smooth later on.

From the photometric data base (Herbst et al., 1994) available on Internet, we retrieved 1358 V, $B-V$, $U-B$ measurements of T Tau, mainly from observations by Zaitseva (1978), Herbst et al. (1983), Rydgren et al. (1984), Kardopolov and Filipyev (1985), Herbig et al. (1986), Bouvier et al. (1988), Herbst et al. (1988), and appended them with 13 V, $B-V$, $B-R$, $W-B$ observations acquired by one of us (Ismailov, 1997). This data set was used for our Fourier frequency analysis according to the method suggested by Scargle (1982), in the later modification by Horne and Baliunas (1986) (the code we applied was written by I. Antokhin). We analyzed subsets of data as well as the complete set, with trend removed. The most significant frequency in the low-frequency domain is $f = 0.000456 \pm 0.000035$ d^{-1}, corresponding to the period $P = 2192$ days. This frequency is represented in the complete data set as well as for its different subsets. In the following, we use the mean value $P = 2200 \pm 150$ days, or about 6 years, derived from several versions of the subsets.

The light curve folded with the above period value is shown in Fig. 1. The general trend between the minimum in 1962 and the maximum in 1985 ($\Delta V = 0\overset{m}{.}4$), with subsequent new fading, has been removed using a third-power polynomial. Clumps of data points, corresponding to individual years, are evident. Despite a large scatter, reaching $0\overset{m}{.}4$ for some years, a periodic component with the amplitude of $0\overset{m}{.}2$ is apparent. From the photoelectric data set, we derive 5 times of minima (2439066, 1965; 2442696, 1975; 2444911, 1982; 2447167, 1988; 2449280, 1993). For better feeling of the reliability of these minima, we present a combined photoelectric light curve in Fig. 2; the Roman numbers indicate the fragments of the light curve used to derive each minimum. Apparently, these minima are of different reliability, but the presence of each of them seems beyond doubt.

It is interesting to check if this period value can be verified using historical visual and photographic observations. The well-known combined visual light curve of T Tau was published by Lozinskii (1949). This light curve causes some questions, probably because the author, who wished to present a smoothed light curve instead of individual data points, did not pay enough attention to his smoothing procedures. Namely, the light curve does not show clear invisibility gaps at one-year intervals, to be expected for a star in a zodiac constellation. If we, nevertheless, consider this standard source of data on the long-term variability of T Tau, we are not able to connect the minima present in this light curve to the above five minima using a period value close to six years. However, it is worth noting that the two best-pronounced minima of the historical light curve, approximately on JD 2402800 and JD 2409500, are separated by 6700 days, almost exactly three suggested periods. It is more difficult to isolate individual minima of the suspected long-term variability in the historical light curve based upon the data in Beck and Simon (2001) because of its large scatter.

If real, the six-years period is not very easy to explain. Quite obviously, it is too short to be an orbital period of any of the numerous companions of T Tau reported in the literature. Fadings of young stars are often explained by dust clumps crossing the line of sight. A proto-planetary body at several astronomical units from the star, not yet directly revealed, could orbit T Tau with the needed period. But it seems impossible to connect the recent data with the historical minima, making interpretations like eclipses by permanently present bodies unlikely; cometary bodies, appearing and persisting for decades and then disappearing, can be an alternative. Also, cycles resembling solar activity come to mind. Note that the recent photoelectric data show continuous brightening of T Tau from 1962 till 1985, with subsequent fading. This unusual behavior of the star needs a special explanation.

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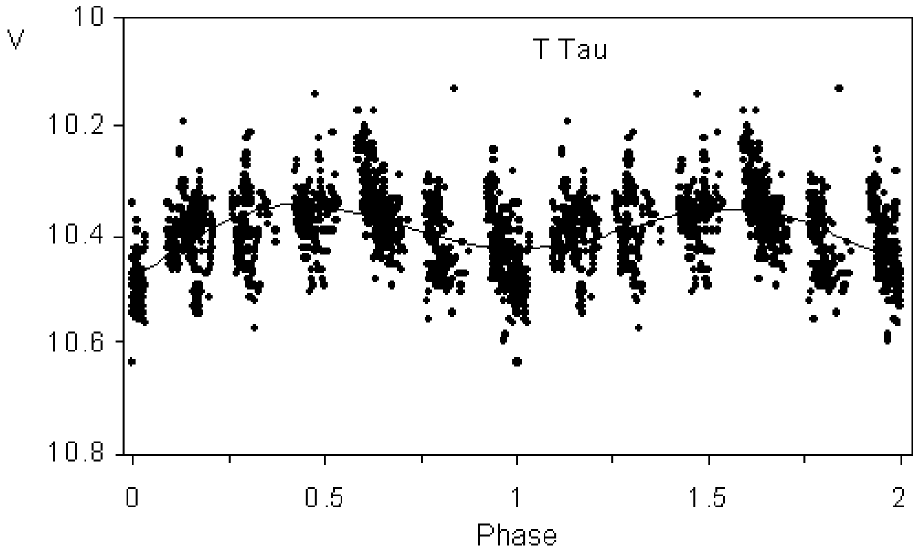

Figure 1. The photoelectric light curve of T Tau folded using our suggested 2200-day period after the removal of the slow trend.

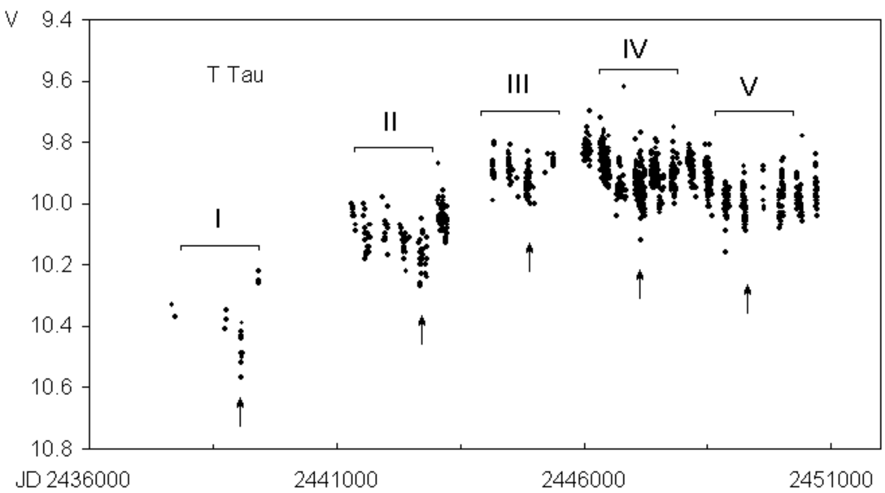

Figure 2. The combined photoelectric light curve of T Tau with minima indicated.