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PZ Mon - THE FLARE STAR WITH THE LARGEST AMPLITUDE OF THE LONG-TERM LIGHT VARIABILITY

PZ Mon has been suspected as a K2 flare red dwarf by L. Munch and G. Munch (1955) after the changes in the hydrogen and calcium emission lines have been detected in its spectrum. In fact, this suspicion was confirmed by photometric measurements of PZ Mon brightness from the Harvard Observatory plate collection carried out by S. Gaposhkin (1955): several sudden brightness variations have appeared with photographic amplitude up to $0^m.66$. Photoelectric patrol observations in 1967–1972 did not reveal high amplitude flares: only one flare with $\Delta m=0^m.11$ was registered during 40 hours of V-monitoring, the B-monitoring during 15 hours did not detect any flare (Cristaldi et al.,1968; Cristaldi & Rodono, 1970). Using the Bergedorf photographic plates A. A. Wachmann (1968) found that the brightness of PZ Mon remained in its high state ($m = 9^m.9–9^m.6$) during 100-150 days, then slowly decreased down to $10^m.6$, occurred at time interval for more than 100 days. According to Petit (1959), PZ Mon is a flare star of UV Ceti-type.

We have searched for long-term variability of PZ Mon using the Sternberg Astronomical Institute of Moscow University (SAI) plate collection. Preliminary analysis of the yearly mean magnitudes obtained as separate rows of data for 1899–1989, showed the existence of the variability with a large amplitude up to 1 magnitude. Similar variability amplitude estimations are given by Kurochkin from his analysis of the SAI collection (private communication). The possible presence of a cycle-like variations with an apparent period of several dozens of years is also detected, but the fragmentary nature of the observations make this result uncertain (Bondar', 1990). Further study of the star is based on the Odessa Astronomical Observatory collection covering the time interval 1968–1989 and to a greater extent on the Sonneberg plates archive allowed to obtain more data in 1928–1991. The yearly mean light magnitudes were reduced to the scale of the SAI measurements: the correction values for data from the Sonneberg archive and from the Odessa collection were $+0^m.06$ and $-0^m.2$ respectively. The flares and uncertain measurements have been excluded from the analysis . All of the available data and standard deviations of a single measurement from the annual mean are given in the light curve in Figure 1a. The lower part of the Figure shows the light curves of two comparison stars, the brighter one was used for the Sonneberg collection. The stellar magnitudes of the comparison stars were measured relatively to the five photometric standard stars (Shugarov, 1976) using the iris-photometer. The sensitivity of the plates should be close to B band, but this does not rule out that a difference may exist between the photoelectric values and measured magnitudes .

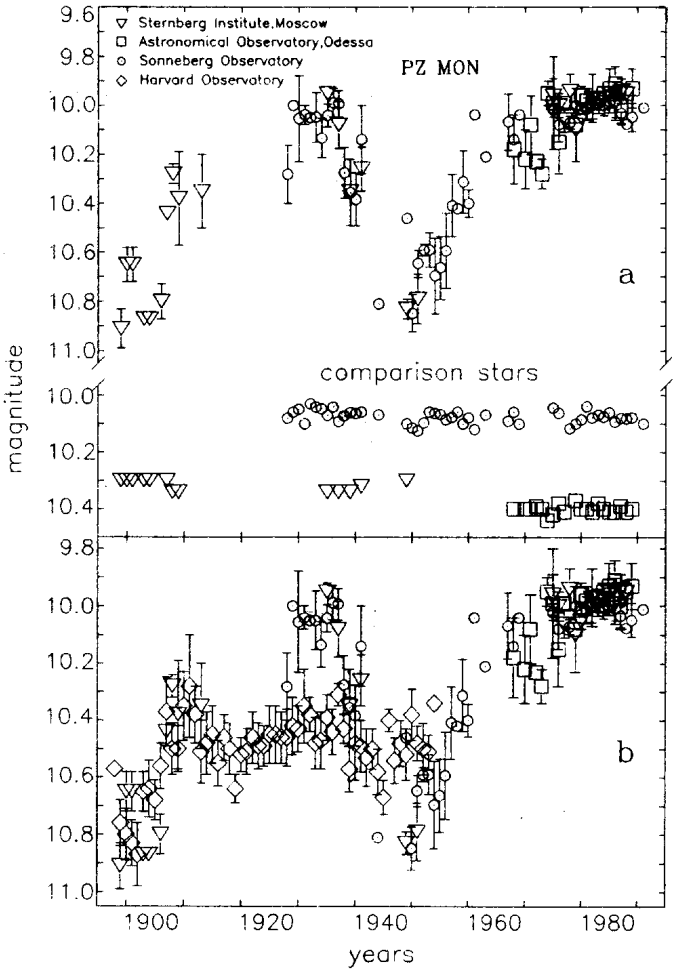

Figure 1: PZ Mon long-term variability

The light curve represented in Figure 1a illustrates the long-term photometric behavior of PZ Mon from 1899 to 1991. It shows two maxima and two minima, the time interval between them is about 50 years. At minimum the light fades down to 10.9, according to other estimations down to 11.0–11.2 mag. At maximum the stellar magnitudes cover the range of 9.9–10.0 mag. The star remains at maximum for 10–15 years and at minimum, probably for less than 10 years. Its high state has been interrupted by short-lived light minimum with depth of 0.2–0.3 mag. It is known, that long-term light variations are found for several red dwarfs of BY Dra type. This phenomenon is being interpreted in terms of activity cycle similar to the solar 11-year one. The duration of a stellar cycle is

being estimated usually as the time between minima of brightness, corresponding to the highest inhomogeneity of the visual stellar surface. The light curve of PZ Mon indicates also the repeated presence of the extreme values of the mean brightness repeated on a timescale of nearly 50 years.

Let us compare this light curve with the data obtained S. Gaposhkin. He has measured the brightness of the star relatively to the comparison stars, whose magnitudes had been determined according to the standard in IPg (Gaposhkin, 1955). These values give a continual row of mean values for 1898–1954. Figure 1b contains the data from Figure 1a supplemented by results of S. Gaposhkin. The Harvard measurements confirm the value of the first maximum and light variations on the following ascending branch, as well as the maximum at the end of 20–ies and in the mid 30–ies, the light decreasing by $0^m.2$ during the maximum and the minimum observed in 1944–1950. However, since 1910 the long-term variations of the mean brightness, according to Gaposhkin, show lower amplitude than in other collections and in the time interval from 1910 to 1920 the light of the star does not increase, but on the contrary, decreases down to its minimum in 1919.

Thus, the considered photometric investigations of the PZ Mon evidences about the presence of long-term light variations with a remarkable amplitude and allow us to suspect the cyclic character of these variations. The duration of the cycle is about 25–50 years long. Currently, cyclic variations with the typical time 50–60 years are known only for the three of BY Dra type stars: BY Dra itself, CC Eri and BD+26° 730 (Phillips & Hartmann,1978; Hartmann et al., 1981). The greatest photometric variability on this time span has been found for BD+26° 730 with the amplitude of 0.6. The amplitude of PZ Mon is exceeding this value significantly.

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N. I. BONDAR'
Crimean Astrophysical Observatory
Nauchny, Crimea, Ukraine, 334413

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