Publ. Astron. Obs. Belgrade No. 80 (2006), 321 - 324 *Poster*

LONG-TERM POLARIMETRIC VARIABILITY OF SOME LATE-TYPE STARS

SNEŽANA MARKOVIĆ, SILVANA NIKOLIĆ, SANJA ERKAPIĆ and
SLOBODAN JANKOV
Astronomical Observatory, Volgina 7, 11160 Belgrade 74, Serbia and Montenegro
E–mail: smarkovic@aob.bg.ac.yu

Abstract. Here we present an attempt to establish the existence of the long-term polarimetric variability for four late-type stars α Ori, RS Cnc, ζ Aur, and π Aur, from the polarimetric programme of the Belgrade Astronomical Observatory.

1. INTRODUCTION

Many late-type stars exhibit intrinsic polarization with broad band values indicating a correlation between the degree of polarization and spectral type. Among 35 stars from the polarimetric programme of the Belgrade Astronomical Observatory several are of the late spectral type. Due to small number of observations for some of late-type stars we cannot draw any conclusions about polarimetric variability (and the existence of intrinsic polarization). For four late-type stars, α Ori, RS Cnc, ζ Aur and π Aur, we have applied a criteria for establishing the existence of the long-term polarimetric variability.

Polarimetric observations at Belgrade Observatory were carried out from 1974 till 1992 with 65-cm Zeiss refractor and stellar polarimeter in the visual (V) spectral region. Integration of the raw polarimetric signal was done in 4-seconds intervals, the angular velocity of the analyzer was one turn per minute. In most cases, "one measurement" is up to 8 one-minute polarimetric sine-wave signals phase-averaged. Typical standard deviation of an individual measurement is about 0.07% for Stokes parameters Q and U.

2. METHOD OF ANALYSIS AND RESULTS

The Q and U normalized Stokes parameters, the degree of polarization P, and the polarization position angle Θ (or the angle of polarization) are all given as the mean for each day of observations. If on a given day only one measurement was done, it was used. We find the justification of this averaging procedure we find in long

periods of optical variability, if any. In this sense we had 12 observations for α Ori (out of total 30), 29 observations for RS Cnc (67), 18 observations for ζ Aur (49) and 7 observations for π Aur (22). The catalogue data about the stars are taken from SIMBAD Astronomical Data base and shown in Table 1.

Table 1: Source list 1950.0

Star	RA (h : m : s)	Dec (° : ′ : ″)	m_v[1] (mag)	Per (days)	Spec. type	Comment
α Ori	05 : 52 : 27.80	+07 : 23 : 57.8	0.42	2070	M1	HD39801, $\Delta m_v = 0.88$ semiregular pulsating
RS Cnc	09 : 07 : 37.79	+31 : 10 : 05.2	6.20	120	M6IIIase	HD78712, $\Delta m_v = 1.00$
ζ Aur	04 : 58 : 58.68	+41 : 00 : 17.8	5.0	~ 972.2	K4Ib − II	HD32069, $\Delta m_v = 0.54$ eclipsing
π Aur	05 : 56 : 13.35	+45 : 56 : 04.2	4.6	irr	M3II	HD40239, variable

[1] Visual magnitude during the maximum brightness

The existence of a time-dependent polarization for a set of observations can be established by statistical (χ^2) tests. However, with the limited number of measurements at hand, statistical tests must be applied with extreme caution. To identify variability a simple 3σ criteria may be applied: if polarization degree changes for more than 3σ over the observational period, we regard a star to have time-dependent polarization.

Although P and Θ carry a statistical bias, while Q and U are more appropriate for evaluating variability, the study of degree of polarization and angle of polarization may provide more physical insight. In Figure 1 are shown median Q-U plots for each star. For saving the space available all four plots are of same dimensions. The data points are marked with open circles, the mean is a cross drawn to the size of the average error of a single measurement and the standard deviation is represented by a solid ellipse centered on the mean. Any elongation of the distribution of data points in the Q-U plots is a good evidence for intrinsic polarization that is variable in degree, but constant in position angle. We confirm this by a conservative 3σ criteria applied on the polarization degree.

By this criteria, we see that in case of α Ori a variable polarization degree is present. During this period the polarization degree reached a maximum of 0.8%, while the minimum observed polarization was 0.1%. Standard deviation for this data set is $\sigma_p = 0.2\%$. Our observations cover about one and a half period, and even with the scarce sampling, we notice the minimum occurring somewhere during October-November 1986. In a month-by-month polarization measurement of Hayes D.P. (1980, 1981) and Tinbergen *et al.* (1981) during October 1979 - May 1981 period, minimum was observed in September 1980. Considering the period of $\sim$ 6.4 years the next minimum should have been at the latest in February 1987, what is in agreement with our observations. Based on the month-by-month data mentioned above Schwartz and Clarke (1984) modelled the polarization changes in Betelgeuse with one hot-spot model, a simple model which should be extended to cover the multi-spot case.

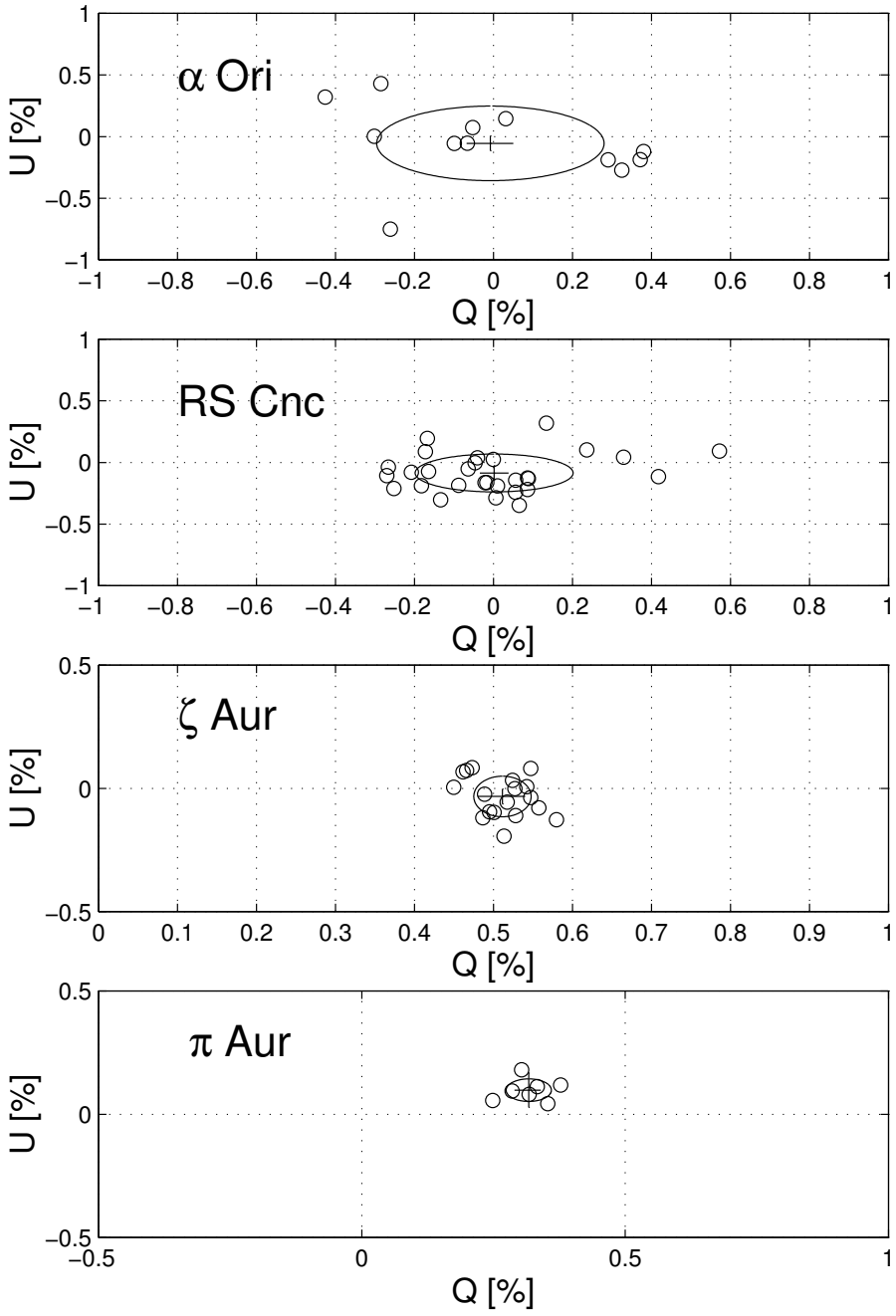

Figure 1: Median Q-U plots for the programme stars.

However, our present data are not sufficient for any detailed modelling.

RS Cnc has a (relatively) short period and analysis of each period separately would be more appropriate. Period December 1989 - April 1990 is well covered and if we apply our criteria a strong evidence of time variable degree of polarization is found: $0.05\% \leq \mathrm{P} \leq 0.6\%$, with $\sigma_p = 0.11\%$. The Q-U plot also indicates that the polarization is time dependent. More detailed analysis will be presented elsewhere.

The interstellar polarization in the area surrounding ζ Aur is uncertain, with a theoretical upper limit of $\sim 0.7\%$. It has probably contributed significantly to the measured degree of polarization. However, if we assume that the interstellar polarization is constant, we find evidence for a time-variable intrinsic polarization: $\delta\mathrm{P} \approx 3\sigma_p$ ($0.45\% \leq p \leq 0.6\%$, with $\sigma_p = 0.04\%$).

Our measured degree of polarization for π Aur of 0.27 - 0.4 % is consistent with the previous reported measurements. The standard deviation of our data is $\sigma_p = 0.04\%$, and the amplitude of polarization degree change does satisfy the employed 3σ criteria. Because of the small number of observations, we have to be cautious: if present, intrinsic polarization component might vary with time, but may be time-independent as well.

References

Hayes, D.P.: 1980, *Astrophys. J.*, **241**, L165.
Hayes, D.P.: 1981, *Publ. Astron. Soc. Pacific* **93**, 752.
Tinbergen, J., Greengerg, J.M., Jager, de D.: 1981, *Astron. Astrophys.*, **95**, 215.
Schwartz, H.E., Clarke, D.: 1984, *Astron. Astrophys.*, **132**, 375.