

## Preliminary results of V440 Per and $\alpha$ UMi observations with the Poznan Spectroscopic Telescope

M. Fagas, R. Baranowski, P. Bartczak, W. Borczyk, W. Dimitrow, K. Kaminski,  
T. Kwiatkowski, R. Ratajczak, A. Rozek, and A. Schwarzenberg-Czerny

Obserwatorium Astronomiczne, Uniwersytet im. Adama Mickiewicza, ul. Śloneczna 36, 60-286 Poznań,  
Poland

### Abstract

Presented herein are preliminary radial velocity results for two classical Cepheids: V440 Per and  $\alpha$  UMi (Polaris). Both stars have been observed with the Poznan Spectroscopic Telescope (PST), operational since Aug 2007 at the Borowiec Station of Poznań Astronomical Observatory in Poland. Data obtained for V440 Per suggest the presence of a low-amplitude secondary mode of pulsations. Results of  $\alpha$  UMi observations confirm further pulsation amplitude growth, as observed during the last decades.

Individual Objects: V440 Per, Polaris

### Introduction

Both V440 Per and  $\alpha$  UMi spectroscopy has been obtained with the old PST configuration. The telescope was equipped with two 0.4 m parabolic mirrors (only one of them was operational during the period of observations). PST is currently being adjusted to simultaneously use both mirrors, which have been replaced with 0.5 m ones in August 2008.

PST is equipped with a mid-resolution ( $R = 35000$ ) fibre-fed echelle spectrograph, based on the MUSICOS construction design (Baudrand & Böhm 1992). It covers the spectral range between 4500 and 9200 Å. Image acquisition was performed with a high-quality low-noise  $2k \times 2k$  ANDOR CCD, at a temperature of  $-90^\circ$  C.

Data reduction and radial velocity measurements were done using the IRAF package (<http://iraf.noao.edu/>), as well as with combined Python and c scripts developed by our team members. The cross-correlation method was used to obtain radial velocities. Further periodicity analysis was conducted using the Period04 (Lenz & Breger 2005) and TATRY (Schwarzenberg-Czerny 1996) software.

### V440 Per

V440 Per is a bright (6.3 mag) star of F7 Ib spectral type. It is an overtone pulsator, with an oscillation period of 7.570 d (Luck et al. 2008). 158 spectra for this star have been obtained with PST between August 2007 and July 2008. Typical exposure times were 600 – 900 s, with a signal-to-noise ratio (S/N) varying from  $\sim 20 - 40$ , depending on weather conditions. Radial velocity data are presented in Fig. 1.

Preliminary radial velocity measurements revealed a low-amplitude ( $\sim 90$  m/s) second harmonic of V440 Per pulsations. If confirmed, that would make V440 Per the overtone

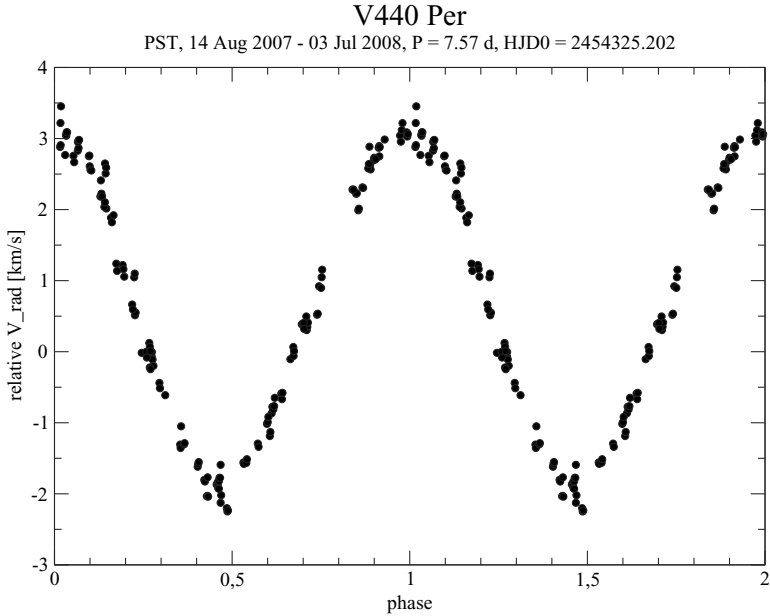


Figure 1: Radial velocity curve of V440 Per obtained with PST.

Cepheid with the longest pulsation period known. Data analysis is being carried out in cooperation with Pawel Moskalik.

### $\alpha$ UMi (Polaris)

Spectroscopic and photometric observations of this bright classical Cepheid over the last century revealed changes in both pulsation period and amplitude. While the period was increasing, the amplitude (both photometric and spectroscopic) seemed to decrease, leading to the conclusion that Polaris' pulsations might eventually cease. This trend, however, diverted during the last decades (Lee et al. 2008).

PST's design allows easy observations of Polaris. 330 spectra have been taken over seven months (Dec 2007 - Jul 2008) with a typical exposure time of 150 s. The S/N in the obtained spectra was  $\sim 30 - 70$ , depending on weather conditions.

190  $\alpha$  UMi spectra (Dec 2007 - Apr 2008) have been reduced so far. The influence of Polaris' orbital motion on the star's pulsation period has not been taken into account, as the analyzed data set only covers 4 months ( $\sim 1\%$  of the orbital period). Preliminary analysis of the radial velocity data revealed a pulsation period slightly longer than expected ( $3.978 \pm 0.002$  d). The 2K amplitude found was  $2.52 \pm 0.03$  km/s, which is consistent with recent work by Lee et al. (2008) and Spreckley & Stevens (2008).

The star is scheduled for further observations with PST in the upcoming years.

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Excursion on the Danube river.