*Precision Asteroseismology*
*Proceedings IAU Symposium No. 301, 2013*
*J. A. Guzik, W. J. Chaplin, G. Handler & A. Pigulski, eds.*

doi:10.1017/S1743921313015019

# Variable stars in the young open cluster NGC 2244

**Gabriela Michalska**

Instytut Astronomiczny, Uniwersytet Wrocławski,
Kopernika 11, 51-622 Wrocław, Poland
email: michalska@astro.uni.wroc.pl

**Abstract.** We present results of a search for variable stars in the young open cluster NGC 2244. As a result we have found many eclipsing systems and pulsating stars, some of which are multiperiodic. Here we show only a few examples.

**Keywords.** galaxies: clusters: individual (NGC 2244), stars: pre–main-sequence

## 1. Introduction

NGC 2244 is a young open cluster associated with the Rosette Nebula and located in the Perseus Arm of the Galaxy. Its age is estimated with 2–6 Myr, the distance with 1.4 – 1.7 kpc and the reddening with $E(B-V) = 0.47$ mag. The cluster is embedded in a H II region and is rich in OB stars. A photometric $UBVI$ and H$\alpha$ study was performed by Park & Sung (2002). They found about 30 OB-type cluster members. They also discovered about 20 pre-main sequence (PMS) stars with H$\alpha$ emission (four of them are massive Herbig BeAe stars) and six stars in NGC 2244 with X-ray emission. A large population of pre-main sequence stars was also found by Bonatto & Bica (2009). The cluster contains the double-lined eclipsing binary star V578 Mon (Hensberge *et al.* 2000) and several spectroscopic binaries. It contains also an Ap star (NGC 2244-334) having a strong magnetic field (Bagnulo *et al.* 2004).

## 2. Observations and reductions

The observations of NGC 2244 were carried out with the 1-m telescope at Cerro Tololo Inter-American Observatory (CTIO) in Chile. This telescope is equipped with a 4064 × 4064 CCD camera covering an area of about $20' \times 20'$ on the sky. Between December 24, 2009 and January 8, 2008 we collected about 2000 frames in the $V$ filter and 170 frames in the $I_{\rm C}$ filter, 150 in the $B$ filter and 70 in the $U$ filter.

## 3. Analysis and results

Using profile and aperture photometry obtained with the DAOPHOT package, differential magnitudes of all detected stars were computed. The $V$-filter differential magnitudes were used in the search for variability. For each star, the light curve, the Fourier periodogram in the range between 0 and 60 $\rm d^{-1}$ and the phase diagram were inspected by eye. As a result we have found many variable stars. The Fourier periodogram of three PMS variables are shown in top panels of Fig. 1. One of them, V1, shows $\delta$ Scuti-type variations. The light curves of two other PMS variable stars, V4 and V5, and an eclipsing binary, V6, are shown in bottom panels of Fig. 1. The color-magnitude diagram and color-color diagram of the observed stars are shown in Fig. 2.

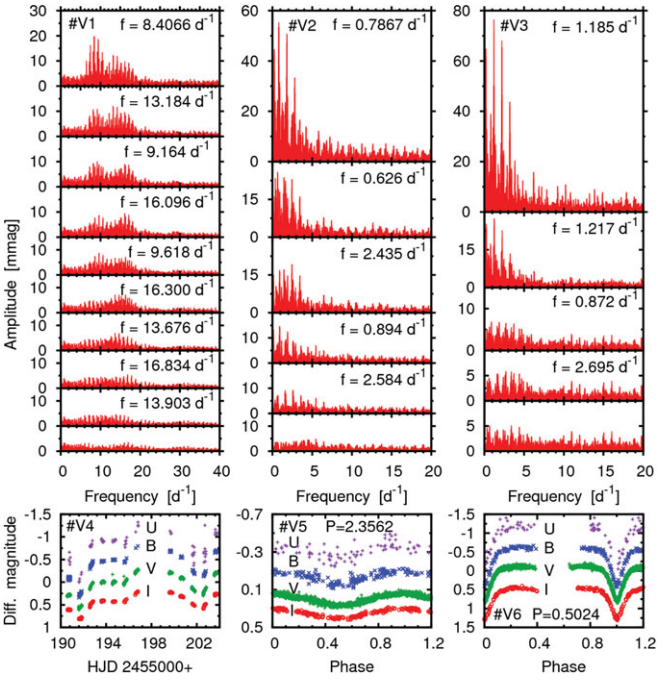


**Figure 1.** Fourier frequency spectra of $V$-filter data of three PMS pulsating stars (V1, V2 and V3) and light curves of two PMS variables, V4 and V5, and one eclipsing system, V6.

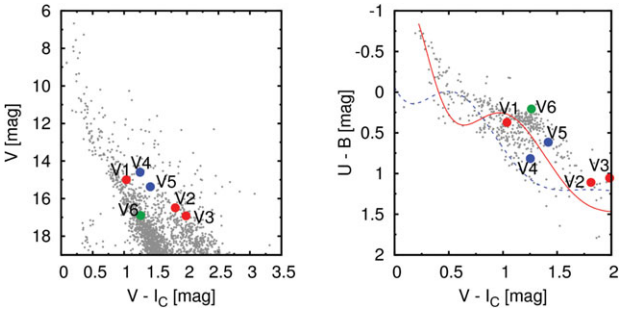


**Figure 2.** *Left*: The $V$ vs. $(V-I_{\rm C})$ color-magnitude diagram for NGC 2244. *Right*: The $(U-B)$ vs. $(V-I_{\rm C})$ color-color diagram of NGC 2244. The dashed line shows the intrinsic color-color relation for main-sequence stars as given by Caldwell *et al.* (1993). The same relation for reddened stars with $E(B-V)=0.47$ mag taken from Park & Sung (2002).

## Acknowledgement

This work was supported by the NCN grant 2011/03/B/ST9/02667.

## References

Bagnulo, S., Hensberge, H., Landstreet, J. D., Szeifert, T., & Wade, G. A. 2004, *A&A* 416, 1149
Bonatto, C. & Bica, E. 2009, *MNRAS*, 394, 2127
Caldwell, J. A. R., Cousins, A. W. J., Ahlers, C. C., van Wamelen, P., & Maritz, E. J. 1993, *South African Astronomical Observatory Circular*, 15, 1
Hensberge, H., Pavlovski, K. & Verschueren, W. 2000, *A&A*, 358, 553
Park, B.-G. & Sung, H. 2002, *AJ*, 123, 892

https://doi.org/10.1017/S1743921313015019 Published online by Cambridge University Press