# DETECTION OF A NEW PHOSPHORUS RICH STAR IN THE OPEN CLUSTER M6

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Abstract. We present the first spectroscopic analysis of HD318101, a member of the M6 (NGC 6405, age 100 Myr) open cluster, using low and high resolution (R~7500, R~25000) spectra stretching from 4500 to 5840 Å. The atmospheric parameters of the star were determined from Geneva photometry and hydrogen line modeling ( $T_e = 15400 \pm 500$  K, log  $g = 4.0 \pm 0.25$ ). The abundances of 8 elements were determined by fitting synthetic spectral lines to the observed ones. We derived a strong overabundance of phosphorus (+1.69 dex, relative to the Sun) from several P II lines. We also found helium to be underabundant (-0.37 dex). These abundance anomalies suggest that HD318101 could be a He-weak PGa type star (CP4).

Keywords: Stars: abundances, Stars: chemically peculiar, Stars: individual: HD318101

### 1 Introduction

Non-magnetic chemically peculiar stars are divided into four main groups (Kurtz 2000):  $\lambda$  Boo (7000-10000 K, metal poor), Am (7000-10000 K, metal rich), HgMn (10000-14000 K), and He-weak PGa (13000 - 18000 K). Elemental diffusion can be the cause of these elemental peculiarities. For B stars, stellar winds might also cause some chemical peculiarities. Detailed discussions of peculiar B and A stars can be found in Alecian (1996), Kudritzki & Puls (2000), Krticka & Kubat (2004), and Gebran & Monier (2008).

HD318101 (NGC 6405 20) is one of the brightest member of the M6 open cluster. Nesterov et al. (1995) ascribed this star a spectral type B9. Johnson UBV, Strömgren *uvby*, and Geneva 7color photometric measurements of the star were published by Talbert (1965), Schneider (1985), and in the WEBDA, respectively.

## 2 Observations

The spectrum of HD 318101 was acquired with FLAMES/GIRAFFE spectrograph with MEDUSA, mounted at UT2 (Kueyen), the 8 meter class VLT telescope in May and June, 2007. The spectral regions cover three wavelength intervals: 4500-5100 Å, 5140-5350 Å, and 5590-5840 Å at resolving powers of about 7500, 25900, 24200, respectively.

#### 3 Abundance Analysis

The color B-V = -0.03 is calculated from Kharchenko & Roeser (2009). We derived an effective temperature  $(T_e)$  of 15950 K using Cox (2000)'s calibrations and an averaged color excess of the cluster:  $E(B-V) = 0.15 \pm 0.01$ . We used Geneva 7color photometry as a second indicator and derived  $T_e = 15864$  K and log g = 4.04 from Kunzli et al. (1997)'s calibrations (CALIB code). We also used synthetic profiles of the H $\beta$  line to obtain more accurate atmosphere parameters, and derived  $T_e = 15400 \pm 500$  K and log  $g = 4.00 \pm 0.25$ . Model atmospheres were calculated using ATLAS9 on Linux (Kurucz 1993, Sbordone et al. 2004, Sbordone 2005). The linelist was first constructed from Kurucz's gfall.dat, and then updated with VALD and NIST. Synthetic spectra were computed using SYNSPEC48 (Hubeny & Lanz 1992), assumming Grevesse & Sauval (1998)'s solar chemical composition.

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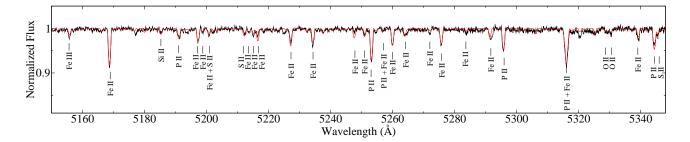


Fig. 1. The high resolution (R=25900) GIRAFFE spectrum of HD 318101 (black) and its synthetic spectrum (red).

### 4 Results and Discussion

Abundances for 8 chemical elements were determined by looking for the best fit between the observed spectrum and theoretical one (Fig. 1). The comparison of synthetic and observed spectra showed that Phosphorus overabundance of HD 318101 should be  $1.7 \pm 0.4$  dex, with respect to the Sun (~50 times more than solar) while iron abundance is solar. We also noticed an underabundance in Helium (-0.37 dex). A detailed NLTE study for O and B type stars (15000 K-35000 K) were performed by Przybilla et al. (2011). According to their comparison of LTE and NLTE models at the temparature of 22000 K, NLTE models form similar or sometimes deeper lines than LTE models for He I lines. A NLTE analysis could reduce the He abundance for this star. We failed to find Ga II lines in the range from 4500 to 5840 Å. New observations at high resolution including ultraviolet region are necessary to derive the abundances of the other elements.

The overabundance of phosphorus and the underabundance of helium suggest that HD 318101 may be a Helium-weak star, and possible a PGa (CP4) star. More accurate fundamental parameters, Iron and Gallium abundances are necessary to confirm that HD318101 is indeed a PGa star.

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