

Time Resolved Photometric and Spectroscopic Analysis of Chemically Peculiar Stars

Santosh Joshi¹, Gireesh C. Joshi², Y. C. Joshi¹ and Rahul Aggrawal¹

¹Aryabhata Research Institute of Observational Sciences (ARIES), Nainital -263129, India
email: santosh@aries.res.in

²Center of Advanced Study, Department of Physics, D. S. B. Campus, Kumaun University, Nainital-263002, India

Abstract. Here we present the report on the “Nainital–Cape survey” research project aiming to search for and study the pulsational variability of main-sequence chemically peculiar (CP) stars. For this study, the time-series photometric observations of the sample stars were carried out at the 1.04 m ARIES telescope (India), while the high-resolution spectroscopic and spectropolarimetric observations were carried out at the the 6.0 m Russian telescope. Under this project, we have recently found clear evidence of photometric variability in the Am star HD 73045, which is likely to be pulsating in nature with a period of about 36 min, hence adding a new member to the family of the δ Scuti pulsating variables that have peculiar abundances.

Keywords. stars: chemically peculiar, variables : δ Scuti, techniques : photometric, spectroscopic, polarimetric

1. Introduction

Chemically peculiar (CP) stars show strong and/or weak absorption lines of certain elements in their optical spectrum in comparison to normal stars of similar spectral type. The two classes of CP stars known as metallic-line (Am) and A-peculiar (Ap) stars are important tools for asteroseismological studies because some of them exhibit multi-periodic pulsational variability. Am stars are non-magnetic and generally found in a binary system. Many of them are now known to exhibit low-amplitude pulsational variability with a period range similar to those of δ -Scuti variables. Conversely, Ap stars are magnetic with field strengths of the order of kG. One of the sub-group of this class is known as rapidly oscillating Ap (roAp) stars which pulsate with periods between 5 and 23 min. The pulsations of Am and Ap stars are important astrophysical tools to study the complex relationship between stellar pulsations and magnetic fields in the presence of atmospheric abundance anomalies. To study these phenomena, we have initiated a survey project at ARIES (India) to search for the pulsational variability in Ap and Am stars.

2. Sample selection, observations and data reduction

The criteria of sample selection was to select those A- and F-type stars having Strömgren indices similar to those of known roAp stars (Joshi *et al.* 2009). The photometric observations were carried out at the 1.04 m telescope of ARIES in the high-speed photometric mode with a continuous 10 s integrations through a Johnson B filter and 30" diaphragm aperture. The data reduction process comprises of visual inspection of the light curve to identify and remove bad data points, correction for coincident counting losses, subtraction of the interpolated sky background, and correction for the mean

and
mically

lahul Aggrawal¹
nital -263129, India

Kumaun University,

search project aiming
nically peculiar (CP)
le stars were carried
rosopic and spectro-
e. Under this project,
star HD 73045, which
lding a new member
ces.

hotometric, spectro-

on lines of certain
ilar spectral type.
(Ap) stars are im-
bit/multi-periodic
l in a binary sys-
l variability with
ars are magnetic
class is known as
and 23 min. The
udy the complex
e of atmospheric
urvey project at
ars.

pe stars having
09). The photo-
the high-speed
on B filter and
al inspection of
incident count-
n for the mean

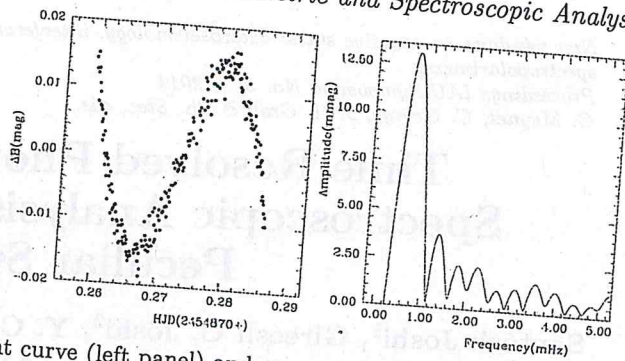


Figure 1. The light curve (left panel) and corresponding amplitude spectrum (right panel) of the Am star HD 73045.

atmospheric extinction. The resulting time-series were then analyzed using Discrete Fourier Transform (Joshi *et al.* 2006).

3. Results

The "Nainita-Cape" survey is running at ARIES since the last fifteen years, during which we found many interesting results. Firstly, we discovered a new roAp star (HD 12098) at ARIES. This is a magnetic star pulsating with a period of 7.6 min (Girish *et al.* 2001). Secondly, δ Scuti-type pulsations were discovered in 6 CP stars, namely HD 13038, HD 13079 (Martinez *et al.* 2001), HD 98851, HD 102480 (Joshi *et al.* 2003), HD 113878, and HD 118660 (Joshi *et al.* 2006). Among these pulsating variables, HD 98851 and HD 102480 are classified as unusual pulsators due to the presence of alternating high and low maxima. We have also performed time-resolved photometric, high-resolution spectroscopic and spectro-polarimetric analysis of the Ap star HD 13038 and the Am star HD 207561 (Joshi *et al.* 2010, 2012). Apart from these discoveries, we have recently detected the pulsational variability of HD 73045 with a period of ~ 36.23 min. This star belongs to the Praesepe open star cluster (Fossati *et al.* 2008). It has been classified as an Am star, in which Ca and Sc are underabundant and the Fe-peak elements are overabundant (Fossati *et al.* 2007). Here we present the preliminary light curve of HD 73045 from ARIES, Nainital obtained on HJD 2451943 (Fig. 1, left panel), while the amplitude spectrum of the time-series is shown on the right panel. A detail asteroseismic study of this star will be presented elsewhere. The prospect of our survey looks bright in the light of the upcoming observational facilities at Devasthal (ARIES), Nainital.

Acknowledgements

SJ acknowledge the International Astronomical Union for providing the travel grant to attend the international symposium IAU 307. Part of this work was done under the Indo-Russian RFBR project INT/RFBR/P-118 supported by DST, Govt. of India and Russian Academy of Science, Russia.

References

- Fossati, L., Bagnulo, S., Landstreet, J., *et al.* 2008, *A&A* 483, 891
- Fossati, L., Bagnulo, S., Monier, R., *et al.* 2007, *A&A* 476, 911
- Girish, V., Seetha, S., Martinez, P., *et al.* 2001, *A&A* 380, 142
- Joshi, S., Girish, V., Sagar, R., *et al.* 2003, *MNRAS* 344, 431
- Joshi, S., Mary, D. L., Chakradhari, N. K., Tiwari, S. K., & Billaud, C. 2009, *A&A* 507, 1763
- Joshi, S., Mary, D. L., Martinez, P., *et al.* 2006, *A&A* 455, 303
- Joshi, S., Ryabchikova, T., Kochukhov, O., *et al.* 2010, *MNRAS* 401, 1299
- Joshi, S., Semenko, E., Martinez, P., *et al.* 2012, *MNRAS* 424, 2002
- Martinez, P., Kurtz, D. W., Ashoka, B. N., *et al.* 2001, *A&A* 371, 1048