DETERMINATION OF CHEMICAL ABUNDANCES OF HD 73574 AND BD +19°2045

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Declaration

I, Gabriel Modo, declare that the work presented in this dissertation is my own and has not been presented to this institution or any other institution for any award. I confirm that where I have quoted from the works of other authors, the source is always acknowledged. With the exception of such quotations, this dissertation is my original work.

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Dedication

To my beloved family and parents.

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Abbreviations

MS	**M**ain-**s**sequence.
CP	**C**hemically **P**eculiar.
H-R	**H**ertzsprung -**R**ussell.
HESP	**H**anle **É**chelle **S**pectrograph.
HCT	**H**imalayan **C**handra **T**elescope
IAO	**I**ndian **A**stronomical **O**bservatory.
ZAMS	**Z**ero-**A**ge-**M**ain-**S**equence.
TAMS	**T**erminal-**A**ge-**M**ain-**S**equence.
Am	**m**etallic line **A** stars.
Ap	**p**eculiar **A** stars.
γ**Dor**	**g**amma **D**oradus stars.
SED	**s**pectral **e**nergy **d**istribution.
CNO	**C**arbon-**N**itroen-**O**xygen.
SME	**S**pectroscopy **M**ade **E**asy.
LTE	**L**ocal **T**hermodynamical **E**quillibrium.
CREST	**C**entre for **R**esearch and **E**ducation in **S**cience and **T**echnology.
IIA	**I**ndian **I**nstitute of **A**strophysics.
CCD	**C**oupled **C**harged **D**evice.
DSO	**D**arkk **S**ky **O**bservatory.
VOSA	**V**irtual **O**bservatory **S**ed **A**nalyzer.
NASA	**N**ational **A**eronautics **S**pace **A**dministration.
2MASS	**T**wo **M**icron **A**ll **S**ky **S**urvey.
WISE	**W**ide-field **I**nfrared **S**urvey **E**xplorer.
GALEX	**G**alaxy **E**volution **E**xplorer.
TESS	**T**ransiting **E**xoplanet **S**urvey **S**atellite.

Astrophysical Constants

Parsec (pc) = 3.085×10^{16} m.
Solar mass ($M_\odot$) = 1.988×10^{30} kg.
Solar luminosity ($L_\odot$) = 3.839×10^{26} W.
Solar metallicity ($m_\odot$) = 0.02.

Symbols

$L_\odot$ = Solar luminosity.
$M_\odot$ = Solar mass.
ξ_t = Microturbulent velocity.
$[M/H]$ = Metallicity.
$T_{\rm eff}$ = Effective temperature.
$v \sin i$ = Projectional rotational velocity.
$\log g$ = Surface gravity.
$V_{\rm r}$ = Radial velocity.
pc = Parsec.

Abstract

The intermediate mass stars on the upper main sequence (MS) of the Hertzsprung-Russell diagram (HRD) show interesting phenomena. These include chemical peculiarities, magnetic field variability, pulsations and rotation. The high resolution photometric data and low resolution ground-based spectroscopic data have been used in the past decades to characterise intermediate mass stars. The number of intermediate mass stars that have been fully characterised as chemically peculiar stars using high resolution ground-based spectroscopic data is still limited. This study increased the number of chemically peculiar stars in the general catalogue by using high resolution ground-based spectroscopic data. This data was used to determine fundamental atmospheric parameters and individual chemical abundances of HD 73574 and BD +19°2045 to fully characterise the target stars. The spectral types of the targets were determined and their fundamental atmospheric parameters obtained by spectral synthesis. The detailed chemical abundance analysis for each target was also performed. The masses of HD 73574 and BD +19°2045 were derived as $1.998 \pm 0.1\,M_{\odot}$ and $1.499 \pm 0.1\,M_{\odot}$, respectively. The ages were found to be 665 ± 34 Myr for BD +19°2045 and 702 ± 69 Myr for HD 73574. HD 73574 was classified as kA7hA8mK2 and BD +19°2045 as F2 V. Therefore, HD 73574 is an Am star while BD +19°2045 is a normal star. To estimate their evolutionary phases, all the targets were placed in the HRD. Based on spectral classification and the chemical abundance pattern of each target, HD 73574, previously treated as chemically normal A-type star, was reclassified as a chemically peculiar Am star (kA7hA8mK2) and BD +19°2045 remained a chemically normal F-type star as previously classified.

Chapter 1

Introduction

1.1 Background

The A- and F-type stars of the main sequence (MS) are intermediate mass stars with a high proportion of chemically peculiar (CP) stars (Preston, 1974; Renson, 1988; Monier, 2019). These stars show various interesting phenomena such as chemical peculiarities, pulsation, magnetic field variability and rotation (Preston, 1974; Monier, 2019; Trust et al., 2021a). Several categories of CP stars populate the interval $7000\,\mathrm{K} \leq T_{\mathrm{eff}} \leq 30000\,\mathrm{K}$ in a well defined but overlapping temperature domain on the upper MS of the Hertzsprung–Russell (HR) diagram (Preston, 1974). The CP stars (Renson, 1988; Monier, 2019) can be distinguished from the normal A-stars (Adelman, 1986, 2004) based on the enhancement of absorption lines in their spectra. The spectra of the CP stars have strong lines of Si and Cr metals and other heavy metals (Ba, Zr, Sr and Y) and/or rare–earth elements with weak lines of Ca (Titus & Morgan, 1940; Conti, 1970; Fossati et al., 2009; Trust et al., 2021a,b). The CP stars are dominated by the metallic line (Am/Fm) stars, followed by magnetic Ap stars in the intermediate mass MS part of the HR diagram (Trust et al., 2021a).

The standard classification given by Preston (1974) subdivided the CP stars into four groups, based on the magnetic field strength and the strength of the absorption lines in their optical spectra. These groups are metallic line A–stars (CP1, Am stars), magnetic Ap stars (CP2), mercury–manganese stars (CP3: HgMn) and Helium weak stars (CP4: He-weak). In Am stars, the commonly used classification includes the three spectral types with prefix *k*, *h* and *m* corresponding to Ca II K-lines, hydrogen-lines and metallic-lines, respectively (Catanzaro et al., 2015, 2019). The Am stars

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