ABSTRACT
The abstract of the paper.

1 INTRODUCTION

1.1 Motivation

The fundamental parameters of stars, such as their effective temperatures and metallicities, dictate their observed apparent properties, such as their luminosities and spectra. Hence, a full accounting of the effects of these parameters, and any physical stellar processes that impact on them, directly or indirectly, must be sought.

1.2 Thermohaline mixing

The first months of the project were dedicated to the study of thermohaline mixing. This effect was proposed by ****Ulrich (1972) and ****Kippenhahn et al. (1982) to explain anomalous chemical abundances at the surface of mature, ****low-mass red giant branch (RGB) stars. Specifically, the anomalies consist of an over-abundance of ^{12}C, ^{16}O and ^{14}N, together with a paucity of ^{7}Li and ^{1}H, in the stellar spectra. Taken together, these particular changes in these particular species indicate an interaction between the RGB star's fusion shell and the surface, i.e. a mixing effect.

$$^3\mathrm{He} +^3 \mathrm{He} \longrightarrow^4 \mathrm{He} + 2^1\mathrm{H} \tag{1}$$

$$\frac{\partial X_i}{\partial t} = \frac{1}{\rho r^2}\frac{\partial}{\partial r}\left(\rho r^2 D_{\mathrm{thl}}\frac{\partial X_i}{\partial r}\right) \tag{2}$$

$$D_{\mathrm{thl}} = C_{\mathrm{thl}} K \left(\frac{\phi}{\delta}\right)\frac{\nabla_\mu}{\nabla_{\mathrm{rad}} - \nabla_{\mathrm{ad}}} \tag{3}$$

$$K = \frac{4acT^3}{3\kappa\rho^2 c_P} \tag{4}$$

$$X_{i,n} = X_{i,n-1} + \delta t\left(\frac{\partial X_i}{\partial t}\right) \tag{5}$$

$$\nabla_\mu = \frac{d\ln\mu}{d\ln P} \tag{6}$$

$\nabla_{\mathrm{ad}} = (\partial \ln T/\partial \ln P)_{\mathrm{ad}}$
$\nabla_{\mathrm{rad}} = (\partial \ln T/\partial \ln P)_{\mathrm{rad}}$

$$\mu = \frac{1}{\sum_{i=1}^{i=N}(Z_i+1)\frac{X_i}{A_i}} \tag{7}$$

1.3 Differential extinction

Extinction of light between a source object, such as a star, and a remote observer is subject to various quantities, such as the density and metallicity of the interstellar medium along the emission travel path.
Bolometric corrections
After accounting for a general extinction effect on an object's emission, its apparent magnitude in a given filter X (i.e. wavelength range, which we define as increasing from λ_1 to λ_2) is given by:

$$m_X = -2.5\log_{10}\left(\frac{\int_{\lambda_1}^{\lambda_2} f_\lambda\left(10^{-0.4A_\lambda}\right)S_\lambda d\lambda}{\int_{\lambda_1}^{\lambda_2} f_\lambda^0 S_\lambda d\lambda}\right) + m_X^0 \tag{8}$$

where f_λ represents the monochromatic flux at a given wavelength λ at the observer distance, A_λ is the extinction value as a function of wavelength, S_λ is the response function and f_λ^0 and m_X^0 represent the monochromatic flux and apparent magnitude, respectively, of a known reference object in X. In this project,the star Vega was used as the reference.
Since our goal, ultimately, is to document potential effects of fundamental stellar properties upon observables, we need to connect the observational and idealised scenarios, for which we use bolometric corrections. For a filter X, the extinction parameter A must be ****calibrated relative to a known value. For this reference, in this work we will input a value of the extinction in the well-studied Johnson-V filter. To derive the equation linking a bolometric correction with the extinction parameter, we start with the definition of a bolometric correction in X, BC_X:

$$BC_X \equiv M_{\mathrm{bol}} - M_X \tag{9}$$

where M_X is the absolute magnitude of the object in X and M_{bol} is its (predicted) absolute bolometric magnitude, defined relative to the Sun using:

$$M_{\mathrm{bol}} = M_{\mathrm{bol},\odot} - 2.5\log_{10}\left(\frac{4\pi R^2 F_{\mathrm{bol}}}{L_\odot}\right) \tag{10}$$

where F_{bol} is the bolometric stellar flux at its surface, R is the stellar radius, $M_{\mathrm{bol},\odot}$ is the solar absolute bolometric magnitude, ****which is assumed in this work to have a value of 4.75 and $L_\odot$ is the solar luminosity, for which we use a value of 3.844×10^{33} erg s^{-1} (****Girardi et al. (2000)).
Bolometric corrections can be expressed as a function of extinction using the universal definition of M_X in terms of m_X and the distance d to the source:

$$M_X = m_X - 2.5\log_{10}\left(\left(\frac{d}{10\mathrm{pc}}\right)^2\right), \tag{11}$$

together with the equation $f_\lambda d^2 = F_\lambda R^2$, where F_λ is the monochromatic flux at λ at the stellar surface. This gives the final function for a bolometric correction:

$$\begin{aligned} BC_X = M_{\mathrm{bol},\odot} - m_X^0 - 2.5\log_{10}\left(\frac{4\pi R^2 F_{\mathrm{bol}}}{L_\odot}\right) \\ + 2.5\log_{10}\left(\frac{\int_{\lambda_1}^{\lambda_2} F_\lambda\left(10^{-0.4A_\lambda}\right)S_\lambda d\lambda}{\int_{\lambda_1}^{\lambda_2} f_\lambda^0 S_\lambda d\lambda}\right) \end{aligned} \tag{12}$$

cell1	cell2	cell3
cell4	cell5	cell6
cell7	cell8	cell9

To extract the extinction parameter A****, use the simple relation:

$$A_X = \left(\frac{A_X}{A_V}\right) A_V \tag{13}$$

together with the chosen value of A_V (for this project the values were $A_V = 0$, 1 - note that $BC_X(A_V = 0)$ assumes no extinction).

2 CURRENT STATE OF THE FIELD

2.1 Thermohaline mixing

2.2 Differential extinction

3 METHODOLOGY

When calculating the bolometric corrections, the reference values taken by the parameters for Vega were:

(i) $m_X^0 = 0.03$ for the Gaia filters
(ii) $m_X^0 = 0.00$ for the Hubble WFC3 filters

together with $M_{\mathrm{bol},\odot} = 4.75$. It should be noted that, during the final subtraction to obtain values of A_X/A_V, the m_X^0 and $M_{\mathrm{bol},\odot}$ values at both A_V calibration values are the same, so the final results are unaffected by any calibration errors.

4 RESULTS SO FAR

5 DISCUSSION

6 FUTURE WORK