Study of red giant stars in Galactic open clusters

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1. Introduction

Galactic open clusters are still the only example of single stellar populations: gravitationally bound stars that presents different masses but the same age and chemical composition. Despite multiple stellar populations are found in globular clusters, its existence in open clusters is still widely discussed in the literature. In globular clusters, one of the most common abundance variations found is the anticorrelation between CN and CH, which is the best studied since the molecular bands are easy to be measured using low resolution spectra. However, the sample of open clusters analysed is still small when comparable to that of globular clusters. Therefore, the UFRGS Open Cluster Survey (UOCS) aims to map over 150 red giant stars in 25 Galactic open clusters to seach for CN and CH abundance variations.

2. Aims

(i) to increase the number of giant stars in open clusters that have been spectroscopically surveyed to date;

(ii) to obtain radial velocities to determine membership for the stars in the survey;

(iii) to analyze their chemical distribution (CN-CH bands), and

(iv) to impose observational constraints on the lower mass needed to start contributing for the formation of multiple stelar populations in clusters.

3. Observations and data reduction

Our sample consists of approximately 150 stars distributed in 25 Galactic open clusters. Their spectra were acquired with GOODMAN, a low resolution spectrograph (R $=$ 2800) mounted at the 4.1m SOAR Telescope.

The observations were carried out on four semesters (2016-2017). The observed wavelength ranges from 350 to 616nm, and the spectra obtained have a signal-to-noise ratio of $\langle S/N \rangle \approx 100$. Data reduction was done using the Image Reduction and Analysis Facility (IRAF) software.

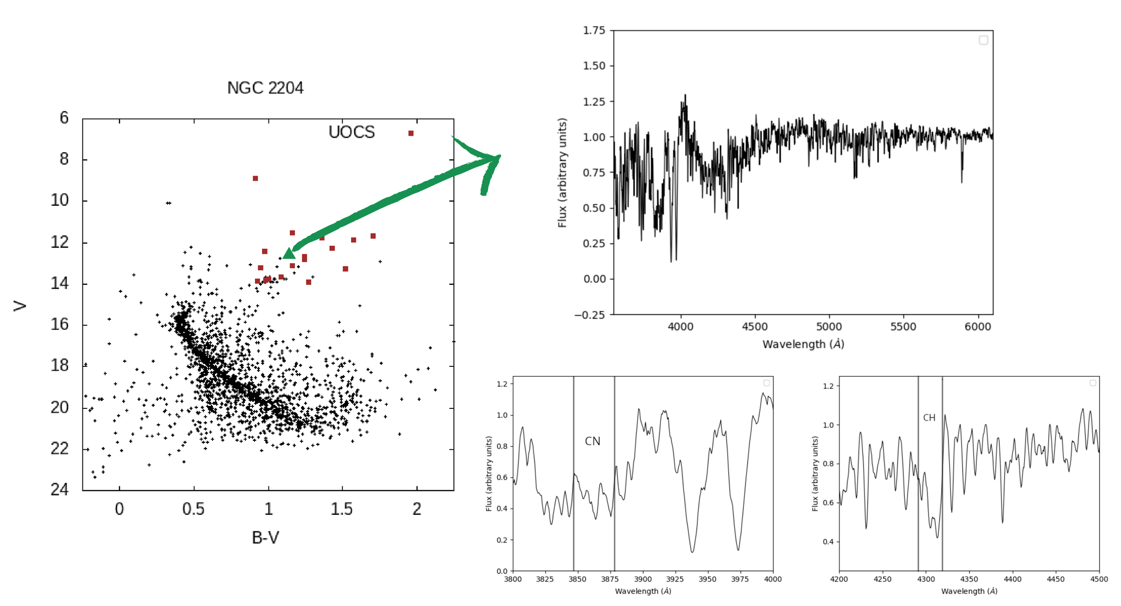

Figure 1: NGC2204_32, red giant star belonging to the open cluster NGC 2204 observed in the survey. In the image its spectrum is shown with the CN and CH indices highlighted, as well as the color magnitude diagram of the cluster.

4. Methods

The stellar atmospheric parameters - effective temperature (T_{eff}) and surface gravity ($log\ g$) - were obtained by photometric methods. The photometric T_{eff} were calculated using $(V - K_s)$ colour employing the calibrations of Alonso et al. 1999. This calibration was chosen because an error of 0.05 in mag implies mean errors of just 1.0 0.7% in temperature. The surface gravity was estimated using the relation

$$log\frac{g_*}{g_\odot} = 4log\frac{T_*}{T_\odot} + 0.4(M_{bol*} - M_{bol\odot}) + log\frac{M_*}{M_\odot}. \quad (1)$$

The heliocentric radial velocities were determined using IRAF *rvidlines* task by measuring the position of a large number of absorption lines along each spectrum. The tangential velocities were obtained from Gaia proper motions' data.

5. Preliminary results

We calculated the effective temperature and surface gravity of the survey stars. In Figure 2, we observe that almost all the stars in the sample have values within the expected for red giant stars (Ciardi et al., 2011). From radial and tangential velocity data, we built velocity fields for the survey clusters. An example is shown in Figure 2, for the Berkeley 39 open cluster.

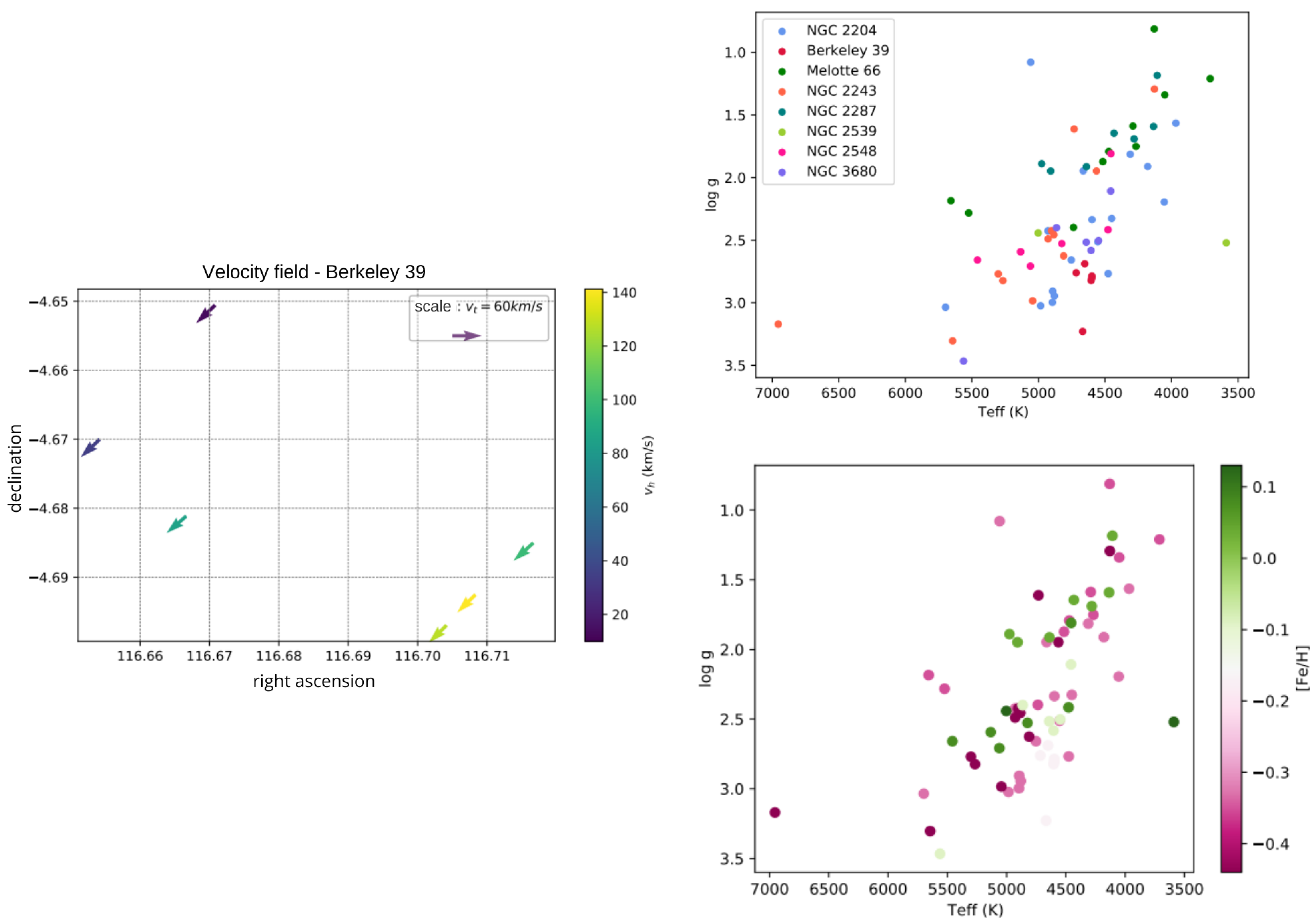

Figure 2: On the left, velocity field of the stars observed in the open cluster Berkeley 39. Right: effective temperature, surface gravity and [Fe/H] of observed stars in different clusters observed. Uncertainties are not shown as they are smaller than the size of the points.

6. Conclusions and perspectives

The results presented in this work are important as a validation mechanism of photometric methods and, in particular, the spectroscopic methods, aiming to determine fundamental stellar parameters of giant stars using low resolution data. The methodology will be applied to other survey stars.

Together with the CN and CH spectral indices that will be measured, the fundamental parameters are essential for characterizing the program stars presented here and answering some of the most fundamental questions about the chemical evolution of stars in star clusters.

7. References

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