Carnegie Observatories Astrophysics Series, Vol. 4:
Origin and Evolution of the Elements, 2003
ed. A. McWilliam and M. Rauch (Pasadena: Carnegie Observatories,
http://www.ociw.edu/ociw/symposia/series/symposium4/proceedings.html)

Metallicities of RGB Stars in Local Group Dwarf Irregular Galaxies

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Abstract

While the current metallicities of Local Group dwarf irregular galaxies (dIrrs) are relatively well-known from spectroscopy of their H II regions, how they reached those elemental abundances over time is less well understood. Measuring the abundances of intermediate-age and old stars in these galaxies is a powerful probe of their chemical evolution. With the Keck I telescope and LRIS spectrograph, we have obtained spectra over the wavelength range 7500 – 9000 Å of red giant branch (RGB) stars in NGC 6822 and IC 1613, two Local Group dIrrs. We have derived Ca abundances for these stars from the equivalent widths of the two strongest lines in the Ca II triplet, and used empirical calibrations from the literature to convert these to values of [Fe/H] for these stars. Our preliminary results indicate that the average RGB metallicity, i.e. [Fe/H], in NGC 6822 is approximately −1.0, while that for IC 1613 is closer to −1.3.

1.1 Introduction

Detailed abundances have been measured for many individual stars in the Milky Way and its halo and globular clusters, providing us with insight into the formation and early evolution of the Galaxy. Until recently, our knowledge of the elemental abundances in other galaxies has been largely derived from aggregate measurements, or from spectroscopy of H II regions, which yields information about the current metallicity in the ISM of star-forming galaxies. However, the advent of 8- and 10-meter-class telescopes in the past decade has made it possible for astronomers to directly measure the elemental abundances of individual stars in nearby galaxies. One method for doing so involves moderate resolution ($\sim$ 1Å) spectroscopy of the Ca II triplet (8498Å, 8542Å, and 8662Å) in red giant branch (RGB) stars (cf. Rutledge et al. 1997, and references therein). Ca abundances measured in this way have been calibrated to Fe abundances using observations of Milky Way open and globular cluster red giants.

1.2 Observations and Data Reduction

During the nights of 11 and 12 September 2001, we observed a sample of RGB stars (Figure 1.1) in the Local Group dwarf irregular galaxies (dIrrs) NGC 6822 and IC 1613 with the LRIS spectrograph on the Keck I telescope (Oke et al. 1995). We obtained spectra over the wavelength range 7500 – 9000Å at a dispersion of 0.64Å pixel^{-1} for stars in two fields in the central regions of NGC 6822 and one field near the center of IC 1613. Exposure times

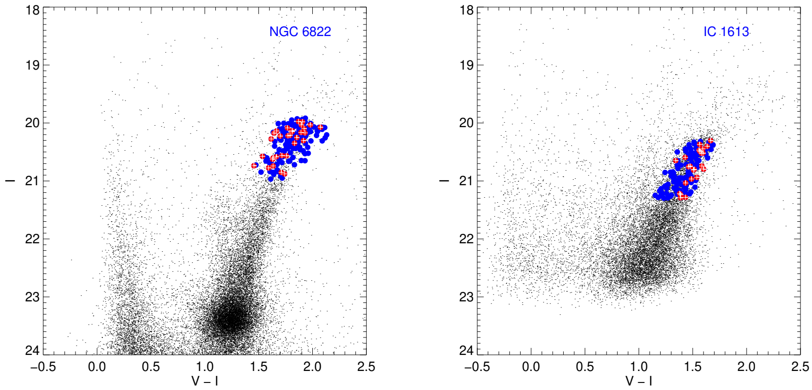

Fig. 1.1. $V, V-I$ color-magnitude diagrams (CMDs) of sections of NGC 6822 (left), created from HST WFPC-2 photometry, and IC 1613 (right), generated from groundbased WIYN photometry (Cole 2000). Stars meeting our photometric and positional selection criteria are shown by blue dots; red dots with white crosses indicate stars for which we here present data.

for each field totaled ~ 2 hours, yielding S/N of $\sim 10-15$ per pixel in the continuum near the Ca II triplet.

We applied standard `IRAF` tasks to reduce the data, using night sky emission lines to calibrate wavelength and to fit and remove geometric distortion from the two-dimensional spectrum produced by each slit. After extracting and combining one-dimensional spectra (Figure 1.2), we measured the equivalent widths (EWs) of the Ca II lines by integrating across each absorption feature.

1.3 Analysis

Following common practice, we have only used the EWs of the two strongest Ca II lines in our analysis and have applied the Ca II EW – [Fe/H] calibrations from Tolstoy et al. (2001), which make use of the results of Cole et al. (2000), Rutledge et al. (1997), and Carretta & Gratton (1997), among others. The summed EWs of these two lines are plotted versus V-band photometric offset from the horizontal branch (HB) for NGC 6822 (Figure 1.3, left panel) and IC 1613 (Figure 1.3, right panel). In Figure 1.4, we show the resulting metallicity distributions for each galaxy. These preliminary results indicate that the average RGB metallicity in NGC 6822 is [Fe/H] ~ -1.0, while the average in IC 1613 is somewhat lower ([Fe/H] ~ -1.3). Our results for NGC 6822 are quite consistent with those obtained by Tolstoy et al. (2001) in a similar study carried out at the VLT.

1.4 Acknowledgements

D. Z. is supported by the National Science Foundation through an International Postdoctoral Fellowship. The data presented here were obtained at the W.M. Keck Observatory, which is operated as a scientific partnership among the California Institute of Technology, the University of California and the National Aeronautics and Space Administration.

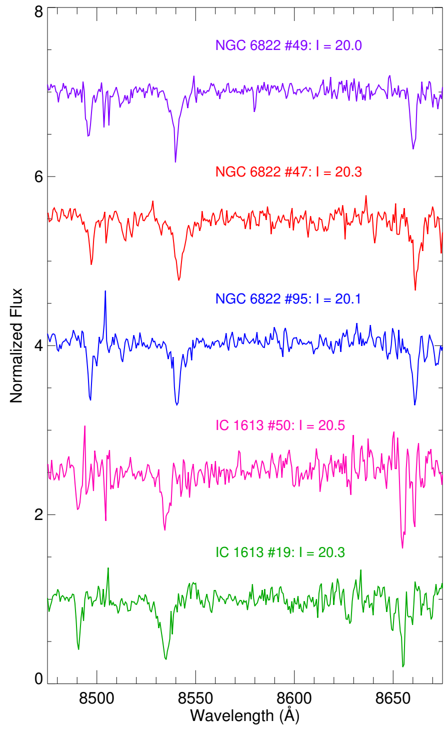

Fig. 1.2. Keck LRIS spectra of a sample of our target stars in the region around the Ca II triplet (8498 Å, 8542 Å, and 8662 Å). The spectra shown are normalized to the continuum level and offset vertically. Each star is labeled with its host galaxy and *I*-band magnitude.

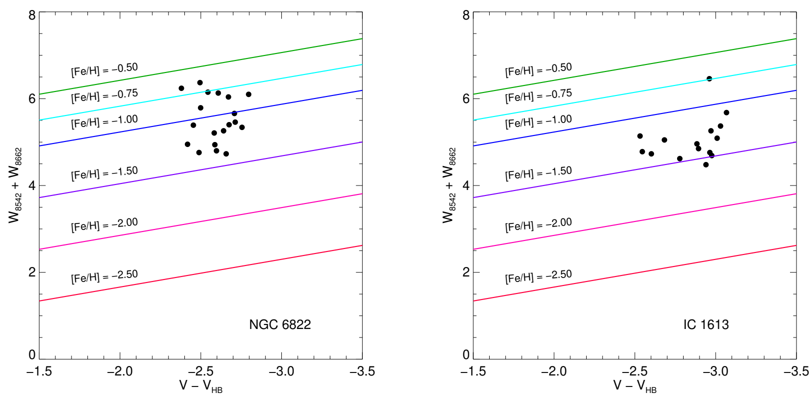

Fig. 1.3. The summed EWs of the two stronger Ca II lines for 19 stars in NGC 6822 (left) and 15 stars in IC 1613 (right), plotted versus V magnitude offset from the horizontal branch (HB). Lines of constant metallicity are overplotted, based on the calibration of Rutledge et al. (1997).

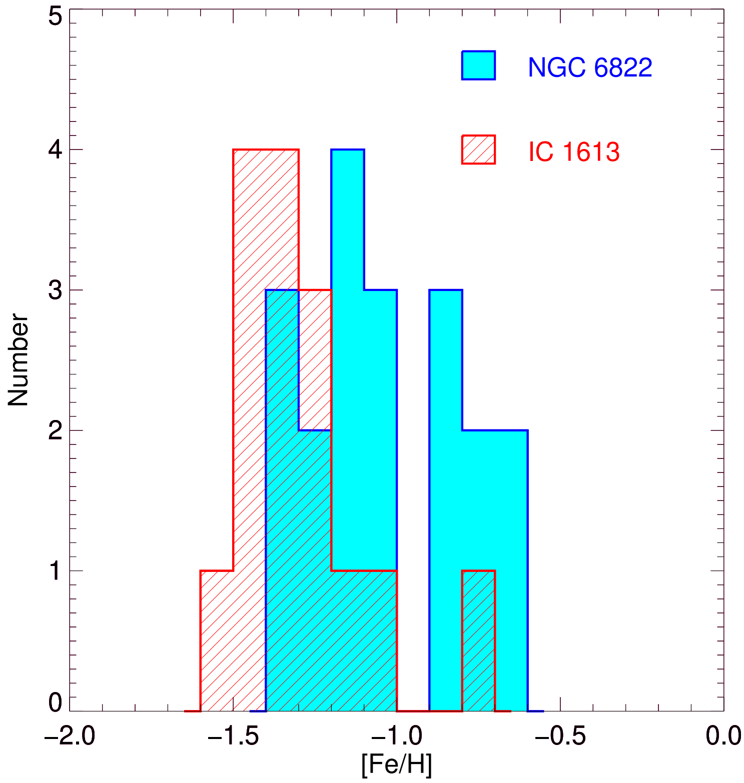

Fig. 1.4. The metallicity distribution of the sample of RGB stars, based on our preliminary analysis.

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