Spectroscopy of Late Type Giant Stars

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The study of chemical abundances and their variation in the galaxy is of fundamental importance for our understanding of galactic evolution. The still unanswered questions about the dynamical and chemical evolution of the different Halo constituents (Globular Clusters, RR Lyrae stars and subdwarfs) demand for more observations of distant stars which are luminous enough to trace the halo. Considerable efforts which require extensive surveying techniques have been undertaken to accomplish this goal. As examples we mention the work of H. Bond (1980) and M. Hawkins (1984).

In this paper we describe the attempt to calibrate the broadband RGU colours of late type giant stars in terms of physical parameters. The three physical parameters describing the stellar atmosphere are the effective temperature, defined as $\Theta_{eff} = 5040°/T_{eff}$, the surface gravity log g and the global abundance of metals with respect to the sun [M/H]. We hope that, once this calibration has been established, the wealth of the existing photographic RGU data (Basel Programme, W. Becker 1972) can be used effectively to constrain models of our galaxy and its evolution.

The programme described here is an extension of our preliminary spectroscopic observations at the Haute-Provence Observatory (Thévenin et al., 1983). We have selected 27 suspected giant stars in the three Basel fields Plaut 1 (Spaenhauer et al., 1983), Centaurus III (Spaenhauer and Fang, 1982) and a field near HD 95540 (Becker and Hassan, 1982). Fig. 1 shows the two-colour diagram of the observed stars. The continuous line denoted with LC V represents the mean loci of disk main-sequence stars (Buser 1978). The V-shaped continuous line denoted with LC III represents the giant branch of M67 (Spaenhauer et al., 1982) which is identical with the one calculated with spectral scans (Buser, 1978).

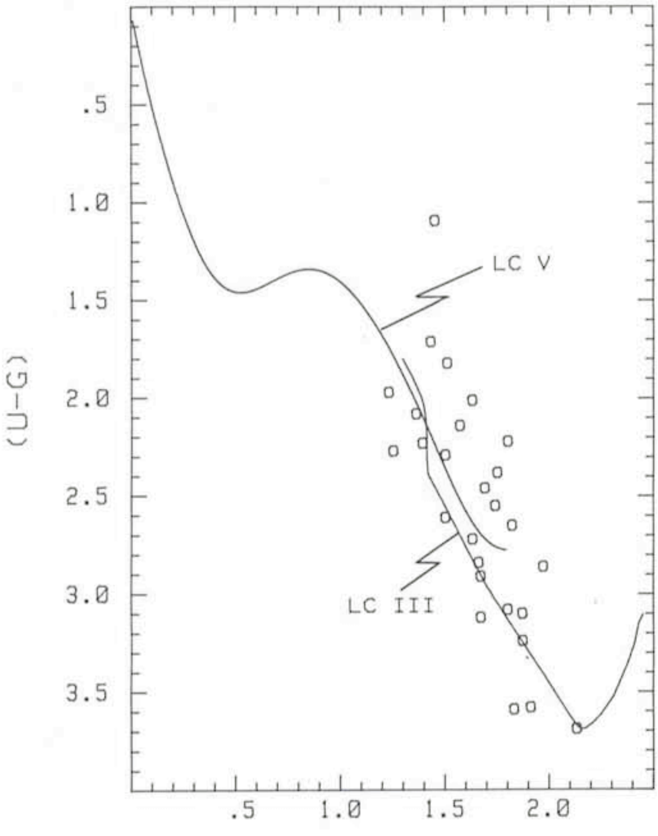

Fig. 1: *RGU two-colour diagram of the programme stars. The two continuous lines represent the mean loci of disk main sequence stars (LC V) and disk giants (LC III) respectively.*

The observations were made with the 1.52 m ESO telescope at La Silla equipped with the Echelle Spectrograph and Lallemand camera giving a resolution of ~ 2 Å. The three physical parameters Θ_{eff}, log g and [M/H] have been determined with the method described by Thévenin and Foy (1983).

For the further discussion, we restrict ourselves to the colour range $1^m\!.50 \leqslant$ G-R $\leqslant 2^m\!.15$ corresponding to the spectral type range K0 to K5, so that a total of 21 stars can be used. In order to get a photometric estimator of the metallicities of these stars, we first applied a multiple linear regression of the form [M/H] = a. (G-R) + b. (U-G) + c, which gave the formal solution a = 3.19, b = −1.61, c = −0.58. We therefore define R = 3.19 (G-R) −1.61 (U-G) −0.58 as the simplest (linear) photometric estimator of the metallicity. It may be useful to visualize R as defined above. When we substitute the actual colour indices (G-R) and (U-G) of the star in the equation above, it turns out that R is (apart from scaling) the distance of the position of the star from the M67 giant branch in the two-colour plane (R = 3.6 distance). The relation between [M/H] and R is shown in Fig. 2. Omitting star No. 1246, which shows a large residual from the relation defined by the other stars, we arrive at the following quadratic relation: [M/H] = −0.48, R −0.44.R^2 with a correlation coefficient r^2 = 0.93.

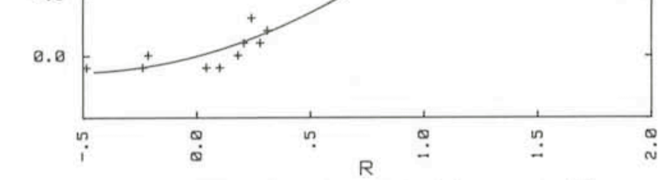

Fig. 2: *[M/H] versus R (broadband metallicity index, see text) diagram + programme stars. The continuous line is a quadratic polynomial regression curve omitting star (+).*

Due to the increasing insensitivity of broadband colours to decreasing metallicity, this formula will no more be valid for [M/H] $\leqslant -2$ (R $\geqslant$ 1.5).

It is interesting to note that there is hardly a correlation between log g and R (r^2 = 0.01) as well as between Θ_{eff} and R (r^2 = 0.18). These findings suggest that R is a metallicity indicator analogue to δ (U-G) or δ (U-B) for the subdwarfs (Wildey et al. 1962).

This report would be incomplete without mentioning the support of the technical staff and night assistants who contributed essentially to the success of our observing run. Furthermore we gratefully acknowledge the financial support from the Swiss National Foundation for part of this work.

References

Becker, W. 1972: *Quarterly Journal Roy. Astron. Soc.* **13,** 226.
Becker, W., Fang, Ch. 1973: *Astron. Astrophys.* **95,** 184.
Becker, W., Hassan, S. 1982: *Astron. Astrophys. Suppl.* **47,** 247.
Bond, H.E. 1980: *Astrophys. J. Suppl.* **44,** 517.
Buser, R. 1977: *Astron. Astrophys.* **62,** 411.
Hawkins, M.R.S. 1984: *Monthly Notices of the Royal Astronomical Society.* **206,** 433.
Spaenhauer, A., Fenkart, R.P., Becker, W. 1982: *Mitt. Astron. Ges.* **57,** 316.
Spaenhauer, A., Fang, Ch. 1983: *Astron. Astrophys. Suppl.* **47,** 441.
Spaenhauer, A., Topaktas, L., Fenkart, R.P. 1983: *Astron. Astrophys. Suppl.* **51,** 533.
Thévenin, F., Foy, R. 1983: *Astron. Astrophys.* **122,** 261.
Thévenin, F., Spaenhauer, A., Foy, R. 1983: *Astron. Astrophys.* **124,** 331.
Wildey, R.L., Burbidge, E.M., Sandage, A.R., Burbidge, G.R. 1962: *Astrophys. J.* **135,** 94.

Deep Photometry of Far Globular Clusters

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Introduction

It is well known that our Galaxy can be represented by a flat disk and an extended approximate spherical halo.

The observed halo population consists of old, sparse stars, somewhat more than one hundred globular clusters and, in the peripheral part, some dwarf spheroidal galaxies.

While the nearest, classical globular clusters, like M 3, M 13, M 15, are the subject of extensive literature, the data concerning the outer halo clusters are sparse.

With a few exceptions these outer halo objects seem systematically different from the inner halo ones in concentration and in brightness. Their low intrinsic luminosity, combined with their large distance, explain why most of them were discovered only by the material collected during the wide field surveys with Schmidt telescopes (mainly Palomar and ESO).

While the role of the white spheroidal galaxies in the evolutionary picture of the Galaxy is not completely clear, the outer halo clusters seem the only presently observable samples of the external regions of the halo. Considering the large galactocentric distance and the low density of their environment, we may suppose that they are good "archeological relicts" of the primeval Galaxy.

About twenty star systems of this kind are known, but only four have been studied in detail. The importance of a systematic survey of them for the study of the early galactic evolution seems evident.

Observations

A general survey of distant and faint globular clusters, specifically the Palomar-Abell clusters, has been undertaken at the Asiago Observatory since 1957 under the direction of Prof. L. Rosino. However, more detailed studies require high photometric accuracy and very good sky conditions (seeing, transparency).

Thus, when Italy joined ESO in 1982, the possibility of using the ESO instrumentation at La Silla appeared very promising. The exploration of the possibilities of the new CCD detector at the Danish 1.5 m telescope seemed particularly interesting for B, V stellar photometry.

About 50 frames were obtained, under excellent sky conditions, during a four-night run in January 1983. Very good B, V pictures of the clusters Am-1, Pal 3 and GLC 0423-21 were the main results of these observations (Fig. 1–3).

The reduction was carried out at ESO's Garching computer centre using VAX/MIDAS and HP/IHAP systems. The results show that a very good photometric accuracy was achieved at very faint magnitudes ($\Delta m = 0.1$ at $m_V = 22$).

The quality of the results is guaranteed by our tests on standard stars showing very good stability (better than 0.03 mag.). The linearity is very good, giving deviations smaller than 0.03 magnitude over a 6-magnitude interval ($17 < m_V < 23$).

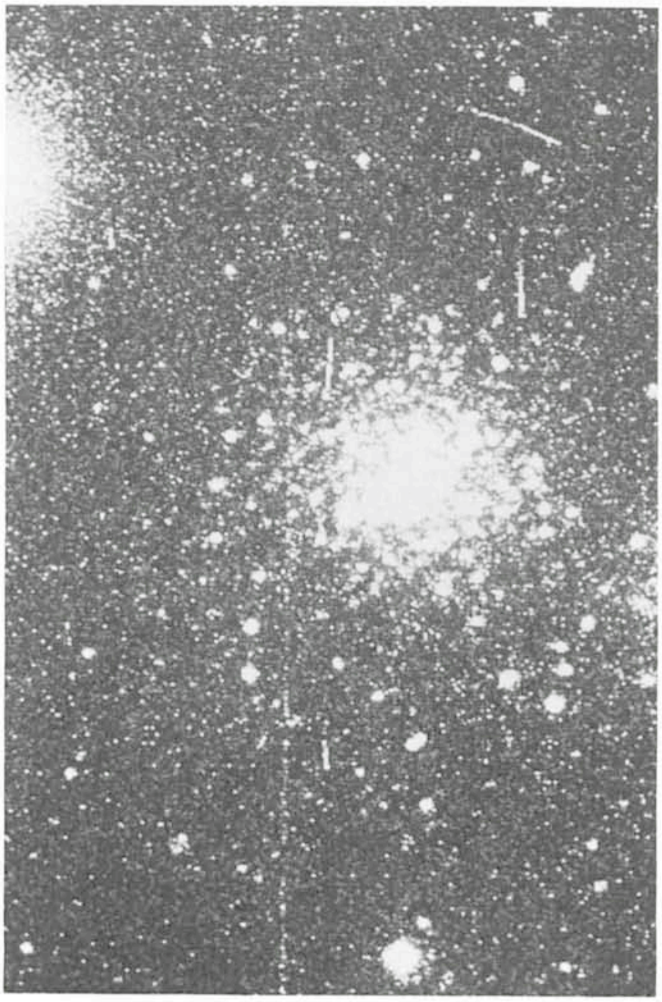

Fig. 1: *B CCD image of the globular cluster AM-1. North at the top, east at right. The field is approximately 3′×4′.*