AN EMPIRICAL CALIBRATION OF THE STRÖMGREN SYSTEM FOR LATE-TYPE STARS

B. Nelles, Th. Richtler and W. Seggewiss

Observatorium Hoher List, Bonn University

1. INTRODUCTION

The applicability of the Strömgren system for abundance determination of late-type stars has been shown by several authors (e.g. Eggen 1978b, Bond 1980, Ardeberg and Lindgren 1981). The aim of our contribution is not to present a completely new calibration. Rather we want to discuss the (b-y)-m_1 diagram with an increased sample of spectroscopically analysed stars, hoping to eliminate some unsatisfying properties of previous approaches and to make improvements in terms of generality and reliability.

We want to show:

(1) the insensitivity of the (b-y)-m_1 diagram to log g effects,

(2) the existence of a uniform relation between metallicity and a suitable parameter for stars in the color range $0.3 < b-y < 1.0$.

2. THE DATA

Our calibration sample consists mainly of stars taken from the [Fe/H] catalog of Cayrel de Strobel et al (1980), for which vby colors are available (the u band shall be ignored). Most of these colors come from the lists of Eggen (1978a) and Olsen (1983). Although Eggen uses a narrower v filter than that of the standard system, one can see from 19 stars in common with Olsen that the mean differences in b-y and m_1 are just $0\overset{m}{.}006$ and $0\overset{m}{.}03$, respectively. We therefore treat the colors as homogeneous.

A few additional, mostly metal-poor stars were measured by Nelles and Richtler (1983). Also included are some further spectroscopically analysed stars, listed by Bond (1980). We end up with 136 stars.

Reddening has been taken into account for 43 stars. The values are from Bond (1980) and Neckel et al. (1980). For most of the other stars we expect that the reddening can be neglected due to their small distances.

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3. THE CALIBRATION

According to the late-type star models of Bell and Gustafsson (1978) the (b-y)-m_1 diagram should be insensitive to gravity effects. In their empirical study, Ardeberg and Lindgren (1981) arrive at a different conclusion. However, they do not make sure that they compare stars of equal metallicity.

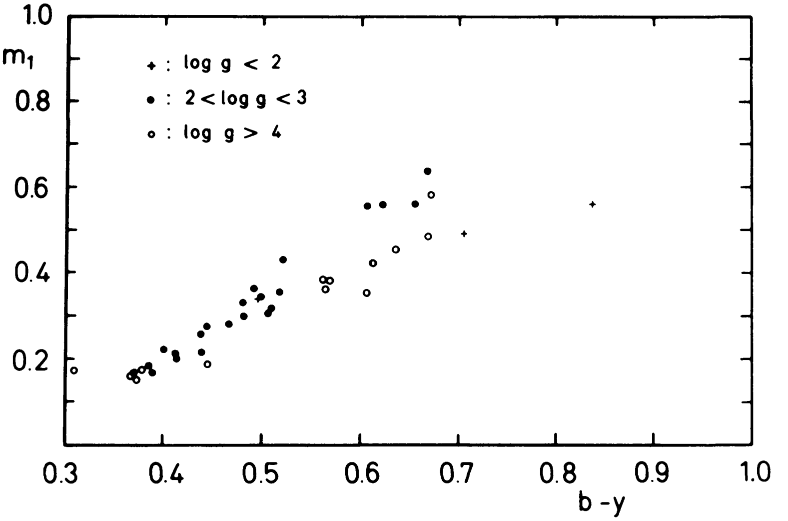

Fig. 1. Stars of different *log* g in the metallicity range $-0.2 < [Fe/H] < 0.2$

Fig. 1 shows all stars in our sample which fall in the metallicity range $-0.2 < [Fe/H] < 0.2$. A gravity effect in the sense of Ardeberg and Lindgren is not seen (one may even suspect the opposite behavior). Furthermore, Eggen's (1983) list of high luminosity stars supports also the theoretical prediction that surface gravity does not affect the locus of a late-type star in the (b-y)-m_1 diagram. (Without that assumption, no simple approach to abundance calibration would be possible.)

We assume that the photometric loci of equal metallicity can be represented by straight lines ($m_1 = a_1 + a_2(b-y)$), whose slopes and intersections depend linearly on metallicity. (The slopes decrease with decreasing abundance, leading to a lower metallicity resolution for blue stars.) Thus the dependence of [Fe/H] from m_1 and b-y takes the form

$$[Fe/H] = A + B \frac{m_1 + C}{(b-y) + D} \qquad \text{with} \qquad \mu \equiv \frac{m_1}{(b-y) + D} .$$

The four constants A, B, C, and D are determined by least-squares' fit using the photometric data and the catalog values for [Fe/H]. Weights were given to the individual values of μ according to the expected photometric errors of m_1 and b-y. In this way allowance is made for the lower metallicity resolution at blue colors.

One yields

$$A = -3.34 \pm 0.11, \quad B = 2.93 \pm 0.13, \quad D = -0.22 \pm 0.01.$$

C can assumed to be zero ($C = 0.016 \pm 0.017$).

Fig. 2 shows the relation between [Fe/H] and μ for our sample. The scatter of the blue stars (crosses) seems not to be larger than that of the red stars (open circles). We take this as a hint that the overall scatter is essentially a consequence of the inhomogeneities in the [Fe/H] data than in the photometric data. Although a proper discussion of individual reddenings, [Fe/H] values etc. would reduce the scatter, we do not expect that the mean relation will change significantly.

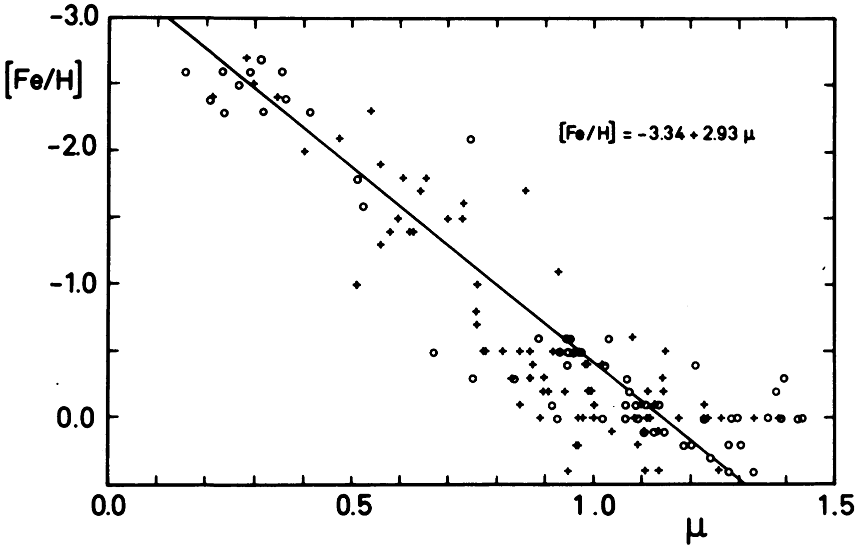

Fig. 2. Calibration of μ against metallicity for our sample of 136 stars. Open circles represent stars in the color range $0.5 < b-y < 1.0$, crosses in the range $0.3 < b-y < 0.5$.

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