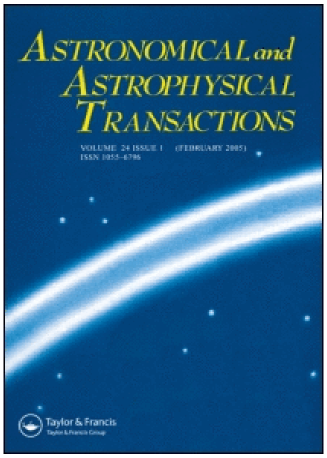

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ON THE CONNECTION OF THE METALLICITY OF A GLOBULAR CLUSTER WITH ITS AGE AND GALACTOCENTRIC DISTANCE BASED ON NEW DATA

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The connection of the metallicity of a globular cluster with its age and galactocentric distance is redetermined according to the new data.

Keywords: Star clusters; Globular star clusters; Age of star clusters; Metallicity; Galactic structure

1 INTRODUCTION

In 1995 (Eigenson and Samus, 1995) the formula connecting the metallicity of globular cluster with its age and galactocentric distance was proposed (unfortunately in the cited paper there was an error, see below). The obtained correlation turned out to represent the data available satisfactorily. Meanwhile the new, more exact information concerning the above-mentioned quantities appeared (Rosenberg *et al.*, 1999). It refers particularly to the age of globular clusters which is the most unreliable quantity. In fact the ages of globular clusters have not been determined clearly so far. This age is a very important parameter. Moreover, we do not know the absolute values nor even relative values. Probably, the only fact that can be asserted with some certainty is that cluster A is probably older than cluster B, and the age of cluster C is likely to be somewhere between them the ages of cluster and B.

The paper by Rosenberg *et al.* (1999) contains more exact values of 35 globular clusters. This is connected with the fact that these relative ages have been determined not only by 'the vertical' method, that is according to the quantity $\Delta V_{\rm TO}^{\rm HB}$ (the difference between the quantities at the turn-off point of the main sequence and its horizontal branch), but also from the horizontal $\delta(V-I)_{2.5}$, that is according to the difference between the turn-off point colours and those of giants at the level magnitude 2.5 above the turn-off point. Rosenberg *et al.* (1999) considered this method to be more accurate and the obtained estimates of the relative age to be more realistic. Because of this, it seems advisable to repeat the calculations made by Eigenson and Samus (1995) by applying the new more accurate data. This is the chief goal of the present paper.

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However, we are going to make some preliminary remarks. Namely, as in the paper by Eigenson and Samus (1995), we assume that the metallicity of globular clusters is determined by the metallicity of the environment in the epoch of its formation. Hence this metallicity depends upon its age and the galactocentric distance at the moment of birth of the globular clusters, but we do not know the places of their birth. Therefore we assume that it is where the clusters are situated or, in any case, it is at the same distance from the centre of Galaxy. However, if the orbit of the cluster is prolongated, this could not be true. Therefore, errors in determining the unknown quantity are unavoidable; in turn, this will inevitably lead to errors in the results.

The other source of errors is uncertainty in the estimation of the age of globular clusters. It is sufficient to note that, in accordance with the work of Rosenberg *et al.* (1999), the error of several hundredths in the assumed reddening will lead to an error of several billion years in the estimation of their age. Finally all these numerous miscellaneous and different-weight uncertainties which are intrinsic to the theory of internal structure and evolution of stars and to the comparison of isochronous with the observed colour magnitude diagrams will inevitably be included in the error in the age estimation.

As was mentioned above (Eigenson and Samus, 1995), all these factors can lead to a partial if not to a full the omission of dependence between the quantities under consideration, if, despite everything, such a dependence has been found, it may be of unquestionable interest.

2 CALCULATIONS AND RESULTS

After all these remarks and 'excuses' let us proceed to the essence of the matter. We apply the data about the metallicity [m/H] given by Rosenberg *et al.* (1999), and those about the galactocentric distance R and relative age t of 35 globular clusters. The same correlation as in the work of Eigenson and Samus 1995 was further assumed:

$$\frac{[\mathrm{m}]}{[\mathrm{H}]} = a + b\left(1 - \frac{t}{t_{\max}}\right) + c\left(1 - \frac{R}{R_{\max}}\right), \tag{1}$$

where $t_{\max}$ and $R_{\max}$ are the maximum age and maximum galactocentric distance respectively of the cluster of the given pattern. In particular, in the previous paper a mistake was made; the solidus sign (/) after a should have been a plus (+) as here. The calculations have been made in three versions. The relative age estimations obtained separately by the vertical method and horizontal method have been used in them, as well as the mean values of these estimations. As a result the following values of coefficients were obtained in equation (1): according to the vertical method,

$$a = -2.11 \pm 0.22, b = 2.67 \pm 0.76, c = 0.89 \pm 0.27, r = 0.55 \pm 0.12;$$

according to the horizontal method,

$$a = -2.12 \pm 0.15, b = 2.98 \pm 0.49, c = 0.83 \pm 0.20, r = 0.72 \pm 0.08;$$

according to mean values,

$$a = -2.16 \pm 0.18, b = 3.09 \pm 0.62, c = 0.90 \pm 0.23, r = 0.66 \pm 0.10,$$

where r is the coefficient of correlation between the actual values of metallicity and those which are obtained with substitution of t and R into equation (1). It is obvious that just this parameter, that is the correlation coefficient between the actual values of metallicity and those predicated by equation (1), is the most illustrative index, namely the indicator of approximate 'quality'.

We see that the greatest value of the correlation coefficient r is obtained in the correlation coefficient r is obtained in the application of the horizontal method. This indicates the quality of the approximation as well as the fact that the 'horizontal' ages are more real. In this connection it should be noted that the value r obtained is considerably greater than found by Eigenson and Samus (1995) (in their paper, $r = 0.5$). This fact allows us to consider that the work reported here is justified.

The obvious advantage of equation (1) is its descriptive note; it shows how the process of enriching interstellar environment with metals proceeds. However, one can try to solve this problem straightforwardly, that is to write the correlation between the values under consideration as a linear approximation:

$$\frac{[\mathrm{m}]}{[\mathrm{H}]} = a + b\frac{t}{t_{\max}} + c\frac{R}{R_{\max}}. \tag{2}$$

Then the corresponding coefficients are as follows: according to the vertical method,

$$a = 1.45 \pm 0.76,\ b = -2.67 \pm 0.76,\ c = -0.89 \pm 0.27,\ r = 0.55 \pm 0.12;$$

according to the horizontal methods,

$$a = 1.69 \pm 0.48,\ b = -2.98 \pm 0.49,\ c = -0.83 \pm 0.20,\ r = 0.72 \pm 0.08;$$

according to mean values,

$$a = 1.83 \pm 0.61,\ b = -3.09 \pm 0.62,\ c = -0.90 \pm 0.23,\ r = 0.66 \pm 0.10.$$

It is not difficult to become convinced that equations (1) and (2) are equivalent, that is that they give the same results.

Thus, summarizing, we propose a new formula connecting the metallicity of globular clusters with their relative age and distance from the centre of Galaxy. New data about ages, distances and metallicities have been used. The results obtained are self-evident; in 9 years we have succeeded in improving essentially the quality of the approximation.

References

Eigenson, A. M. and Samus, N. N. (1995) *Astron. Astrophys. Trans.* **8**, 261.
Rosenberg, A., Savaire, I., Piotto, G. and Aparicio, A. (1999) *Astron. J.* **118**, 2306.