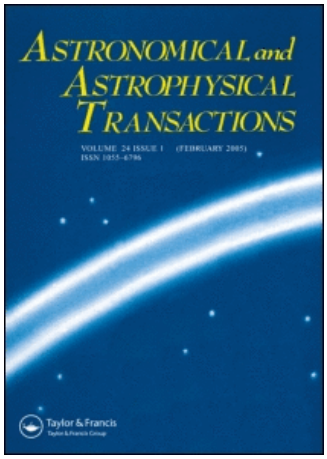

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

On the relation among metallicity, age, and galactocentric distance of globular clusters

A. M. Eigenson [a]; N. N. Samus [b]
[a] Astronomical Observatory of Lviv University, Lviv, Ukraine
[b] Institute of Astronomy of Russian Academy of Sciences, Russia

Online Publication Date: 01 November 1995
To cite this Article: Eigenson, A. M. and Samus, N. N. (1995) 'On the relation among metallicity, age, and galactocentric distance of globular clusters', Astronomical & Astrophysical Transactions, 8:4, 261 - 262
To link to this article: DOI: 10.1080/10556799508226941
URL: http://dx.doi.org/10.1080/10556799508226941

Astronomical and Astrophysical Transactions, 1995,
Vol. 8, pp. 261–262
Reprints available directly from the publisher
Photocopying permitted by license only

ON THE RELATION AMONG METALLICITY, AGE, AND GALACTOCENTRIC DISTANCE OF GLOBULAR CLUSTERS

A. M. EIGENSON[1] and N. N. SAMUS[2]

[1] *Astronomical Observatory of Lviv University, Lviv, the Ukraine*
[2] *Institute of Astronomy of Russian Academy of Sciences, Russia*

(Received February 12, 1995)

Using the least-square solution, we have derived an equation relating metallicity of a globular cluster to its age and galactocentric distance. We discuss the possibility to use this equation for studies of the Galaxy's chemical evolution.

KEY WORDS Star clusters: globular — star clusters: age — star clusters: metallicity — galactic structure

According to common ideas, metallicity of a globular cluster (GC) is determined by the metallicity of the surrounding medium at the epoch of its formation. Thus, metallicity [m/H] of a GC must be primarily determined by its age t and by its galactocentric distance R_{GC} at its formation epoch. However, the particular form of the relation among [m/H], t, and R_{GC} remains unknown. This paper aims to an attempt to find such a relation.

Here we encounter a number of difficulties. First, we do not know where a given cluster was formed. We have to use the present galactocentric distance as an estimate of the original distance value. However, for elongated GC orbits this assumption may lead to errors. Second, GC age estimates are extremely uncertain. Third, errors are present also in metallicity determinations. As the result, superposition of all these uncertainties could be able even to completely "wash out" the ties among the variables of interest, even in the case of the relation in question really existing. But if a significant relation comes out, it might be of interest.

We are aware of two most complete lists of GC ages. Peterson (1987) presents t values for 41 GCs, and a later study by Chabayer *et al.* (1992) contains estimates of t for 32 GCs. In the first case, the range of ages is from 10 to 22 Gyr; in the second one, it is from 10 to 17 Gyr. Both studies use ΔV_{TO}^{HB} values (magnitude differences between the main sequence turn off and the horizontal branch), along with metallicity values, as the base of age determinations. The two systems of ages differ somewhat, and they use different metallicity scales; our calculations have been made for both lists separately.

We assume the following relation for the considered variables:

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

where $t_{\max}$ and $R_{\max}$ are the greatest values (or some limiting values) of age and galactocentric distance. Such form of this relation is convenient because it clearly demonstrates the process of enrichment of the medium with metals. We impose on both samples a limit of $R_{\max} = 25$ kpc; this leaves 34 GCs in the first sample and 29 GCs in the second one.

The least-square solution of equations (1) gives for the first sample:

$$\begin{aligned} a = -2.33 \pm 0.32; \quad b = 1.70 \pm 0.55; \quad c = 0.73 \pm 0.38; \\ \sigma_0 = 0.37; \quad r = 0.51 \pm 0.13. \end{aligned} \tag{2}$$

For the second sample:

$$\begin{aligned} a = -2.43 \pm 0.26; \quad b = 2.21 \pm 0.71; \quad c = 0.71 \pm 0.33; \\ \sigma_0 = 0.35; \quad r = 0.50 \pm 0.14. \end{aligned} \tag{3}$$

Here r is the correlation coefficient between the tabulated [m/H] values and those "predicted", i.e. derived when substituting the tabulated t and R values into Eq. (1).

Significant correlations appear in both cases. Taking into account the above-mentioned sources of errors, we may consider this result quite satisfactory.

Strictly speaking, Eqs. (1–3) are an acceptable approximation only for the covered range of metallicities, ages, and galactocentric distances of GCs. Assuming, however, that the process of metal enrichment was universal for the interstellar medium, and substituting solar parameters ($R \approx 8$ kpc, $t \approx 5$ Gyr), we obtain $[\mathrm{m/H}] \approx -0.5$ from Eq. (2) and $[\mathrm{m/H}] \approx -0.4$ from Eq. (3). Considering the above-discussed uncertainties, these values seem quite reasonable. Is this fact a chance coincidence, or is our assumption sufficiently realistic? In the latter case, Eqs. (2–3) could be used as an independent method of age estimations for objects with known metallicities and galactocentric distances. This would lead to ages considerably below 10 Gyr for a number of GCs inside the "solar circle" showing high metallicity. To answer the formulated question, it is apparently necessary to further accumulate and improve observational data.

References

Chabayer, B., Sarajedini, A., and Demarque, P. (1992) *Astrophys. J.* **394**, 515.
Peterson, Ch. J. (1987) *Publ. Astron. Soc. Pacif.* **99**, 1153.