APPARENT ROTATION OF THE GALACTIC GLOBULAR CLUSTER SYSTEM

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ABSTRACT: We use the radial velocities of galactic globular clusters, corrected for solar motion to calculate their apparent angular momentum. Comparing the apparent angular momentum with a numerical simulation we show, with 90% confidence, that the globular cluster system is in prograde rotation. The distribution of angular momentum with Fe/H reveals three distinct groups of clusters with different kind of rotation:

1) 19 clusters with Fe/H > -0.8 have a solid-body rotation in the direct sense.
2) 33 clusters with -1.75 < Fe/H < -0.8 do not exhibit any rotation (80%.confidence).
3) 27 clusters with Fe/H < -1.75 have a uniform rotational velocity in the direct sense (90% confidence).

1. SIMULATION OF THE GLOBAL SYSTEM

At the present time we have only the radial velocities of the globular clusters to determine the kinematics of the global system. Thus the results that we can obtain concern apparent motions. In this paper we calculate the apparent angular momentum of 99 clusters whose radial velocities are given by Zinn (1985) and the resulting apparent total momentum of the system. We find J_T = 7900 kpc km/s and we search to see if this value is sufficiently high to represent a global rotation. To do that we replace the radial velocity of each cluster by a random velocity whose value is between plus and minus 270 km/s, that is the maximum observed radial velocity corrected for the solar motion and we calculate the corresponding total angular momentum. This simulation is made 2000 times; the resulting moments J_S are always between ± 10,000 kpc km/s. Thus the observed value, J_T is inside these maxima and could be simply explained by the lack of tangential velocities. But the 2000 angular moments obtained by simulation are centered on zero and are distributed according to a Gaussian curve with a standard deviation T = + 5200 kpc km/s. The observed value is out of the standard deviation and the probability to obtain it is 10%. Thus, the probability that the system of globular clusters rotates is 90%.

J. E. Grindlay and A. G. Davis Philip (eds.),
The Harlow-Shapley Symposium on Globular Cluster Systems in Galaxies, 521–522.

2. ROTATION OF THE SUBSYSTEMS OF THE GLOBLAR CLUSTERS

The plot of the apparent angular moments against the galactocentric distance for each cluster is not very significant, but the angular moments against the metallicities divide the system of globular clusters into three groups (Fig. 1.):

1) Fe/H > -0.8 with only positive values of the angular moments.
2) -0.8 > Fe/H > -1.75 with positive and negative values.
3) -1.75 > Fe/H with positive values.

For each of these three subsystems we use the same simulation as that used for the global system. We find that the first group has a prograde rotation (95% confidence), the second group has no rotation (48% confidence) and the third group has a prograde rotation (92% confidence).

For each group, we investigated the angular velocity of a frame in which the sum of the residual angular moments is zero. We also investigated the constant rotational velocity V_{Rot} calculated in such a way that, if for each cluster we take out the partial angular momentum corresponding to V_{Rot}, the sum of the residual moments is zero. This is a way to define the global rotation.

Therefore, we find that the metal-rich clusters have a prograde solid-body rotation; the metal-intermediate group has no rotation (or perhaps a slow retrograde one), and the metal-poor clusters have a prograde differential rotation.

REFERENCE

Zinn, R. 1985 Astrophys. J. 293, 424.

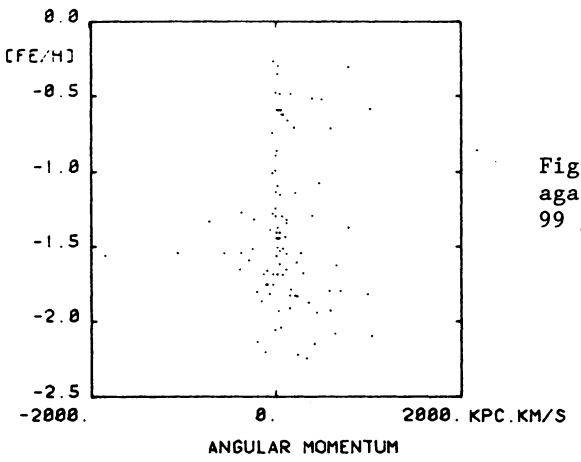

Fig.1. Distribution of Fe/H against angular moments for 99 globular clusters.

https://doi.org/10.1017/S0074180900042911 Published online by Cambridge University Press