RADIAL VELOCITY STUDY OF NGC 6712

J. Grindlay, C. Bailyn, R Mathieu and D. Latham

Harvard/Smithsonian Center for Astrophysics

ABSTRACT: We report MMT Echelle radial velocity observations of 52 giants within 3 core radii of the center of NGC 6712. The mean radial velocity of these stars is -107.5 km/s, with a line of sight velocity dispersion of 4.0 km/s. We use these data, together with CCD photometry of the cluster, to derive a mass to light ratio for the center of the cluster of 0.7, an unusually low value.

1) VELOCITY DISPERSION

NGC 6712 is an unusual globular cluster in that it is the only cluster with a high luminosity X-ray source which is *not* centrally condensed. If tidal capture of neutron stars is the mechanism responsible for the X-ray binaries, as is generally accepted, one would expect that they would preferentially arise in dense clusters. NGC 6712 is therefore a particularly strong candidate for a cluster which is currently in a state of post-core-collapse reexpansion, since the X-ray source could then have been created when the cluster was denser at some time in the past (Grindlay, 1985). There may be dynamical differences between collapsing and reexpanding clusters (Bettweiser and Sugimoto 1984); with this in mind, we undertook a study of the radial-velocity dispersion of NGC 6712.

74 giants within three core radii of the center of NGC 6712 ($13.4 \leq m_V \leq 15.2$) were observed with the MMT Echelle spectrograph, to an accuracy of $\approx$ 1 km/s. Of the stars observed, 52 were found to have velocities between -116 km/s and -98 km/s and we consider these to be cluster members. Several of these stars were observed more than once; none showed any significant velocity variation. The other stars all had velocities more than 50 km/s away from these values. All of these stars were reobserved; no significant velocity changes were found, and we conclude that they are not members.

The 52 cluster members have a mean velocity of -107.5 km/s and a line of sight velocity dispersion of 4.0 km/s. The radial distribution of the velocity dispersion is consistent with an isothermal distribution. No sign of rotation is detected in the cluster.

2) MASS-TO-LIGHT RATIO

We have also obtained CCD photometry of the central regions of the cluster

J. E. Grindlay and A. G. Davis Philip (eds.),
The Harlow-Shapley Symposium on Globular Cluster Systems in Galaxies, 659–660.

as part of a UBV photometric survey of X-ray globular clusters (Bailyn et al. 1986). The CCD frames allowed us to determine several other cluster parameters. We find that the central surface brightness in V is 18.48 magnitudes per square arcsecond, which is within 0.02 magnitudes of the value quoted by Webbink (1985).

From the radial-velocity distribution, central surface brightness, and core radius ($\approx 40''$ Cohn and Lugger, private communication) one can derive a value of M/L at the center of the cluster which is relatively model independent (see Richstone and Tremaine, 1986). Richstone and Tremaine's Equation 1 can be written in the form

$$\left(\frac{M}{L_V}\right)_0 = \eta\ 5.2 \times 10^{-32} \times \left(\frac{\sigma^2 d}{R_{hb} 10^{\cdot 4(D_V + V_\odot - l_0)}}\right)$$

where σ is the line of sight velocity dispersion in cm/s, d is the distance to the cluster in cm, R_{hb} is the half brightness radius of the cluster in arc seconds, D_V is the observed distance modulus to the cluster in V, $V_\odot = 4.8$ is the absolute V magnitude of the Sun, l_0 is the central surface brightness of the cluster in V magnitudes per square arc second, and η is a numerical factor very close to unity for a wide variety of dynamical models. Using the values given above of σ = 4km/s, $R_{hb} = 40''$, $l_0 = 18.48$, $D_V = 15.6$ and d = 6.2kpc (Webbink 1985), we derive a value of M/L of 0.7. The errors in this value come primarily from uncertainty in the velocity dispersion and the core radius, and are probably around 20%. This is one of the lowest mass-to-light ratios yet found for a globular cluster (see Pryor et al. 1987) which would indicate that there is relatively little dark matter in the center of NGC 6712.

ACKNOWLEDGEMENTS: We thank H. Cohn and P. Lugger for performing the surface density profile, and useful discussions. This work was partially supported by NSF grant NSF-AST-84-17846.

REFERENCES

Bailyn, C. D., Grindlay, J. E., Cohn, H. and Lugger, P. M. 1986, in preparation.

Bettweiser, E. and Sugimoto, D. 1984 Monthly Notices Roy. Astron. Soc. 208, 493.

Grindlay, J. E. 1985 in IAU Symposium No. 113, Dynamics of Star Clusters, J. Goodman and P. Hut, eds., Reidel, Dordrecht, p. 43.

Pryor, C., McClure, R. D. and Hesser, J. E. 1987 in IAU Symposium No. 126, Globular Cluster Systems in Galaxies, J. E. Grindlay and A. G. D. Philip, eds., Reidel, Dordrecht, p. 661.

Richstone, D. O. and Tremaine, S. 1986 Astron. J. 92, 72.

Webbink. R. F. 1985 in IAU Symposium No. 113, Dynamics of Star Clusters, J. Goodman and P. Hut, eds., Reidel, Dordrecht, p. 541.