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Newly Discovered Globular Clusters in the Outer Halo of M31

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Abstract. We present nine newly discovered globular clusters in the outer halo of M31, found by a semi-automated procedure from an INT Wide Field Camera survey of the region. The sample includes a candidate at the largest known projected galactocentric radius yet from M31.

1. Introduction

ΛCDM cosmological models, and their semi-analytical extensions, have had considerable success in describing hierarchical structure formation and galaxy evolution. However, important questions still remain. For example, where are the predicted large number of low mass dark halos? What are the profiles of the dark halos? How important are major and minor mergers in building galaxies and star formation? One way to address such issues is by detailed study of nearby resolved galaxies, to deduce evolutionary history from their present day structure. The galaxies of the local group are ideal for such investigations, and a wide area CCD survey of the halo of M31 has been undertaken by our collaboration. This survey has already revealed previously unknown detail and structure (Ferguson et al. 2002), including the discovery of a large stellar stream,

presumably the relic of dwarf galaxy destruction (Ibata et al. 2001). We have now used this survey to complete a search for previously undiscovered globular clusters, which are important tracers of the dynamics and chemistry of the outer halo .

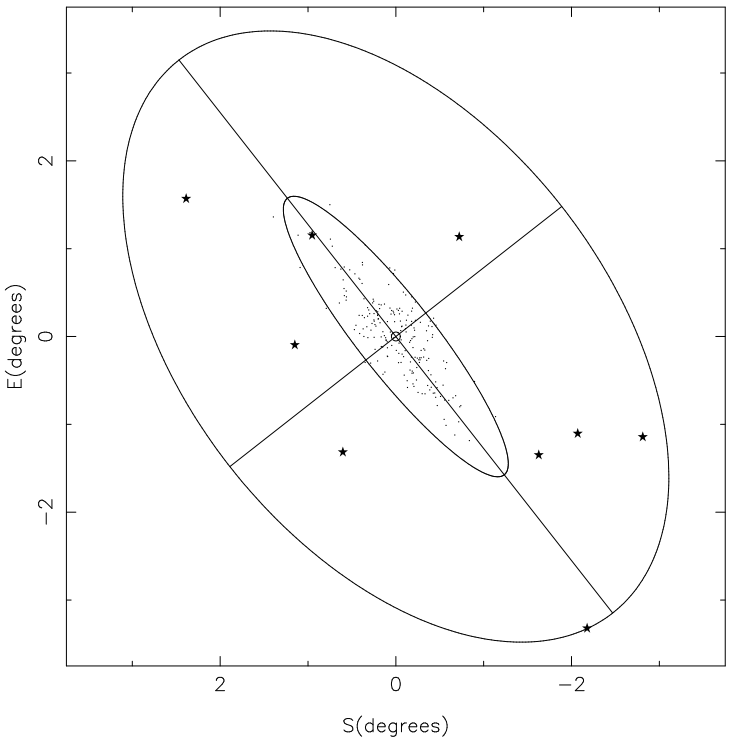

Figure 1. The area of our imaging survey (roughly outlined by the large ellipse) in relation to the visual extent of the M31 disk (small ellipse). The new GCs (asterisks) contribute additional dynamical probes, which, although few in number, extend well beyond the region for which radial velocities have been published (points) by Perrett et al. (2002).

2. GCs as Dynamical and Chemical Tracers

Recent modeling by Evans et al. (2000) suggests that, contrary to accepted wisdom, the mass of the halo of M31 is comparable to, or less than, that of the Milky Way. However the uncertainties are large. For example, test particles at large galactocentric radius are important to constrain the total mass, but are currently limited to dwarf satellites and other Local Group galaxies whose past interactions with, for example, Milky Way are not known. Thus Evans & Wilkinson (2000) emphasize the need for more test particles at an appropriate distance. Globular clusters (GCs) are particularly useful, being relatively

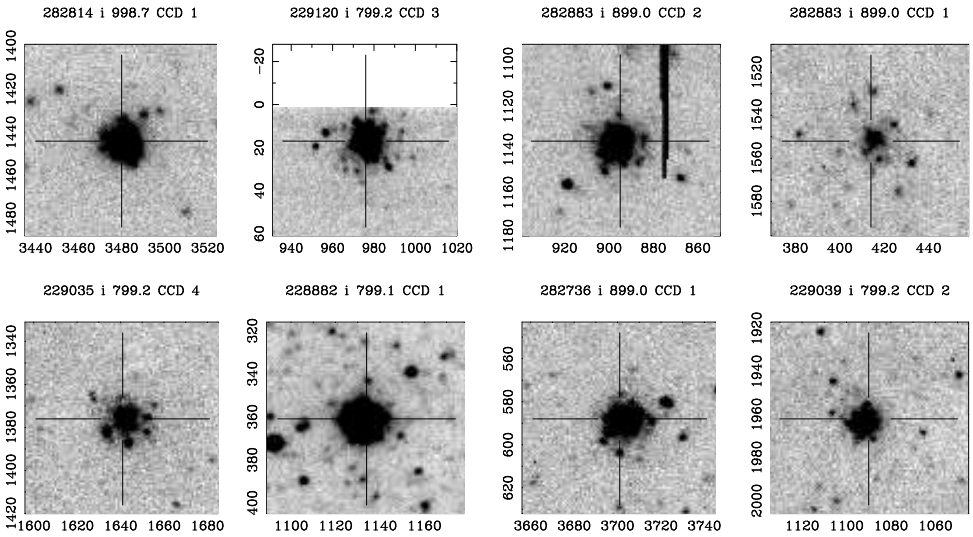

Figure 2. Eight of the globular cluster candidates. Images are from the INT Wide Field Camera survey, taken in the i band; each is $30'' \times 30''$. North is up and East is left.

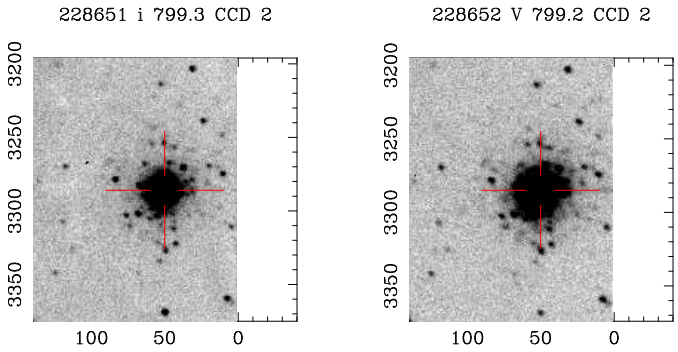

Figure 3. i and V band images of the GC candidate that is at the largest known project galactocentric distance, some 55 kpc. Images also from the INT/WFC survey, and have same size and orientation as in Figure 2.

bright, they enable good spectroscopy, and are found far from the host galaxy (e.g., Figure 1), hence our motivation in seeking new examples in the outer halo. Furthermore, there is evidence that they occur in distinct sub-populations, as characterized by position, velocity, and color (Perrett et al. 2003). These populations provide a fossil record of the formation history of the galaxy. Various routes have been proposed for the production of GCs. Each produces specific

signatures being found in that GC population, which will help to unravel the history of the M31 system. Hence, we are also interested in the metallicity of our candidate globular clusters, in addition to their kinematics.

3. Candidate Identification

Initial candidates were found from the survey database, produced by the standard INT Wide Field Survey pipeline and provided by the Cambridge Astronomical Survey Unit. Candidate selection was based on magnitude, color, ellipticity, object classification (stellar/non-stellar), and image width (sigma). These values were iteratively refined, by ensuring that known good quality cluster candidates were accepted by the cuts. Few GCs are expected at such large galactocentric radii, and selecting candidates based solely on the criteria listed above would produce too many false positives for spectroscopic follow-up. Hence, the initial list of candidates were visually inspected to identify final candidates, and these were finally cross-checked against existing catalogues (especially the online catalogues maintained by Barmby and by Huchra) giving the final nine, previously unknown, GCs presented here.

4. Future Work

One of the candidate GCs, at the extreme south-west of the M31 survey field, lies at the largest known projected galactocentric radius from M31. Spectroscopy of this object was obtained with WHT/ISIS in service time at the end of 2002. The data is currently being reduced, and the results will presented in a later paper. Further time for radial velocity and metallicity determination of the other eight candidates is currently being sought.

References

Evans, N. W., et al. 2000, ApJ, 540, L9
Evans, N. W., & Wilkinson, M. I. 2000, MNRAS, 316, 929
Ferguson, A. M. N., et al. 2002, AJ, 124, 1452
Ibata, R., et al. 2001, Nat, 412, 49
Perrett, K. M., et al. 2003, ApJ, 589, 790
Perrett, K. M., et al. 2002, AJ, 123, 2490