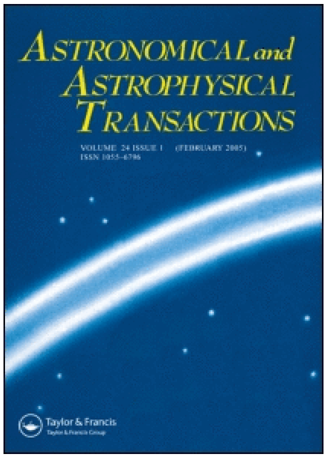


Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

# Globular clusters in early-type dwarf galaxies

M. E. Sharina; T. H. Puzia [a]
[a] Space Telescope Science Institute, Maryland, USA

Online Publication Date: 01 April 2006
To cite this Article: Sharina, M. E. and Puzia, T. H. (2006) 'Globular clusters in early-type dwarf galaxies', Astronomical & Astrophysical Transactions, 25:2, 217 - 220
To link to this article: DOI: 10.1080/10556790600896024
URL: http://dx.doi.org/10.1080/10556790600896024

*Astronomical and Astrophysical Transactions*
Vol. 25, Nos. 2–3, April–June 2006, 217–220





# Globular clusters in early-type dwarf galaxies

M. E. SHARINA*† and T. H. PUZIA‡

†Special Astrophysical Observatory, Russian Academy of Sciences, Nizhnii Arkhyz, Karachai-Cherkessian Republic 369167, Russia
‡Space Telescope Science Institute, 3700 Sun Martin Drive, Baltimore, Maryland 21218, USA

*(Received 5 July 2006)*

One of the main aims of modern astrophysics is to understand the role of dwarf galaxies and their globular cluster (GC) systems as building blocks of massive galaxies. Dwarf spheroidal (dSph) and dwarf elliptical (dE) galaxies reveal unusual properties. Recent studies of dSph galaxies in the Local Group and other nearby groups within 10 Mpc show that these galaxies are composed mainly of old stars, contribute the faintest end of the galaxy luminosity function, are repositories of dark matter and often contain bright globular clusters near their centres. Studying the abundances and colour–magnitude diagrams of GCs in nearby dSph and dE galaxies can shed light on their evolutionary histories. GCs in the early-type satellites of the Andromeda galaxy, NGC 147, NGC 185 and NGC 205, are close enough to be resolved into single stars by the Hubble Space Telescope (HST). We discuss the results of our high-quality HST–WFPC2 photometry of stars in these GCs and the measurements of ages, metallicities and [$\alpha$/Fe] ratios for these GCs, based on integrated-light spectra obtained with the SCORPIO spectrograph at the 6 m telescope of the Russian Academy of Sciences.

*Keywords*: Dwarf galaxies; Globular clusters; Abundances; Stellar content

## 1. Properties of globular clusters in dwarf elliptical and dwarf spheroidal galaxies

It is known that 50–80% of dwarf elliptical (dE) galaxies in nearby clusters, Virgo and Fornax, are nucleated (see, for example, [1, 2]). High-resolution Hubble Space Telescope (HST) images show that the cores of dE galaxies are in fact bright compact globular clusters (GCs). Dwarf spheroidal (dSph) galaxies are fainter analogues of dE galaxies. They have absolute magnitudes $M_V$ greater than $-14$ and mean surface brightness magnitudes $\mu_V$ greater than 22 magnitude per square arcsecond [3]. Very few dSph galaxies can be seen at a distance of about 30 Mpc. Owing to the observational selection effect (see, for example, [4]), hundreds of dSph galaxies could be missed because of their low surface brightnesses. Our search for GCs in nearby low-surface-brightness dwarf galaxies within 10 Mpc [5] has shown that the detection rate of globular cluster candidates (GCCs) in dSph galaxies is approximately twice that in dwarf irregular (dIrr) galaxies. In contrast with dIrr galaxies, about 60% dSph galaxies with GCs have a cluster located near their galaxy centre. The distribution of GCCs in the half-light radius

*Corresponding author. Email: sme@sao.ru

*Astronomical and Astrophysical Transactions*
ISSN 1055-6796 print/ISSN 1476-3540 online 
http://www.tandf.co.uk/journals
DOI: 10.1080/10556790600896024

versus luminosity plane (see figure 9 in [5]) shows that the majority of GCCs in dSph galaxies fall below the relation found by van den Bergh and Mackey [7] for Galactic GCs. All Galactic GCs reside below this line except for NGC 2419 and ω Cen, which have luminosities and half-light radii similar to our sample central GCC in KK84, a dwarf elliptical satellite close to NGC 3115. It would be probably more correct to call this GC a core of its parent galaxy. Another GCC in KK221, a dSph galaxy in the Cen A group, shows roughly the same absolute magnitude as the core of KK84: $M_V = -9.8$. However, it is located at a distance of about 1.8 kpc from the centre of the galaxy. KK221 is one of the faintest galaxies in our sample with a mean surface brightness magnitude $\mu_{V0}$ of 27 magnitude per square arcsecond. There are another five GCCs in this galaxy. The total number of GCs normalized to the visible stellar light in KK221 is much higher than in KK084. Why does KK221 host this amount of GCs? Either KK221 was much brighter in the past and has lost its mass recently, or it has a very high $M/L$ ratio. A question about the distinction in properties and possible evolutionary connection between nuclei of dE galaxies and central GCs of dSph galaxies should be addressed to dynamic evolutionary and detailed spectroscopic and colour–magnitude diagram (CMD) studies.

## 2. Globular clusters in NGC 205, NGC 185 and NGC 147

Three dwarf elliptical satellites of M31 provide an unique opportunity to study the GC systems of dE galaxies in detail. These galaxies were classified by van den Bergh [8] as E5p/dSphN, dSph/dE3p and dSph/dE5 respectively. They are composed mainly of old stars. However, in distinction to NGC 147, NGC 205 and NGC 185 have a considerable amount of gas and an intermediate-age stellar population. According to previous extensive studies summarized in a monograph by van den Bergh [9], NGC147 hosts four GCs, one of which (not the brighter GC) is very close to the centre of the galaxy, whereas NGC 205 and NGC 185 host seven and eight GCs, respectively. NGC 205 has a bright intermediate-age star cluster at its optical centre. A star-forming region near the centre of NGC 185 [10] may be where a massive young star cluster is forming. All three galaxies are embedded in an extended halo of M31 consisting of red giant stars [11]. So, it might be suggested that the GCs of NGC 205, NGC 185 and NGC 147 can share some properties with the M31 halo GC system.

High-quality HST–WFPC2 photometry of individual stars in eight globular clusters in NGC 205, NGC 185 and NGC 147, namely Hodge II, FJJ I, FJJ II, FJJ III, FJJ IV, FJJV, Hubble II and Hubble VIII, was performed by Sharina *et al.* [6]. The Hess diagrams obtained for the GCs after decontamination of the CMDs from the contribution of field stars are shown in figure 5 of [6]. It appears that all eight GCs contain blue horizontal branch stars, which implies old ages. The approximate ages of the GCs were estimated to be in the range $10 \pm 4$ billion years, and the metallicities in the range [Fe/H] = [$-1.3$ to $-2.1$] dex after comparison of the stellar photometry data with theoretical isochrones of the Victoria-Regina models of VandenBergh [12].

Sharina, Afanasiev and Puzia [13] observed 16 GCs in NGC 205, NGC 185 and NGC 147 with the SCORPIO spectrograph [13] at the 6 m telescope at the Russian Academy of Sciences. Line index measurements in the well-known and universally used Lick index system (see, for example, [14]) were made by Sharina *et al.* [6] to derive accurate chemical compositions and ages of the individual GCs. Figure 4 in [6] shows the Lick index measurements for the metal-sensitive absorption index [MgFe]′ versus the age-sensitive Balmer-line indices H$\alpha$, H$\gamma_{\rm A}$ and H$\gamma_{\rm F}$ for GCs in NGC 205 and NGC 185. The distributions of the GCs according to the obtained age, [$Z$/H], and [$\alpha$/Fe] using SSP model predictions from [15] are shown in figure 1. All the

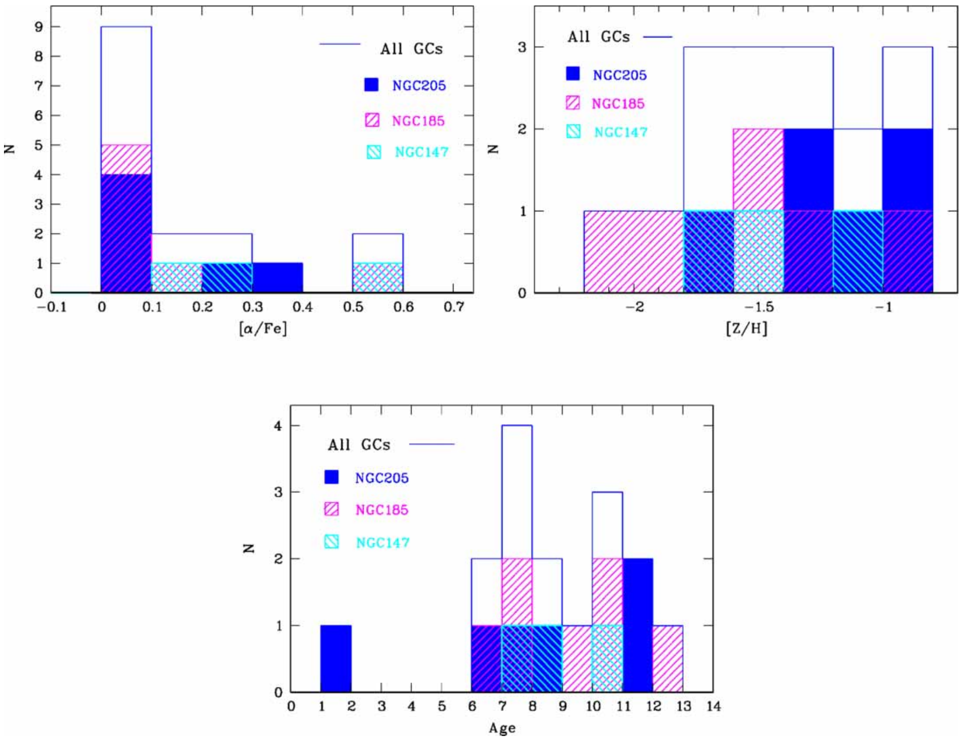


Figure 1. Age, $[Z/\mathrm{H}]$ and $[\alpha/\mathrm{Fe}]$ distributions of globular clusters in NGC 205, NGC 185 and NGC 147.

studied GCs appear to be old ($T > 8$ Gyears) and metal-poor ($[Z/\mathrm{H}] < -1.1$), except for the GCs Hubble V in NGC 205 ($T = 1.2 \pm 0.6$ Gyears; $[Z/\mathrm{H}] = -0.6 \pm 0.2$), Hubble VI in NGC 205 ($T = 4 \pm 2$ Gyears; $[Z/\mathrm{H}] = -0.8 \pm 0.2$), and FJJ VII in NGC 185 ($T = 7 \pm 3$ Gyears; $[Z/\mathrm{H}] = -0.8 \pm 0.2$). The majority of the GCs have solar $[\alpha/\mathrm{Fe}]$ ratios in contrast with the halo population of GCs in M31 and the Milky Way. This might prove a powerful diagnostic tool in distinguishing GCs that were accreted from satellite dwarf galaxies from GCs which formed together with the majority of stars in the host galaxy.

## Acknowledgements

M.E.S. would like to thank colleagues for the organization of this meeting.

## References


[1] B. Binggeli and L.M. Cameron, Astron. Astrophys., Suppl. Ser. **98** 297 (1993).
[2] P. Cote, S. Piatek, L. Ferrarese *et al.*, Astrophys. J., Suppl. Ser. **165** 57 (2006).
[3] E.K. Grebel, J.S. Gallagher III and D. Harbeck, Astron. J. **125** 1926 (2003).
[4] I.D. Karachentsev, V.E. Karachentseva and M.E. Sharina, in *Near-field Cosmology with Dwarf Elliptical Galaxies*, IAU Colloqium, Vol. 198, edited by H. Jerjen and B. Binggeli (Cambridge University Press, Cambridge, 2005), p. 105.
[5] M.E. Sharina, T.H. Puzia and D.I. Makarov, Astron. Astrophys. **442** 85 (2005).
[6] M.E. Sharina, V.L. Afanasiev and T.H. Puzia, Mon. Not. R. Astron. Soc. (in press) (2006).
[7] S. van den Bergh and A.D. Mackey, Mon. Not. R. Astron. Soc. **354** 713 (2004).
[8] S. van den Bergh, Astron. J. **107** 1328 (1994).
[9] S. van den Bergh, *The Galaxies of the Local Group* (Cambridge University Press, Cambridge, 2000).

[10] L.M. Young and K.Y. Lo, Astron. J. **476** 127 (1997).
[11] P. Guhathakurta, J.O. Ostheimer, K.M. Gilbert *et al.*, Astrophys. J. (2005) (astro-ph/0502366).
[12] D. VanDenBergh, Astrophys. J., Suppl. Ser. **162** 375 (2005).
[13] V.L. Afanasiev and A.V. Moiseev, Astron. Zh. Lett. **31** 216 (2005).
[14] T.H. Puzia, R.P. Saglia, M. Kissler-Patig *et al.*, Astron. Astrophys. **395** 45 (2002).
[15] D. Thomas, C. Maraston and R. Bender, Mon. Not. R. Astron. Soc. **339** 897 (2003).