Nuclear Clusters in Dwarf Irregular Galaxies and Their Connection to Massive Galactic Clusters

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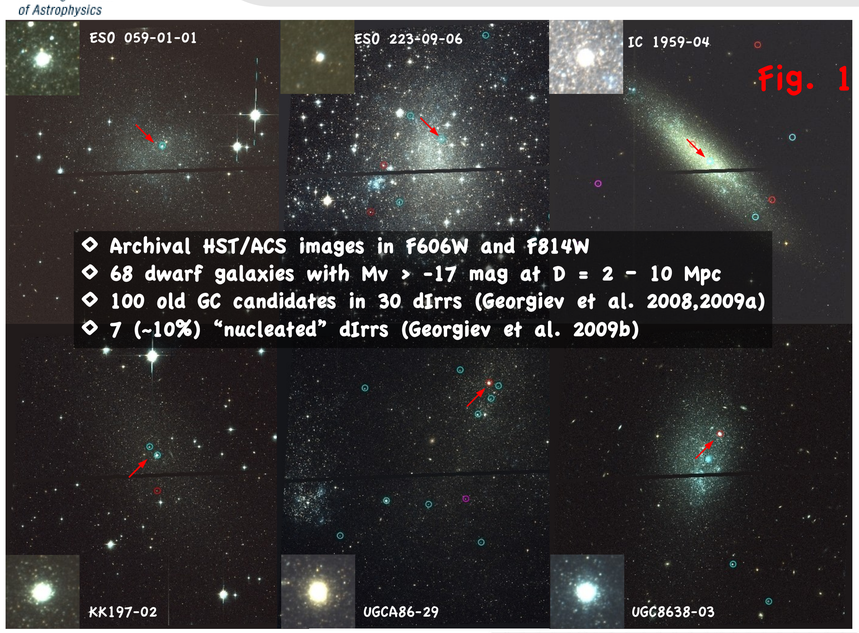

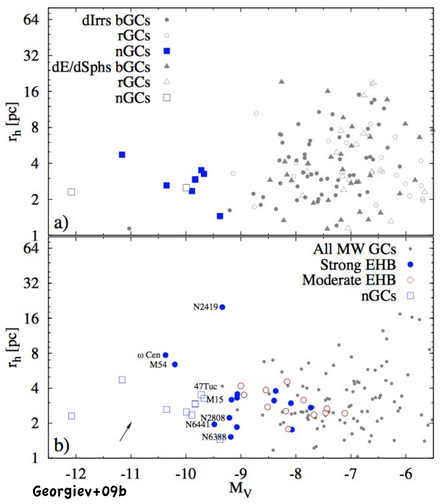

Fig. 2: Absolute magnitude (M_V) vs. cluster half-light radius (r_h) for nGCs in dwarf galaxies (squares) and Galactic GCs with extended horizontal branches (EHB-GCs circles).

- nGCs and EHB-GCs similar structure
  $\langle r_h \rangle$ ~ 3 pc, $\langle e \rangle$ = 0.11
- r_h expansion due to change in tidal potential upon accretion?

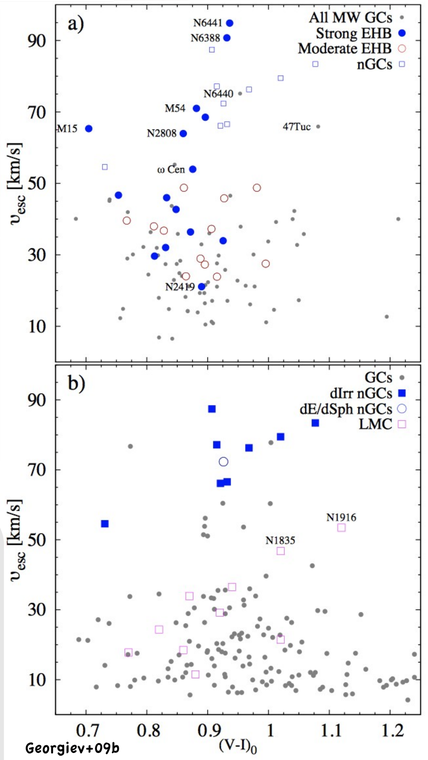

Fig. 4 Internal cluster escape velocities (υ_{esc}) vs. cluster V-I color for Galactic GCs (a) and GCs in dwarf galaxies (b).

Overview

We study nuclear globular clusters (nGCs) in dwarf irregular galaxies (**Figure 1**) and compare them with massive Galactic GCs with extended (hot) horizontal branches (EHB-GCs) in order to *i)* test the suggested origin of the latter as nuclei of now dissolved dwarf galaxies (Zinnecker'88, Freeman'93, Lee'07) and *ii)* the conditions at which GC self-enrichment can operate. Self-enrichment from the winds of first generation AGB stars is currently the most favored mechanism (Ventura&D'Antona'05, Recio-Blanco'06) for the observed peculiarities (abundance patterns and multiple stellar populations) in Galactic GCs (Lee'99, Hilker&Richtler'00, Bedin'04, Villanova'07, Piotto'07'08).

Our analysis shows that *i)* nGCs have similar M_V,r_h distributions to EHB-GCs (**Figure 2**), although not as extended as ω Cen and NGC 2419. We suggest that during accretion of the dwarf galaxy the r_h of its nGC can increase due to significant mass loss and drop in the external cluster potential as a result of the rapid dissolution of the dwarf galaxy (**arrow in Figure 2b**).

ii) for EHB-GCs, we find a correlation between the present-day cluster escape velocity (υ_{esc}) of stellar ejecta to reach the cluster tidal radius and their metallicity (**Figure 3b**). This υ_{esc},[Fe/H] relation is similar to the relation of increasing *stellar wind velocity* with metallicity (**model curves in Figure 3b**). This in turn explains why more metal-poor clusters typically show more peculiarities in their stellar population than more metal-rich clusters of the same mass do. The similar υ_{esc},(V-I) distribution of nGCs and EHB-GCs (**Figure 4**) indicates evolution in similar tidal environment and implies that nGCs could also have complex stellar populations. Spectroscopic observations of the nGCs in our sample are currently in progress to determine their age, chemical abundances and dynamical mass.

- υ_{esc} calculated assuming M/L_V=1.88 for nGCs and 2.0 for EHB-GCs (McLaughlin & van der Marel, 2005)
- Present-day υ_{esc} (nGCs ~ EHB-GCs)
  Evolution in similar tidal environment
- EHB-GCs orbit kinematics consistent with accretion (Lee'07)
- nGCs in low-mass galaxies good candidates for the progenitors of Galactic EHB-GCs.
- Escape velocity to tidal radius
  $\upsilon_{esc} \sim f_c \times (M/r_h)^{1/2}$, $\upsilon_{esc,in} \uparrow$ 30%
- Self enrichment if $\upsilon_{wind} < \upsilon_{esc,in}$
  AGB ~ 20 km/s^{-1} (Habing & Olofsson 2003)
- Self-pollution defined by cluster [Fe/H] and $\upsilon_{esc,in}$

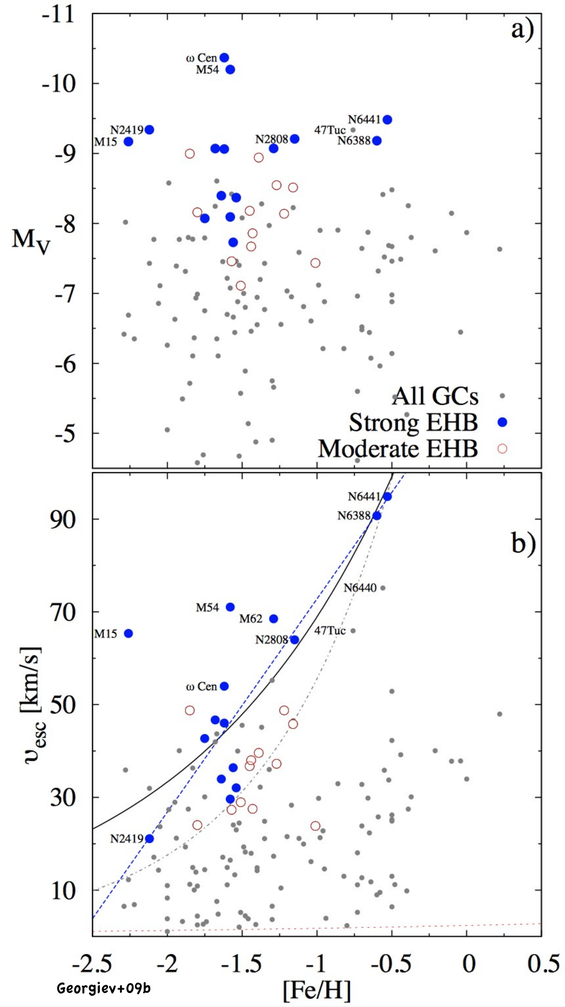

Fig. 3 Metallicity ([Fe/H]) vs. cluster luminosity (a) and internal cluster escape velocity υ_{esc} (b) for Galactic GCs. Dash-dotted curve shows the relation between terminal velocity and metallicity for a dust-driven AGB wind model ($\upsilon_{wind} \propto Z^{0.5}L^{0.25}$, Marshal+04). The solid curve is the least-squares fit to the EHB-GCs ($\upsilon_{esc} \propto Z^{0.32}$). The dashed line in (b) is a linear least-squares fit to the EHB-GCs excluding M15.

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