



Galaxy Structure and Formation SWG: *Science Cases*



***Richard de Grijs
(University of Sheffield, UK)***

***With Pepi Fabbiano
Laurent Cambresy
Mary Kontizas***

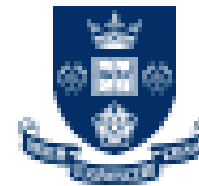
Key AVO Science Requirements

- *Stellar population parameters: age, metallicity, extinction, mass*
- *Stellar population parameters plus internal kinematics from high-resolution spectroscopy*
- *Spectral time variability of AGN*
- *Cross identification: proper motions, “weird” populations, multi-wavelength and multi-redshift cross-IDs, etc.*

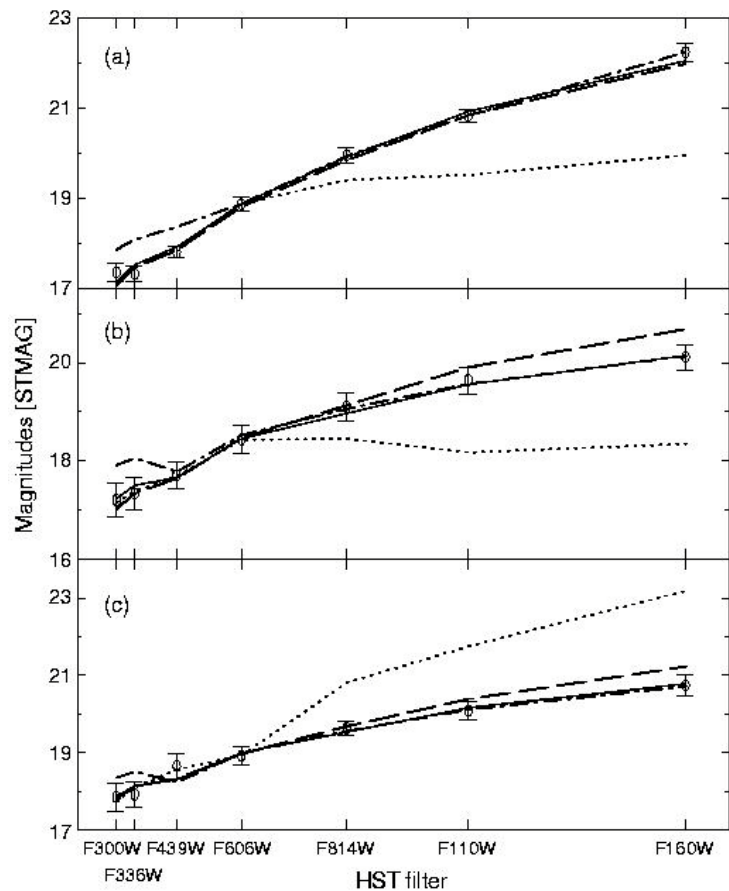
1 and 2: Stellar population parameters

AVO requirements:

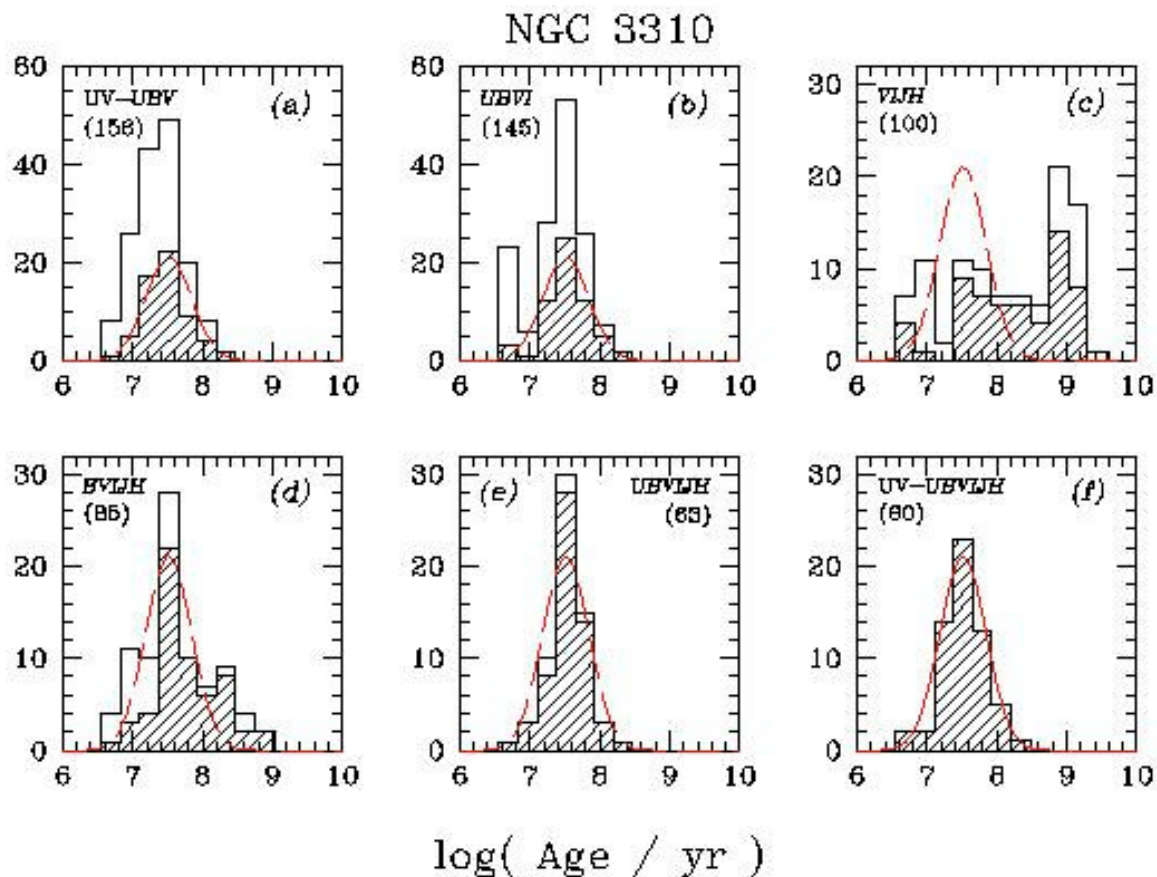
- Astrometry visualiser;
- SED generation from archival data;
- Propagation of errors;
- Parameter fits using standard SSP *and stellar spectral libraries* (e.g., Bruzual & Charlot, PEGASE, Starburst99, GALEV)
- Service for generating standard models with user-provided parameters;
- User uploads (publication) of models in the AVO;
- Model convolution with instrument function(s) *and spectral resolution*;
- Fits of convolved models to observed SEDs.

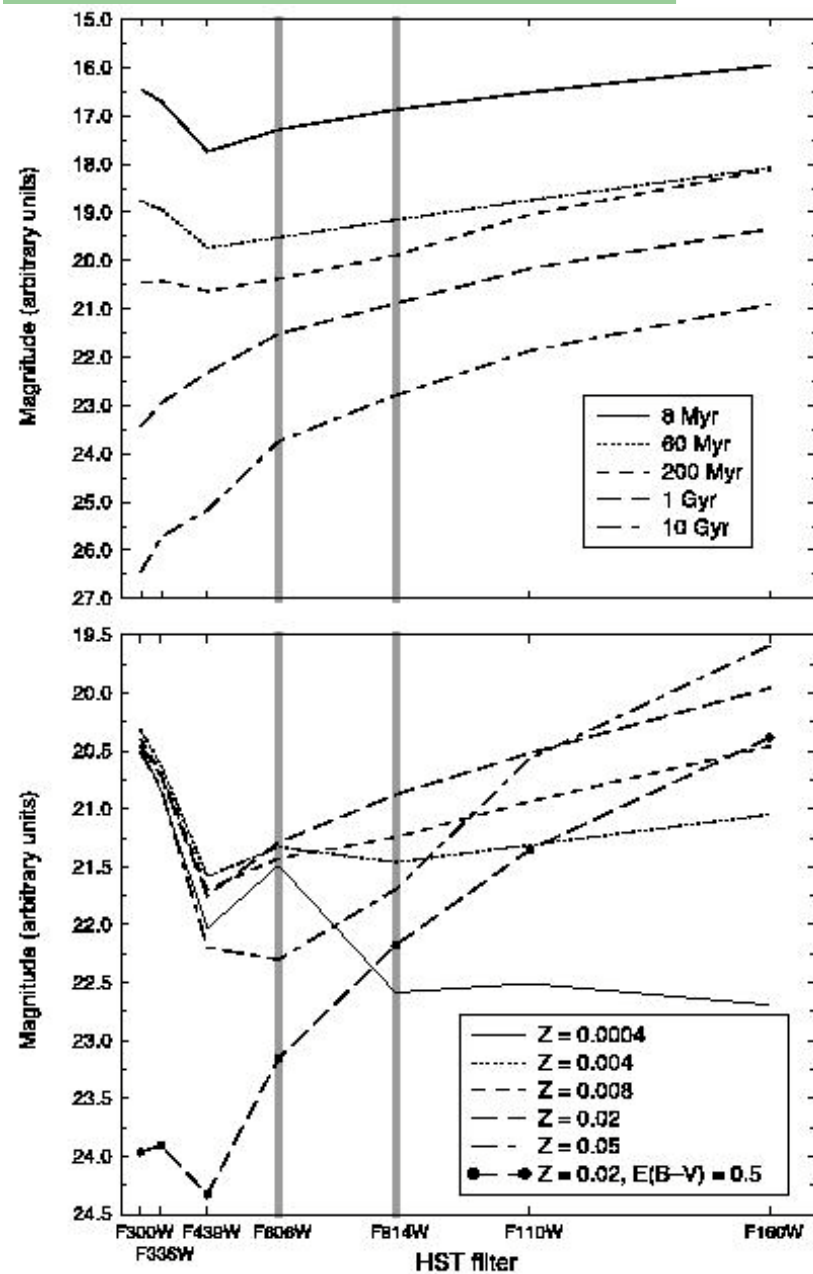


(de Grijs et al. 2003: MNRAS, 342, 259)

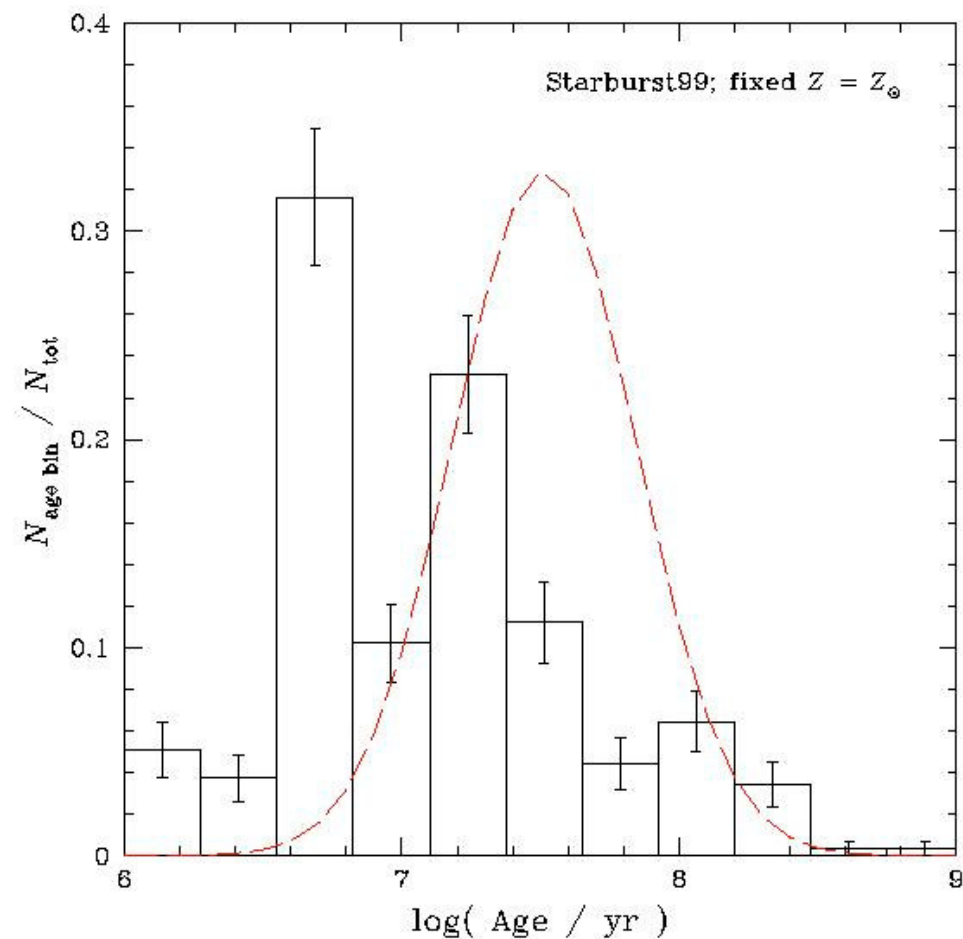


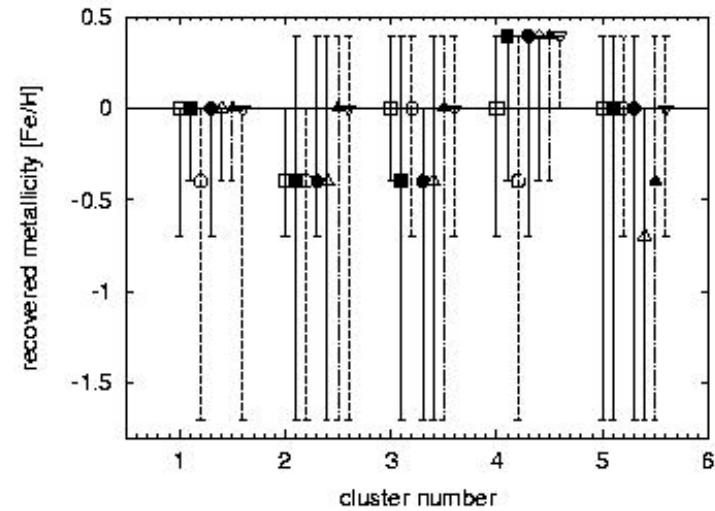
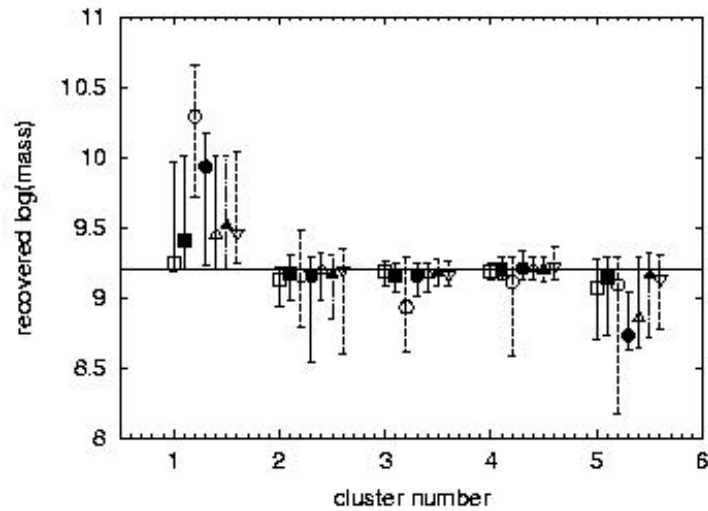
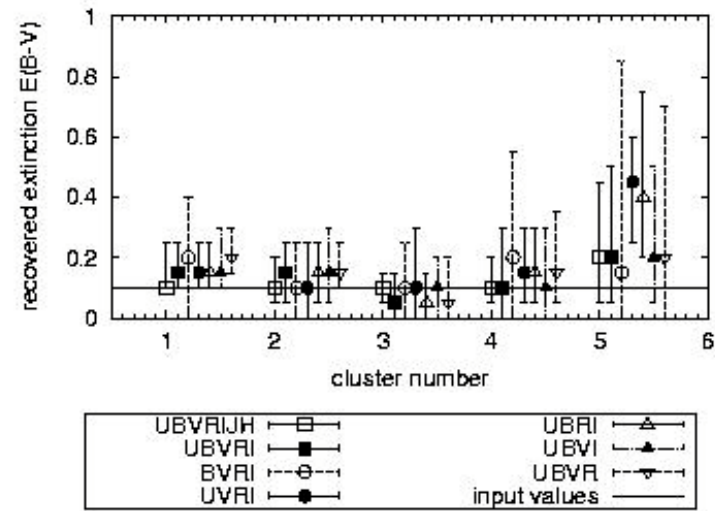
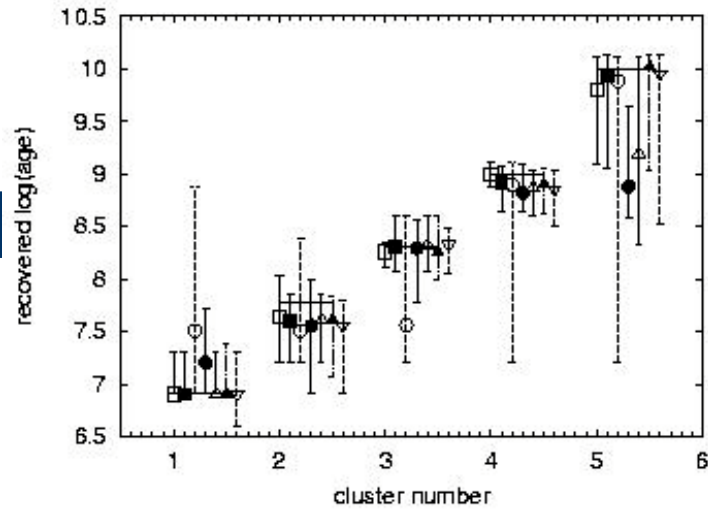
N_{clusters}





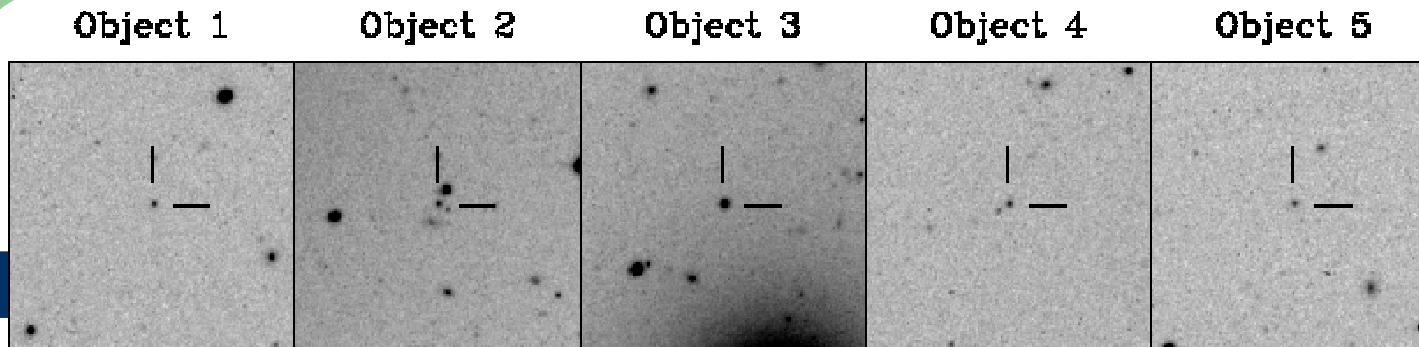
(de Grijs et al. 2003: MNRAS, 342, 259)



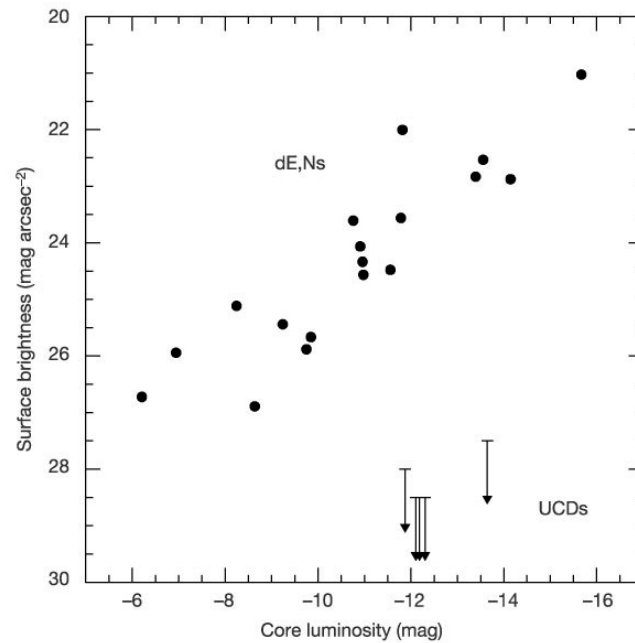


Science Case I: UCDs

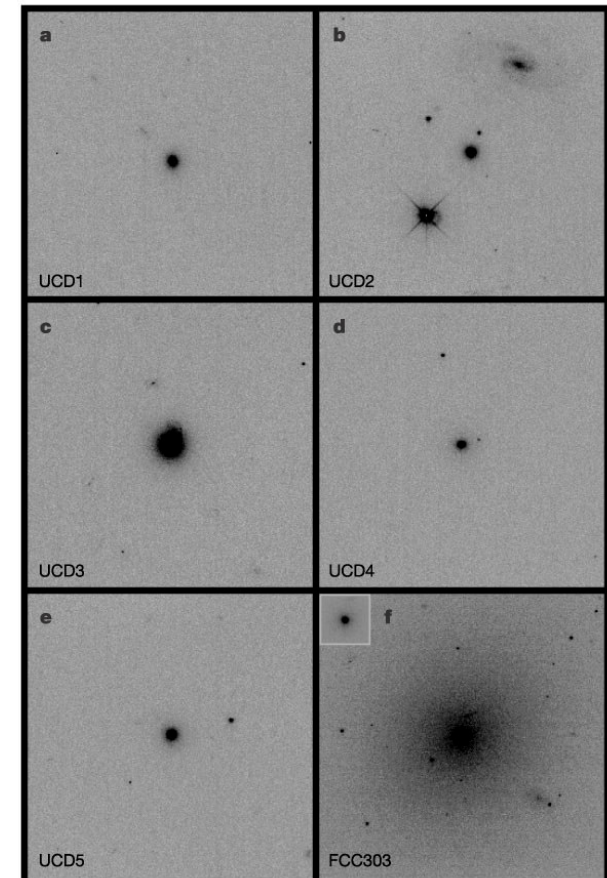
- Dwarf galaxies are *ideal tracers of galaxy transformation processes* in rich clusters
- Thus far, only *light trails* and a few *intracluster stars* have been the only evidence of galaxy disruption, however...
- Recently, a *new class of dwarf galaxies* was discovered in the Fornax cluster, with structural and dynamical properties in between globular clusters and known types of dwarf galaxies
(Drinkwater et al. 2000, Hilker et al. 1999)



(Drinkwater et al. 2000, PASA, 17, 227)



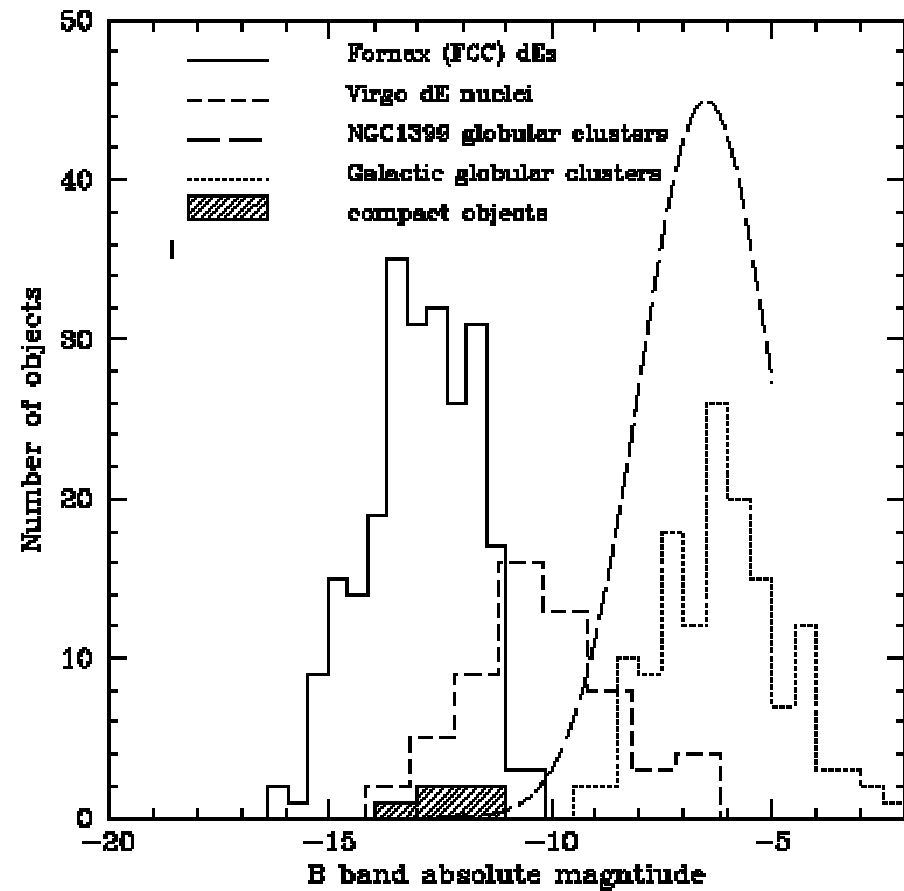
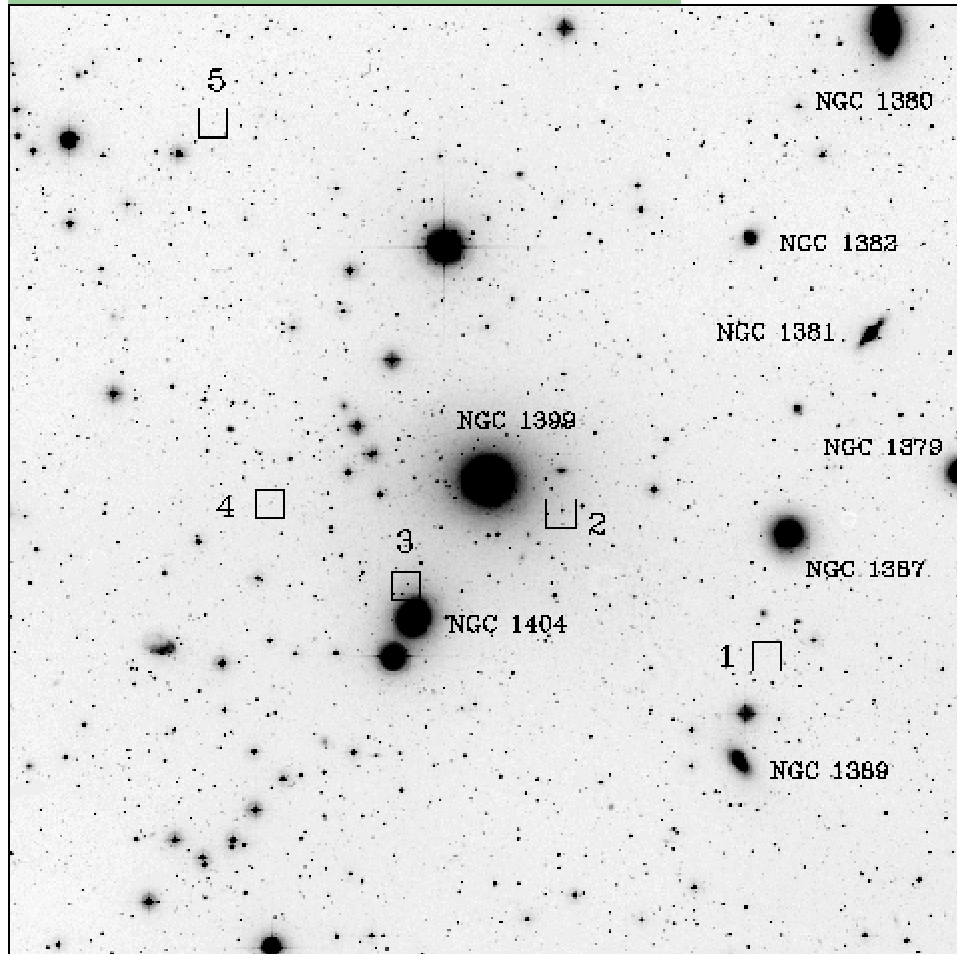
(Drinkwater et al. 2003, Nature, 423, 519)



UCD selection – I

- $-13 < M_B < -11$ or $-14 < M_V < -11.5$
(towards the lower limit of dwarf galaxies)
[Drinkwater et al. 2000, 2003; Mieske et al. 2002]
- Within 30 arcmin (~ 130 kpc) of the central cluster galaxy (NGC 1399)
- Extended over larger radii than its globular clusters
- High surface brightness and luminosity compared to Galactic GCs ($M_{B(\omega\text{Cen})} \sim -10$) – but similar luminosities to those of NGC 1399!
- GC-type colours: $0 < (V-I) < 1.4$ mag *[Mieske et al. 2004]*

(Drinkwater et al. 2000)



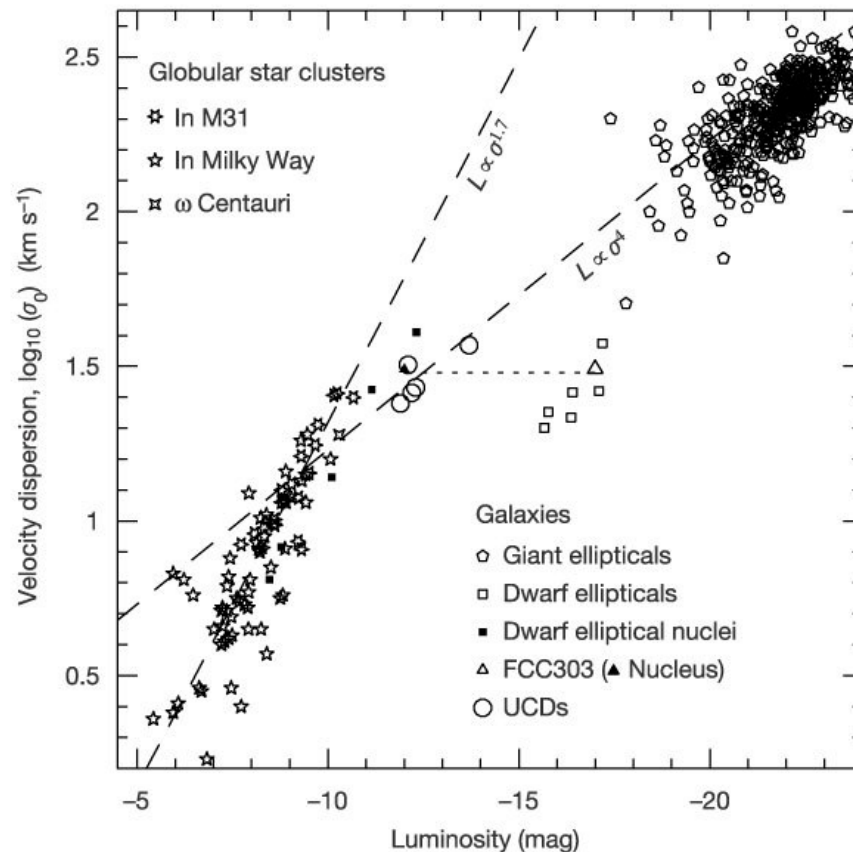
UCD selection – II

- Intermediate in size between GCs and the smallest known dwarfs in the Local Group (Leo I, $r_e \sim 3''$) → **FWHM < 100 pc** (in Fornax)

[Drinkwater et al. 2000, 2003]

- *Are these objects extreme examples of compact dE's (e.g., M32), nucleated dwarfs, of super-massive star clusters?*
- *Follow-up high-resolution spectroscopy is required to determine their masses (low-res for cluster membership)*

The AVO is ideally suited to find more of these objects in the nearest rich galaxy clusters!



Will the AVO provide the definite classification?

(Drinkwater et al. 2003)

Science Case II: Stellar populations in nearby galaxies (Mary Kontizas)

- **The spatial distribution of stars of various spectral types.**
- **Carbon stars detected from IR observations and their spatial distribution**
- **Density profiles**
- **Galaxy morphology evolution from the distribution in time of the stellar content.**

3. *Spectral time variability of AGN*

AVO requirements:

- Add time axis; Produce time – SED tables
 - Visualise time – SED
 - Provide model fitting functionality (as in 1 and 2)
 - Variability tests
- *While this is in essence similar to a normal spectrum (where time replaces wavelength), we would need some new functionalities to perform variability tests*
- *Include Fourier analysis capabilities?*

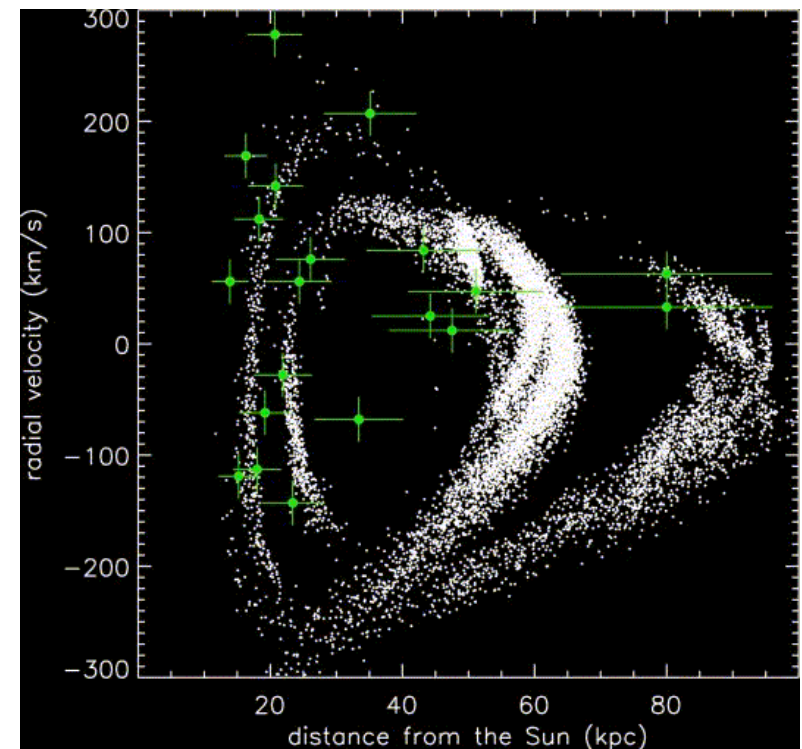
4. *Cross-ID science cases*

- ***Galactic structure*** from proper motions of individual stars;
- ***Structure in Galactic streams*** → ***Galactic assembly history***;
- ***The identification of the Chandra X-ray source population***;
- ***Finding and characterising “weird” populations***;
- ***Multi-wavelength morphology of galaxies at a range of redshifts*** → ***hierarchical scenarios***, extinction estimates



The Sagittarius dwarf galaxy
(Ibata et al. 1995, MNRAS, 277, 781)

Spaghetti survey *(Helmi 2002)*



Cross-ID AVO requirements

- **Statistical tools** – probabilities, outliers, etc.
- Source detection / extraction **must** make use of PSF information (or instrumental beam), and source extent
- **Crucially**, allow **filtering** options in the cross-ID routines (e.g., magnitude, extent, colours, exclusion regions in parameter space, etc.)
- Include a morphology asymmetry measure