The smallest* galaxies

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• *smallest=oldest=faintest=building block???
• = direct test of small scale fluctuation spectrum
• = test of uv divergence in extrapolation
• = scale on which astroparticle physics might be seen
galaxy scaling relations are well-established

The dSph-larger galaxy link is a long-standing puzzle
There is a discontinuity in (stellar) phase-space density between small galaxies and star clusters. Why?

- Dark Matter
- Sizes

Phase space density ($\sim \rho/\sigma^3 \sim 1/(\sigma^2 r_h)$)

Walcher et al 2005
Finding dSph – discoveries all require confirmation: SDSS data, while excellent, are slightly imperfect
Size-luminosity relations
New photometric and kinematic studies of UCDs, nuclear clusters, etc → ALL the small things are purely stellar systems, $M/L \sim 1$–$4$

cf Seth et al 0801.0439 re nuclei

Virgo & Fornax UCDs have stellar $M/L$ –


N5128 GC; Rejkuba et al, A+A 469 2007

MWG GCs extend down to $M \sim -2$

MWG nuclear cluster has size $\sim 5$pc, mass $10^6$Msun

Schodel et al, A+A 469 125
Slightly different perspective… (updated data)

Nuclear clusters, UCDs, M/L ~ 3

Pure stars

Star clusters

Tidal tails: non-equilibrium?

Dark Matter haloes

dSph galaxies

GG, Wilkinson, Wyse et al 2007
Is the galaxy size spectrum continuous?

ACS studies

Very recent support that galaxies break from the lum-size scaling relation at dSph luminosities

Gilmore et al. 2007

Sharina et al. 2008

MN 384 1544
The very low luminosity objects have too few stars to allow robust dynamical masses: can we determine if they are/were star clusters or more massive dSph galaxies?

- Normal globular clusters have small or no internal chemical abundance dispersion
- Star clusters form from pre-enriched material
- dSph galaxies, and massive star clusters, self-enrich

- Mass threshold is about $10^8M_{\text{sun}}$ to see internal abundance scatter
- So use internal abundance scatter as a proxy for initial mass
Abundance mean and dispersion is a mass proxy, and a direct test of the minimum length scale hypothesis.

Norris, GG, Wyse et al 2008 – submitted

cf Kirby et al

NB: self-enrichment on these scales requires low SFR, and weak feedback
Derived mass density profiles: scale of $\sim 100$pc

Jeans’ equation with *assumed isotropic* velocity dispersion: all consistent with cores.

CDM predicts slope of -1.3 at 1% of virial radius and asymptotes to -1 (Diemand et al. 04)

NB these Jeans’ models are to provide the most objective sample comparison – DF fitted models agree with these
Conclusion:

- There is a well-established size bi-modality:
  - all systems with size $< 30$ pc are purely stellar
  - $-16 < M_v < 0$ (!!) $M/L \sim 3$;
  - all systems with size greater than $\sim 100$ pc have a dark-matter halo, and self-enrich

- There are no known (virial equilibrium) systems with half-light radius $30 < r < 100$ pc

- $100$ pc seems a physical scale imprinted on, or by, Dark Matter