Edward F. Hayes Forum – April 12th 2008

Delving Deeper into the Tumultuous Lives of Galactic Dwarfs

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with

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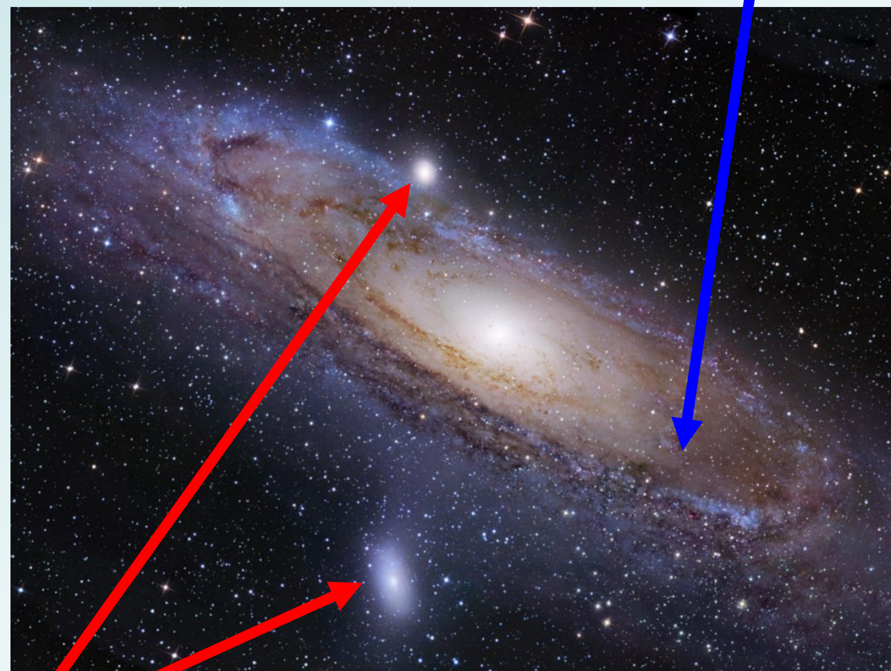
The Small Magellanic Cloud a dwarf companion of the Milky Way

Background Info

You are here



Think Globally

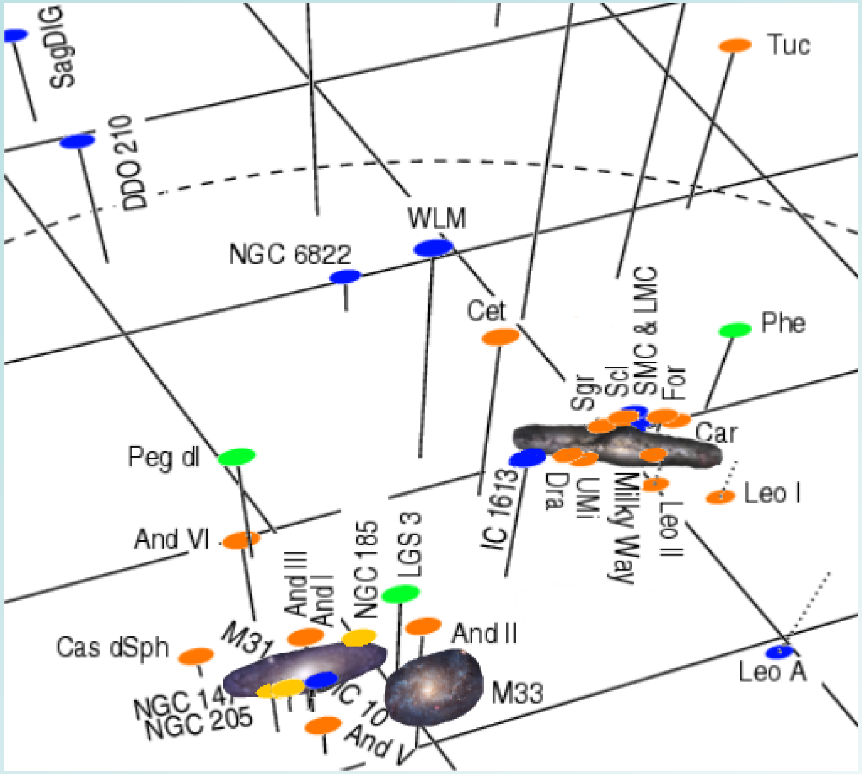
Act Locally

Dwarf galaxies are here

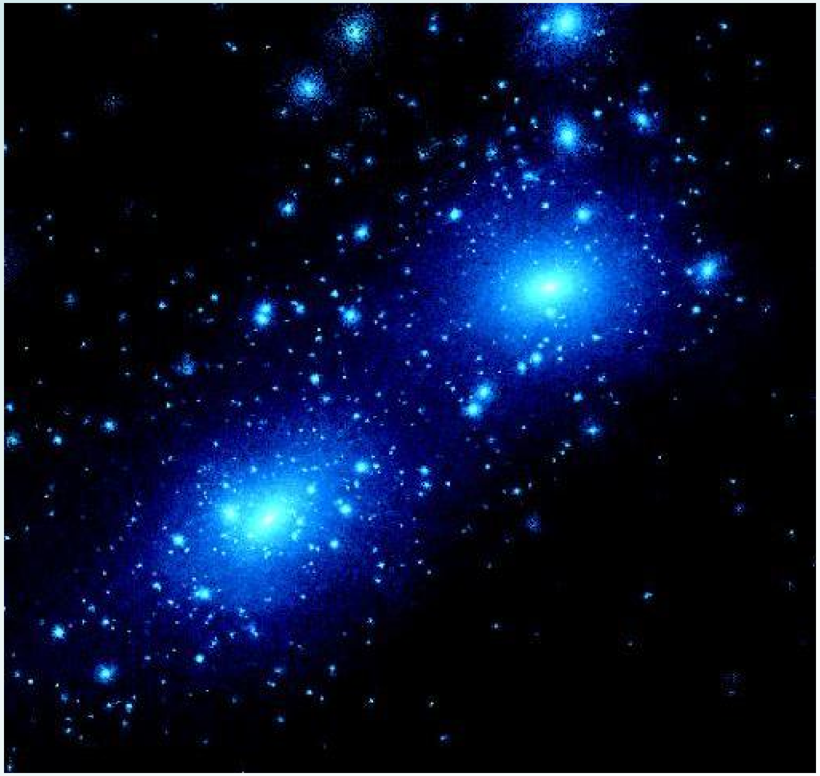
Think Locally

Infer Cosmologically

In theory…



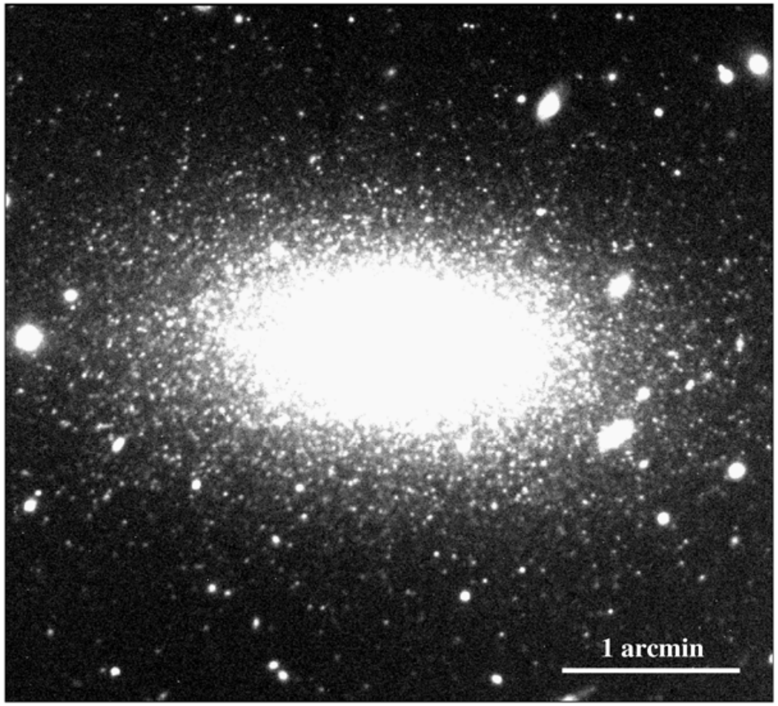
Map of Galaxies in the Local Group



N-body Simulation

(Kravtsov, Gnedin & Klypin 2004)

Missing!



Reward: Ph.D. Thesis

Last Seen: N-body Simulations

Options:

- Keep Looking?
  - Not likely to find enough…
- Maybe they're not there?
  - e.g. Zentner & Bullock 2003, Kamionkowski & Liddle 2000
- Maybe they're just dark?
  - e.g. Kravtsov, Gnedin & Klypin 2004, Madau, Diemand & Jurg 2008, Thoul & Weinberg 1996

This Study!

"The Tumultuous Lives of Galactic Dwarfs"
(a.k.a. KGK04)

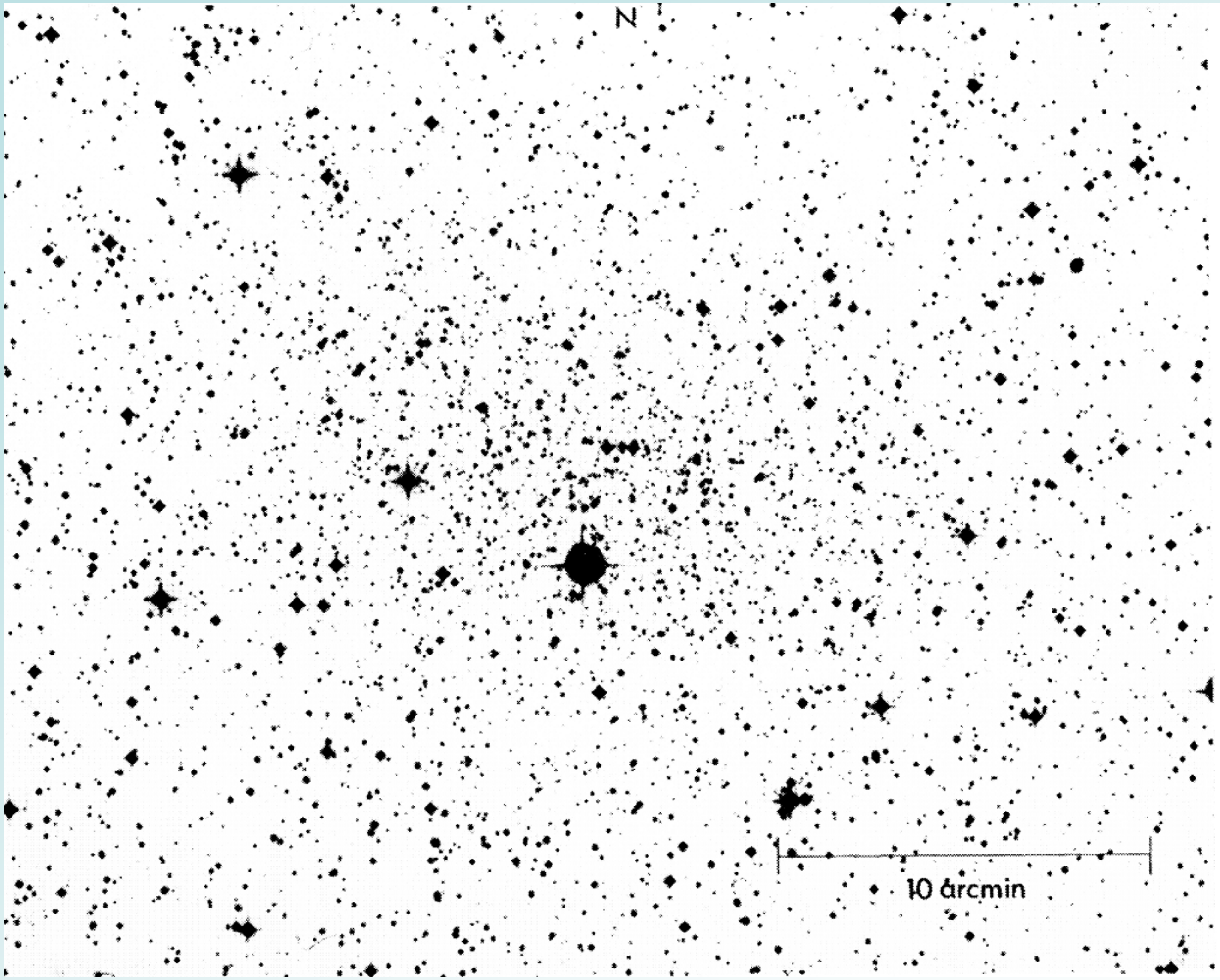
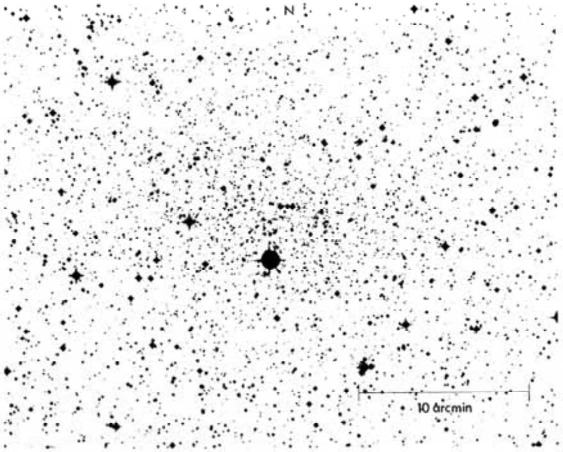
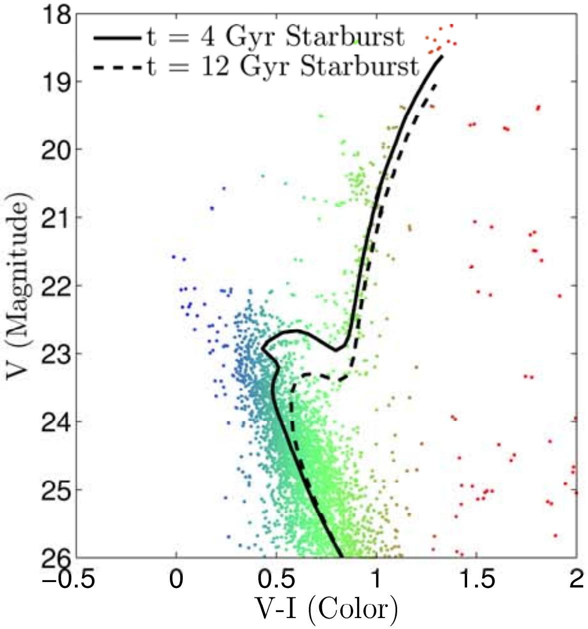


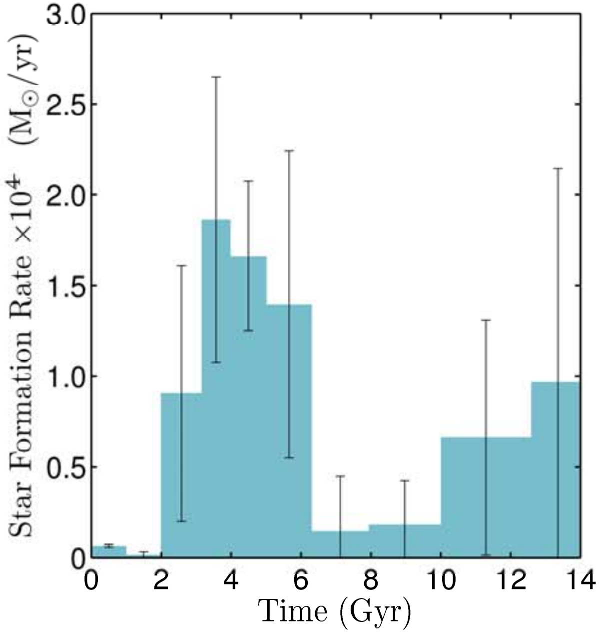
Image of Carina Dwarf Galaxy

Things to Think About

Galaxy Image	Color-Magnitude Diagram	Star Formation History

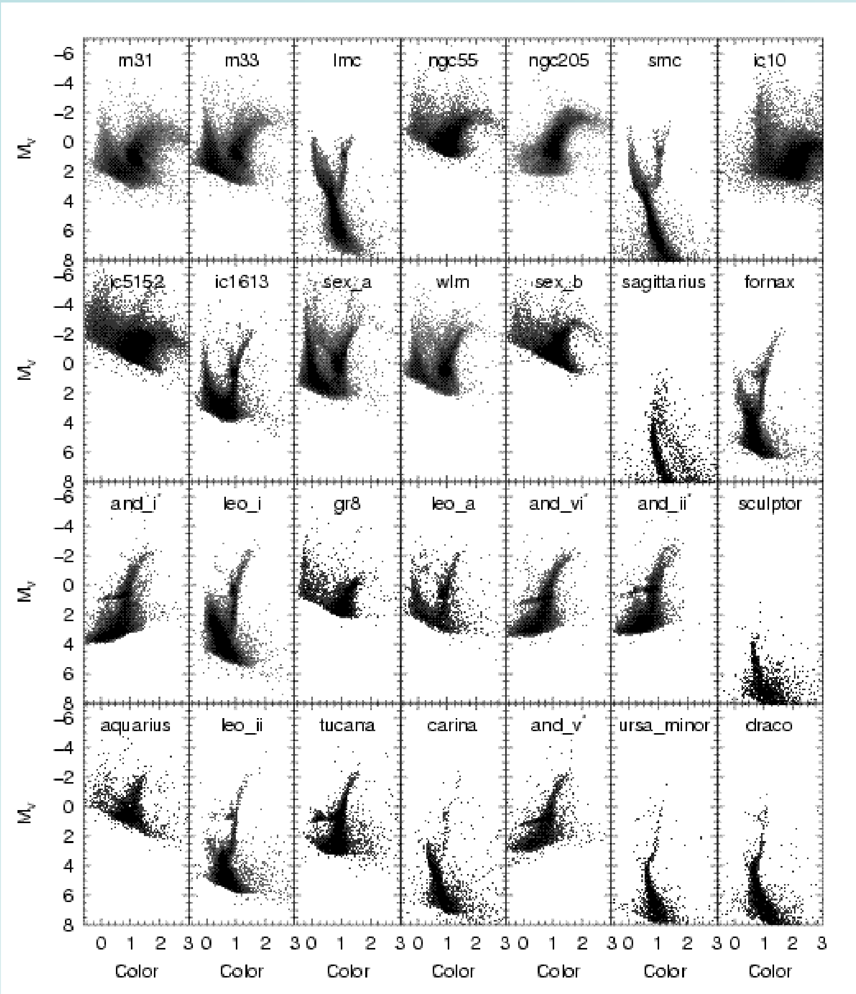






New Data!

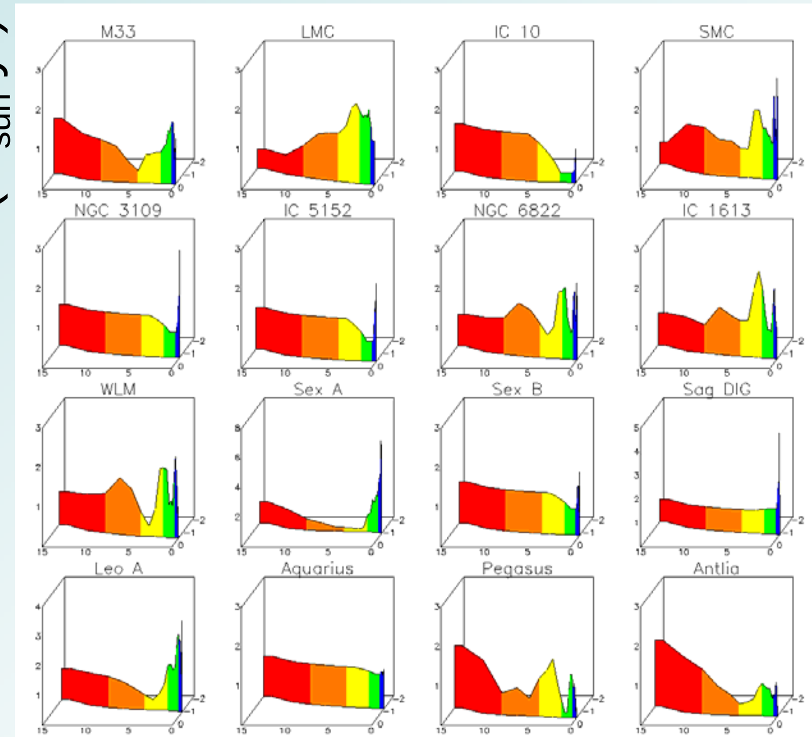
Color-Magnitude Diagrams



Holtzman, Afonso, & Dolphin, 2006

Star Formation Histories

Star Formation Rate (M_{sun}/yr)

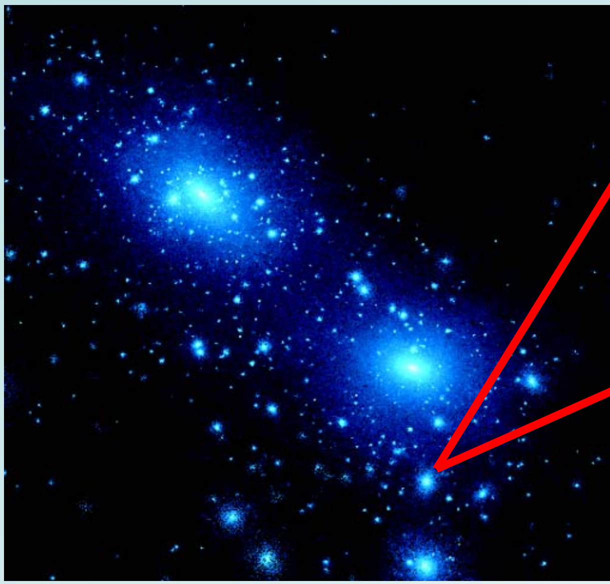


Time ➔

Dolphin, Weisz, Skillman & Holtzman 2005

Forming Stars in N-body Simulations

Dark Matter Dynamics



M_{dm} (t) = Dark Matter halo mass

Gas Disk

$\Sigma_g(r) = \Sigma_o \exp(-r / r_d)$

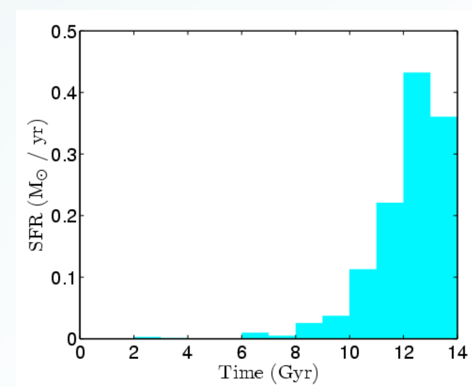
= Gas Surface Density

Star Formation Rate

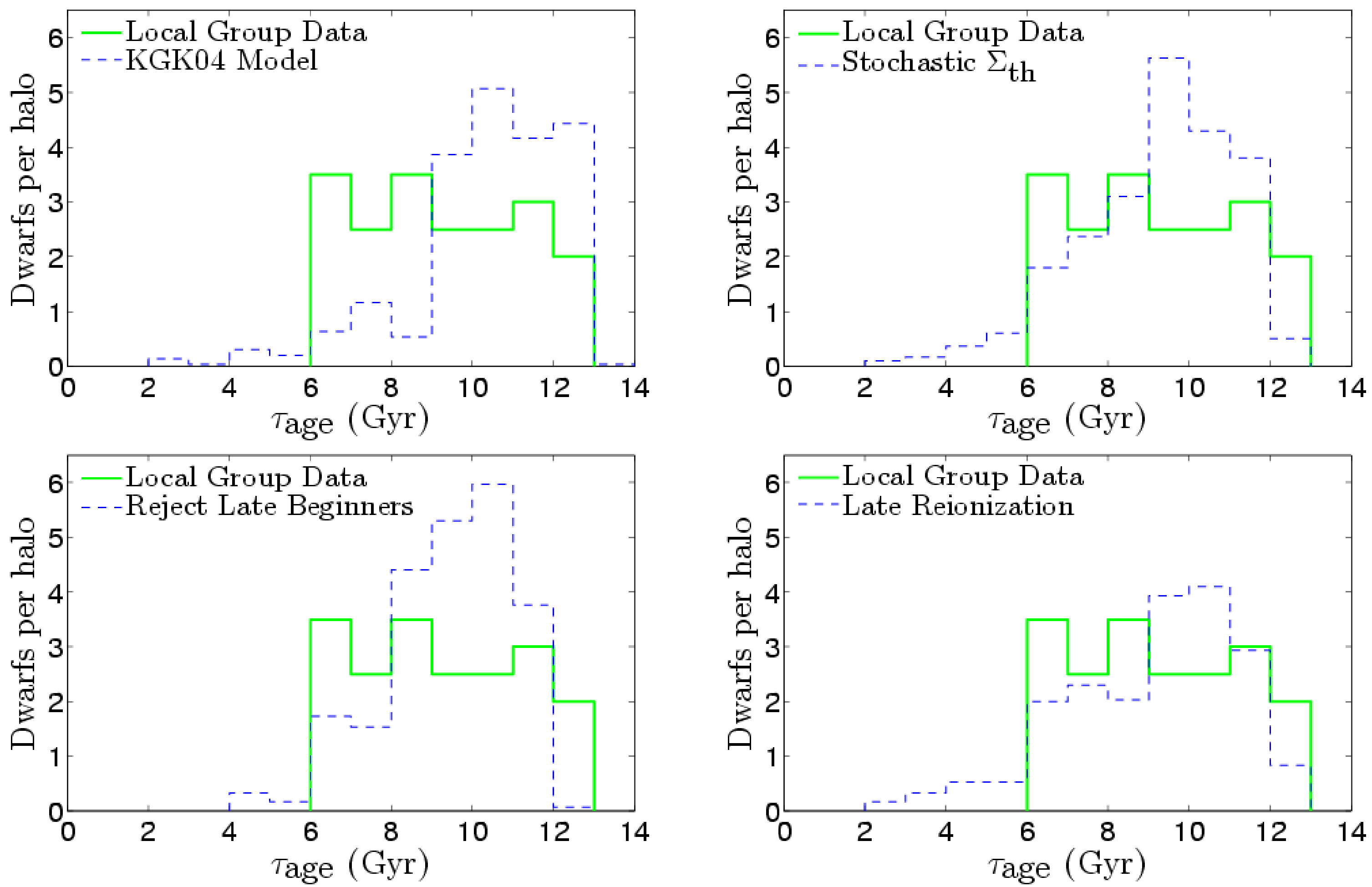
$\Sigma_*(t) \sim \Sigma_g^{1.4}$

(more gas → more stars)

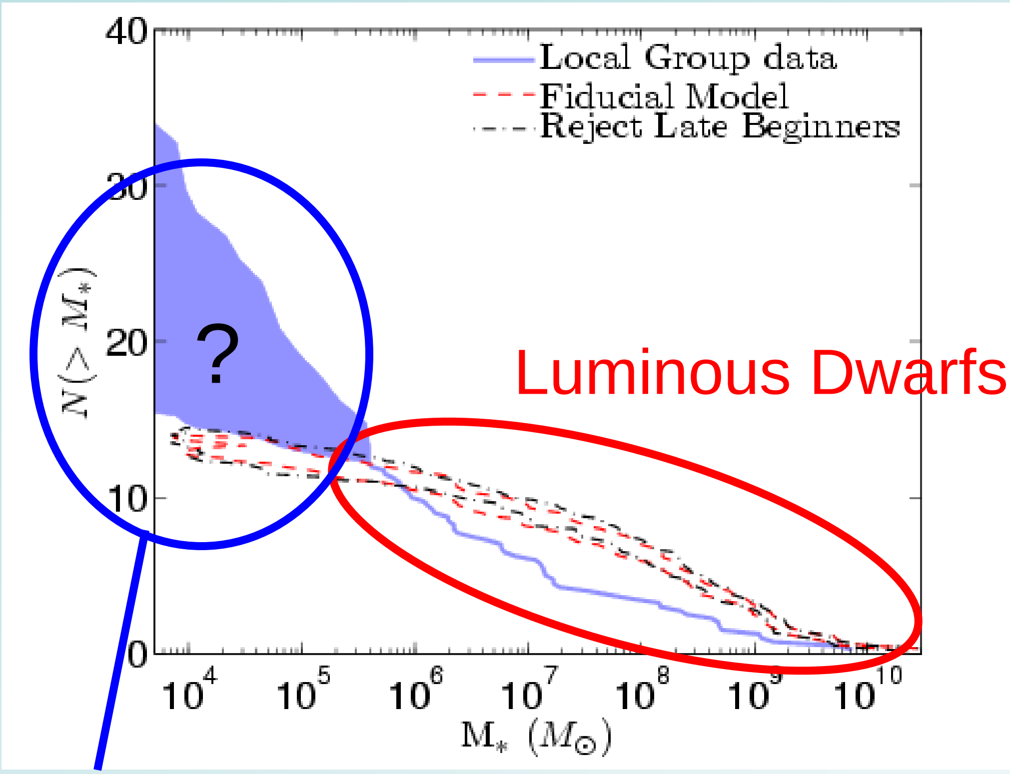
SFR (t) ~ Σ_* x Area



Testing Different Models



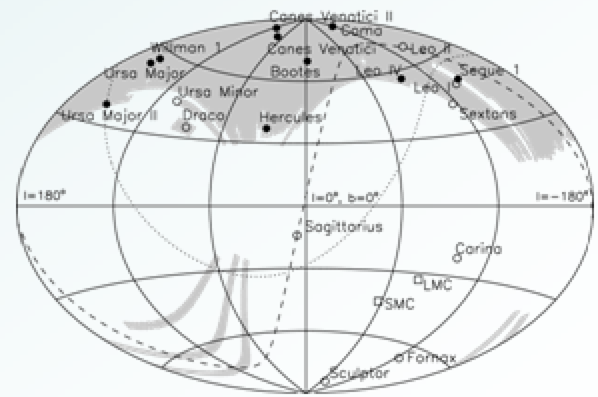
Ultra-faint Dwarfs



Uncharted Territory!

Bootes I Dwarf

Discovery Map



(Belokurov et al. 2007)

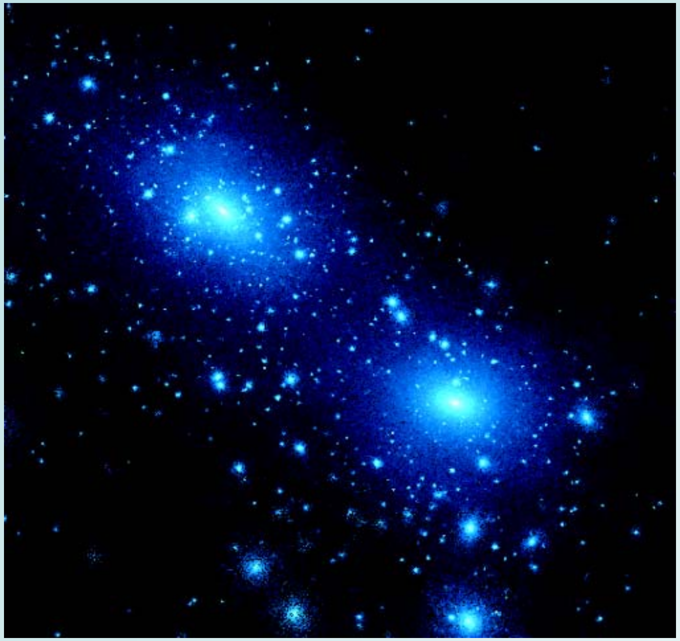
Conclusions

- **Missing satellites problem can be explained without fundamentally changing currently-accepted cosmological theories**
- **No radical revision of the properties of the dark matter particle are required to explain the data**
- **Early universe scenario does not seem to matter**
- Remaining problems: all models have a small population of dwarfs that are too young and models do not predict enough ultra-faint dwarfs

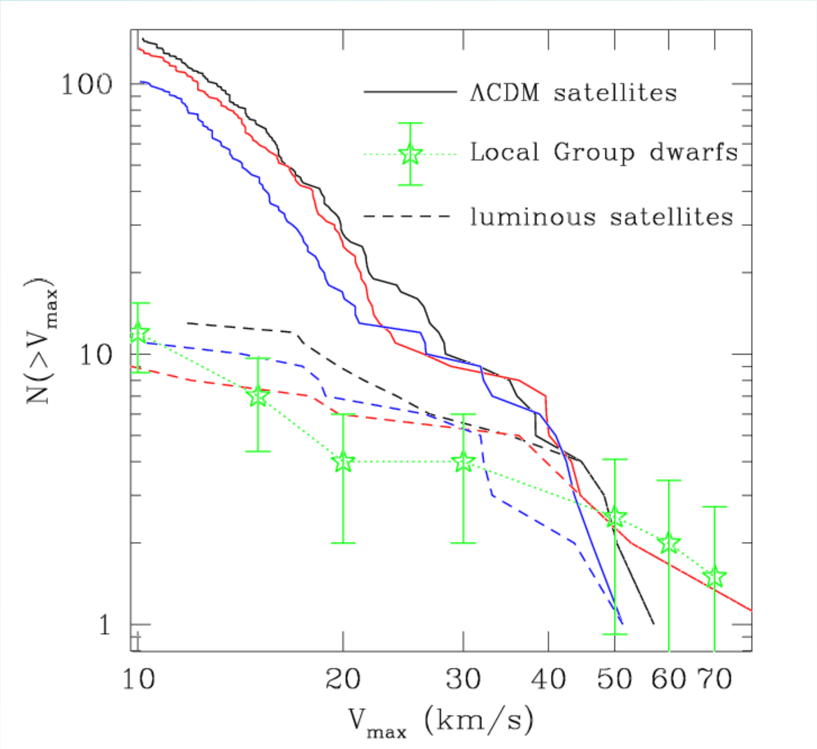
Special Thanks to:

Oleg Gnedin, Luke Corwin,
John Beacom

Missing Satellites Problem



Kravtsov, Gnedin & Klypin 2004



- About 10% of the small DM halos at $z = 0$ had LMC/SMC-sized halos in the past
- Strong tidal interactions cause dramatic mass loss

Mass ➔

$V_{max} = (GM/R)^{1/2}$

Star Formation Rate Gas Density Profile