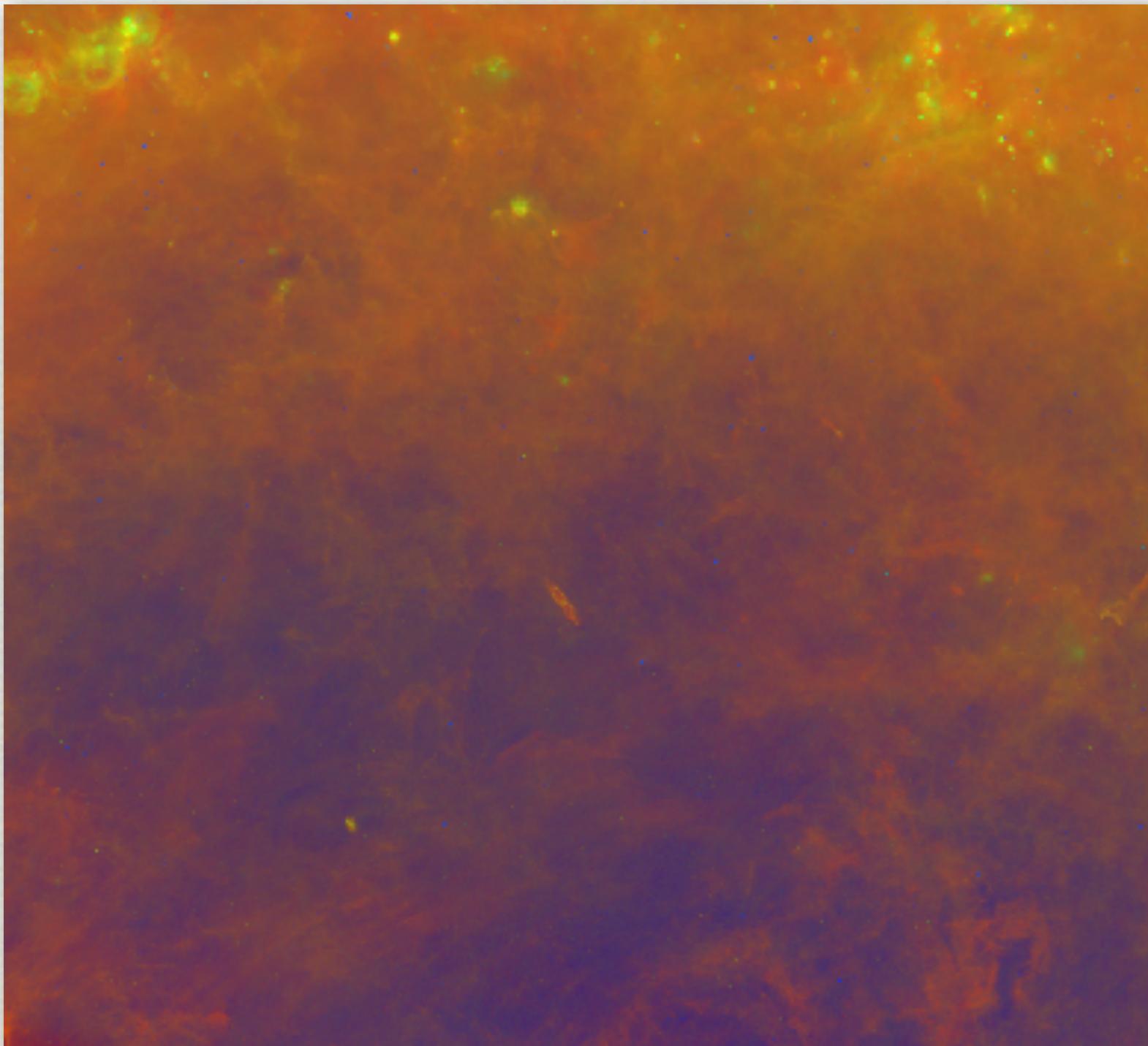


# The M31 Dwarf Galaxy Population



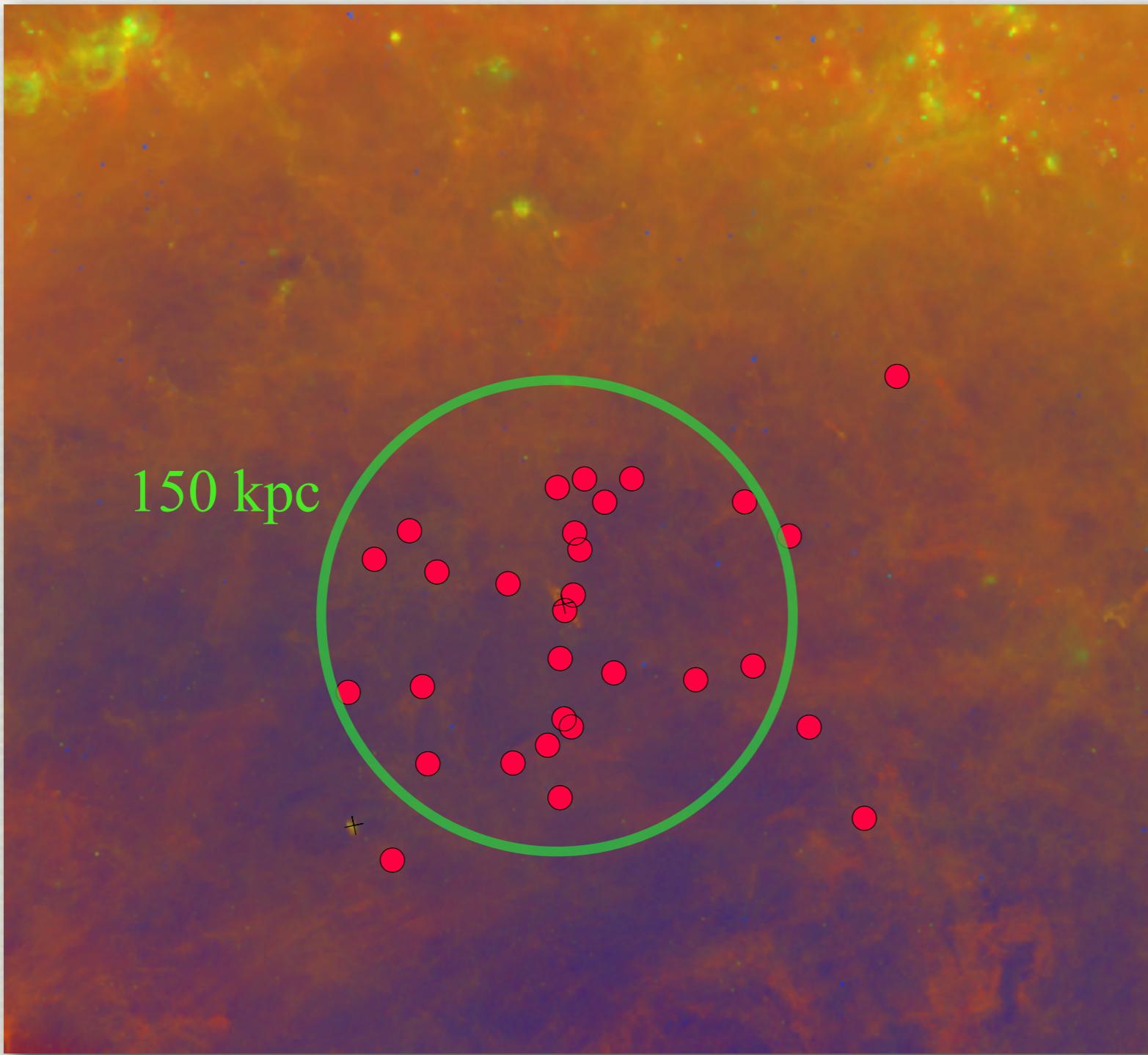
Google Sky IRAS map

Marla Geha (Yale)

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Raja Guhathakurta (UCSC)  
Jason Kalirai (STScI)  
Steve Majewski (UVa)  
Roeland van der Marel (STScI)  
Racheal Beaton (UVa)  
Kirsten Howley (LLNL)  
Nhung Ho (Yale)  
Erik Tollerud (UCI/Yale)

# The M31 Dwarf Galaxy Population



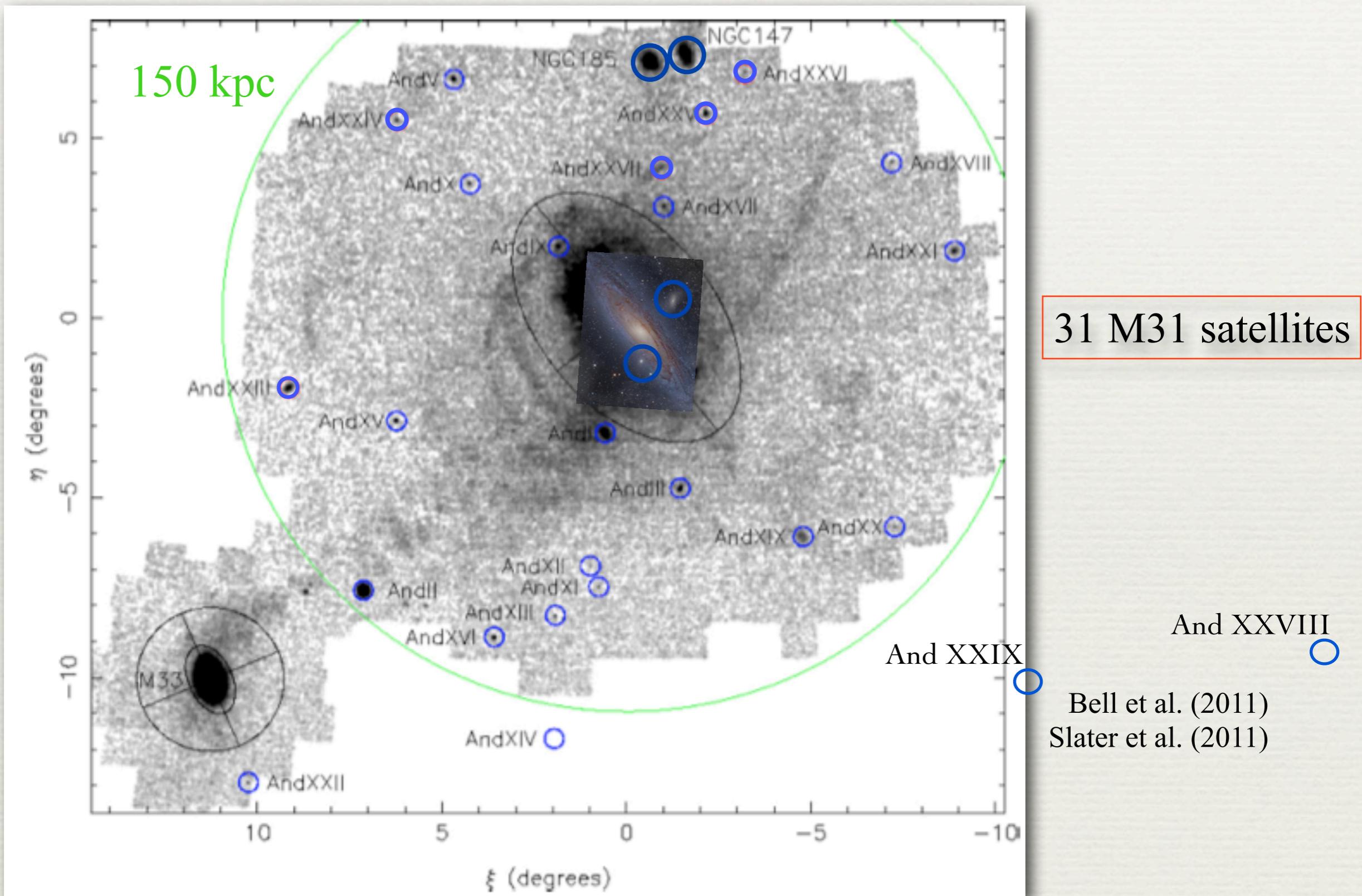
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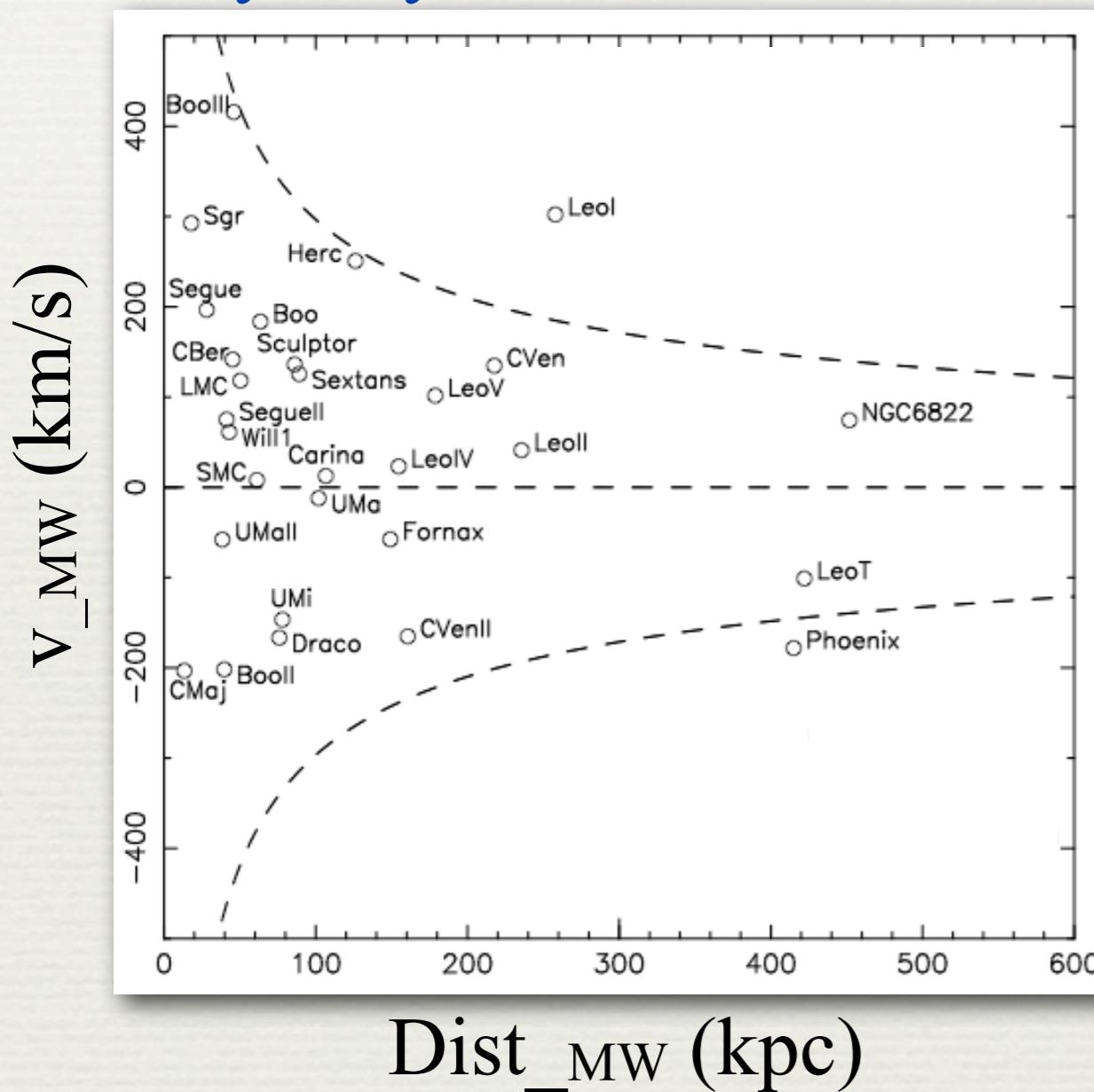
# The M31 Dwarf Galaxy Population



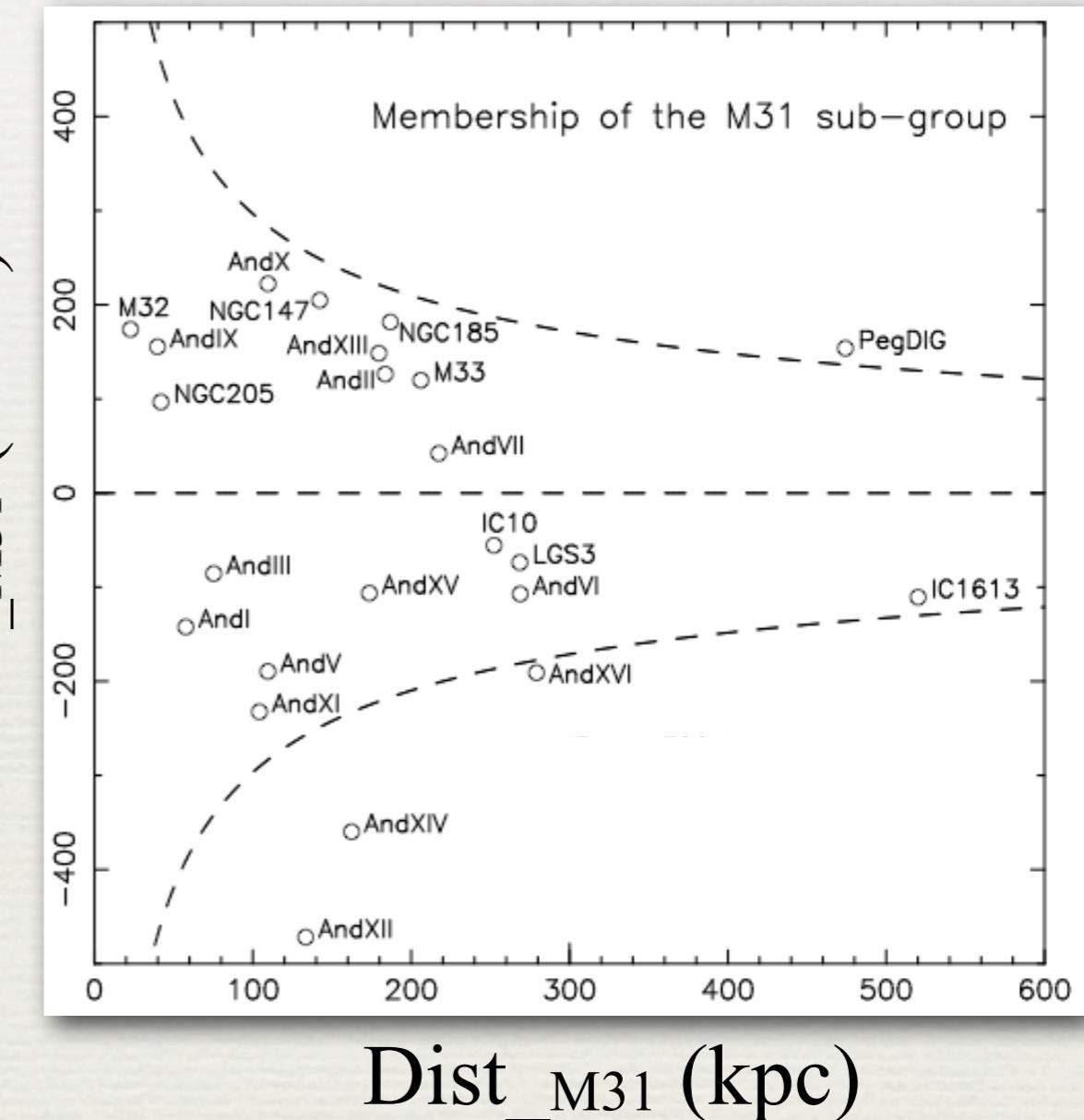
PAndAS Survey: Richardson et al. (2011)

# Local Group Dwarf Satellites

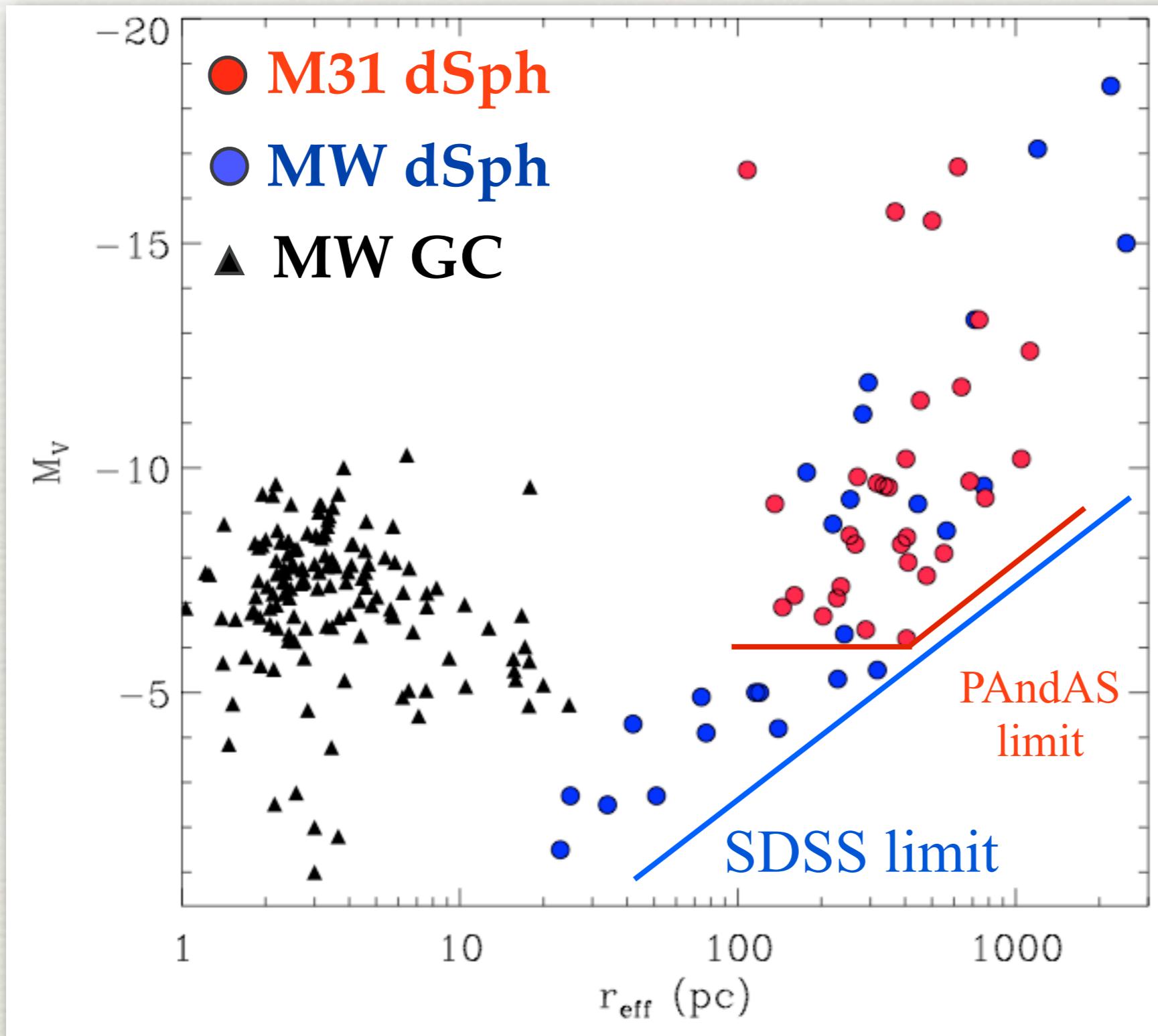
Milky Way: 26 dwarf satellites



M31: 31 (20) dwarf satellites



# Local Group Dwarf Satellites

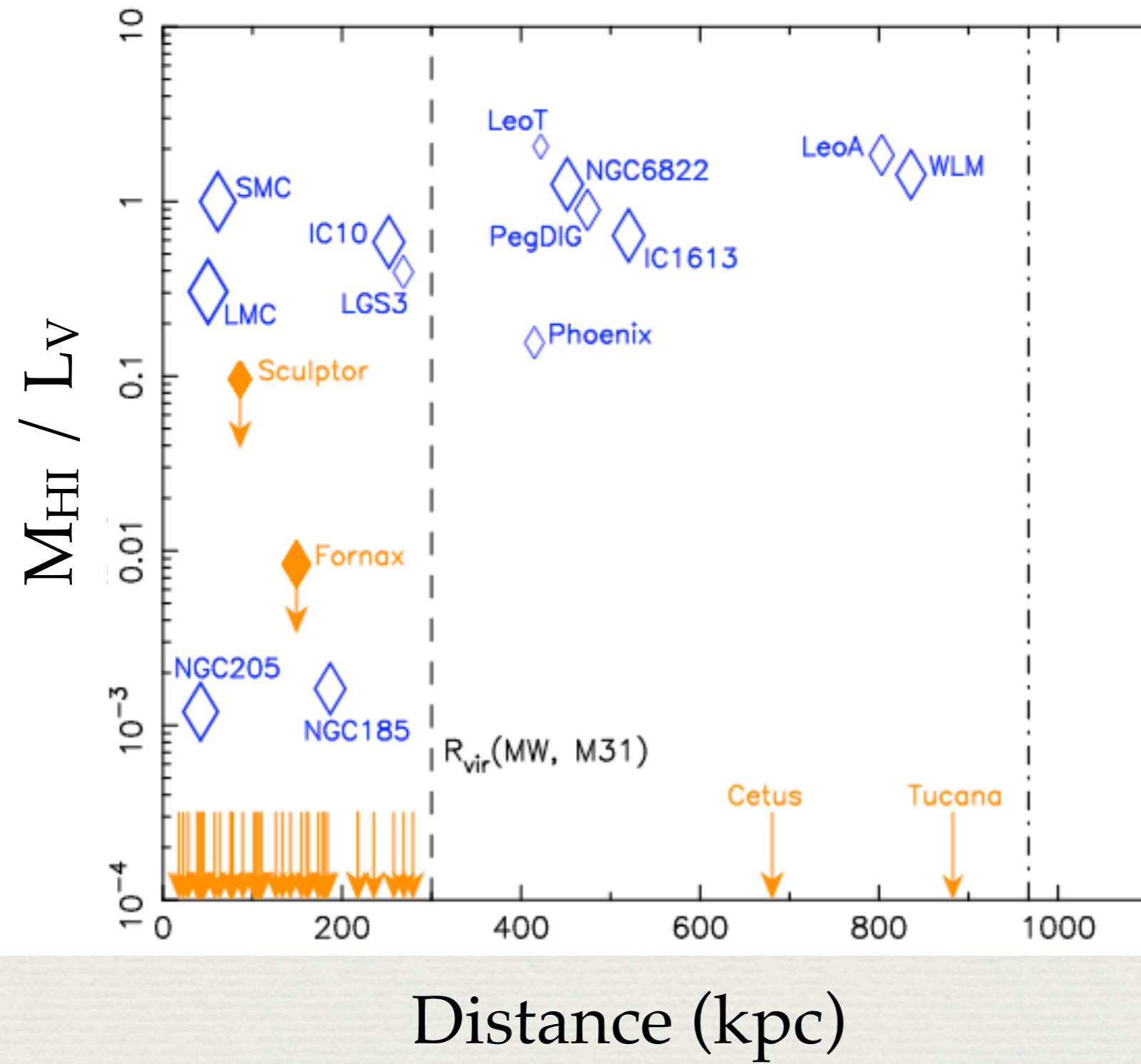


Faintest M31 satellite  
 $M_V = -6.1$

To this mag limit,  
M31 has 2.5x more  
satellites than MW

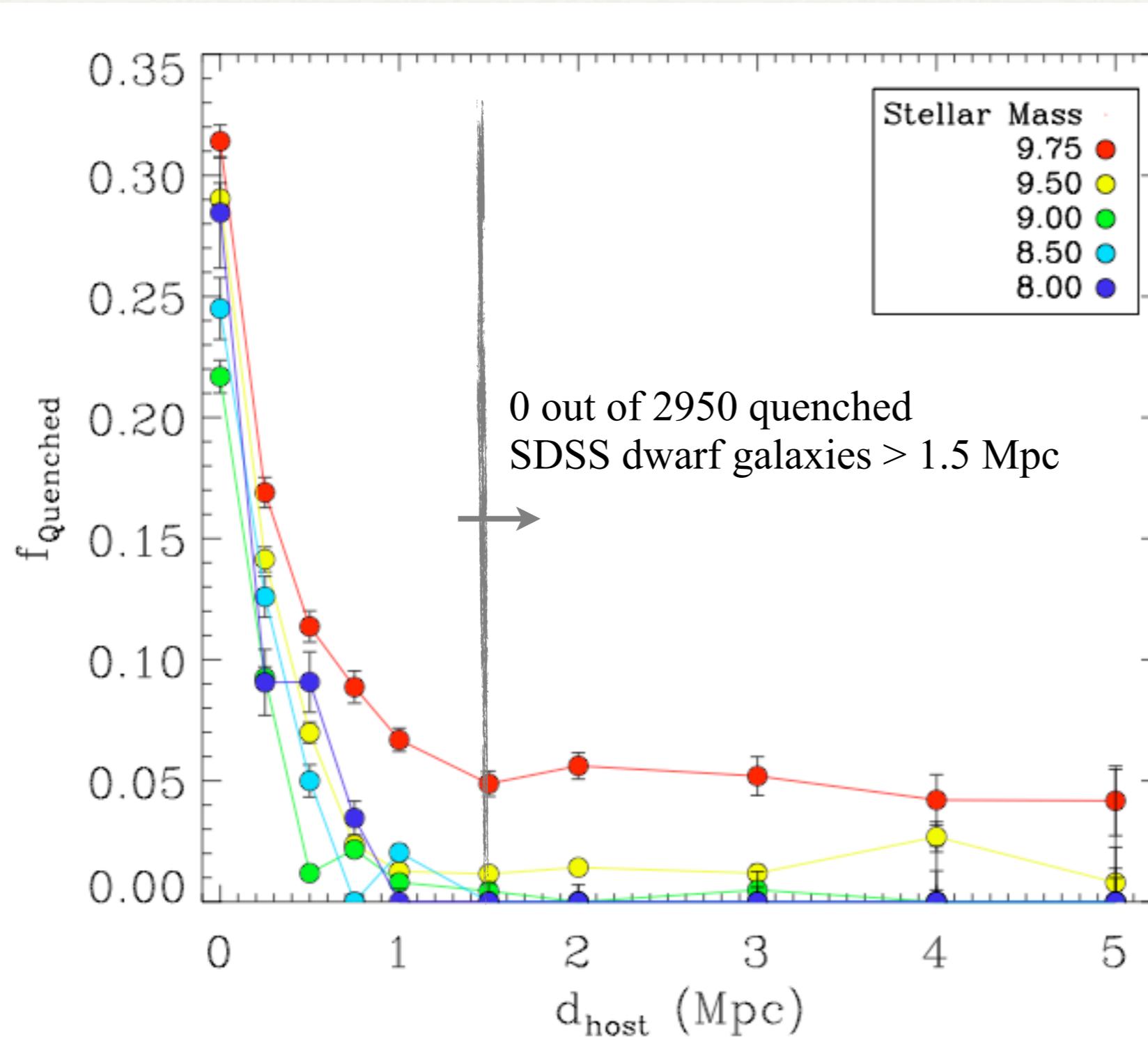
# Quenched M31 Dwarf Satellites

McConnachie (2012)



Most MW/M31 satellites are quenched galaxies (no ongoing SF, little to no HI).

# Environment and Quenched Dwarf Galaxies



MG et al (2012):  
Quenched fractions as a function of distance to a massive host galaxy

Below LMC stellar mass,  
**\*all\*** quenched galaxies  
found within  $\sim 4 r_{\text{vir}}$  of a  
massive host.

# Keck/DEIMOS Observations of M31 Satellites

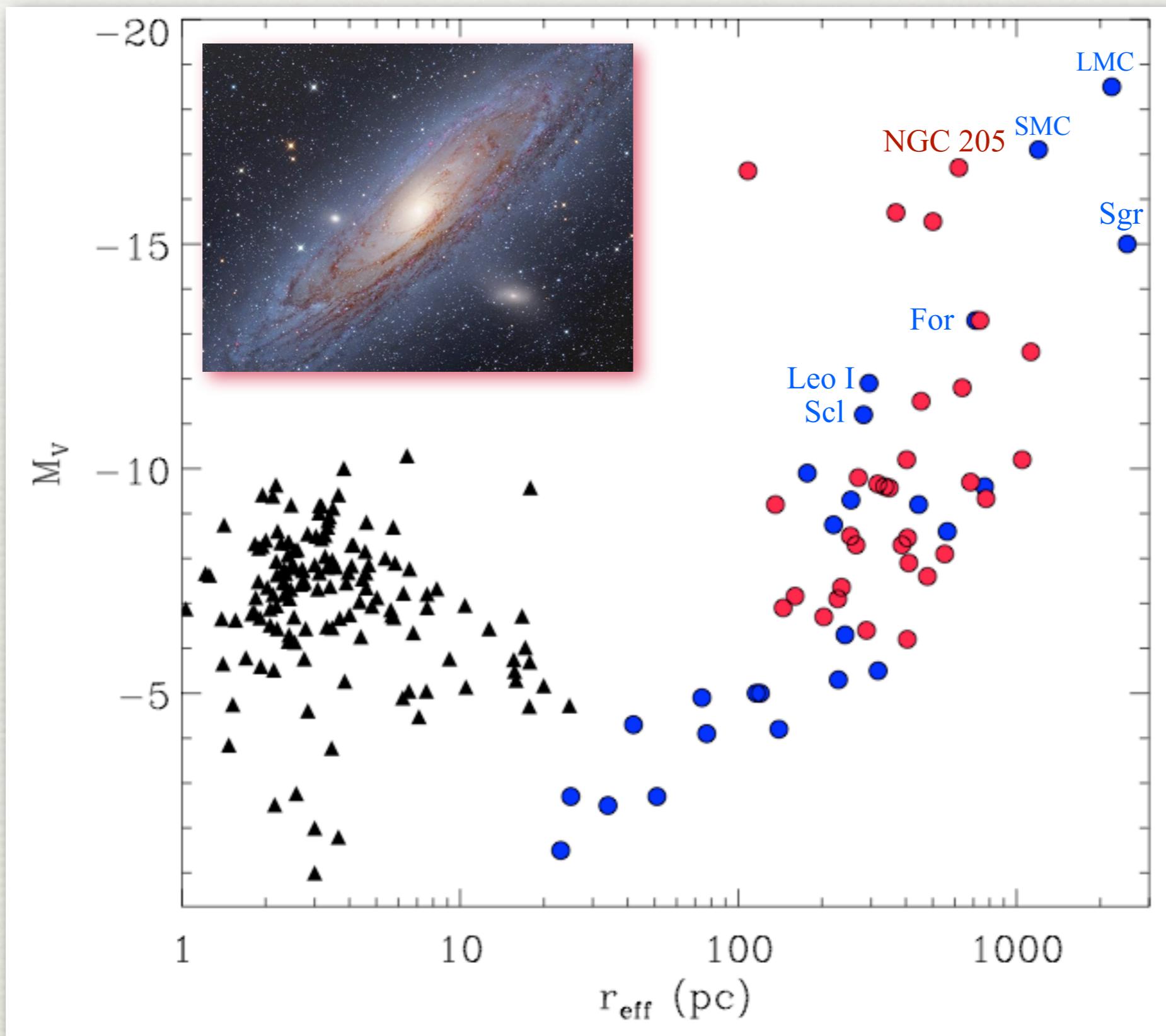


Majority of work on M31 satellite kinematics and metallicities enabled by Keck/DEIMOS spectrograph:

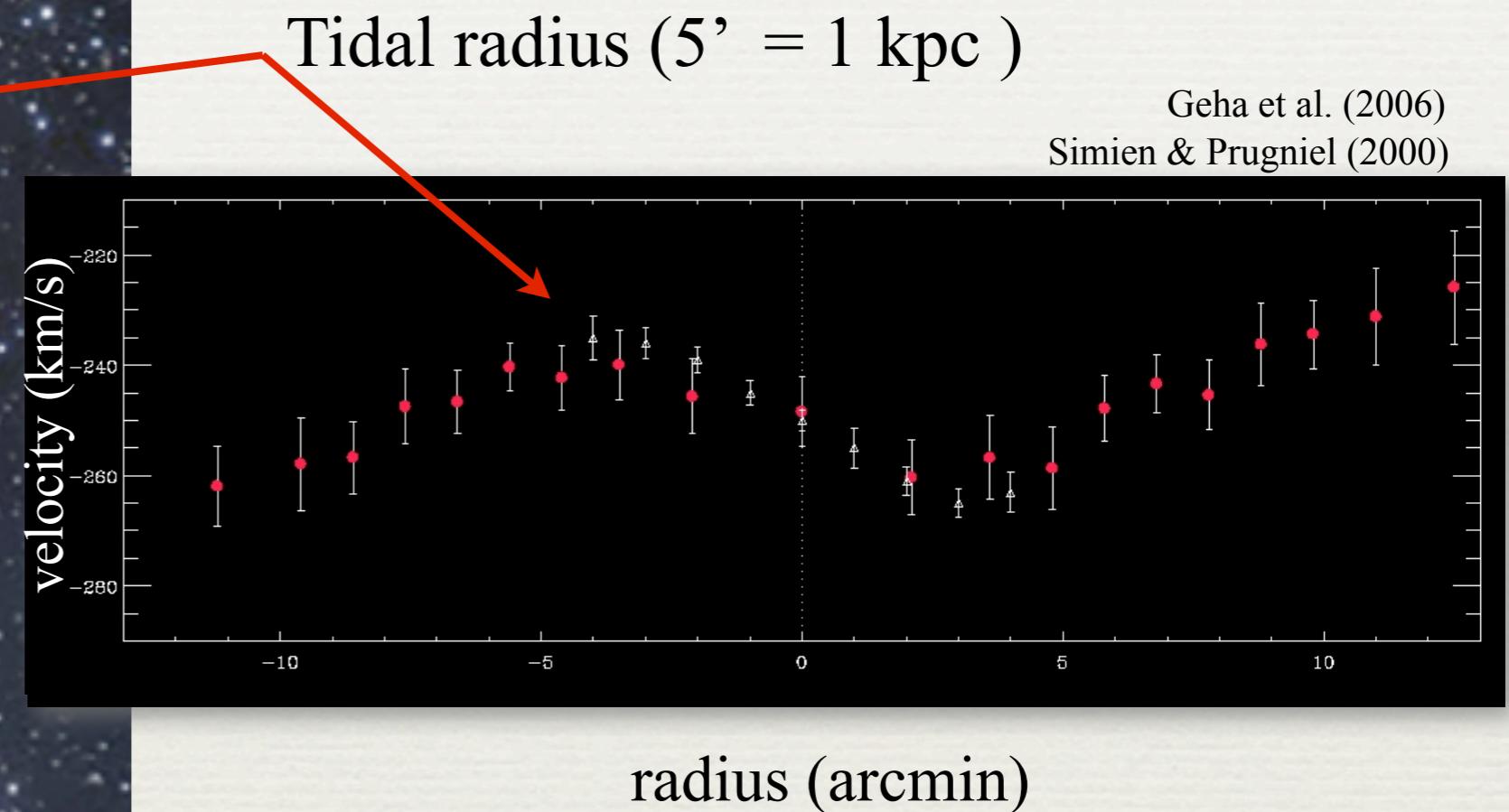
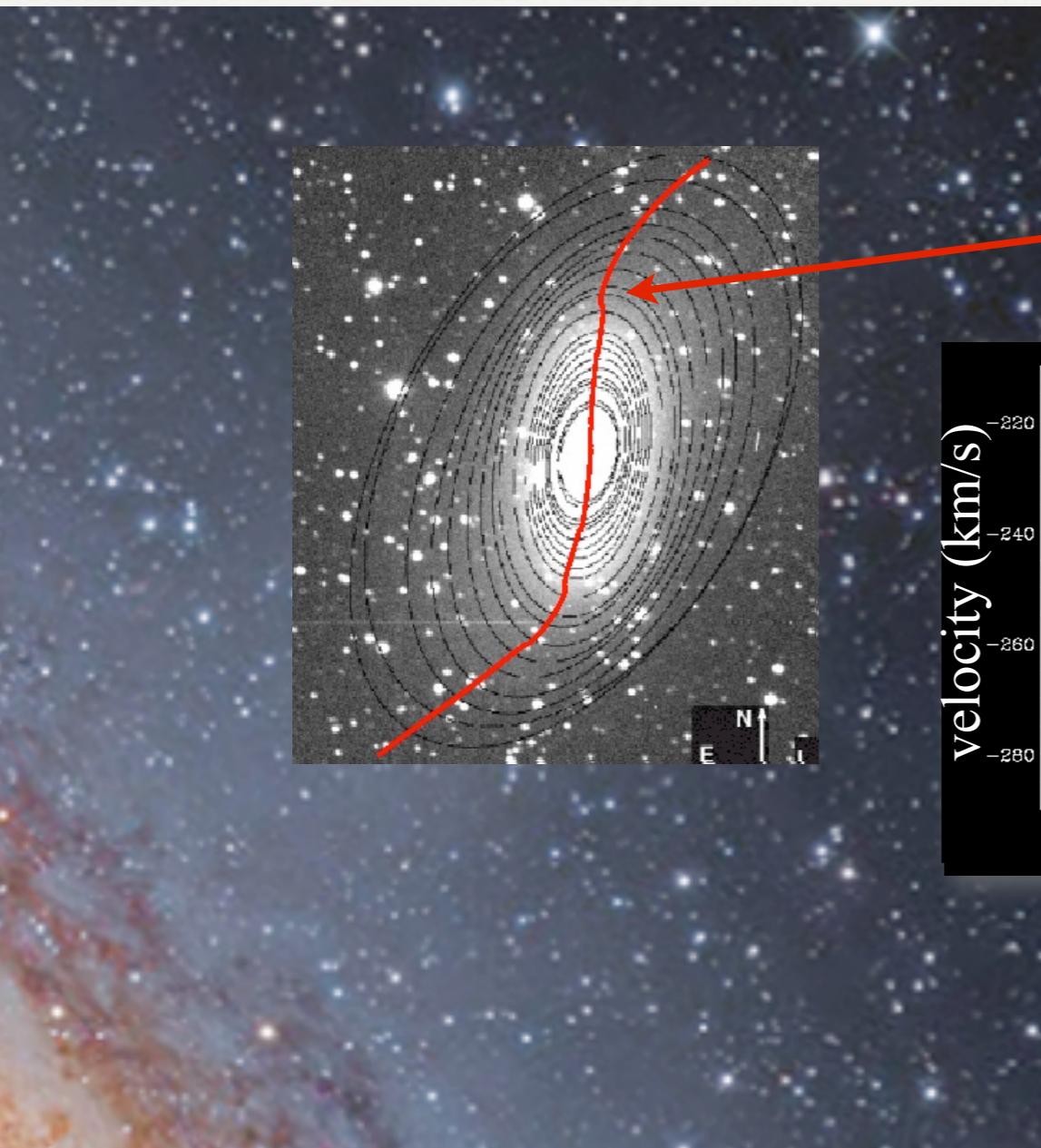
Chapman et al. 2005, Geha et al. 2006, Majewski et al. 2007, Kalirai et al. 2009, Letarte et al. 2009, Geha et al. 2010, Kalirai et al. 2010, Collins et al. 2010, Howley et al. 2012, Ho et al. 2012, Tollerud et al 2012

- ♦ RGB stars selected from photometry.
- ♦ Typically Ca II triplet region,  $\Delta v \sim 2\text{-}3 \text{ km/s}$ .
- ♦ Radial velocities for  $\sim$ hundred of RGB stars in one hour in good conditions.

# A Quick Tour of M31's Satellites



# NGC 205

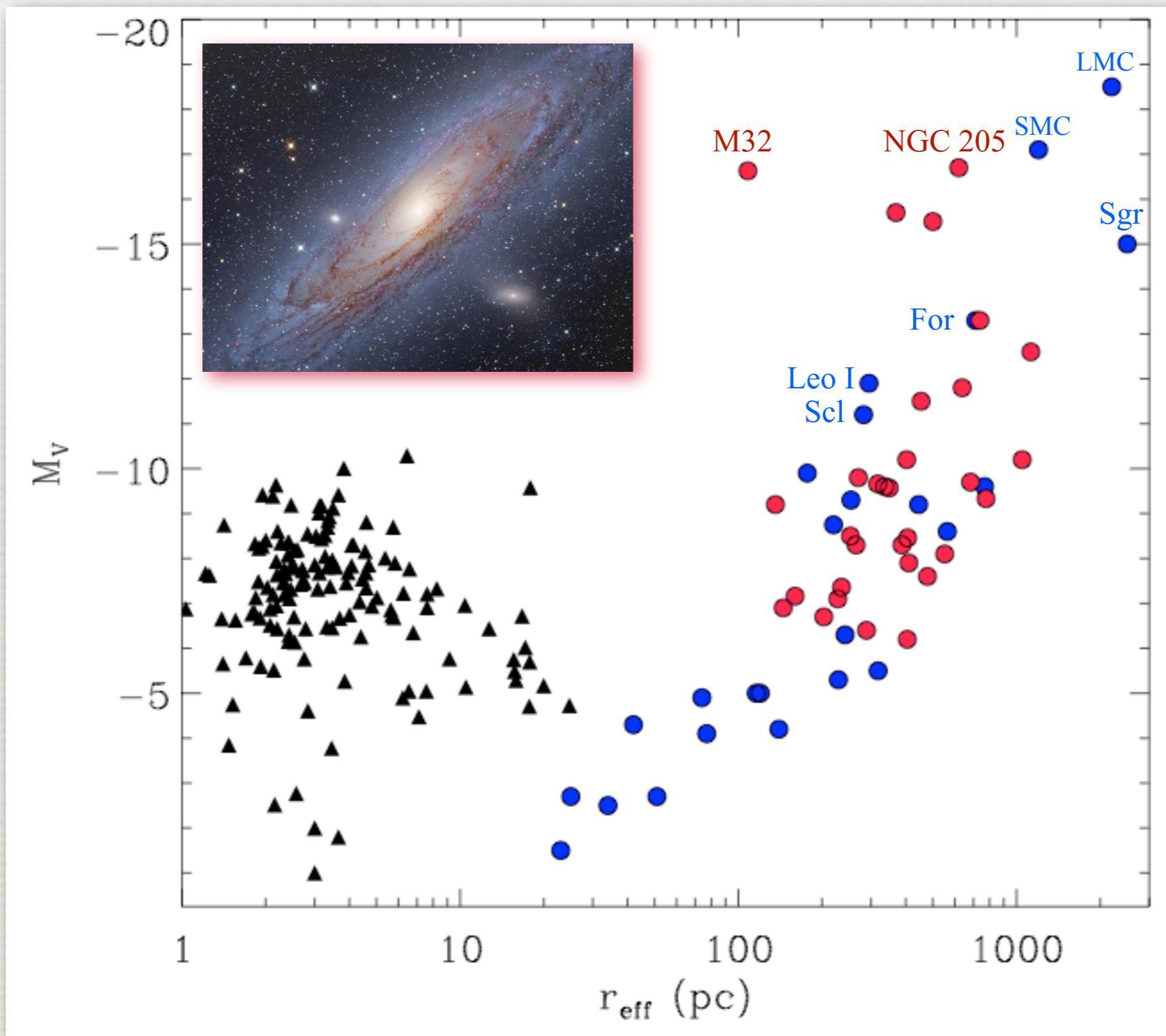


Inner rotation =  $15 \text{ km s}^{-1}$

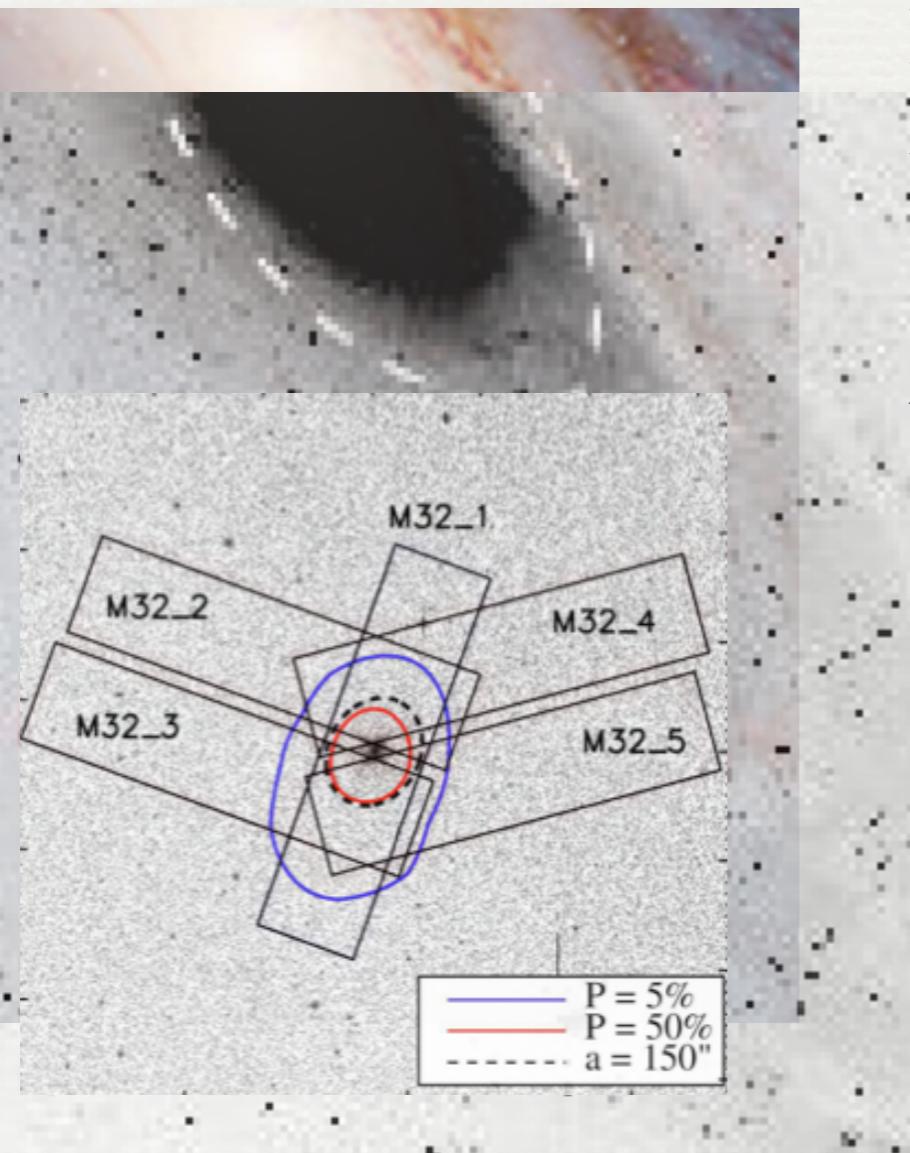
Velocity turn-over at tidal radius (730 stars)

NGC 205 on first passage? (Howley et al. 2008)

# A Quick Tour of M31's Satellites



# M32: Compact Elliptical with a Black Hole



**M32 has a central black hole**

$$M_{\text{BH}} = (2.4 \pm 1.0) \times 10^6 M_{\odot} :$$

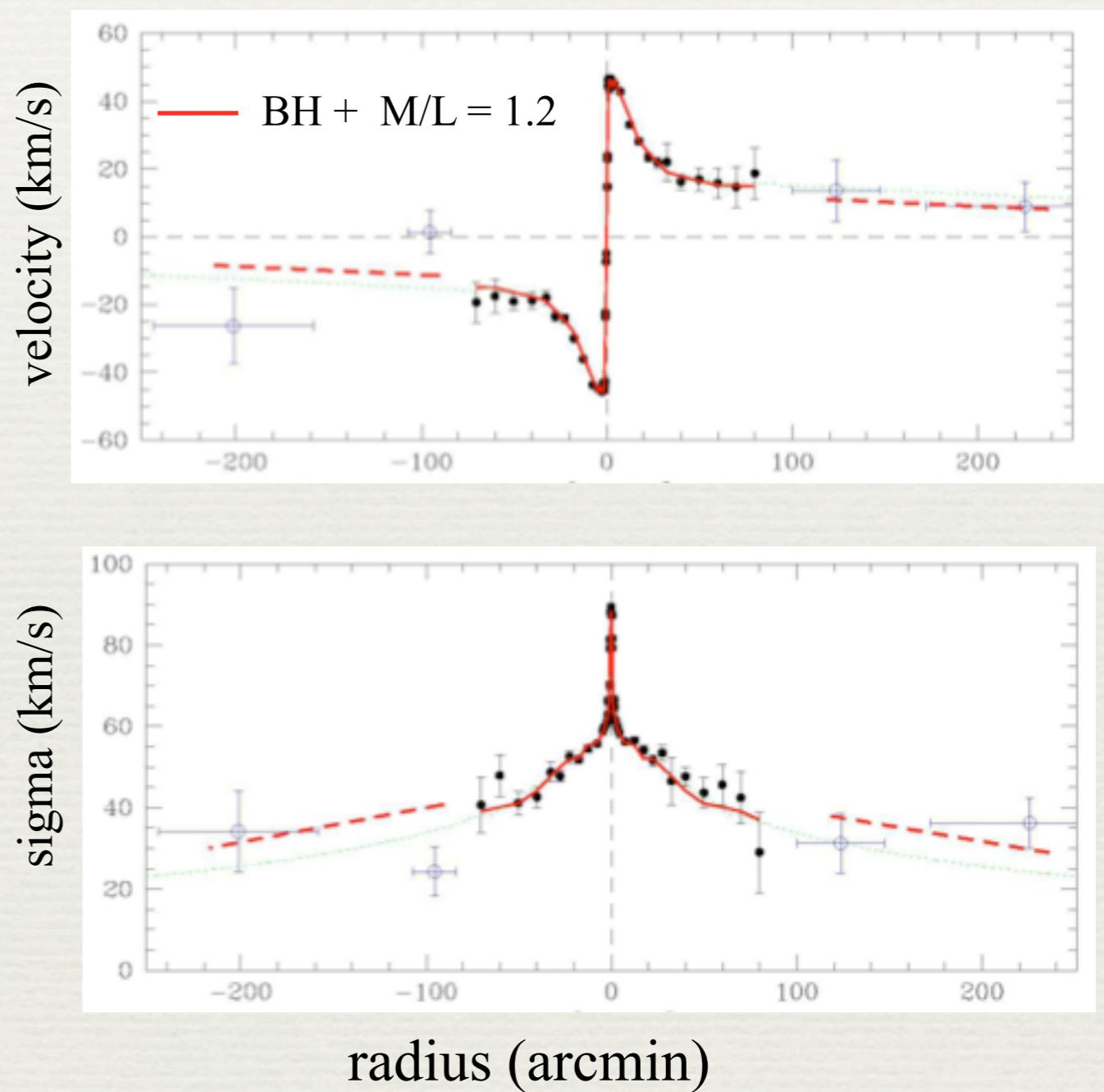
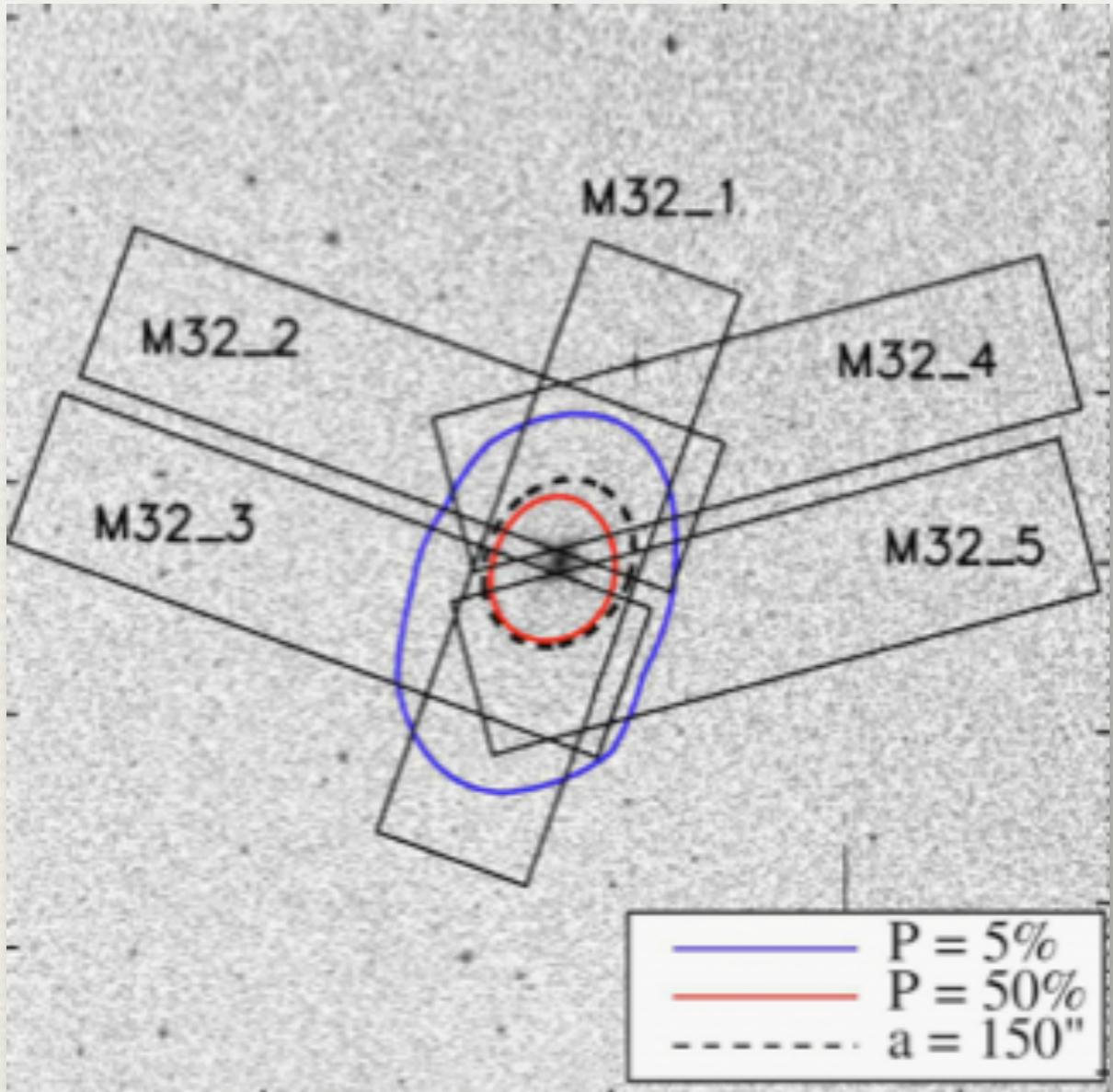
Goodman & Lee 1989; Bender, Kormendy & Dehnen 1996; van der Marel et al. 1998b; Joseph et al. 2001; Verolme et al. 2002; Tremaine et al. 2002; van der Marel et al. 1997; van den Bosch & de Zeeuw 2010

Based on kinematics within  
 $r_{\text{eff}} = 30'' = 0.1 \text{ kpc}$

Choi, Guhathakurta & Johnston (2002):  
Distorted M32 isophotes around 150'',  
consistent with tidal interactions.

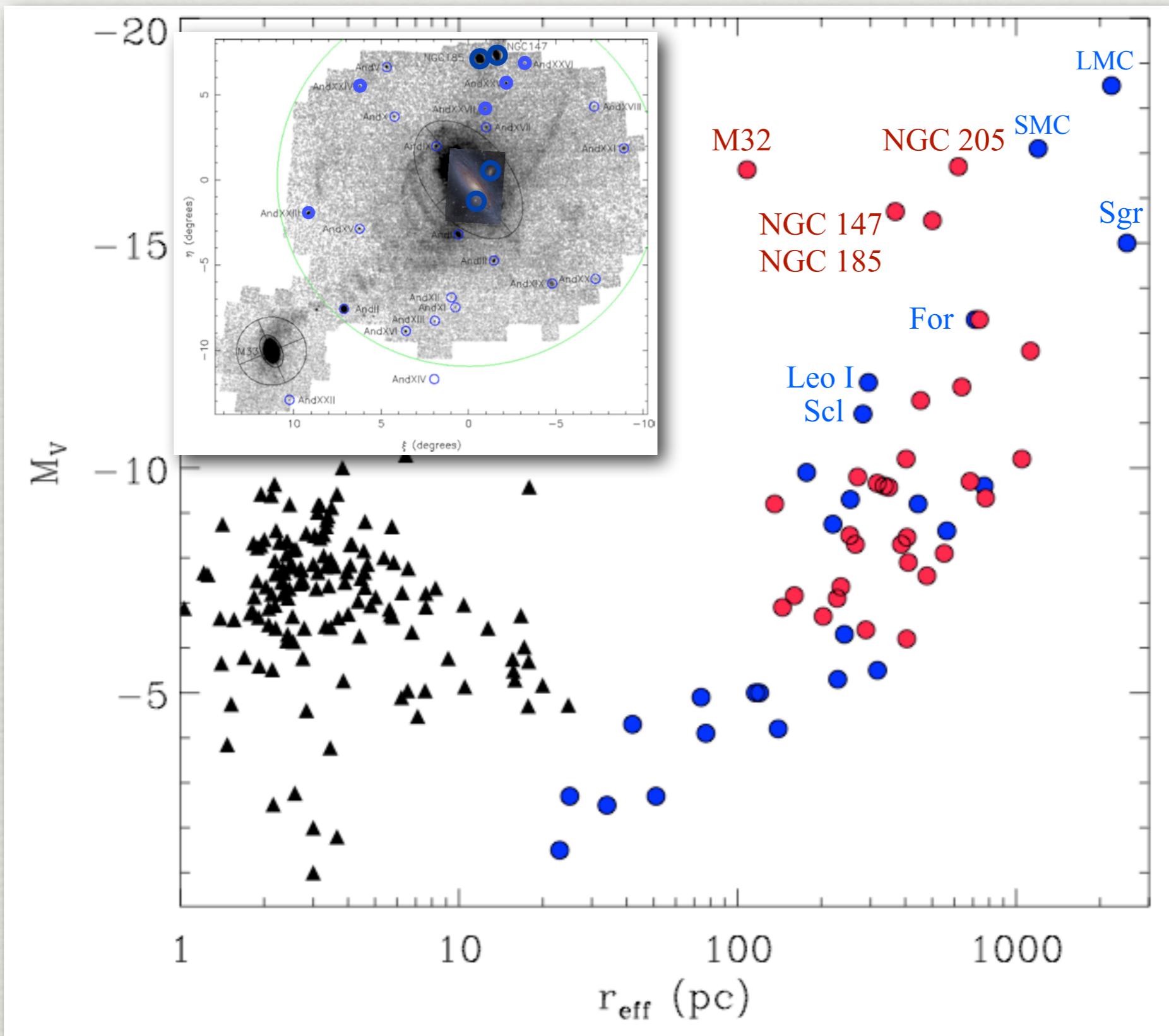
# M32: Compact Elliptical with a Black Hole

Howley et al. (2012)



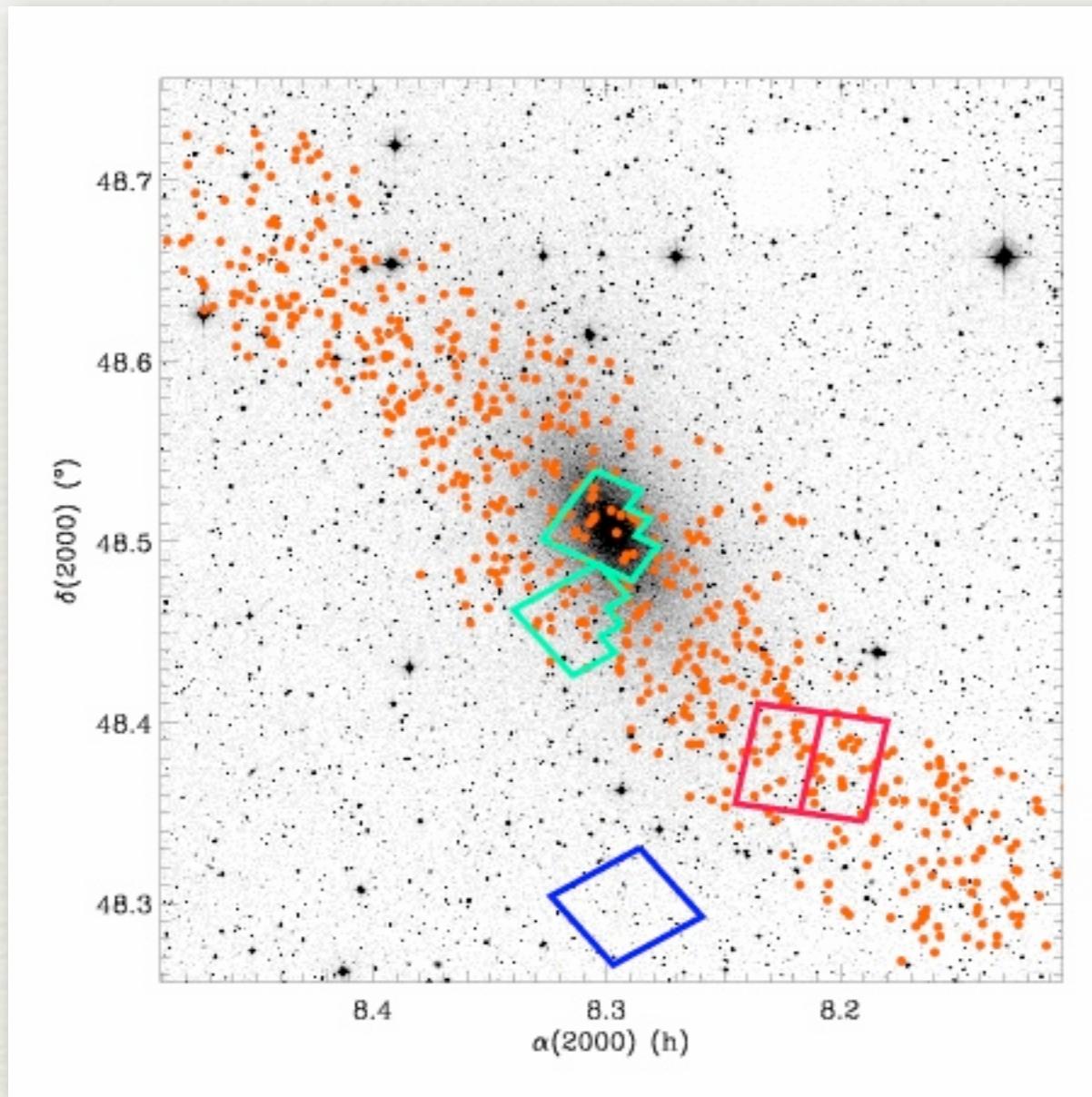
M32 kinematics appear well-behave out to large radius

# A Quick Tour of M31's Satellites

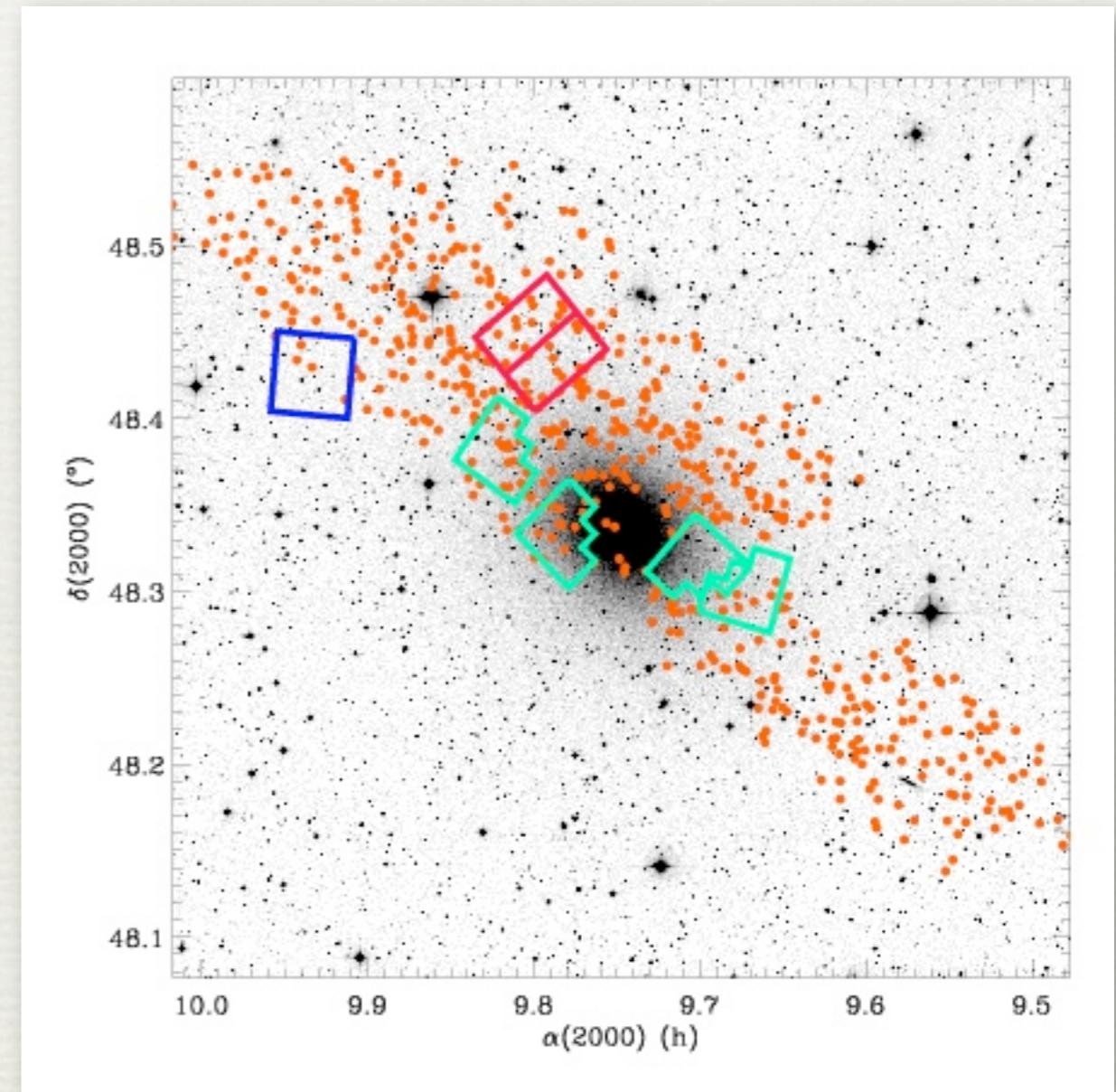


# NGC 147 and NGC 185: Normal dEs

NGC 147



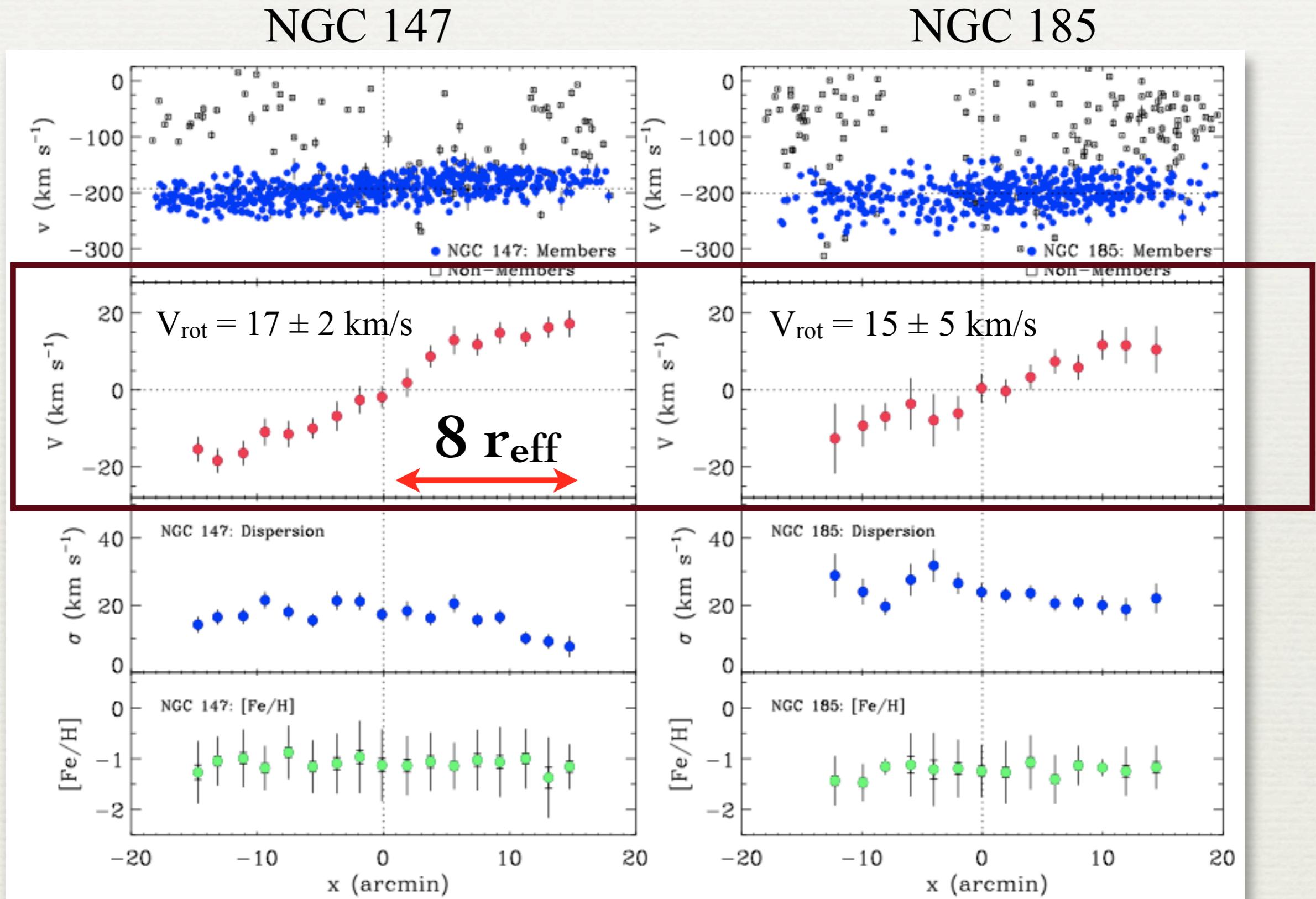
NGC 185



Keck/ DEIMOS  
spectroscopy

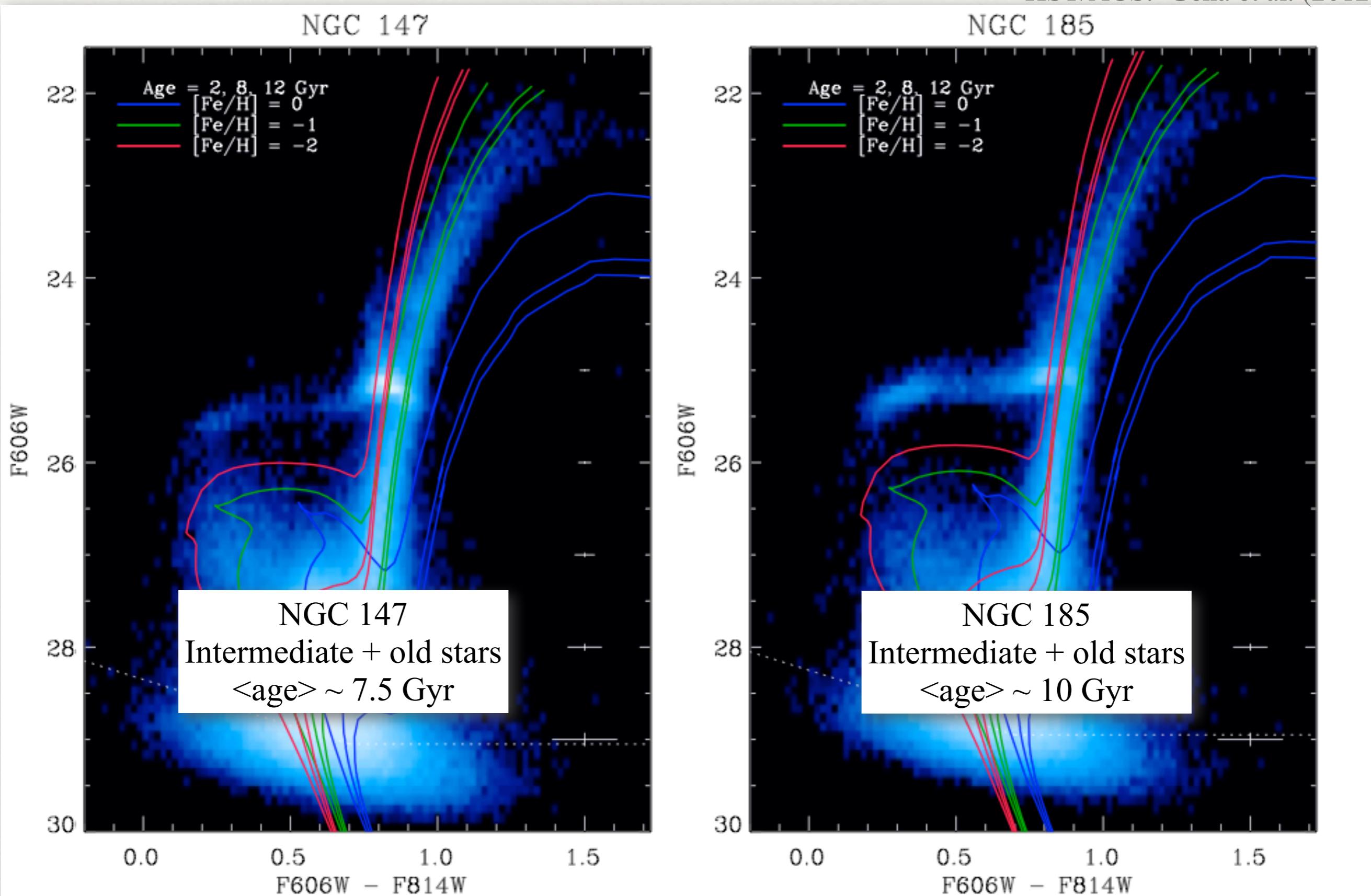
HST WPFC2  
HST ACS  
HST WFC3

# NGC 147 and NGC 185: Normal dEs

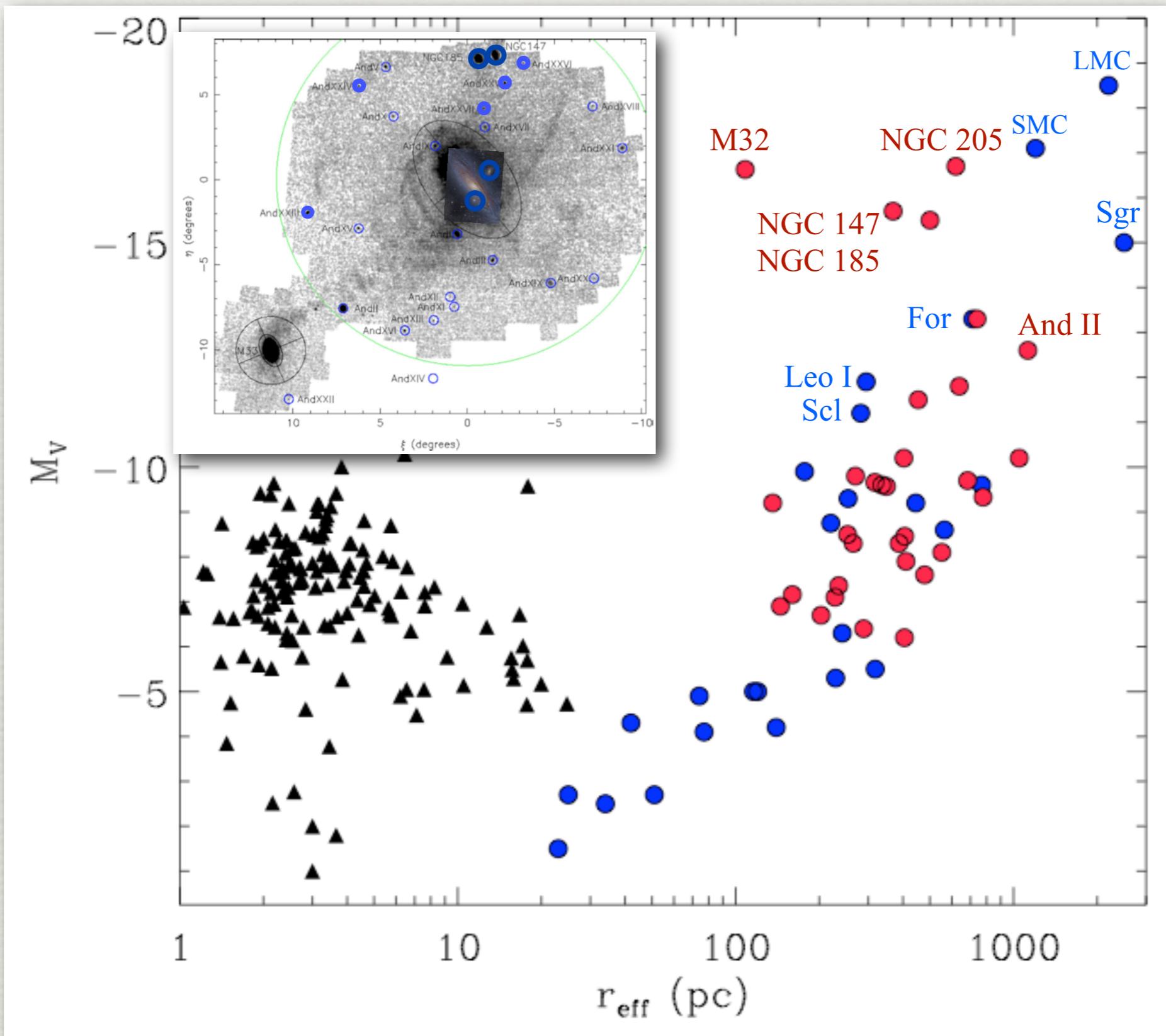


# NGC 147 and NGC 185: Normal dEs

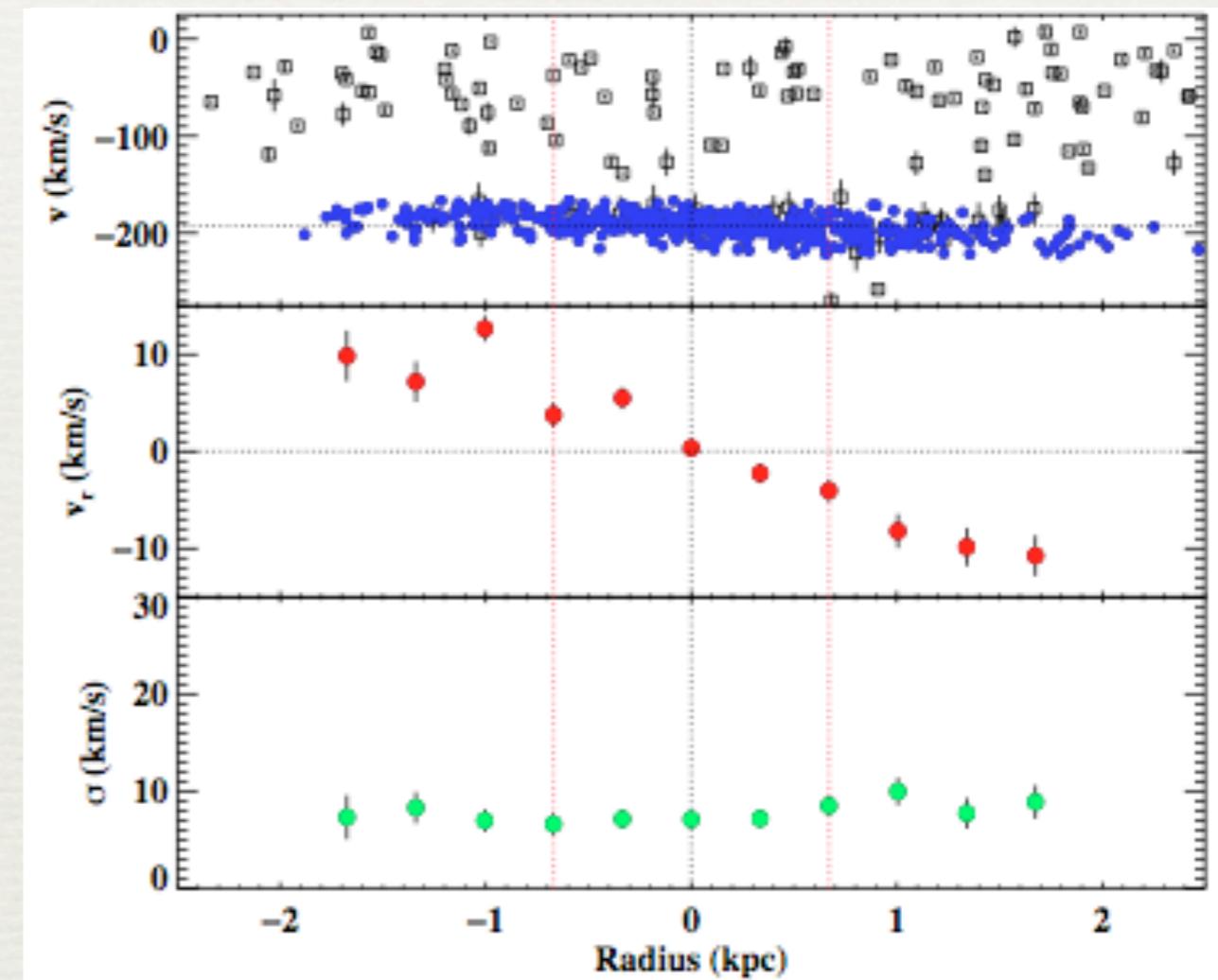
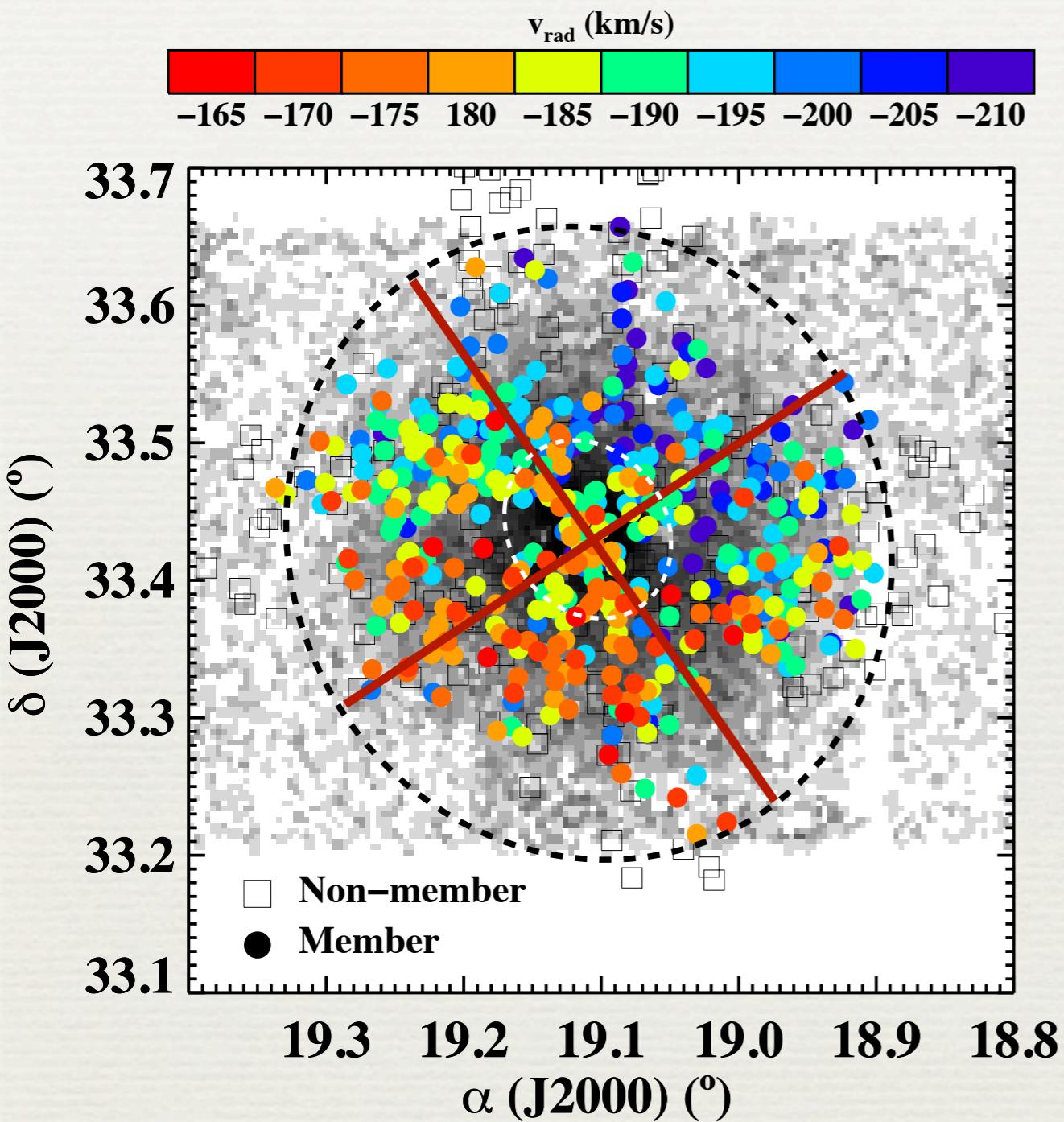
HST/ACS: Geha et al. (2012)



# A Quick Tour of M31's Satellites

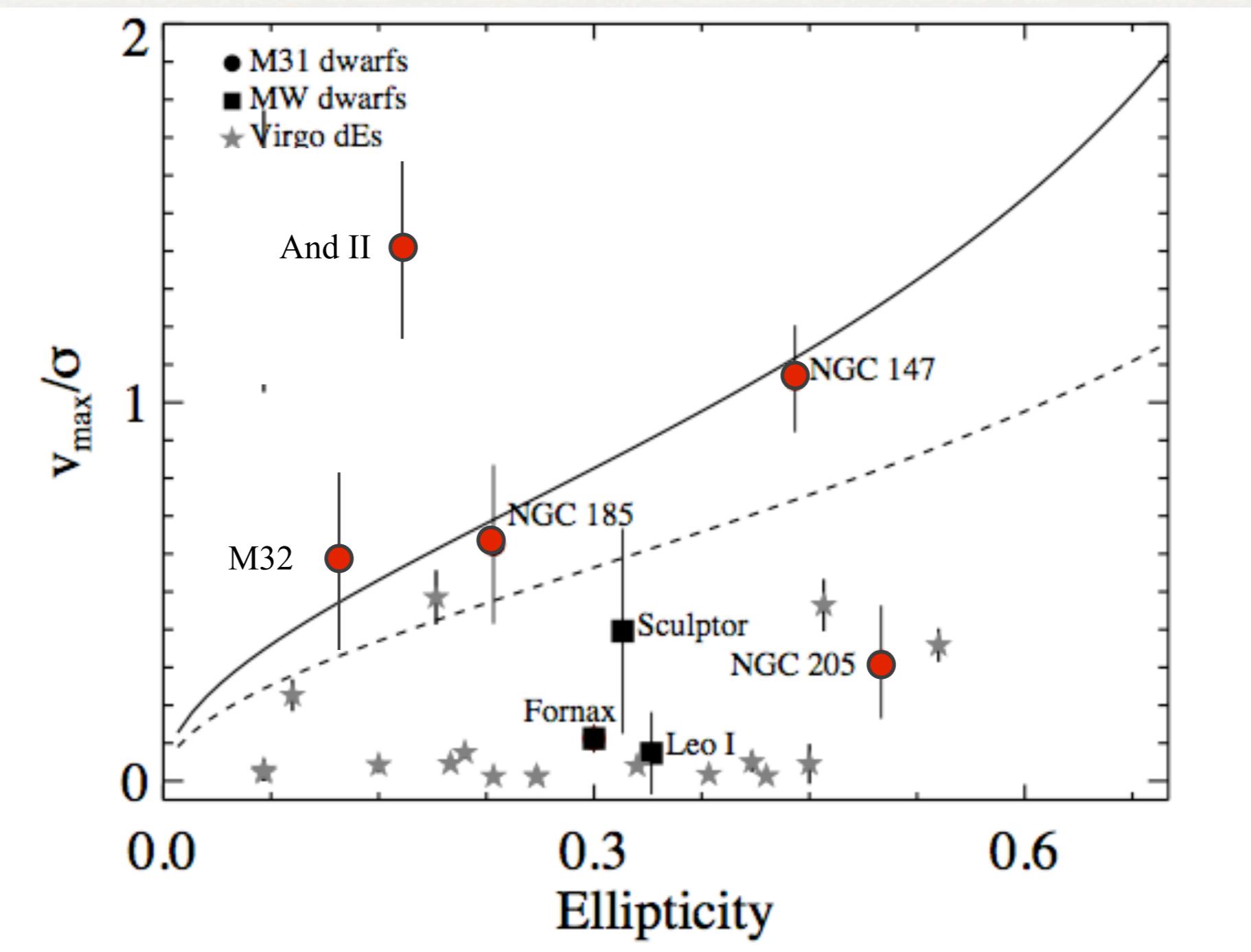


# And II



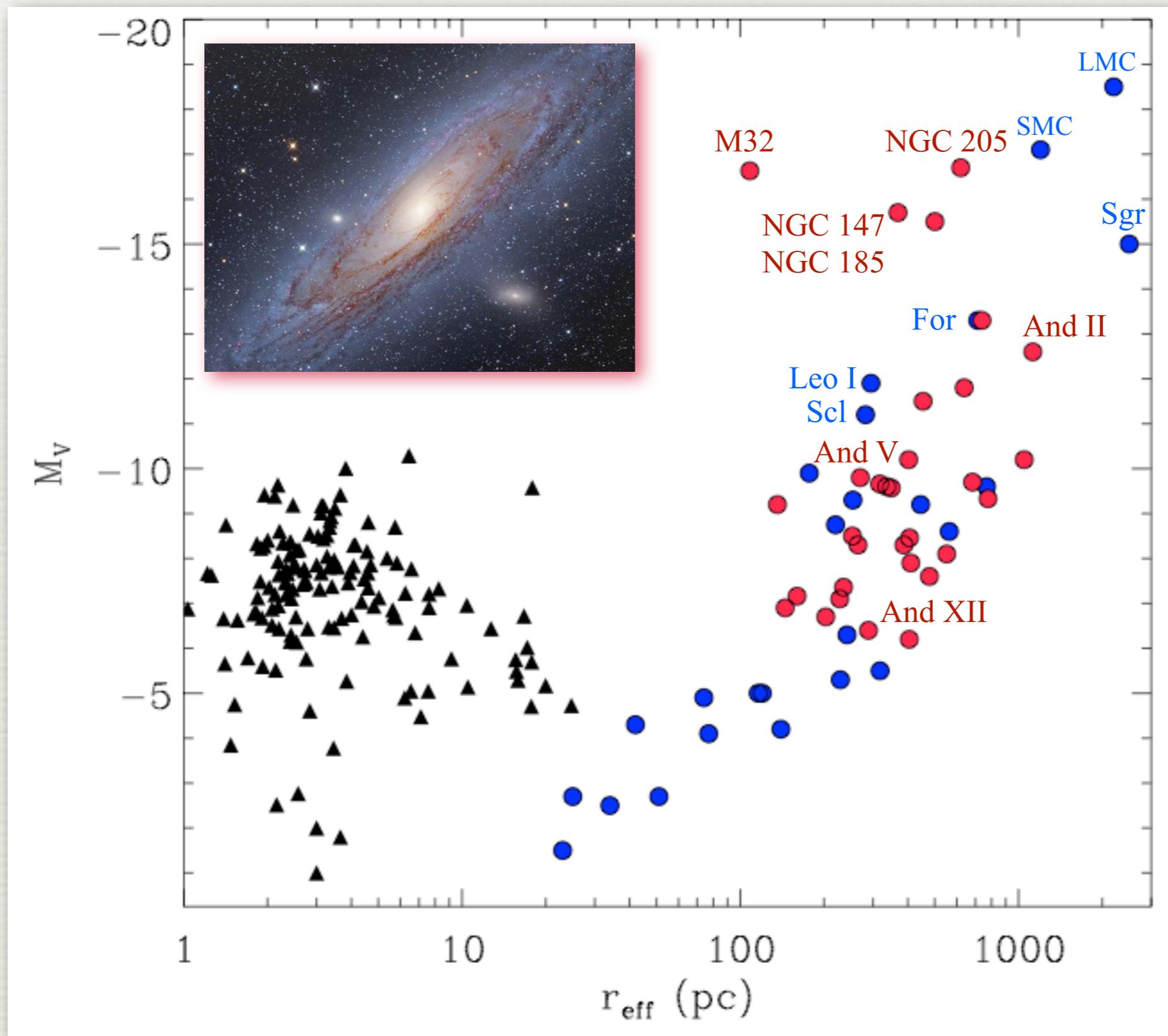
Radius (kpc)

Prolate or triaxial rotation: dynamically stable?



More M31 satellites with rotation as  
compared to MW

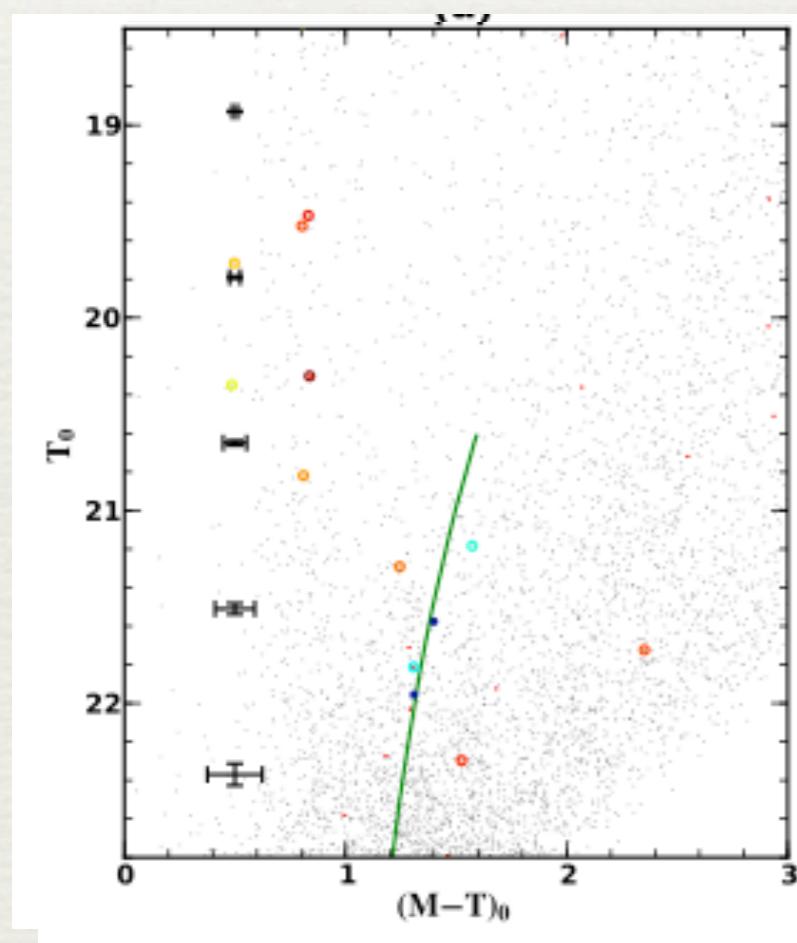
# A Quick Tour of M31's Satellites



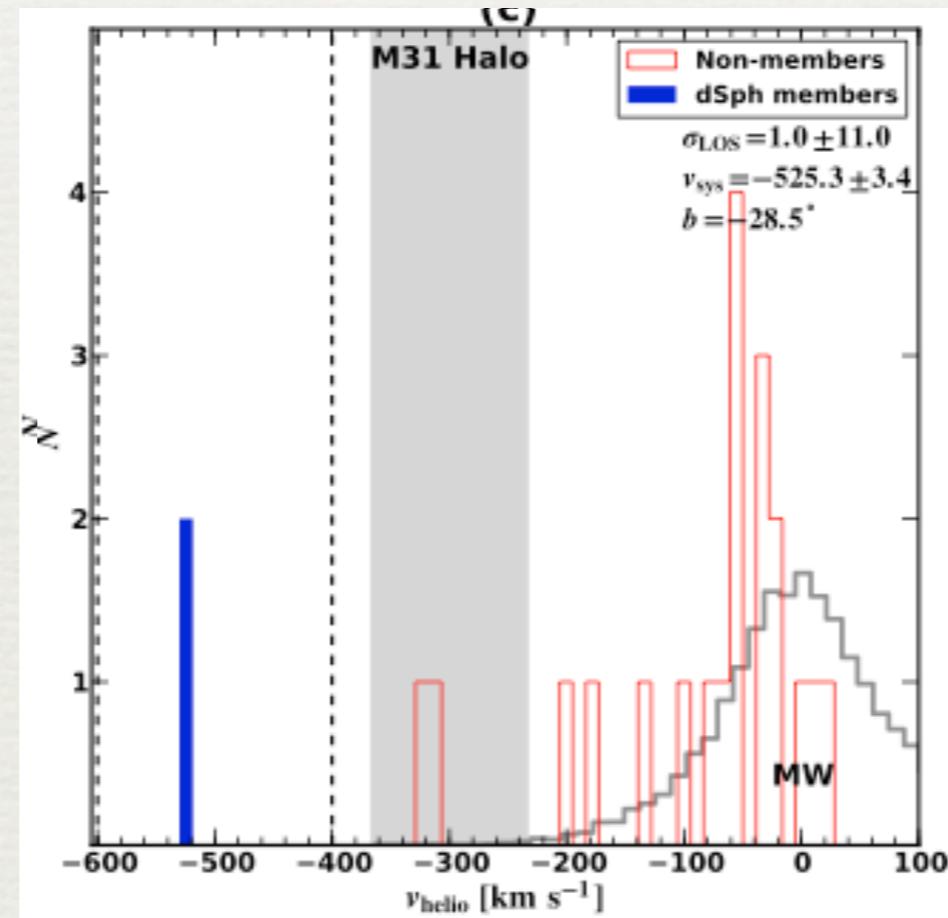
And XII:  $M_V = -6.2$

sigma = ??  
(2 member stars)

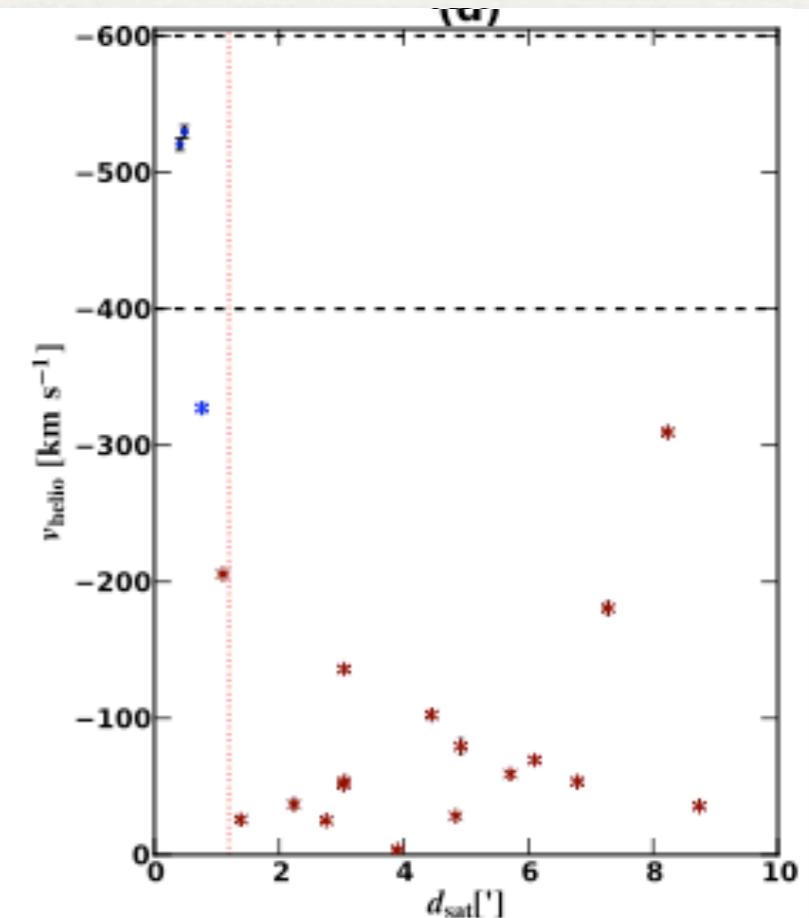
CMD



Velocity



Velocity vs. radius

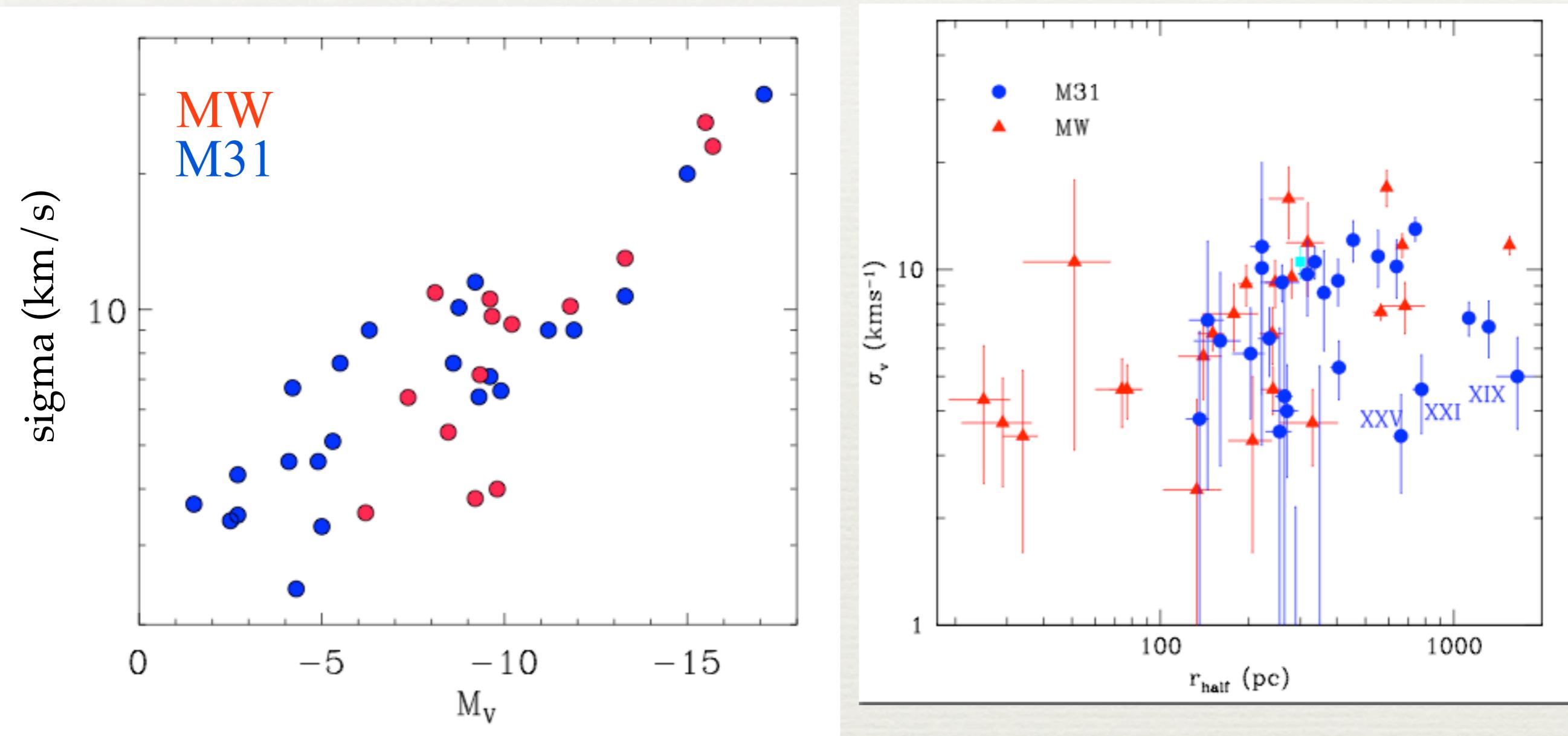


Tollerud et al. (2012)

See also poster by M. Collins!

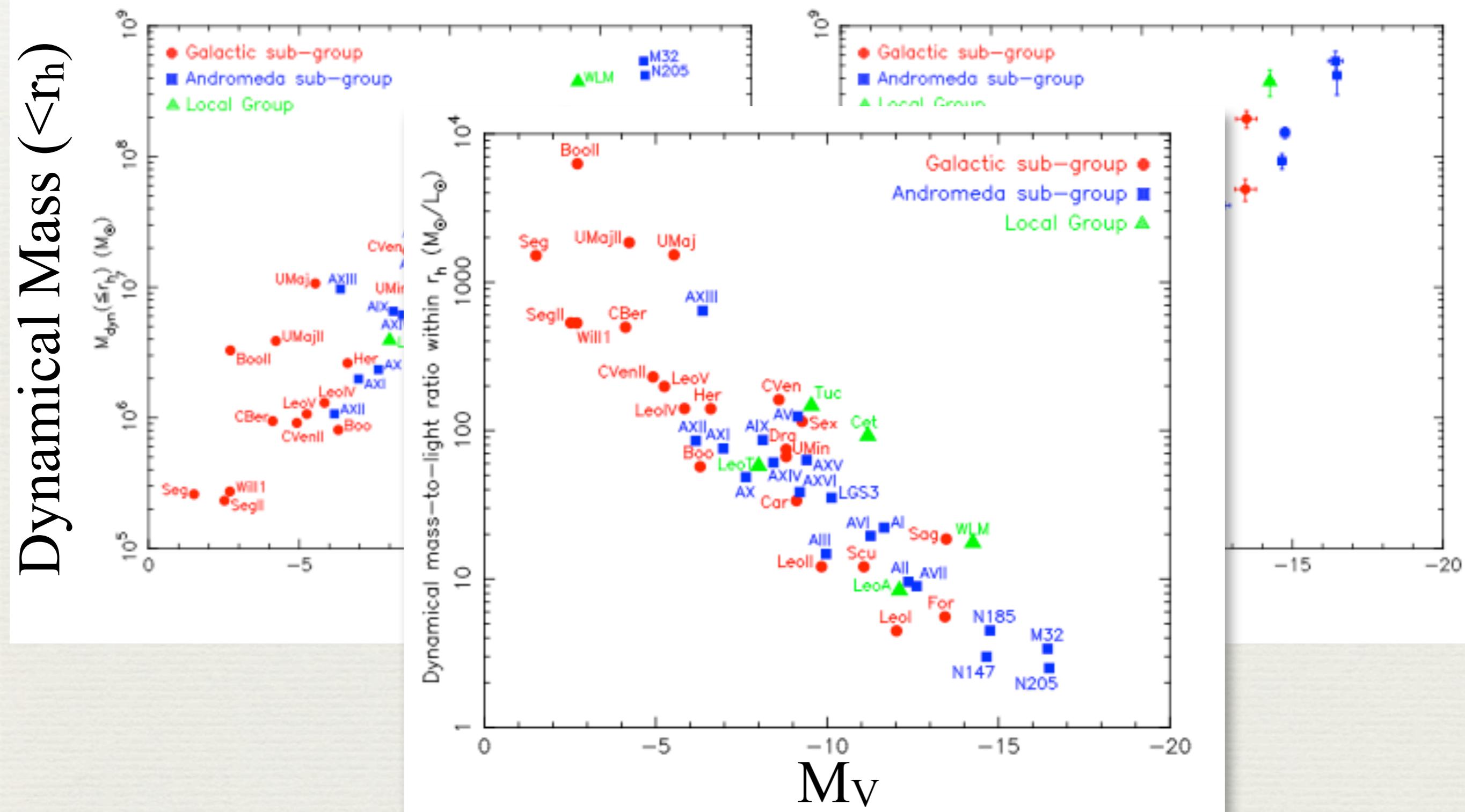
# M31 vs. MW Satellite Systems

from M. Collins



# M31 vs. MW Satellite Systems

McConnachie (2012)



# The M31 Dwarf Galaxy Population

The Milky Way satellite system provides strong constrain on cosmological models (number of satellites, central densities, ages/metallicities)

→ M31 satellites now have competitive observational dataset

-- M31 satellite system is similar to MW:

- Basic scaling relations
- Evidence for on-going tidal interactions/merging

-- M31 satellite system is different to MW:

- Basic scaling relations
- Number of satellites
- Detailed properties