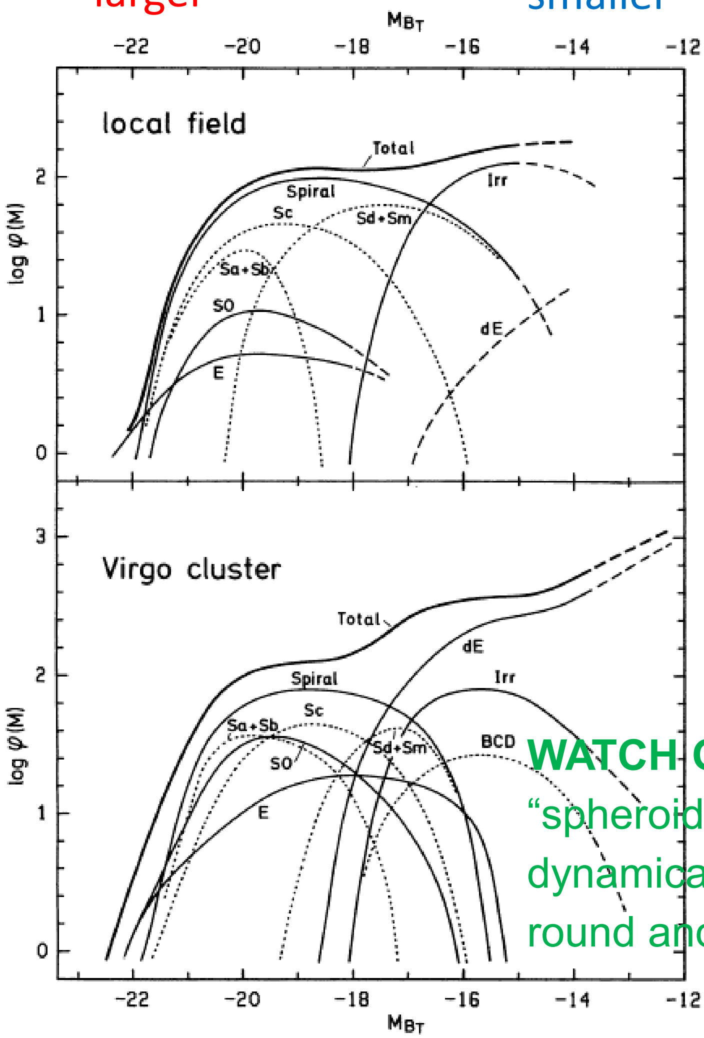
Galaxies as a Population II

ASTR 503/703

Counting Galaxies

larger

smaller

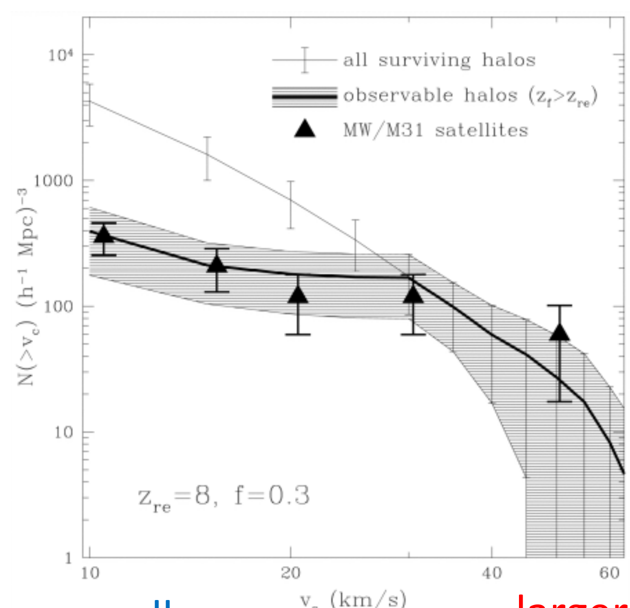


WATCH OUT!
"spheroidal" = both dynamically hot/ round and cold/flat

Binggeli 1988 ARAA:
morphology-environment relation

Luminosity Function:
frequency distribution of objects by luminosity

frontier: stellar/baryonic mass functions, velocity functions…

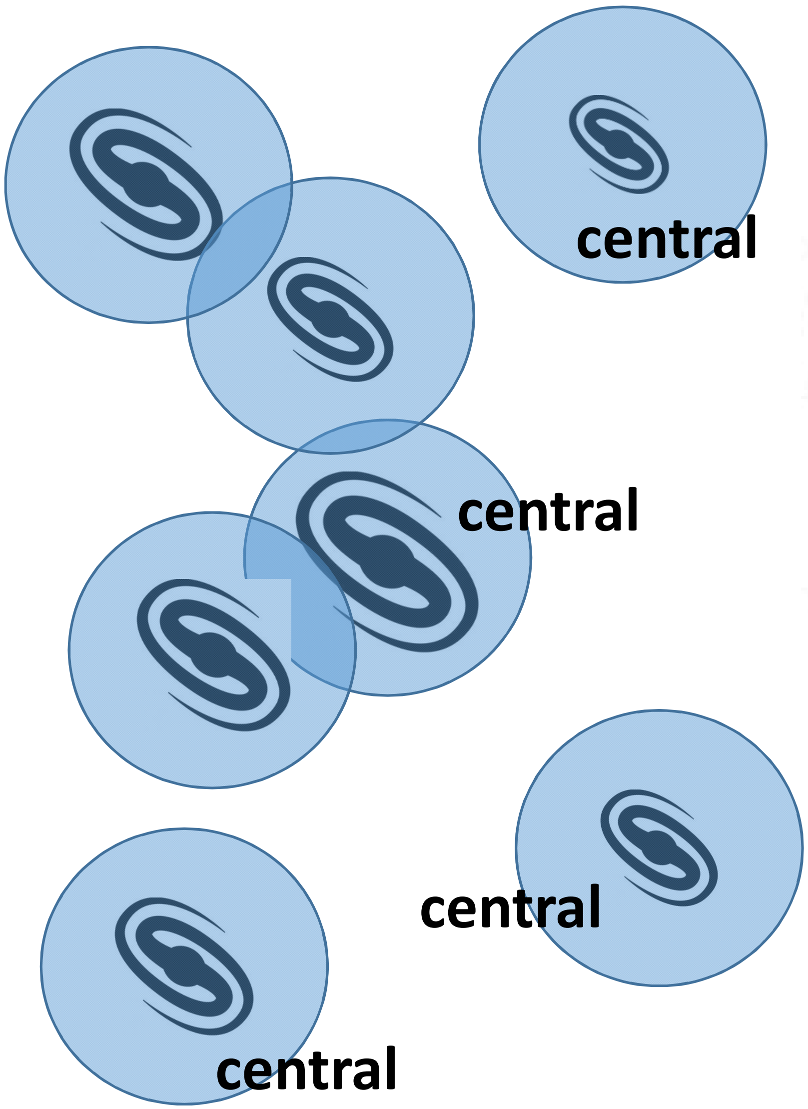


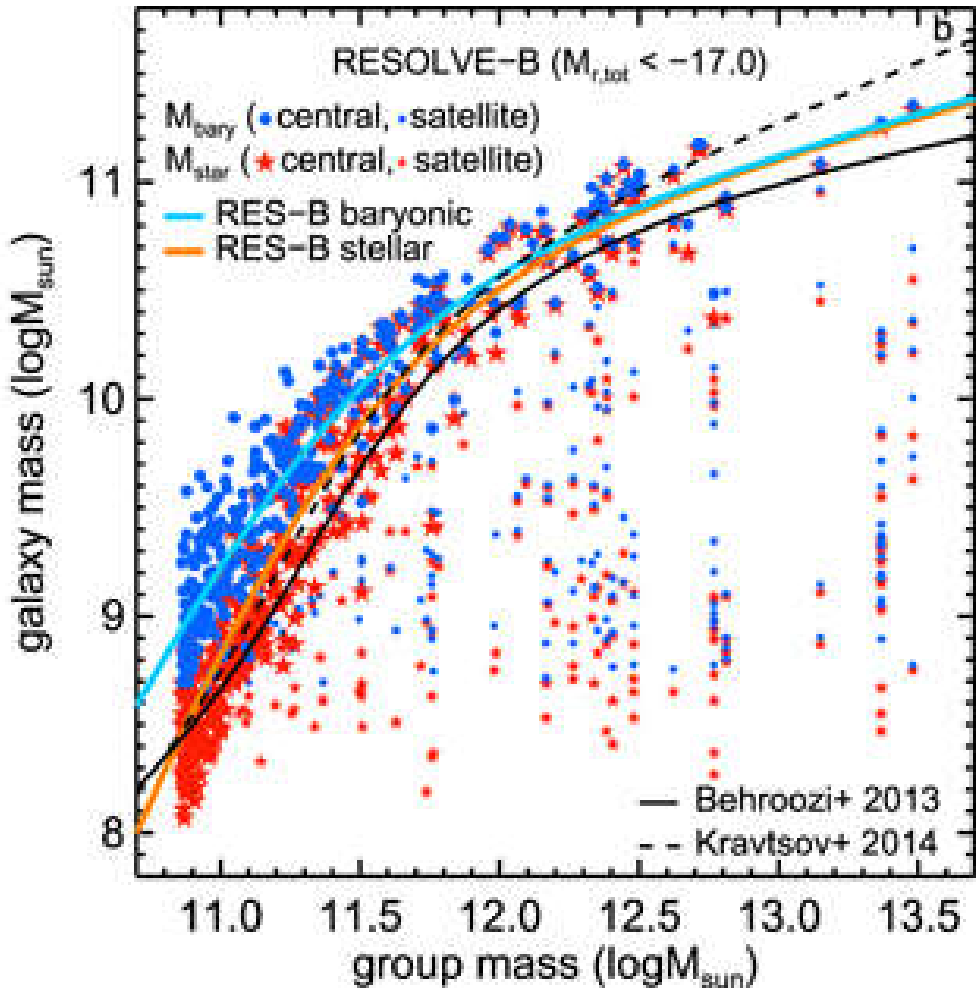
smaller

larger

Bullock+00) – Local Group VF "**missing satellites problem**" (aka "substructure problem")

Group Finding:
the Central-Satellite Paradigm



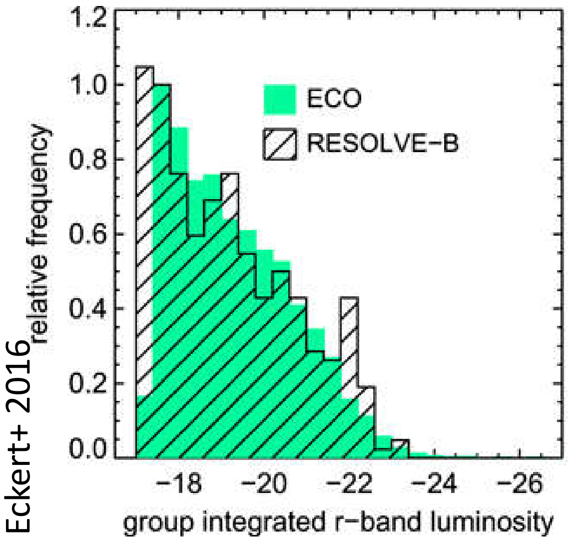


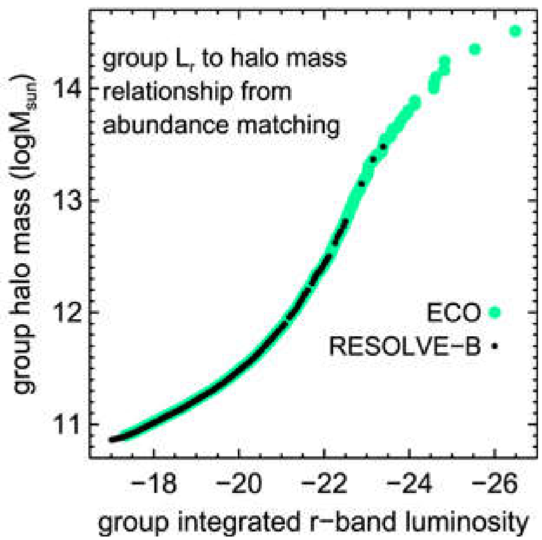
Eckert et al. 2016

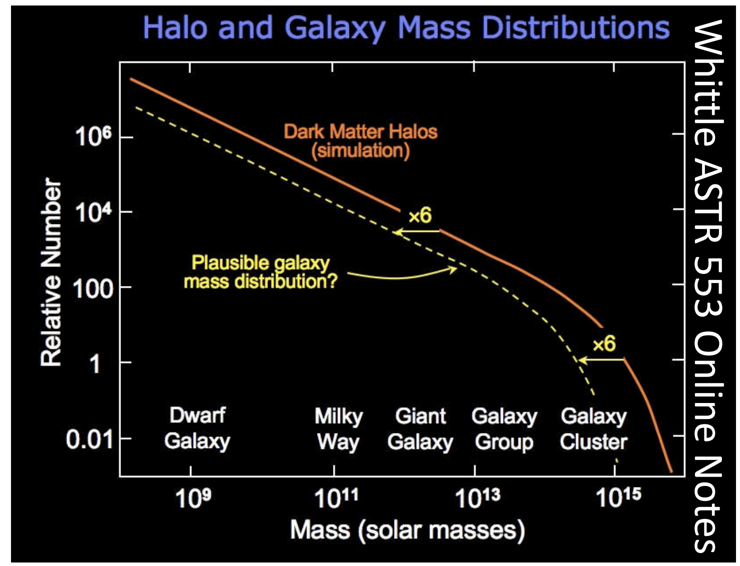
Mapping galaxies & groups to halos

Map Group LF to theoretical Halo MF → "halo abundance matching", "halo occupation distribution" (HOD) modeling…

Eckert+ 2016







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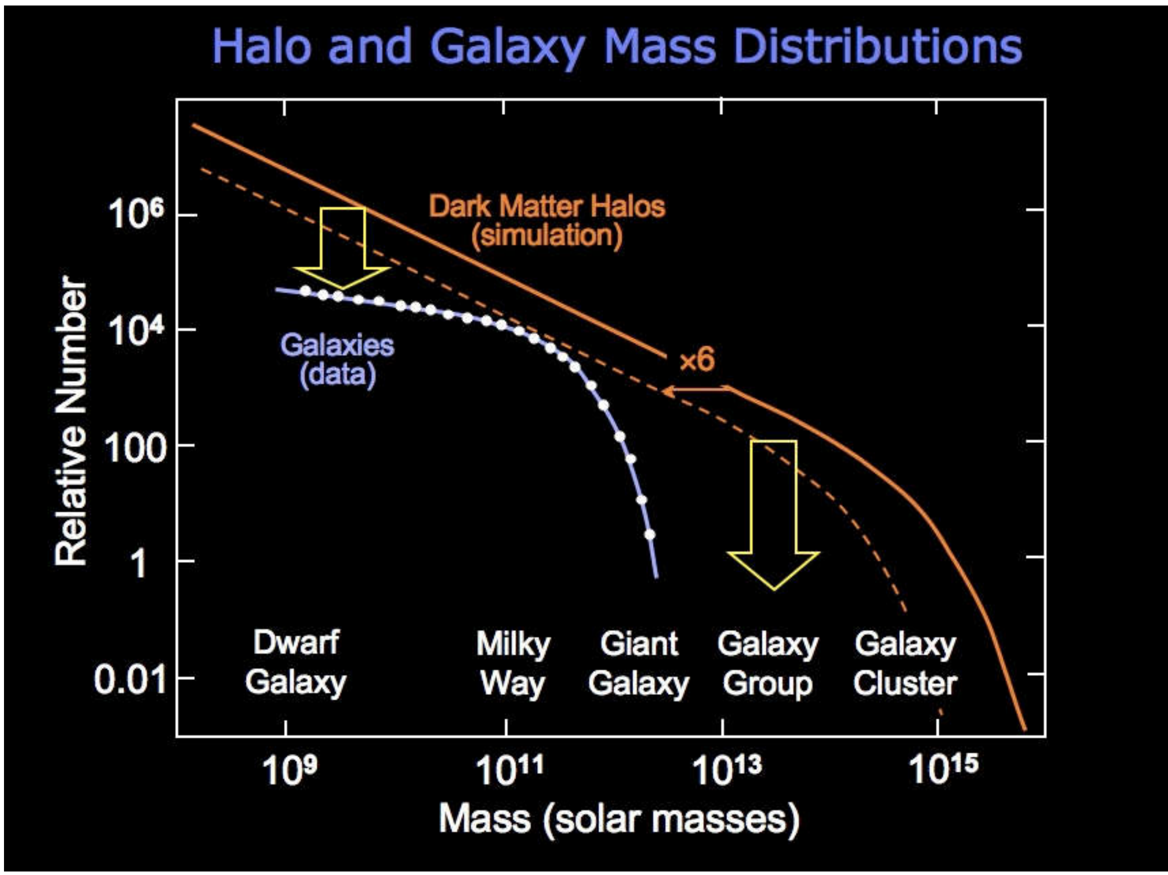
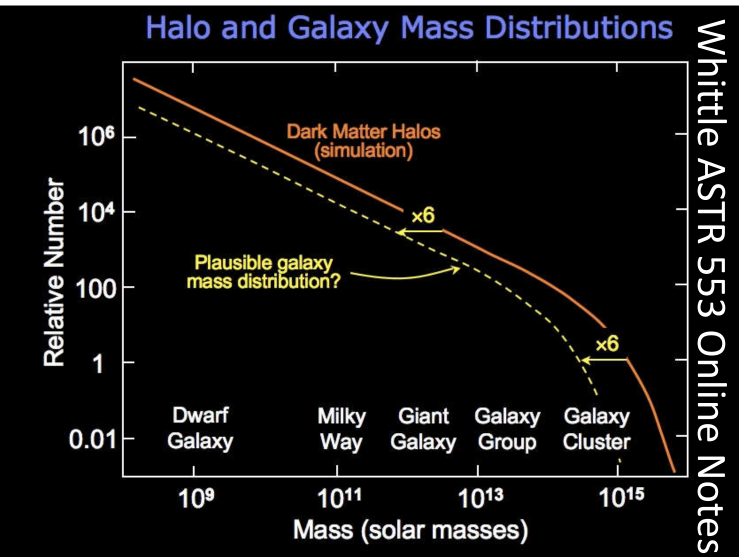
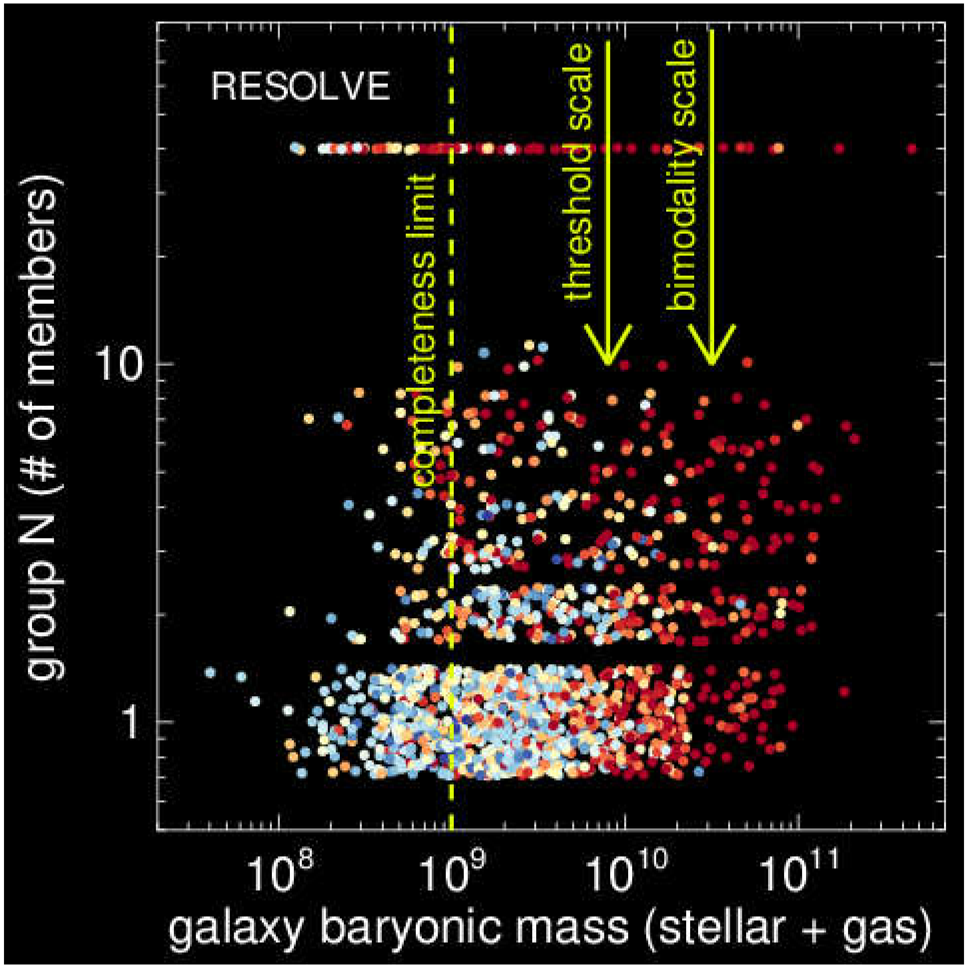




Galaxy formation "efficiency" peaks for small groups

Star formation histories reflect both mass and environment



Kannappan et al., in prep.

colorscale = fractional stellar mass growth (last Gyr/previous Gyrs)

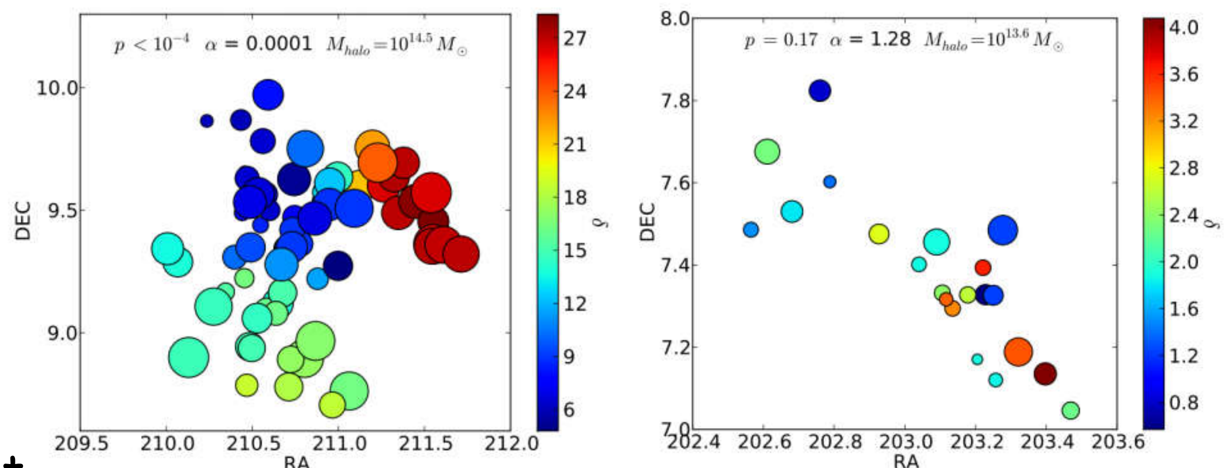
"Quenching" models:

- Bulge growth reduces star formation efficiency (morphology quenching)
- Black hole growth increases AGN feedback (mass quenching)
- Hot halo gas ram-pressure strips existing cold/warm reservoirs, "starves" replenishment by cooling (environment quenching)
- Larger scale quenching may reflect assembly bias, competitive accretion, or flybys/ejected satellites

Metrics of environment

- galaxy-galaxy or galaxy-group center separations
- merger signatures (tidal features, double nuclei)
- group virialization state, mass (by dynamics vs. HAM/HOD vs. lensing), N, central/satellite status
- density field (KDE, k-neighbors), cosmic variance
- filament and wall IDs/properties
- correlation functions

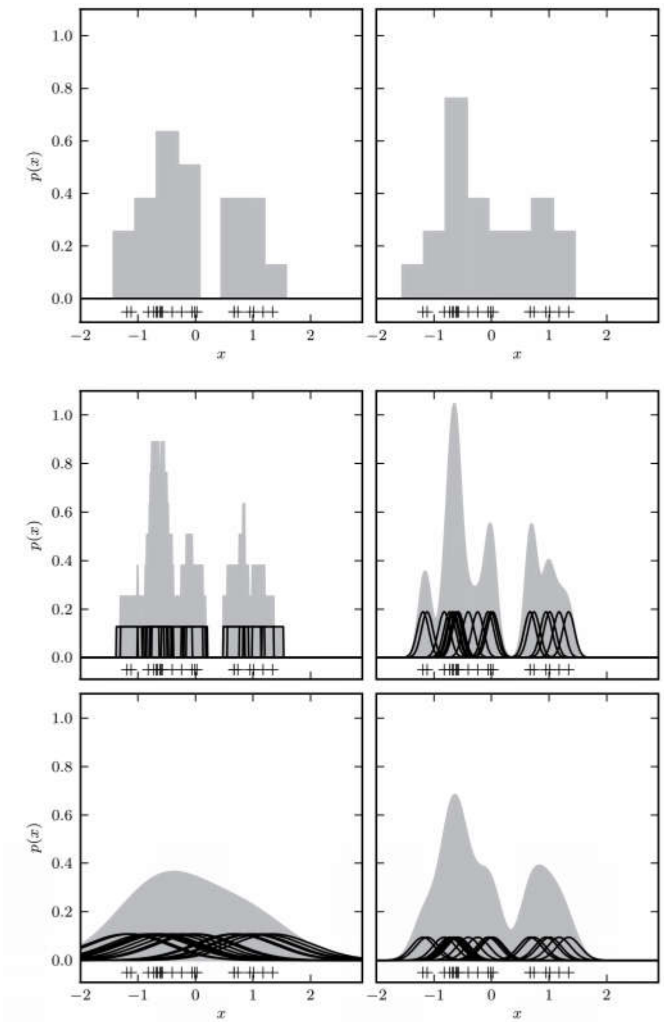
Dressler-Schechtman test for dynamical substructure

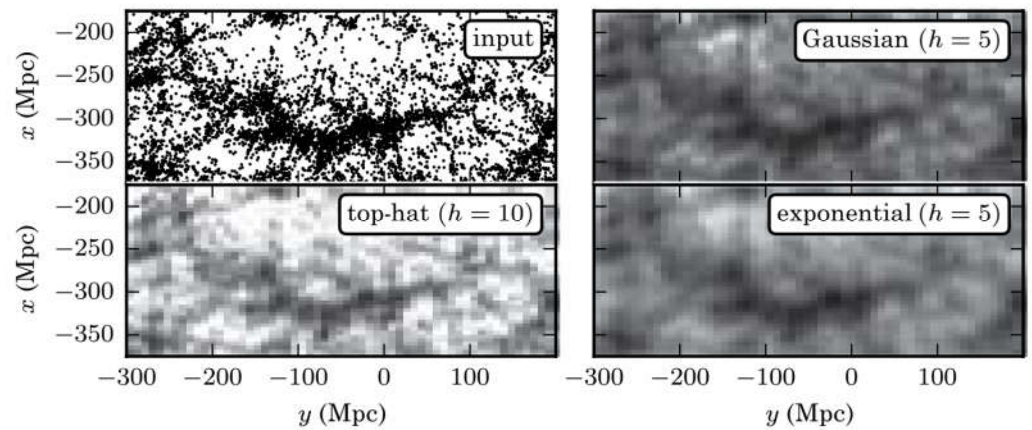


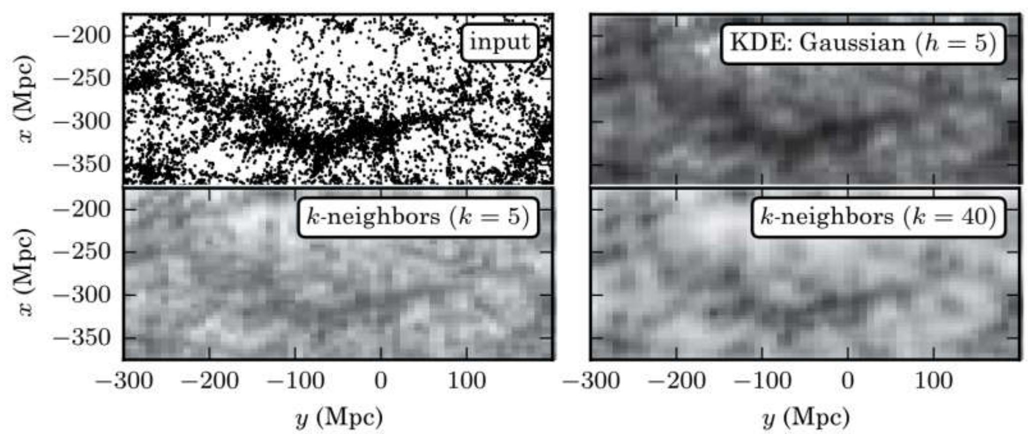
"peculiar velocities" not just simple orbital motions

A. D. Baker senior honors thesis, ECO

Kernel Density Estimation (KDE) & K-neighbors







Figs. 6.1, 6.3, 6.4 from Ivezic et al. text

Orientation to Real Data

Cons:

- inclination/projection
- dust extinction
- redshift distortion/fingers of God
- spherical coordinate systems
- absolute and apparent magnitudes (AB and Vega)
- dark matter is dark

incompleteness affects both real and simulated data…

Pros:

- the real universe is full of surprises & discoveries
- only reality can teach us about reality