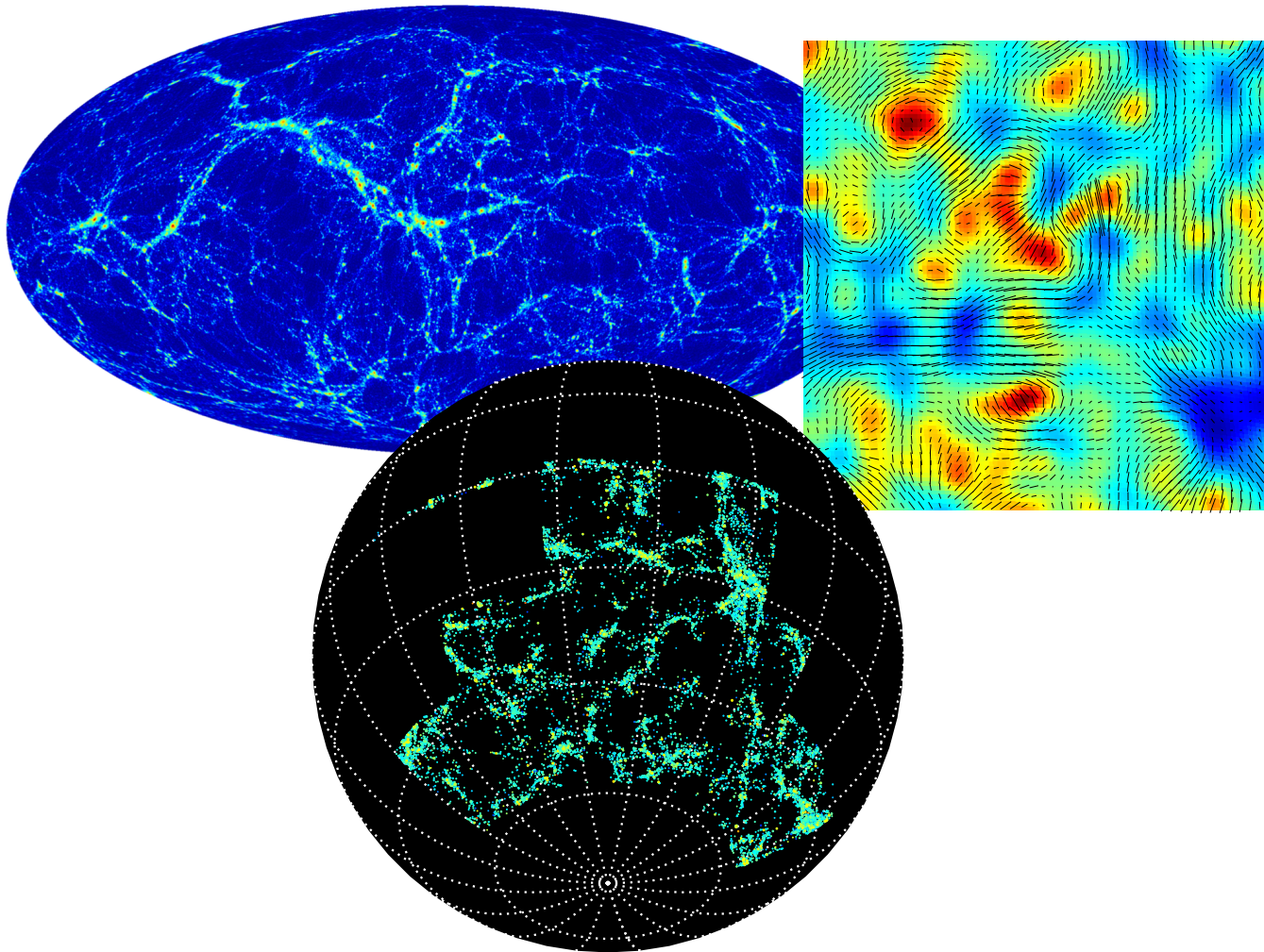# Simulated Galaxy Catalogs

Risa Wechsler
Stanford/SLAC/KIPAC

with Matt Becker,
Michael Busha
& DES sim working group
+
Yu Lu (SAMs)
+
Rachel Reddick
Eli Rykoff
(validation)
+
Hao-Yi Wu
Oliver Hahn
Sam Skillman
(cluster resims)

Strategies

- high resolution: associate all galaxies with resolved halos and subhalos.

  - assign luminosities using abundance matching + galaxy properties based on environment

  - extensive testing against data from SDSS at low z, including correlation functions, group statistics, galaxy-galaxy lensing, etc.

  - need very high resolution, e.g ~ kpc force resolution and 1e8 mass resolution to resolve Mr = -19 galaxies.

  - currently have/creating catalogs based on various boxes with ~ 150-600 Mpc

  - SAM models on the same merger trees using model of Yu Lu, further development informed by empirical results

- medium resolution: minimum needed, in order to produce multiple sky surveys in many cosmologies

  - associate all galaxies with dark matter overdensities + central galaxies where halos are well resolved

  - well developed pipeline:

  - simulation lightcone
  - galaxy luminosities
  - SEDs for galaxies
  - shear at every galaxy position (current version, 6.2" resolution)
  - galaxies lensed / sheared & magnified
  - photometry in many bands, including LSST bands and DES, SDSS, VISTA, CFHTLS, NDWFS, DEEP, WISE, IRAC
  - photometric errors & photometric redshifts

Large area simulations BCC-Aardvark/Buzzard-v1.0

- currently available simulations:

  — LCDM cosmology; N-body lightcones to z~2 (based on 3 sim boxes with 2048^3 particles)

  — one additional cosmology (currently blind parameters for DES Blind Cosmology Challenge)

  — halo finding from rockstar, includes multiple mass def., concentrations, etc.

  — ~ 1 billion galaxies added using addgals, over 1/4 sky (10313 sq. degrees), complete to i ~ 25

  — photometry in many bands, including LSST bands and DES, SDSS (DR8+S82), VISTA (VHS +VIKING), CFHTLS, NDWFS, DEEP, WISE, IRAC

- shear on the full quarter of sky using CALCLENS; currently with 6.2" resolution

- extensive development and testing with SDSS data and other higher redshift data, including early DES data; designed to go to full DES depth
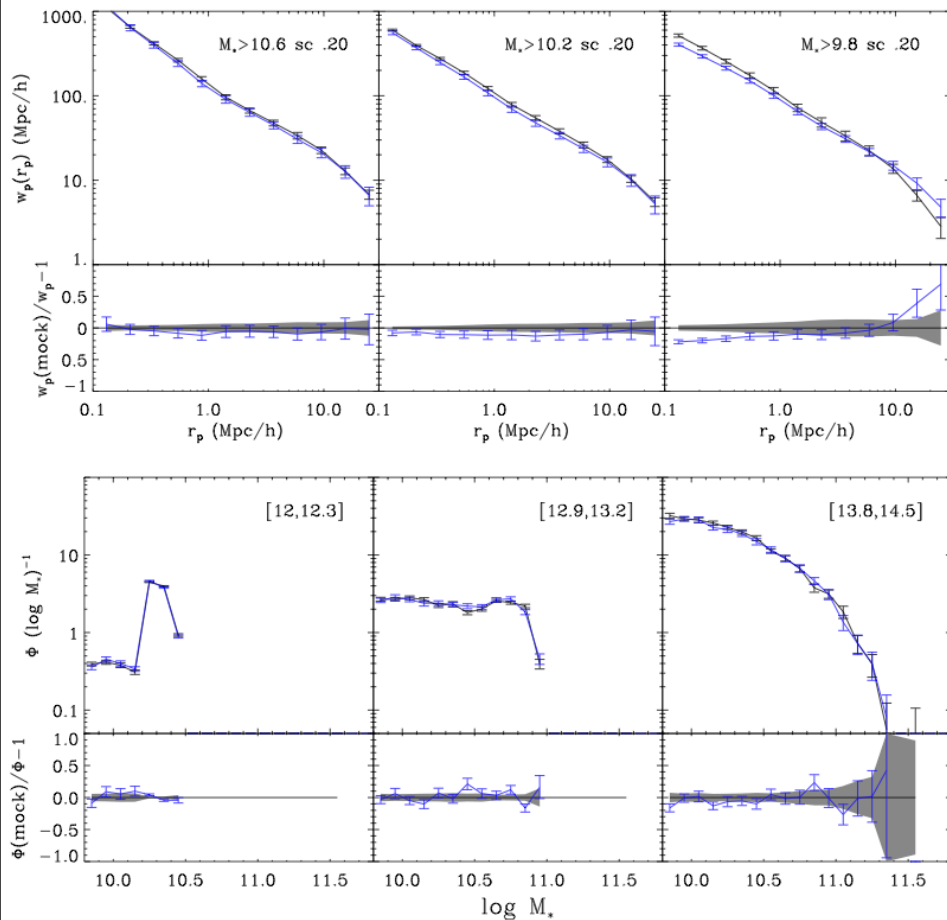
- should contain all of the galaxies in the LSST "gold sample"

- stars included now, quasar model very soon

- simulations currently in hand: five cosmologies; 10 1/4 skies in one cosmology.

- allows science analysis related to clusters, weak lensing, LSS, photometric redshifts, spectroscopic followup design, etc.
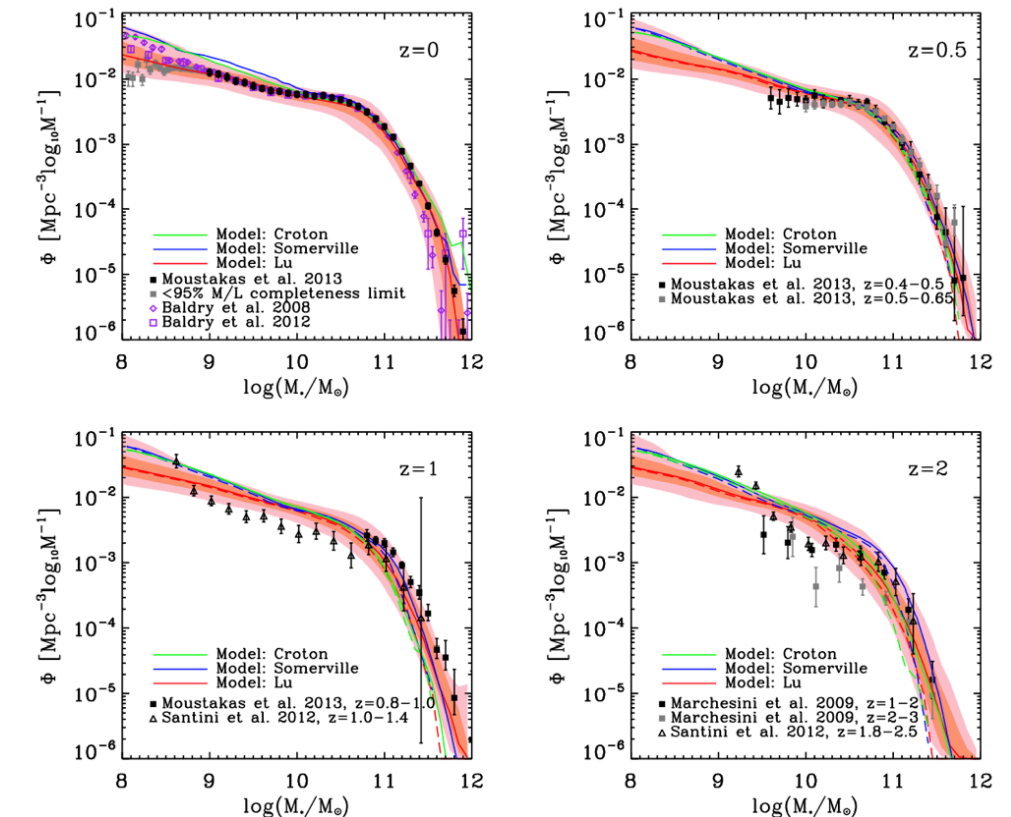
High resolution / abundance matching

- luminosities assigned to resolved halos and subhalos

- currently testing algorithms and resolution requirements

- colors and additional properties added based on selecting from real galaxies with similar local density & luminosity

- doing comparisons now between this method and other color methods based on same base catalogs and lum assignment (e.g. Hearin & Watson)

- Status: plan to produce fully lensed 100-200 sq. degree catalog using this method early 2014.

- Future plans: in 2014 large high res box (INCITE proposal PI: Warren) will allow similar method in Gpc volume

Semi-analytic model

- running Lu SAM on same merger trees as the previous version.

- Bayesian SAM which can be constrained to various observables.

- actively developing the model, including constraints with CANDELS, DES data

CALCLENS: Curved-sky grAvitational Lensing for Cosmological Light conE simulatioNS

See Becker 2013

CALCLENS is a multiple-plane ray tracing algorithm designed to add weak lensing signals to mock catalogs from N-body light cones.
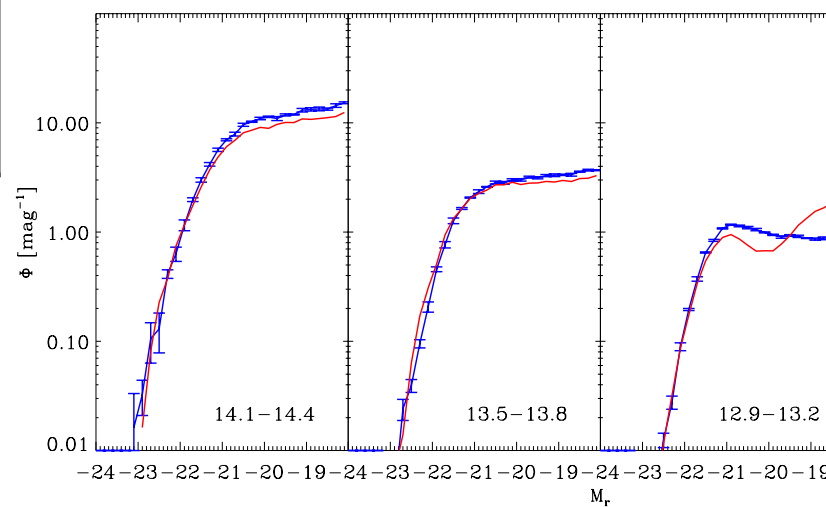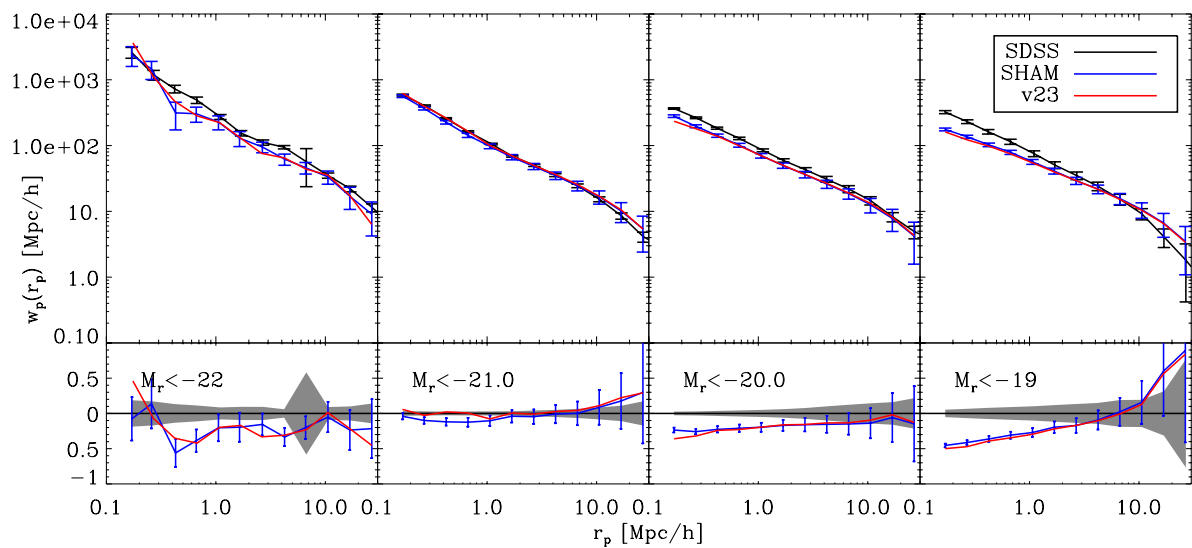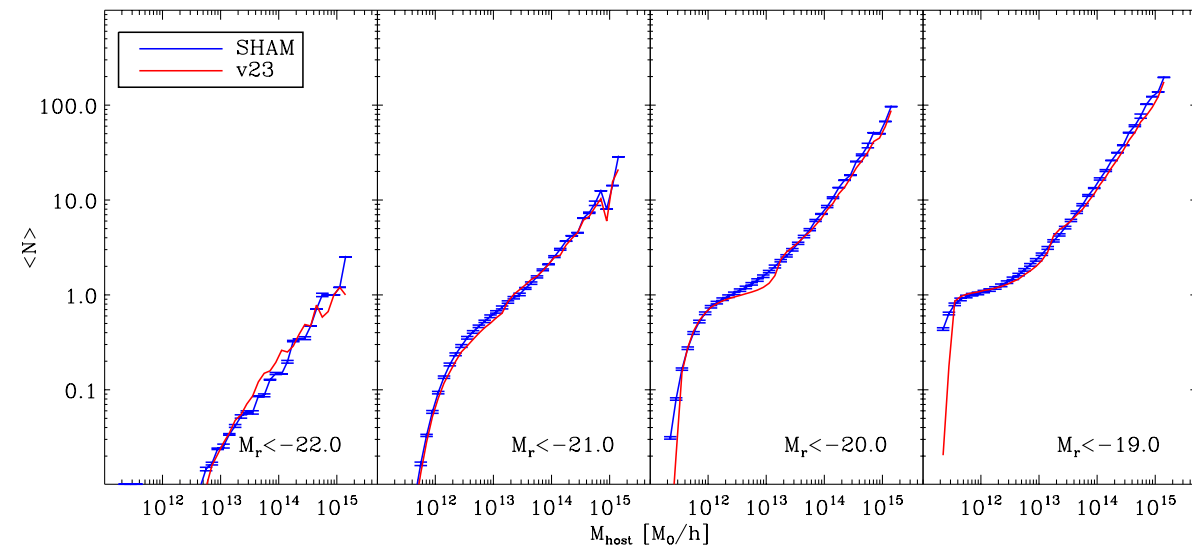
Features:
- works on the curved sky
- fast, approximate 2D Poisson solver
- works in the Limber approximation
- fully redshift dependent shear
- captures all of the magnification effects (i.e., finds galaxy images correctly)
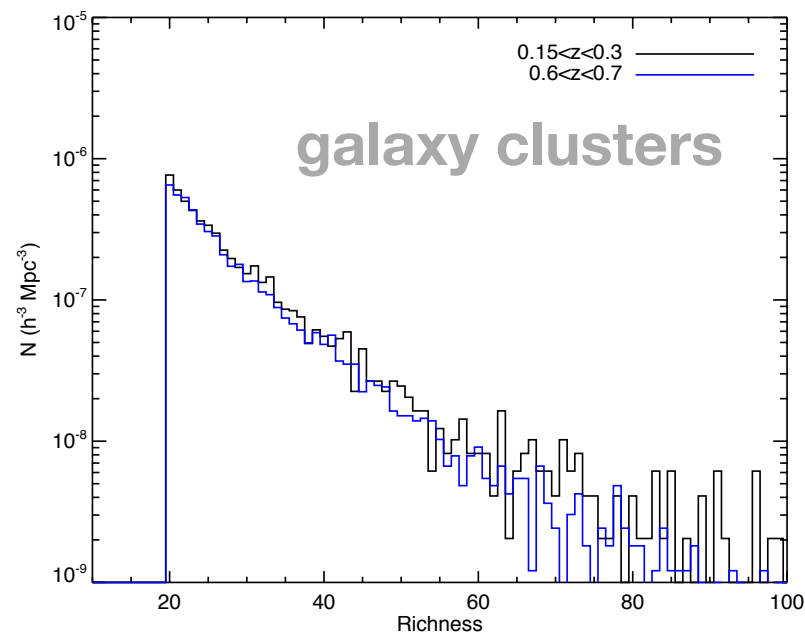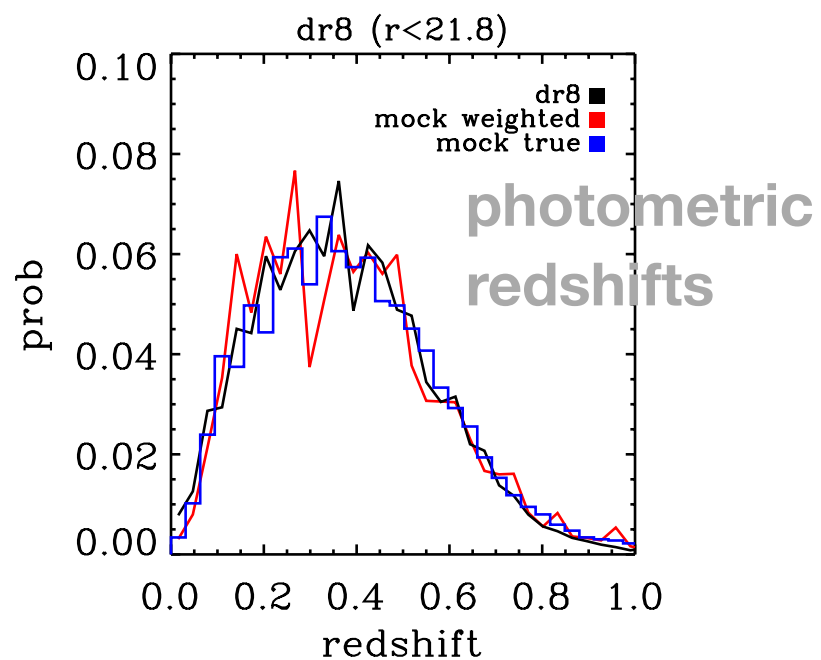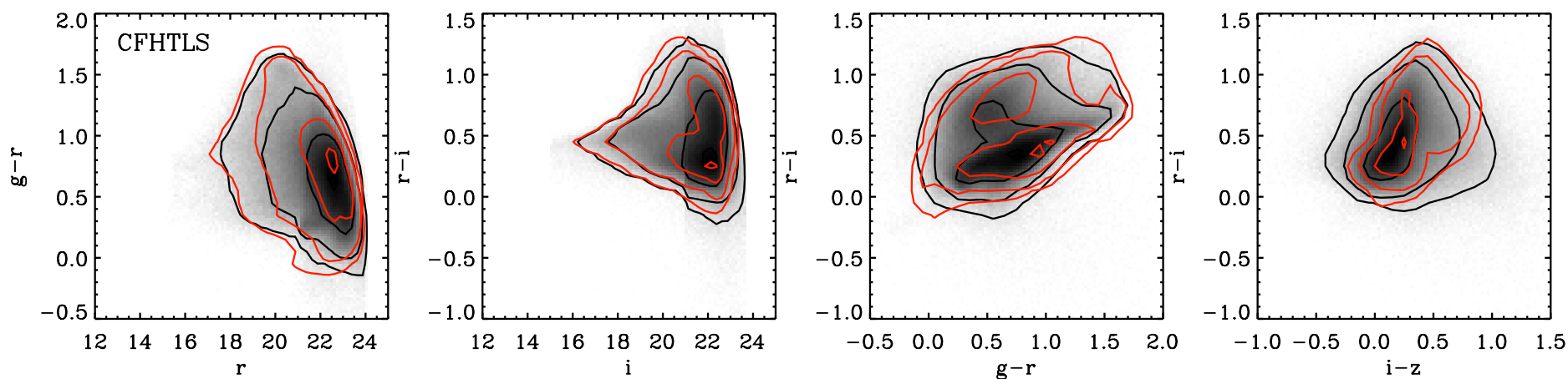
Other "Features":
- approximate 2D Poisson solver
- works in the Limber approximation

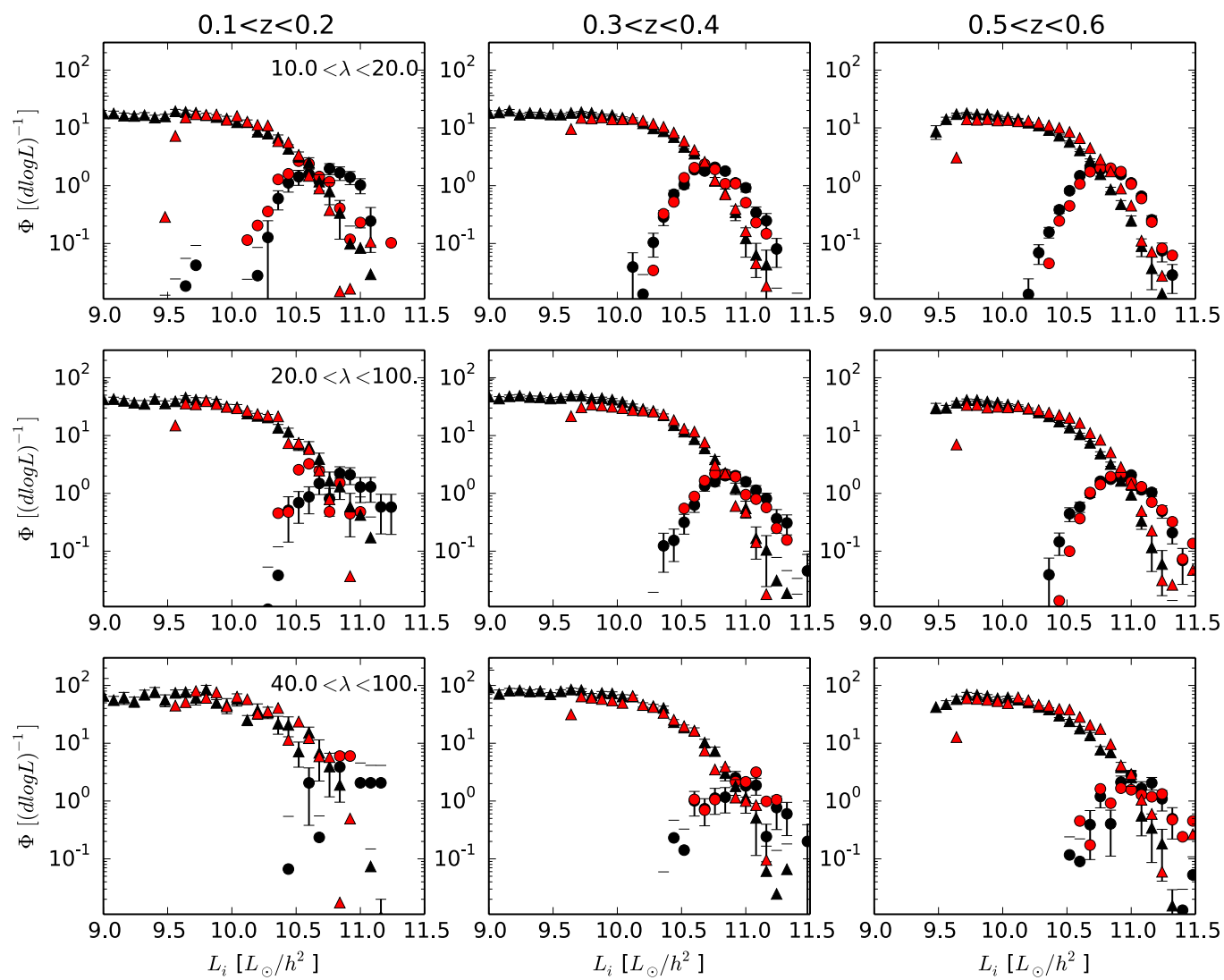# abundance matching vs. addgals

with Michael Busha
& Rachel Reddick

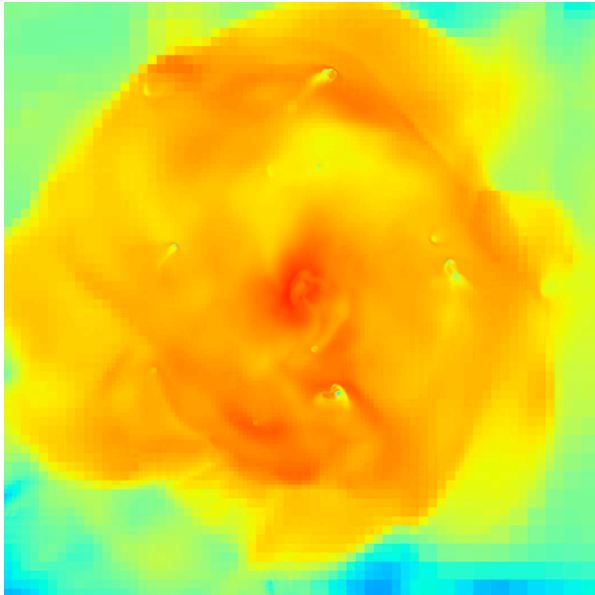# galaxy colors and luminosities

CFHTLS

dr8 (r<21.8)

dr8
mock weighted
mock true

photometric redshifts

galaxy clusters

0.15<z<0.3
0.6<z<0.7

conditional luminosity function in clusters
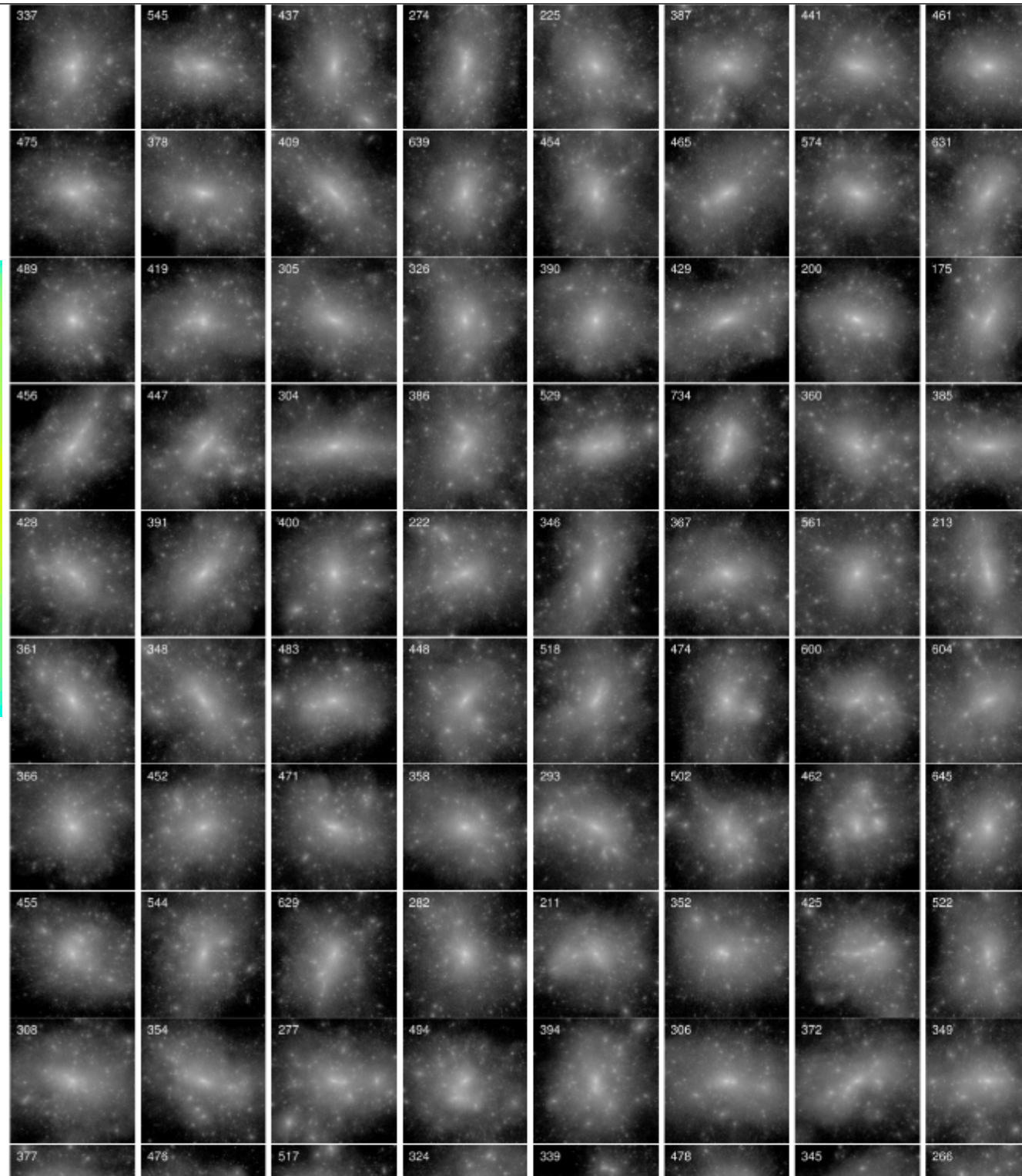## S82 vs mocks

R. Reddick, w. RW, Rykoff, Rozo

cluster sims

Rhapsody resims of 100 clusters,
working now on hydro
(RAMSES & ENZO)

LSST-DESC summary

- large area / low res

  – quarter-sky, lensed galaxy catalogs on a lightcone, with LSST magnitudes to i ~ 25 and z=2 exist now in two cosmological models.

  – expanding sample to cover several cosmologies, further developing galaxy model and testing against data (SDSS, DES), improving resolution, etc.

- small area / high res

  – high-resolution simulations which allow galaxies to be placed on resolved halos and subhalos available for smaller areas of sky (currently ~100 sq. degrees, with replication)

  – populated using empirical (abundance matching) and semi-analytic methods

  – mid-2014: apply these methods to new Gpc box with 1e12 particles (approved INCITE w M. Warren)

- working on integrating both sets of simulations with ImSim tools (with Debbie Bard)

- for cluster work: sample of 100 high resolution cluster simulations (RHAPSODY), now under development with hydro

- *please contact me (rwechsler@stanford.edu) if you would like to use them for DESC tasks! please give us feedback on DESC priorities for accuracy, resolution, properties, volume!*