

# Virtual Telescopes

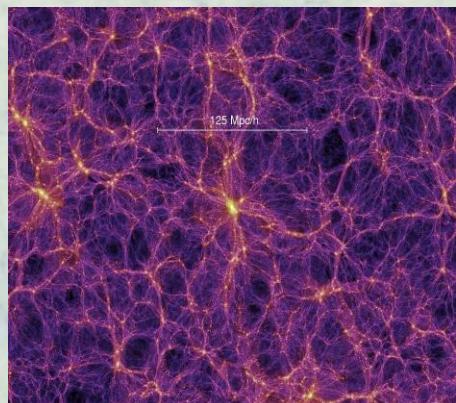
Implementations and thoughts  
from the VO

Gerard Lemson, MPA Garching  
with slides from  
Veronica Biffi, Roderik Overzier

# Questions

- How can we publish simulation data so that observers can use them?
  - Or, how should simulations be compared to observations?
  - What data products are of interest?
  - Where is the handshake?
- Can we divide the work?
  - Interoperable services
  - Standard data formats
  - IVOA
- What are the interesting use cases?
  - Observation planning
  - Observation interpretation
  - ...
- How can we ensure scientific integrity?
  - publish ALL data, with documentation

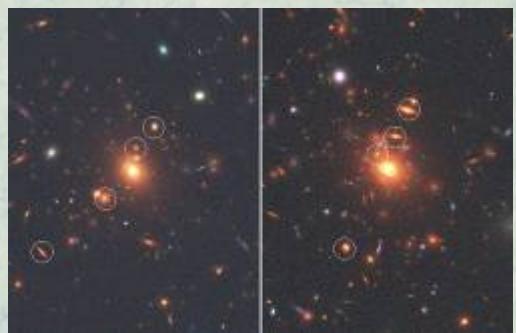
Raw data:  
Particles



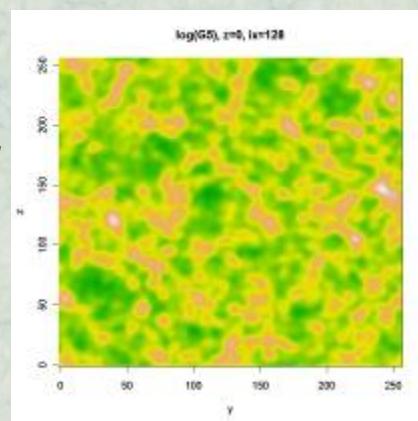
FOF groups and Subhalos



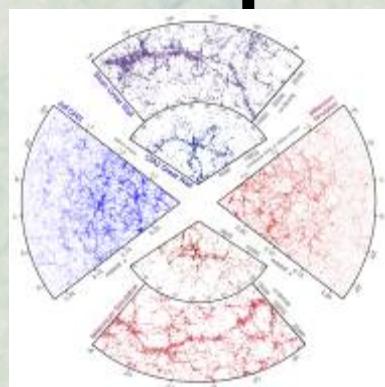
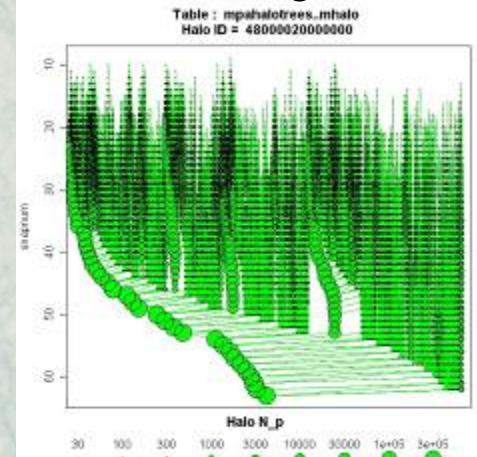
Mock images



Density fields

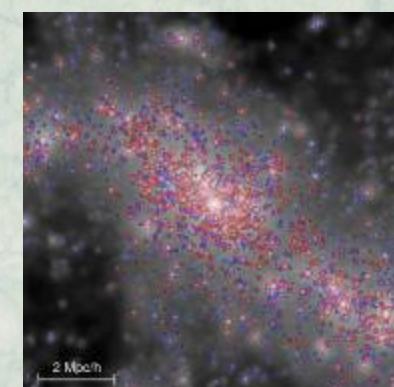
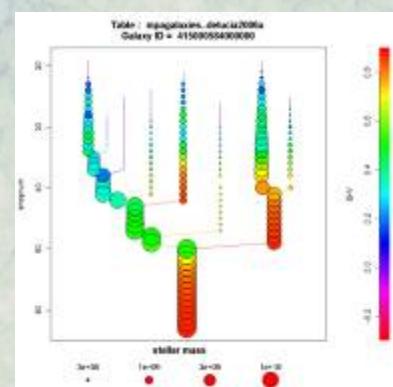


Subhalo merger trees



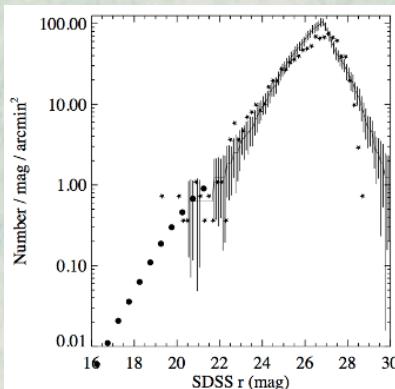
Mock catalogues

Synthetic galaxies (SAM)



# Observations

Images +  
Detected Objects  
("Galaxies")  
**(mags, colors, sizes, (z))**



# Comparison

number counts/clustering

Physical properties  
(needs SED fitting of data)

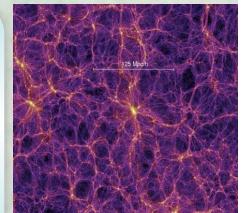
Luminosity functions

$N(z)$ ,  $N(m)$

Mock images  
“True Comparison”

# Simulations

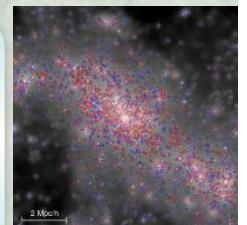
N-body Dark Matter  
+Halos:  
 $M_{\text{halo}}, pos, vel, \dots$



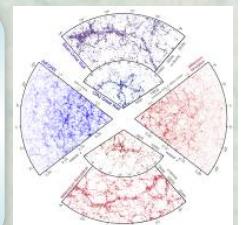
SAM/Hydro  
Galaxies:  
 $M_{\text{stars}}, SFR, size, \dots$



+ synthesis modeling:  
rest-frame mags, colors



Mock/Lightcone:  
obs-frame mags/ colors,  
apparent redshifts

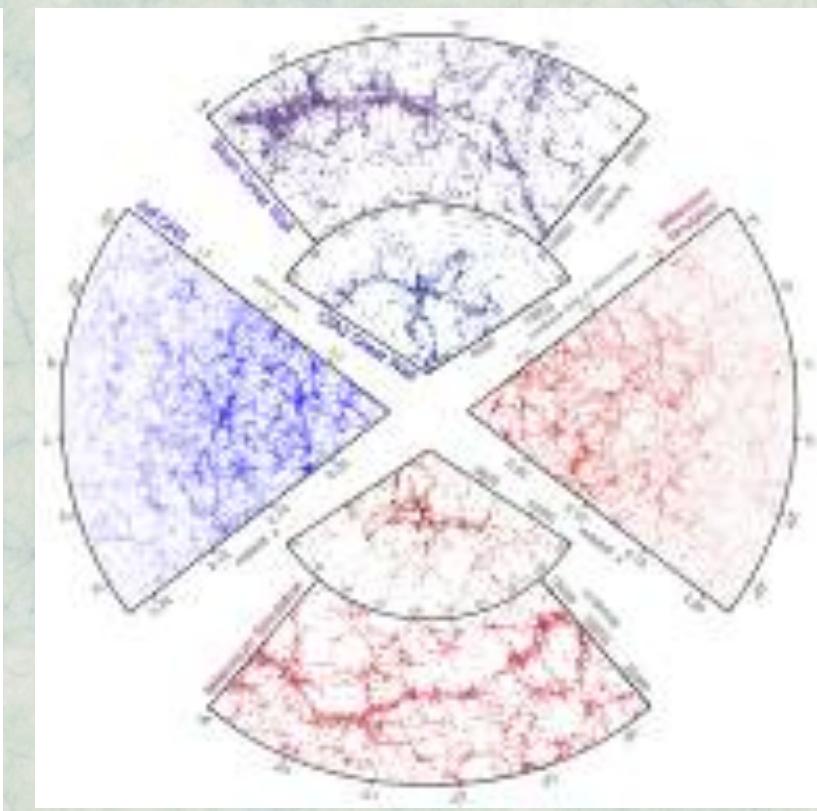
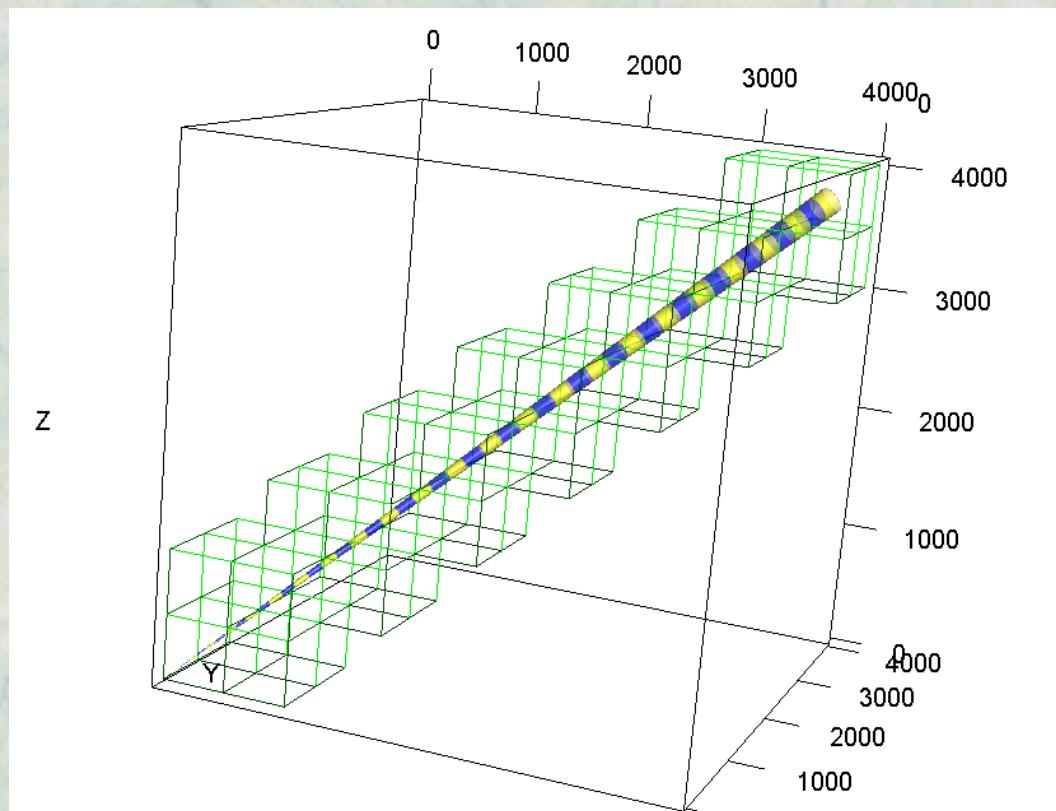


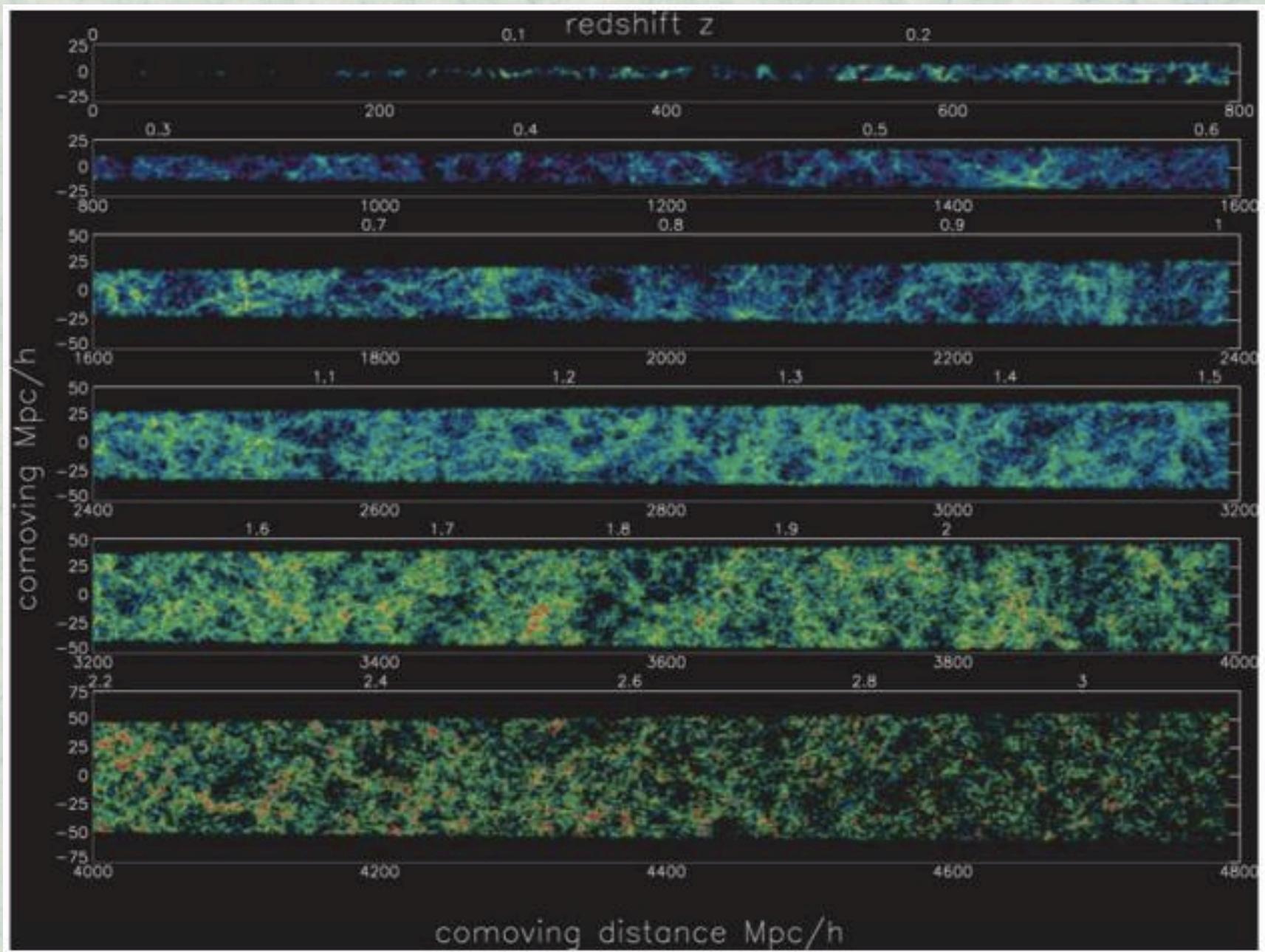
Simulated (Noisy)  
Image:  
mags, colors, sizes,  
orientations



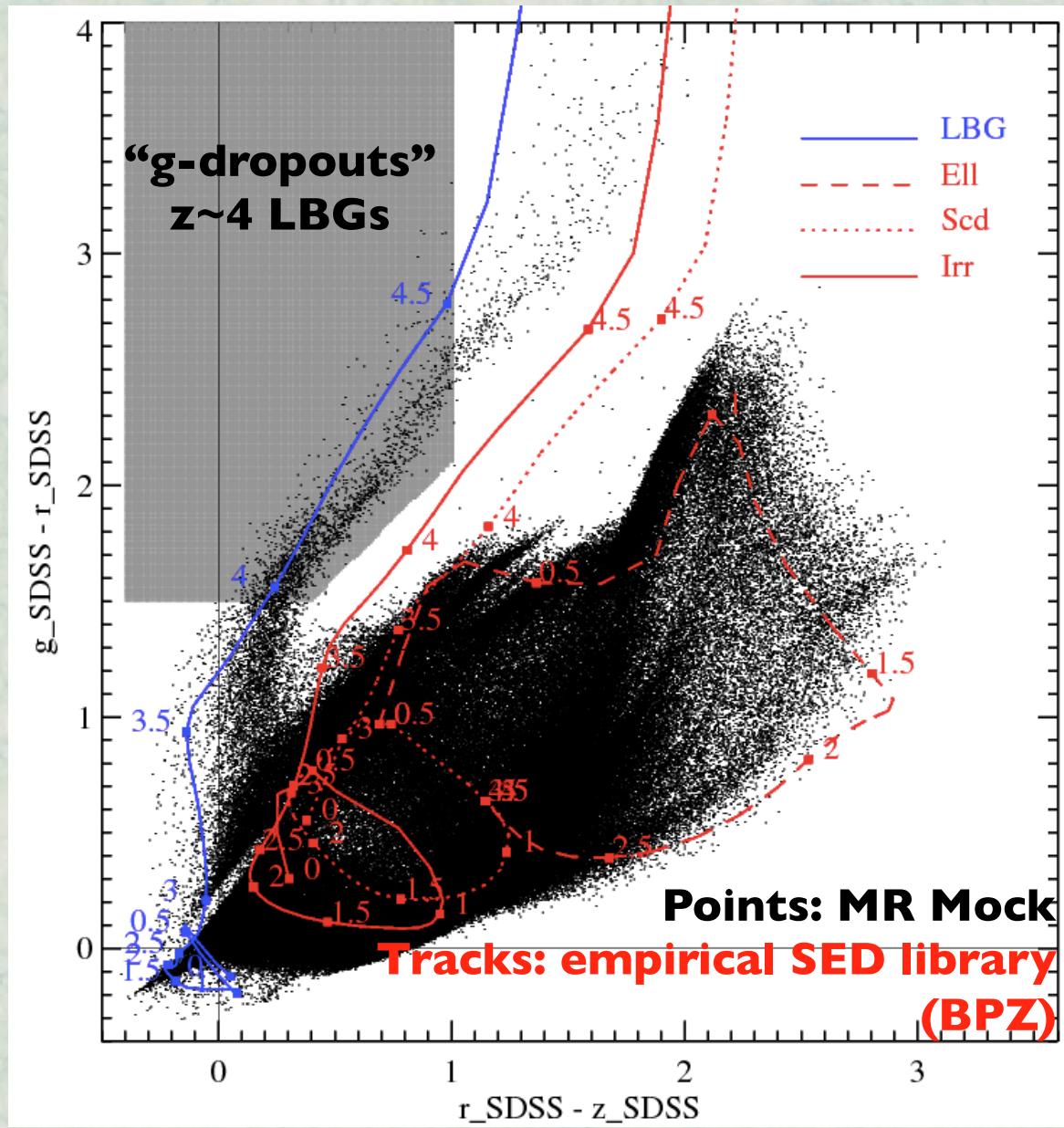
# Millennium Run Observatory

# Mock catalogues



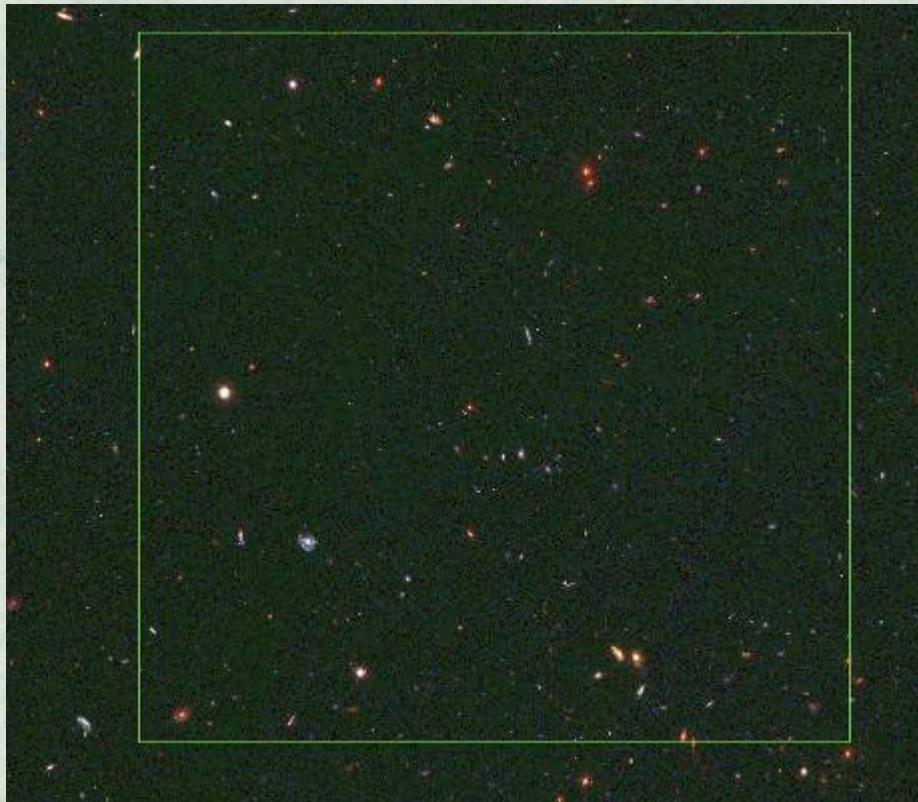


# Color-color plots

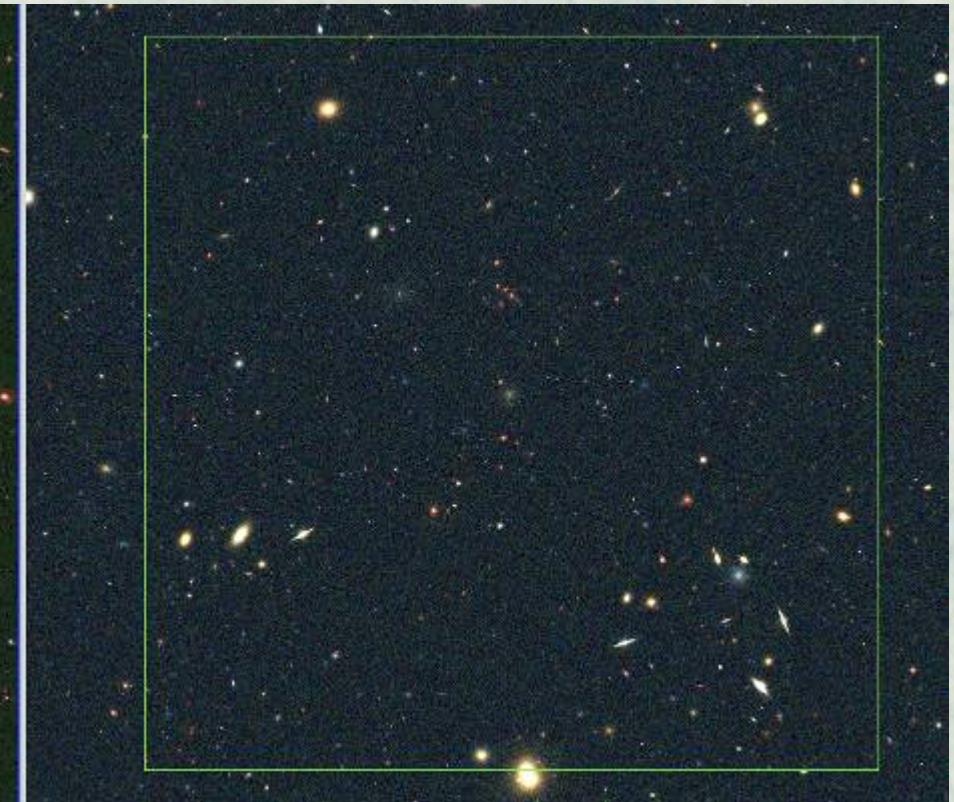


# Millennium Run Image Simulator

- Quo2010a: **pos, rest mags, physical sizes of disk & bulge, bulge/disk ratio**
- MOMAF Lightcone: **ra, dec, z\_geo, z\_app, observed mags**
- MR Database: **angular sizes, inclination & PA (from DM spin axis)**
- IGM absorption: **corrected magnitudes (important for high-z)**
- SKYMAKER: **Bulge + disk profiles on simulated telescope image (PSF,S/N,scale)**

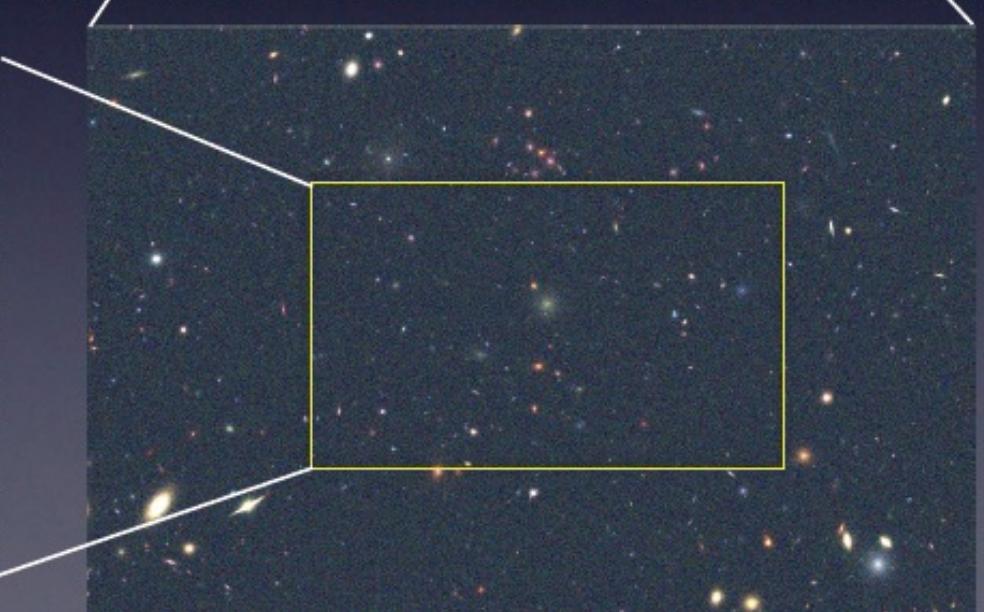
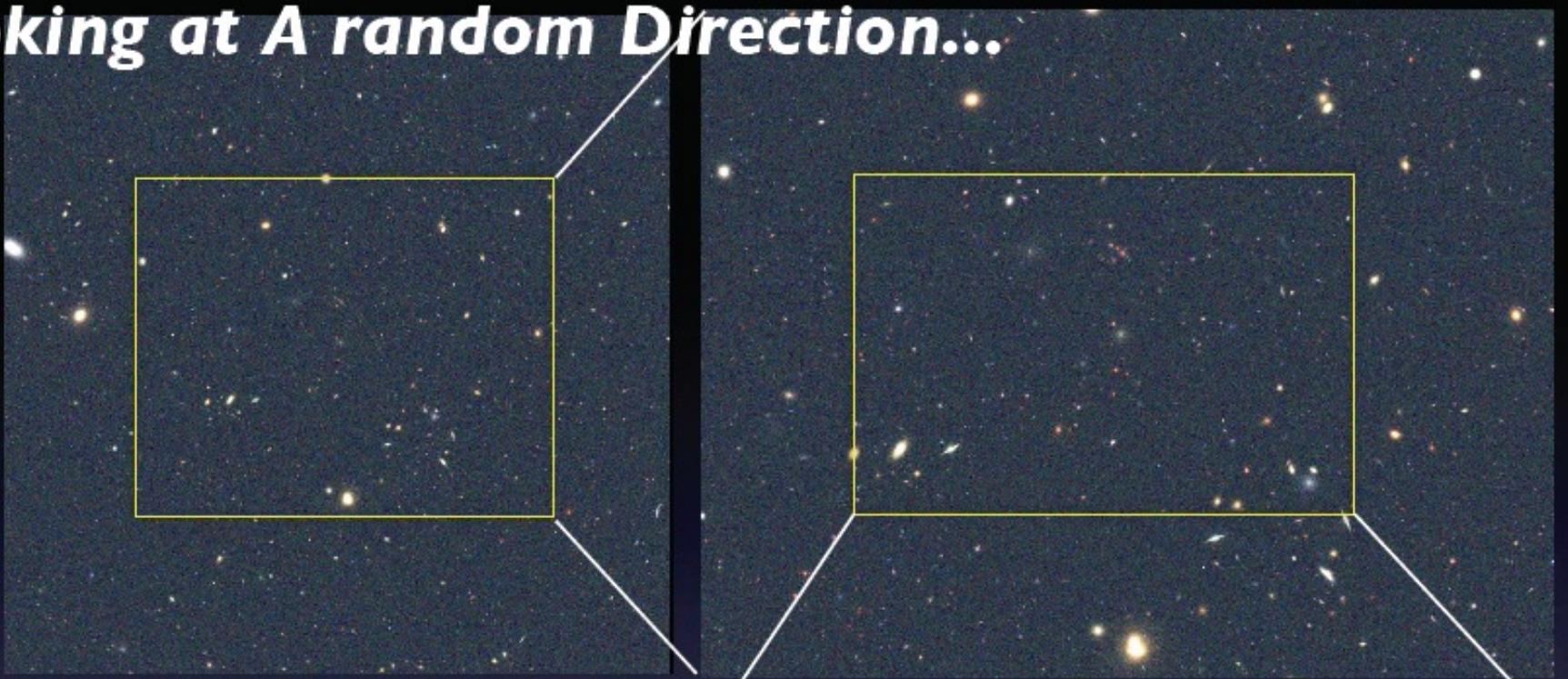


HST GOODS-S (tile 33) B,V,z

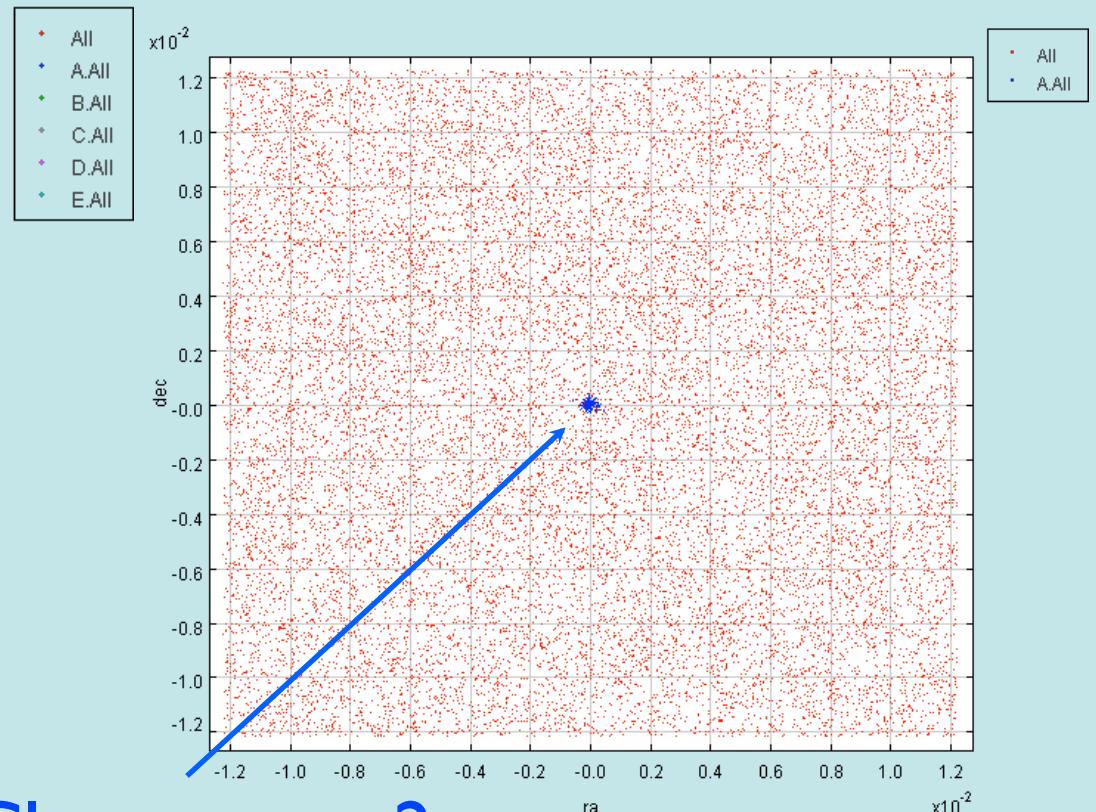
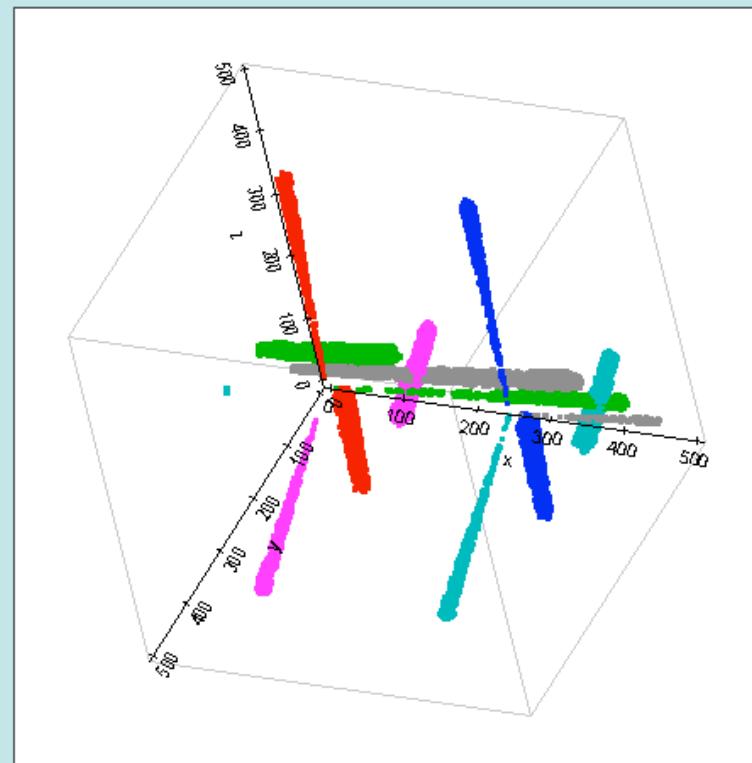


HST MR g,r,z simulation

*Looking at A random Direction...*

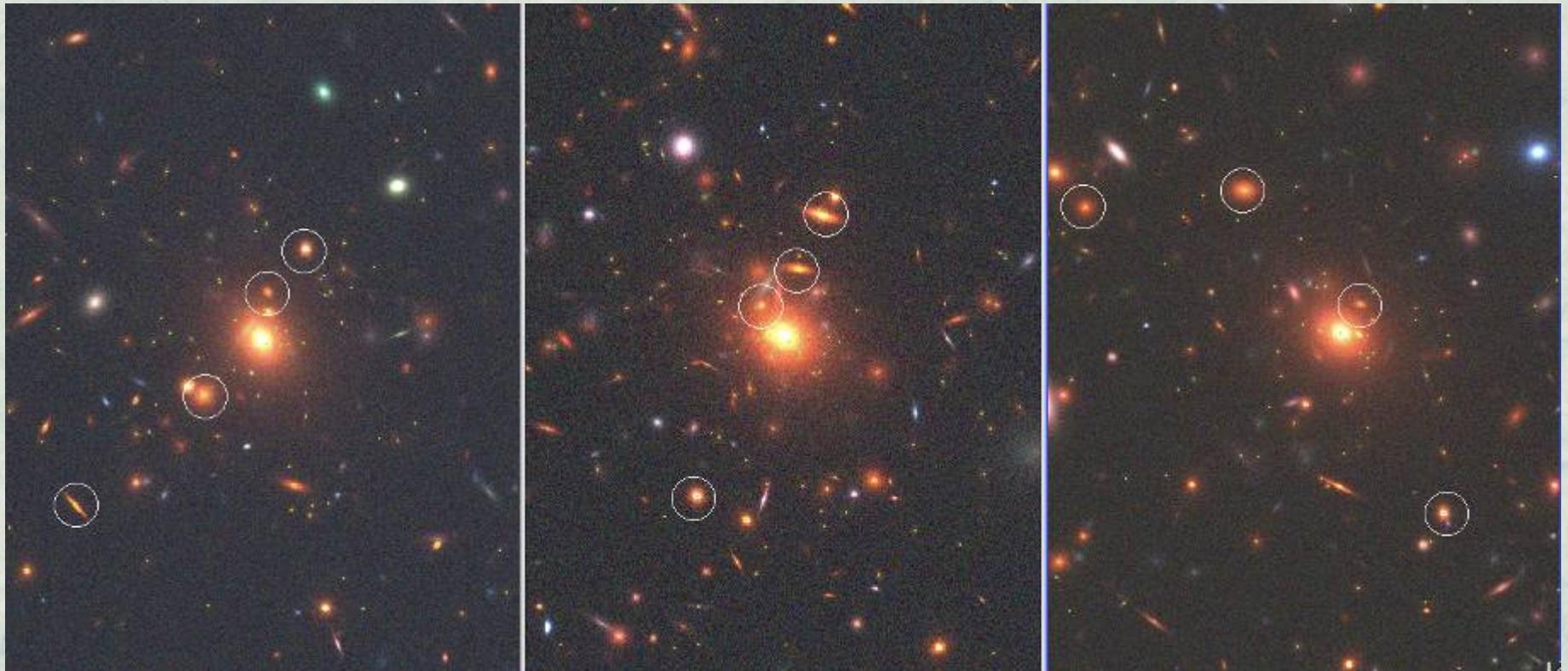


# Aiming at Specific Objects at Desired Redshift...



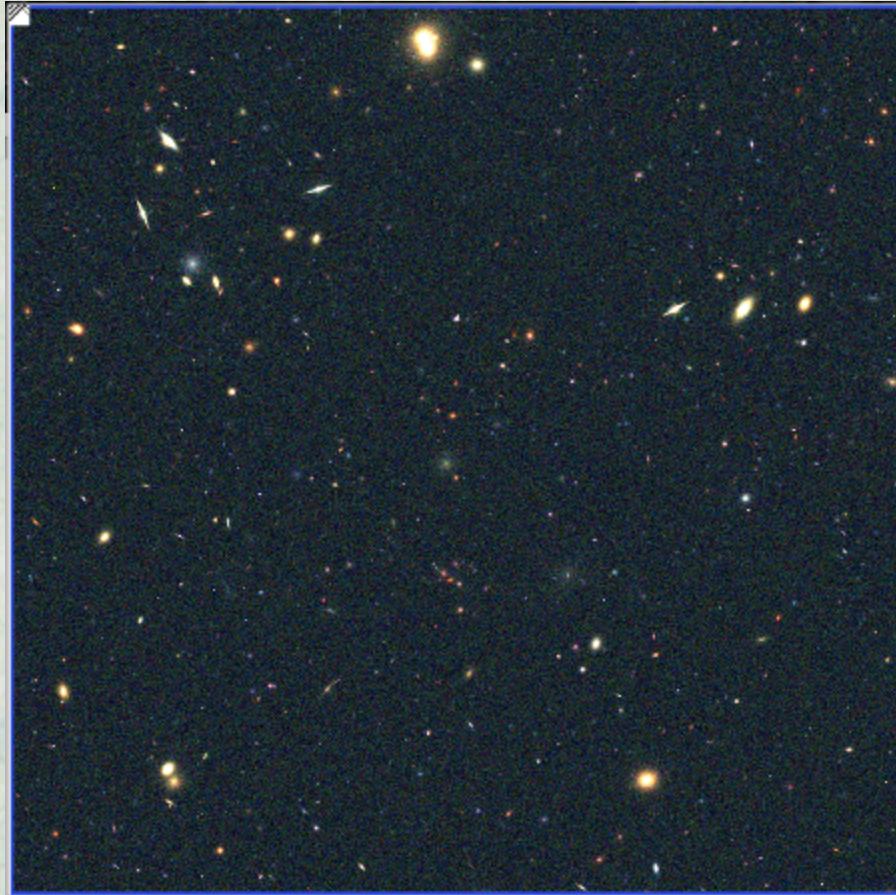
Cluster at  $z=2$

# Moving around an Object...

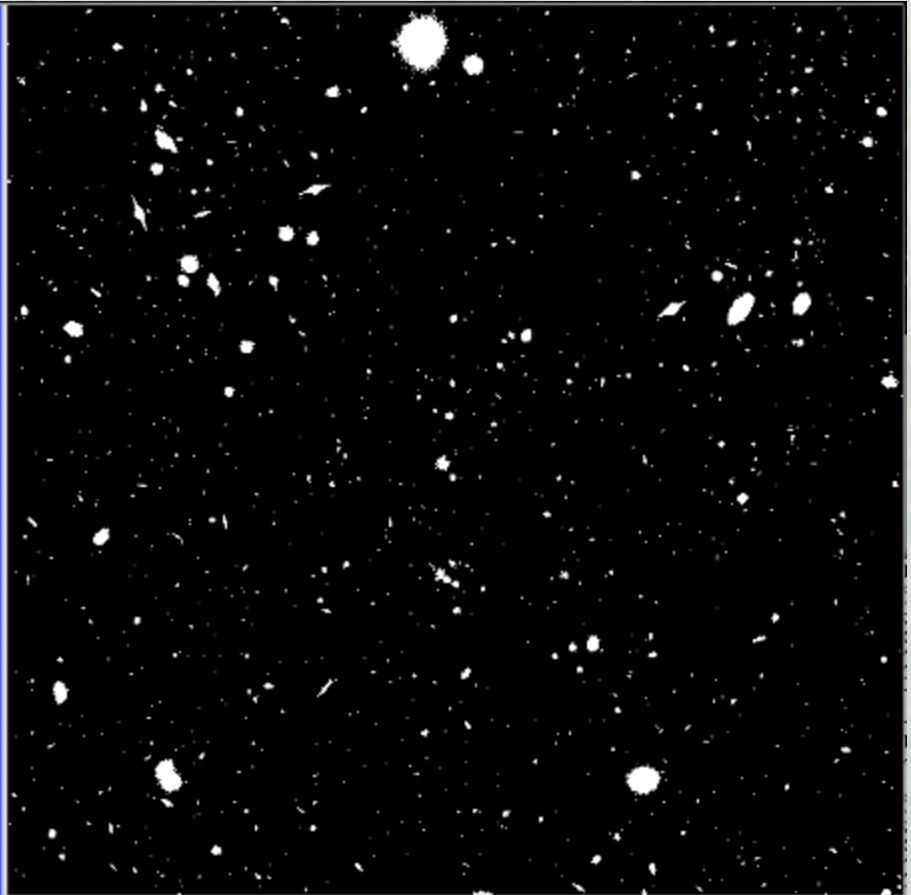


**(most massive  $z=0$  MR cluster, seen at  $z=0.83$ ,  
three different observer's viewing angles)**

# Taking it one step further... Source Extracting from Simulated Images



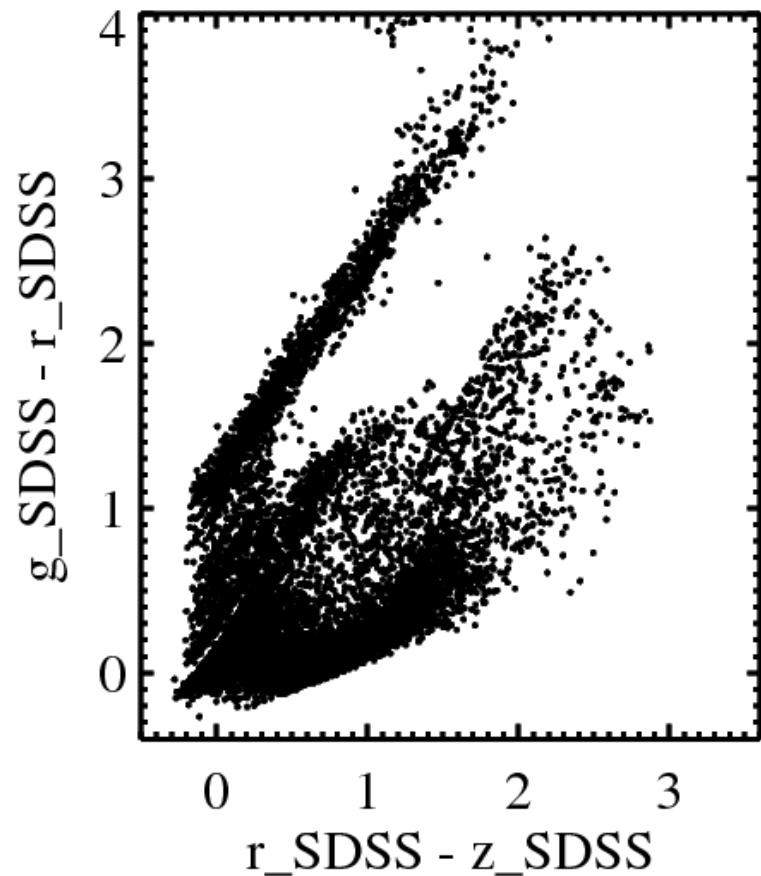
Simulated image



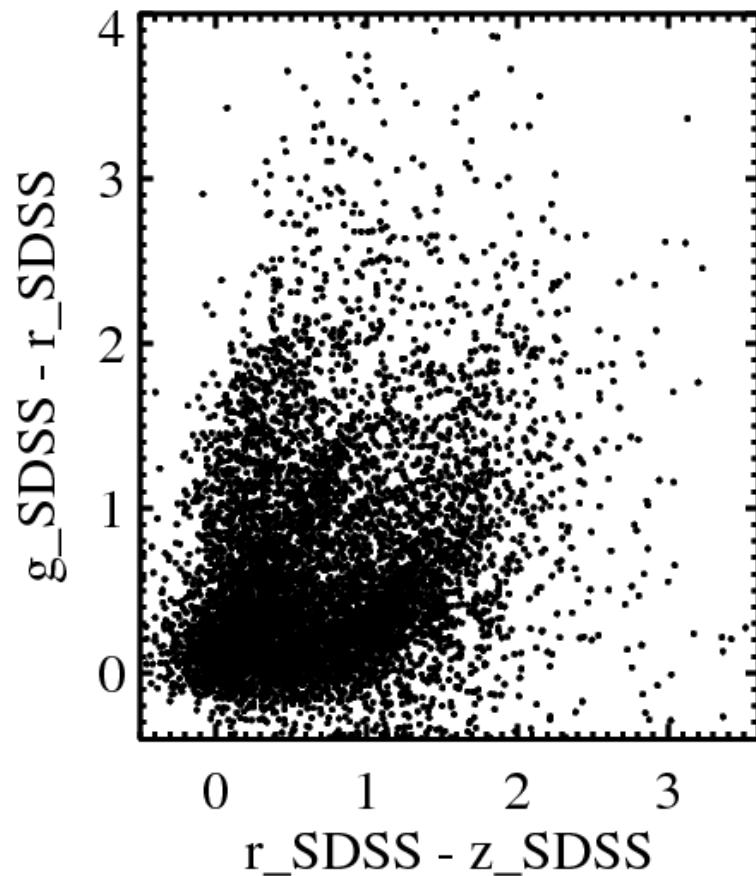
SExtractor segmentation image

# Source Extracting from Simulated Images

## Color-color plot Lightcone vs. Recovered



MR Mock Lightcone



Extracted from  
MR Mock Image

# MRObs browser

With Roderik Overzier and Raul  
Angulo

# PHOX

Biffi, Dolag, Böhringer, Lemson  
submitted

# Interoperability

