



A Wavelet-based Cluster Search for Euclid

Anthony Gonzalez



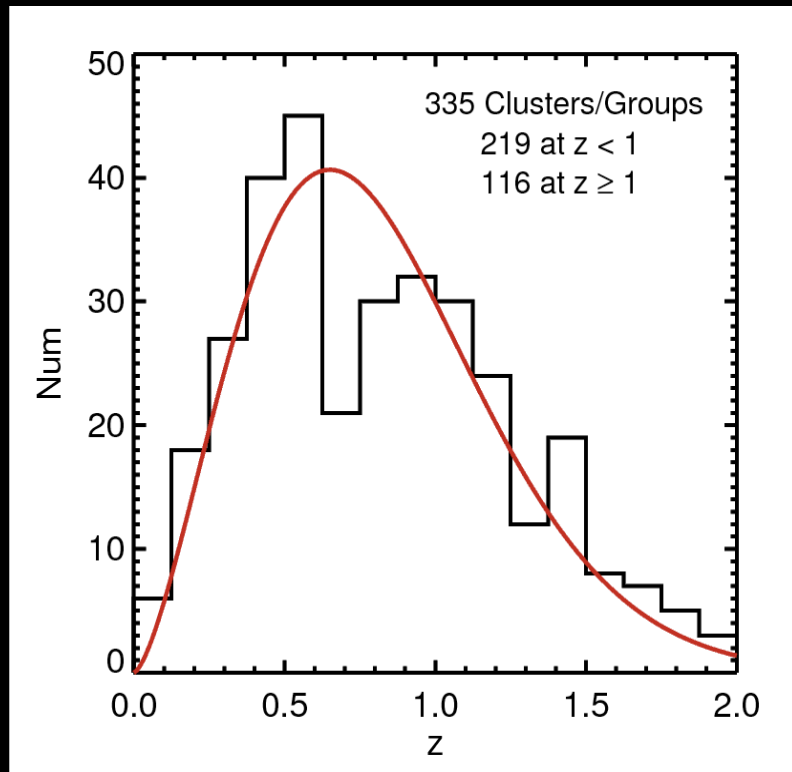
YACS (Yet Another Cluster Search) for Euclid

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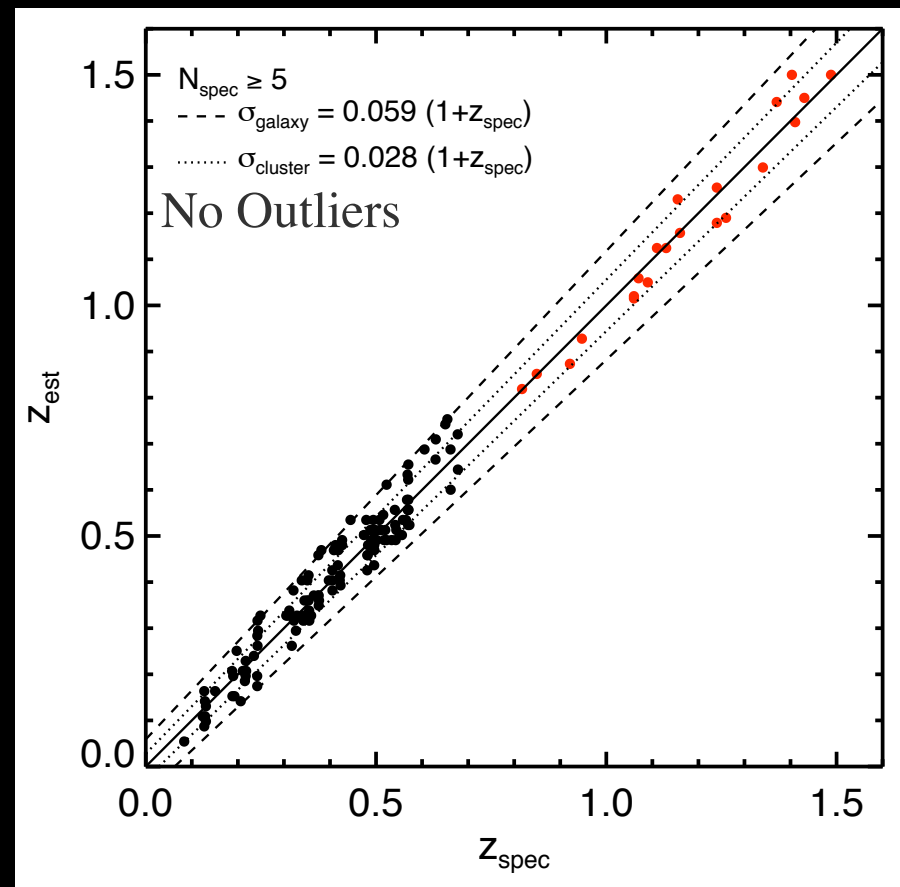
Overview

Heritage: IRAC Shallow Cluster Survey (ISCS)



Photometric redshifts for all candidates

Cluster/group sample spanning wide redshift range



Overview

Heritage: IRAC Shallow Cluster Survey (ISCS)

General Philosophy:

- Try to select similar galaxies at each redshift
- Use full $P(z)$ for every galaxy
- Divide data into overlapping redshift slices
- Use wavelet-type smoothing within each slice to detect clusters
- Merge detection lists

Uniformity of galaxy sample

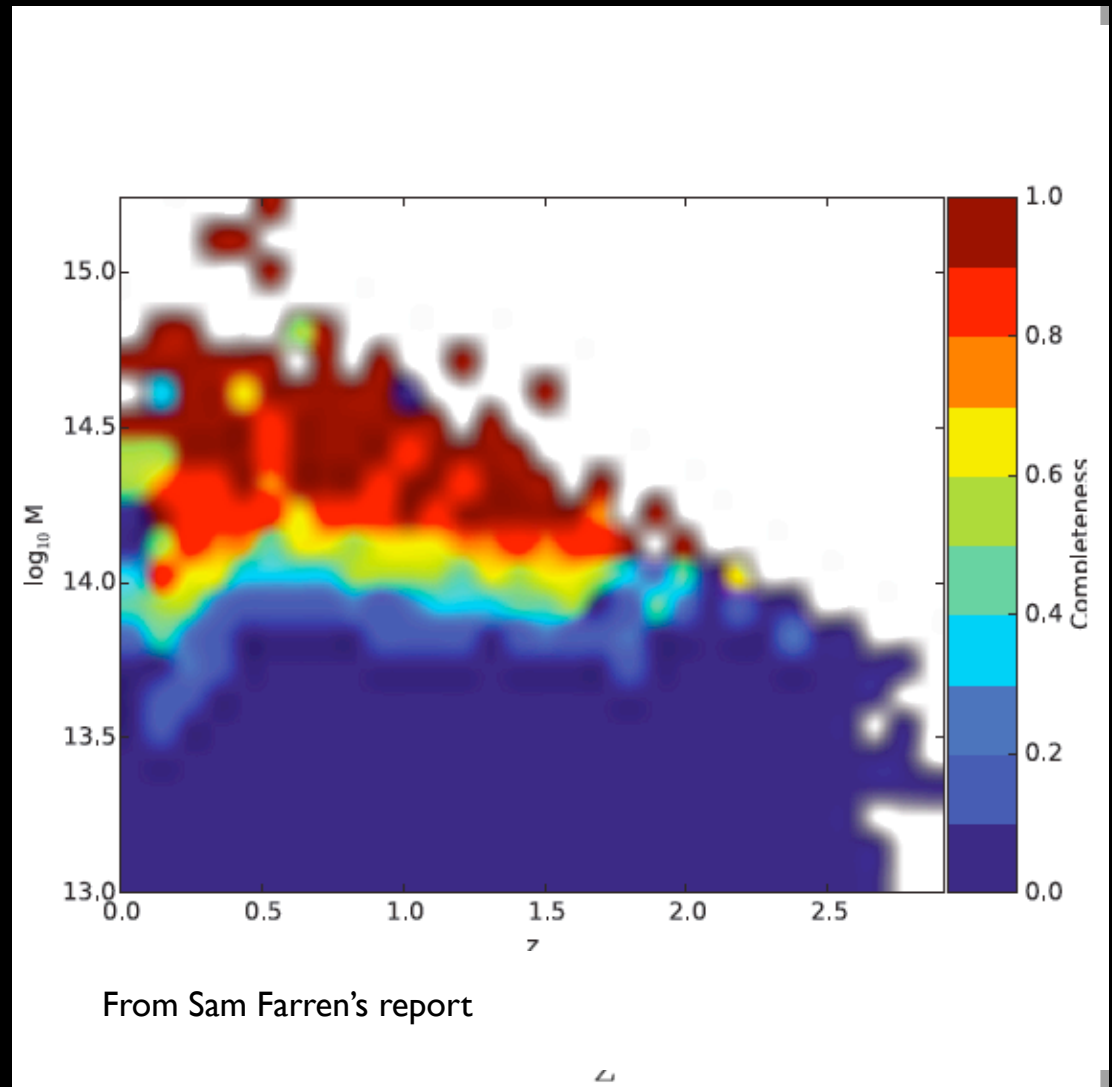
ISCS: 4.5 μ m selection

- Nearly constant stellar mass limit
- Yields very flat cluster mass threshold with redshift.

Euclid search: Try to reach fixed L/L^*

- Currently using H-band, $z_f=5$ passive model
 - Using H^*+2 until $H=24$ ($z \sim 1.6$)
 - Data deep enough for H^*+1 to $z=3$
- Could switch...

This feature of code makes mass threshold flatter with redshift.



Galaxy $P(z)$'s

For each slice, insert galaxy with weight

$$w = \int_{z_1}^{z_2} P(z) dz$$

- In current mocks, Gaussian $P(z)$ with $\sigma=0.05 (1+z)$
- Extensible to arbitrary $P(z)$

It would be very good to have full $P(z)$'s for real survey.

Density & Smoothed Maps

Method uses a Gaussian difference kernel

Inner scale: 300 kpc

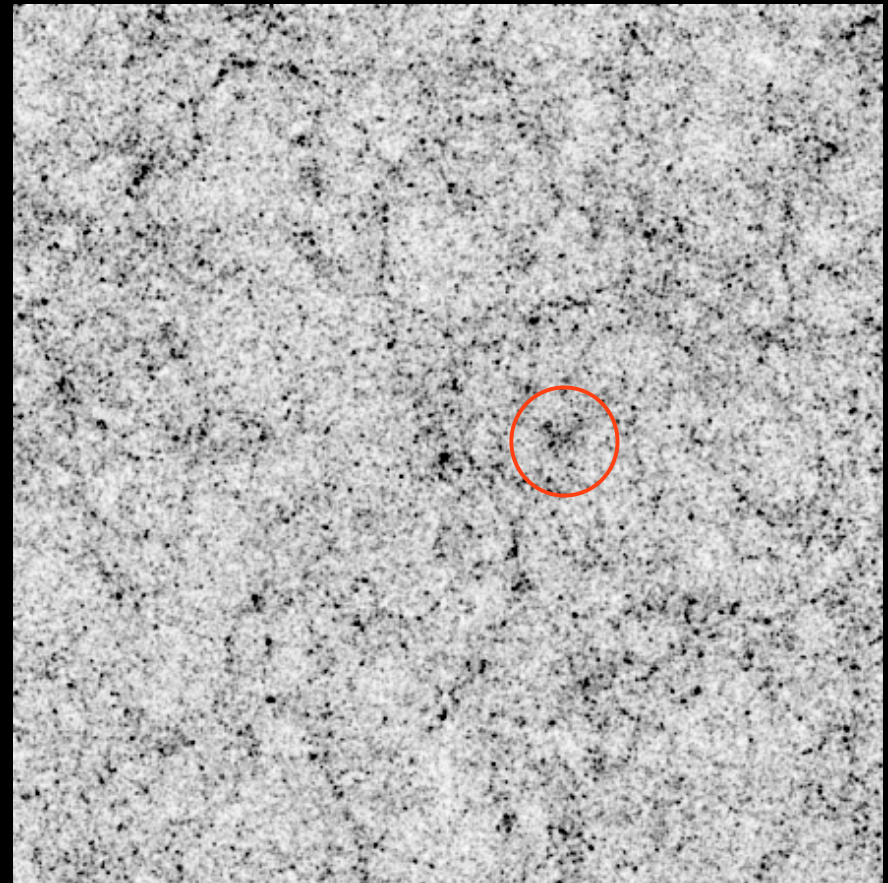
Outer scale: 1200 kpc

Relatively insensitive to precise values

Larger scale signal removed from map.

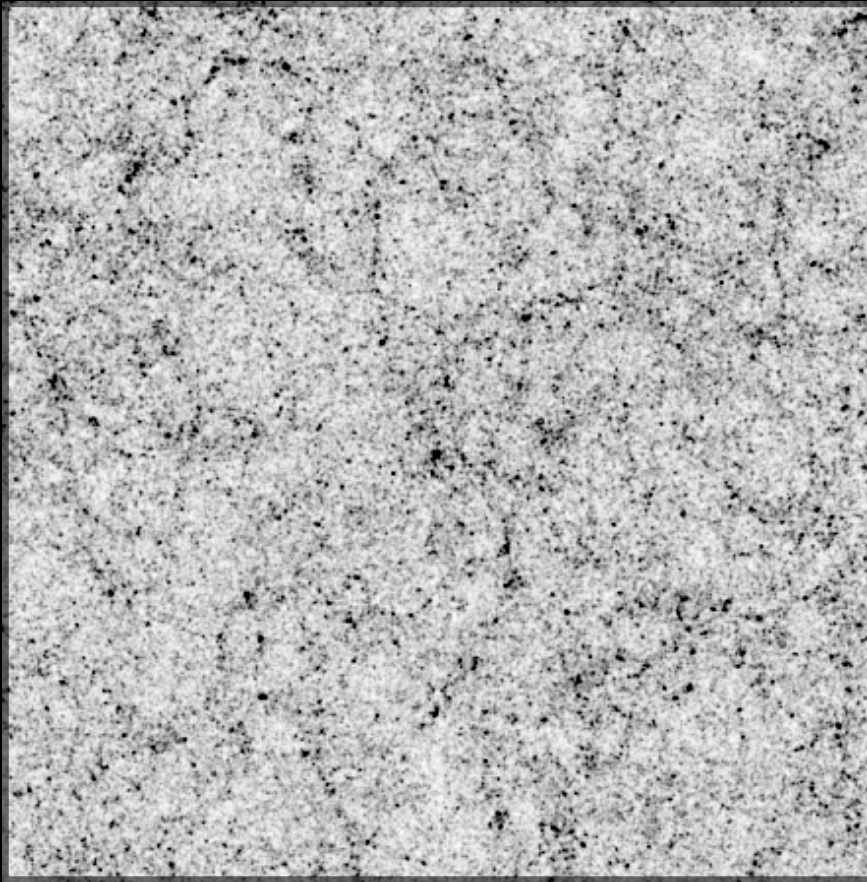
- *Adds robustness to large scale depth variations*
- *Removes impact of density variations due to large scale structure*

Method exists to include an input mask.

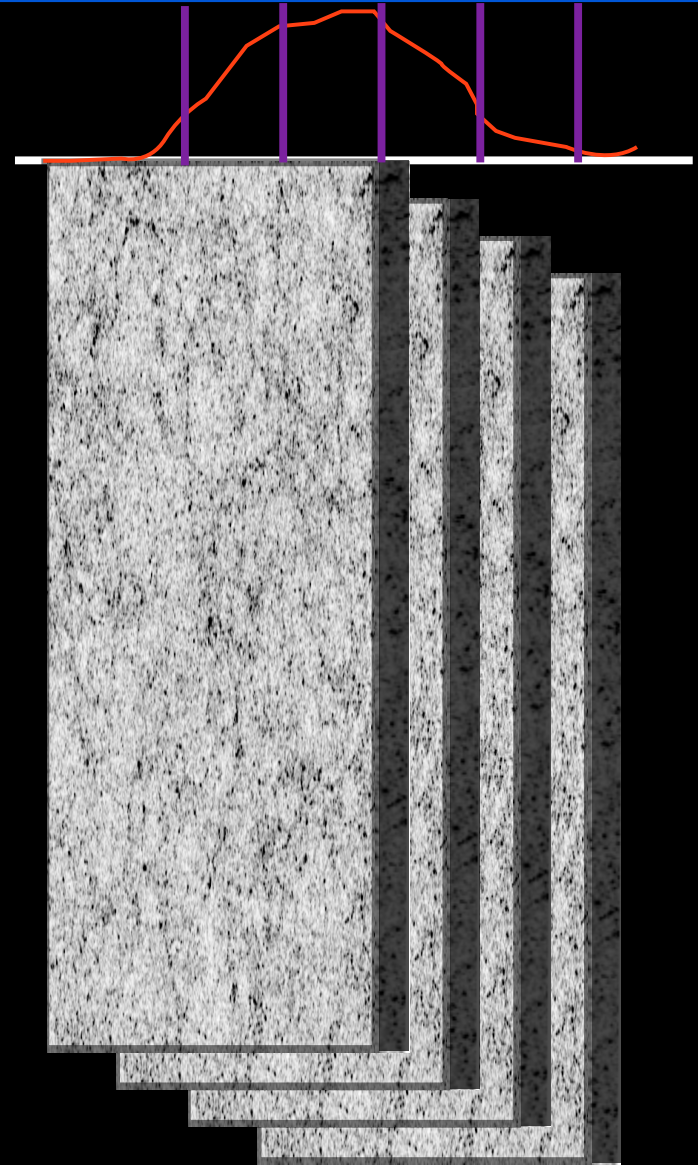


Smoothed map

Galaxy $P(z)$'s & Overlap



Currently redshift slices overlap by 50%



Peak Finding

Pure python - very simple search for highest peaks



Merging Detection Lists

Number density of galaxies varies with redshift.

How does one maintain constant threshold across slices?

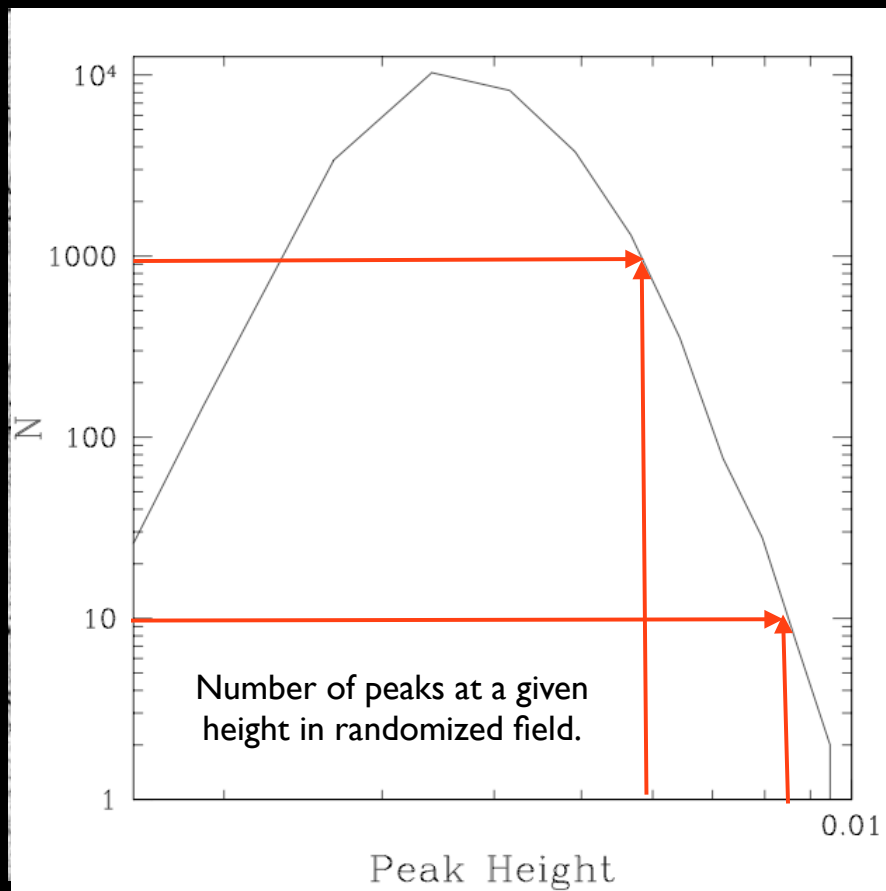
If this step is ignored, it can yield both a jitter in the mass limit with redshift, as well as a redshift dependence to the mass limit.

Solution: Search down to same detection significance in each slice.

Detection Significance

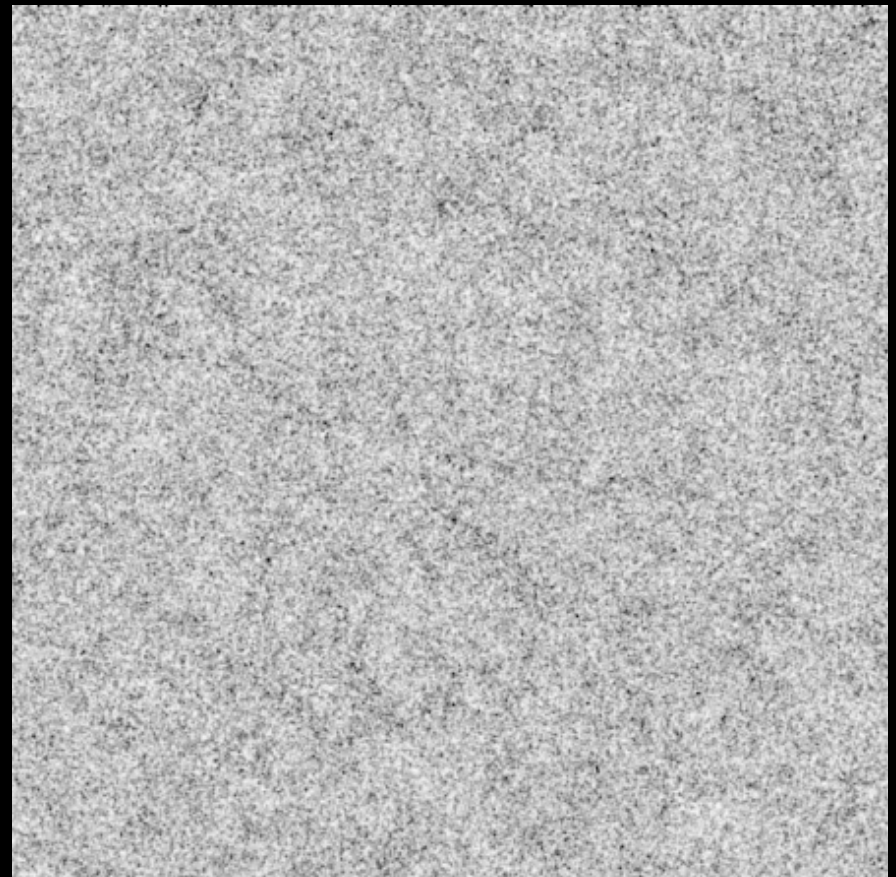
Repeat search on blank maps

Real Data



Apply spline fit to distribution

Redshifts randomized relative to coordinates

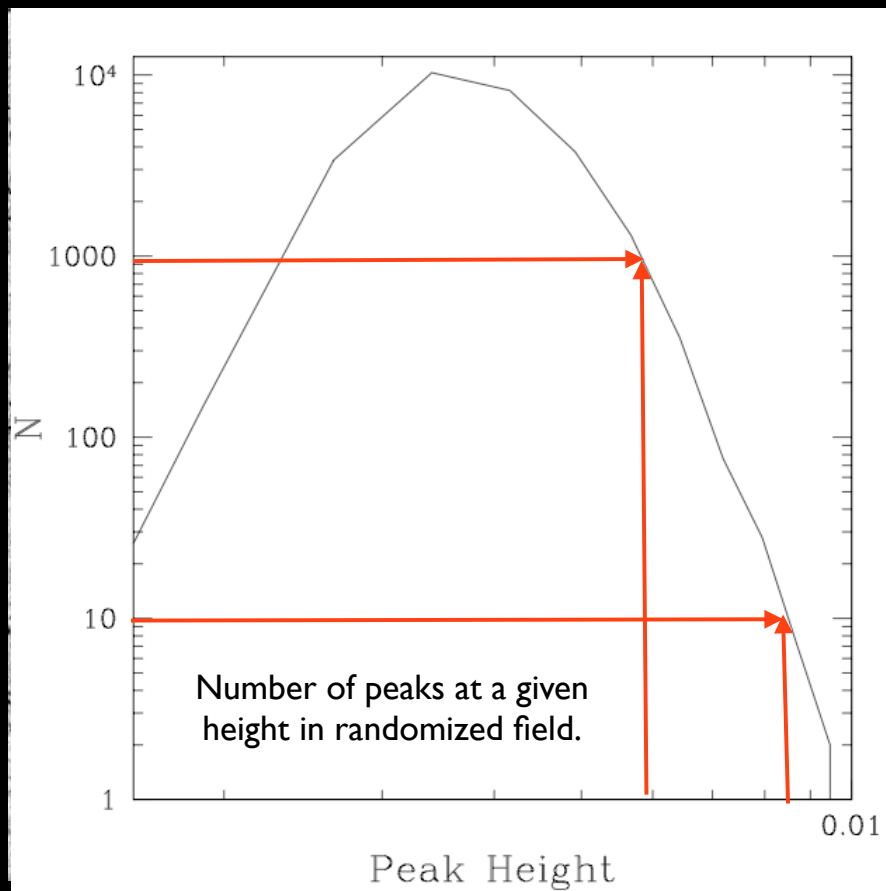


Preserves masking, local density

Detection Significance

Repeat search on blank maps

Real Data



Apply spline fit to distribution

Redshifts randomized relative to coordinates

Significance in a slice defined as
peak height/threshold.
→ “Normalized Peak Height”

Normalization places all slices on
equal footing

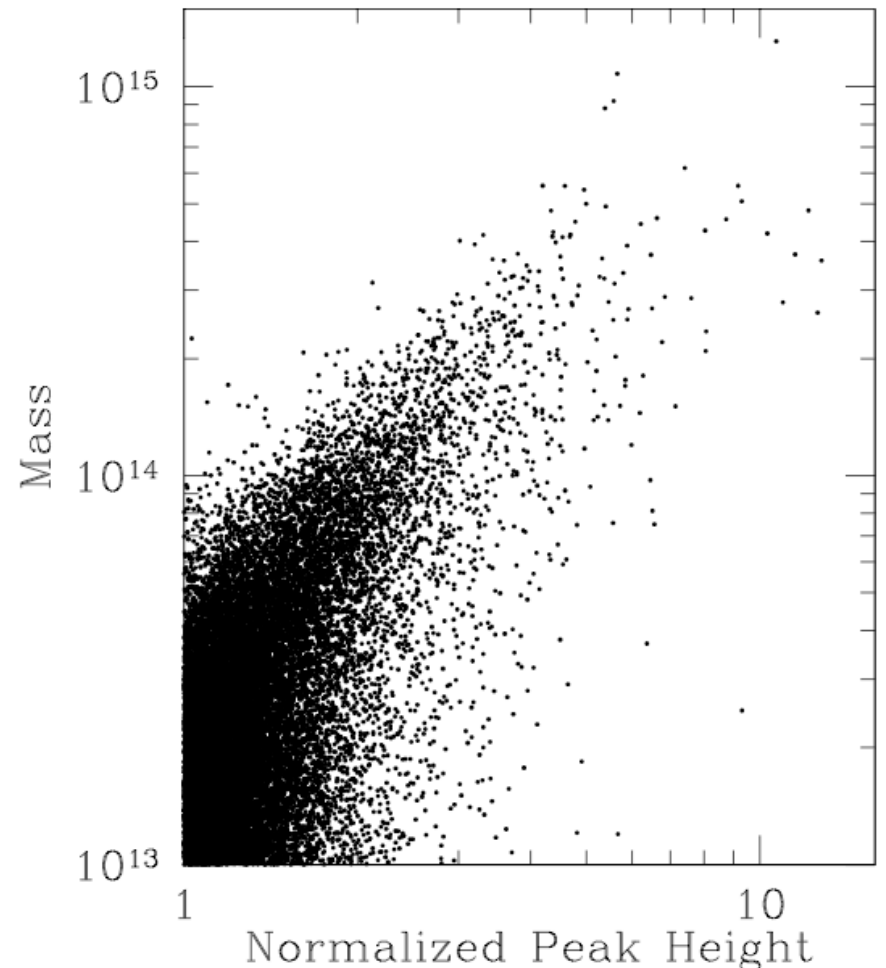
Preserves masking, local density

“S/N” and Richness

Right now, this code does *not* have an optimized richness output.

I provide simply the normalized peak height for the detection.

Could augment with a post-detection, improved richness measure.



Challenge 2, calibration field (really pushing into noise)

Redshift Estimates

Redshift of slice with most significant detection gives first estimate.

Refine post-search:

- Compute composite $P(z)$ for all galaxies within 1.5 Mpc (based on bin redshift)
- Take peak of $P(z)$ as best redshift.

** Noisy at low masses...not sure whether scatter is too large for matches in 2nd challenge*

Key Parameters

Input Galaxies

magbelow1star: faintest galaxies to include (M*+2 in H-band)

Slices

dz: width of redshift slice (0.06)

zstep: size of steps in redshift (0.06)

Smoothing

scale1: inner scale of gaussian difference kernel (300 kpc)

scale2: outer scale of gaussian difference kernel (1200 kpc)

Detection

det_thresh: detection threshold (10→1000)

Merging

dr1im: maximum projected separation to merge (1500 kpc)

dz1im: maximum redshift separation to merge (0.4)

Key Areas for Improvement

- Scale to full Euclid Area (Tiles or HEALPIX)
- Improved richness estimator
- Re-implement masking and full $P(z)$ capabilities
- ...plus whatever 2nd challenge indicates...

An aside on general issues

- Cluster clustering: We need to consider including in challenges soon. Excellent sanity check on uniformity of detection.
- We should to fold masking into upcoming challenges.
- Variable quality of photo-z's is a potentially critical issue which we need to consider sooner rather than later.