Olber's paradox revisited: effects of overlapping sources on cosmic shear estimation

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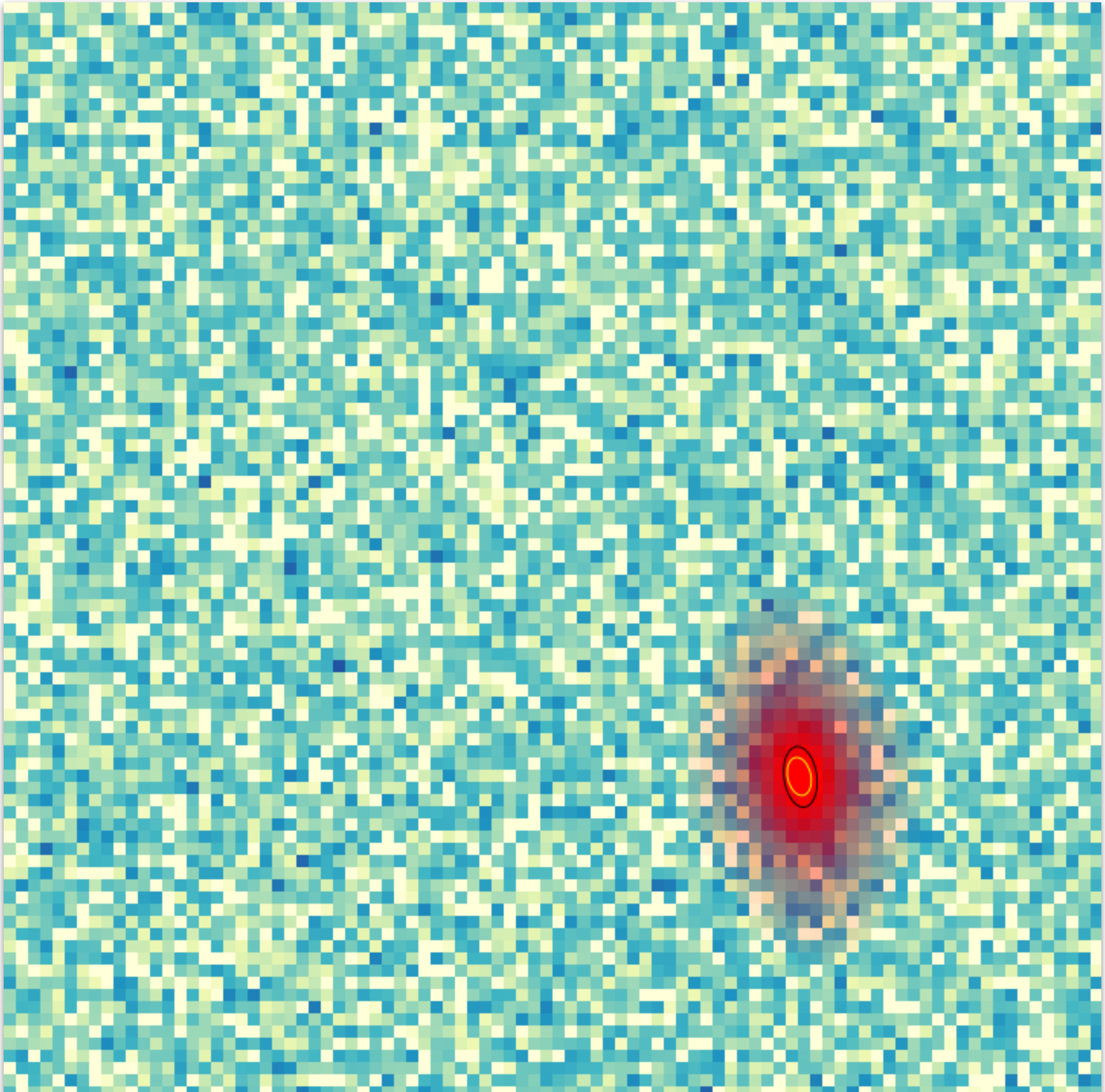
Accurate Astrophysics. Correct Cosmology.

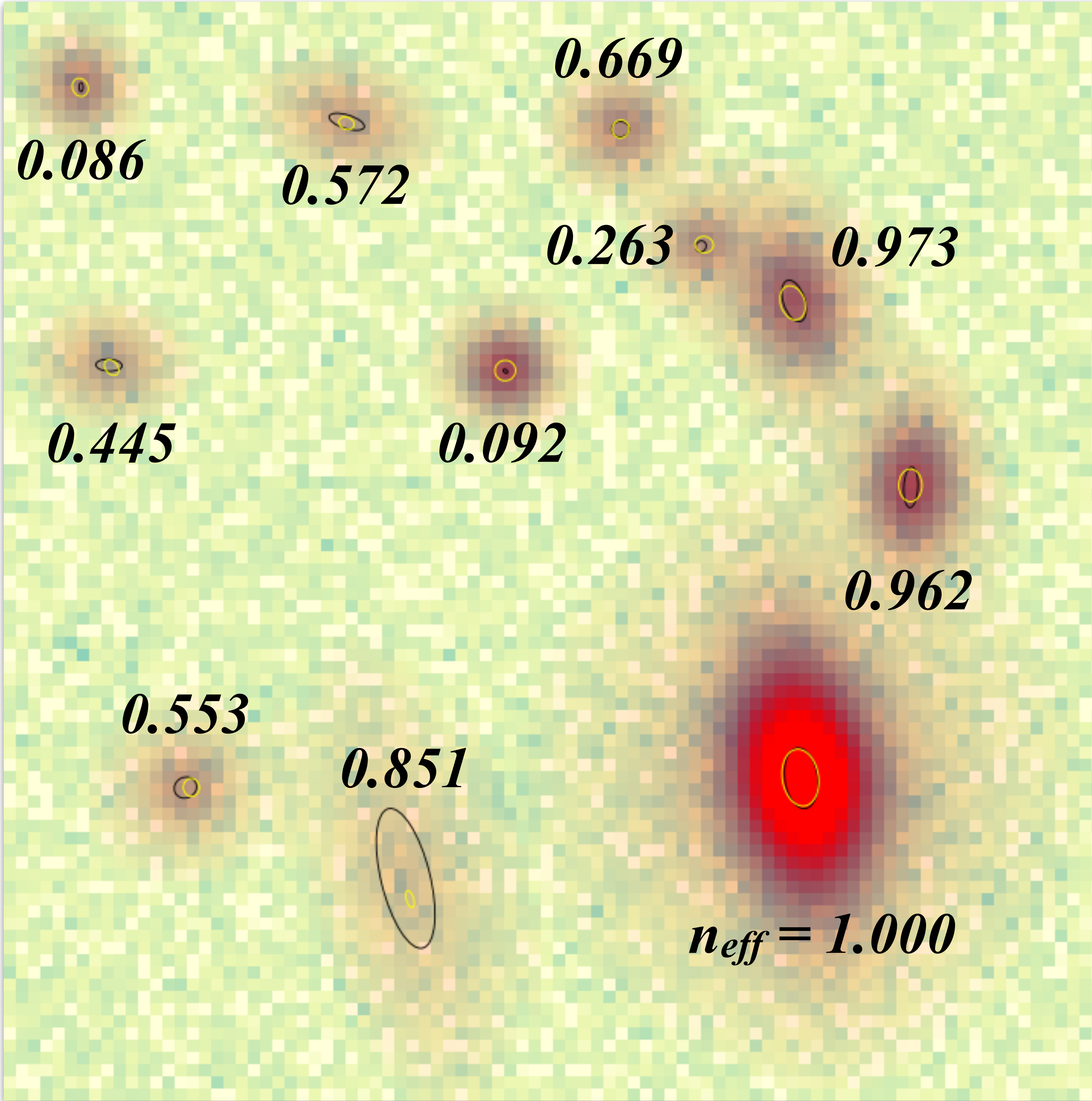
London, 16 July 2015.

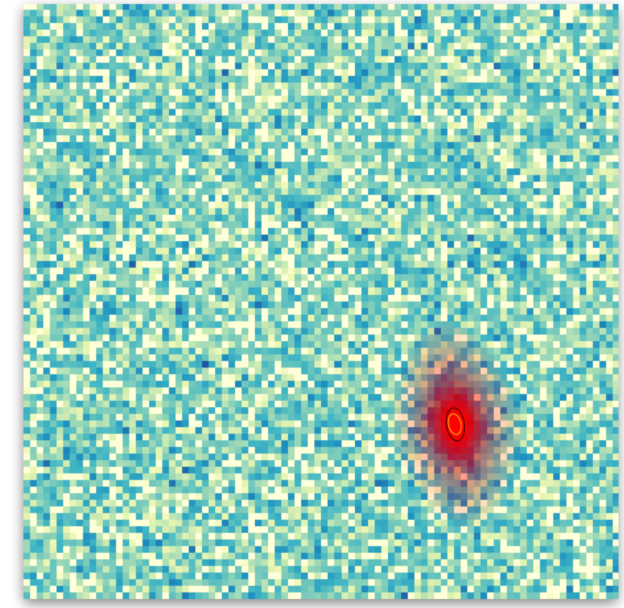


LSST i-band
single visit
(2x15 seconds)

$n_{detected} = 1$
$n_{eff} = 0.962$

18” x 18”

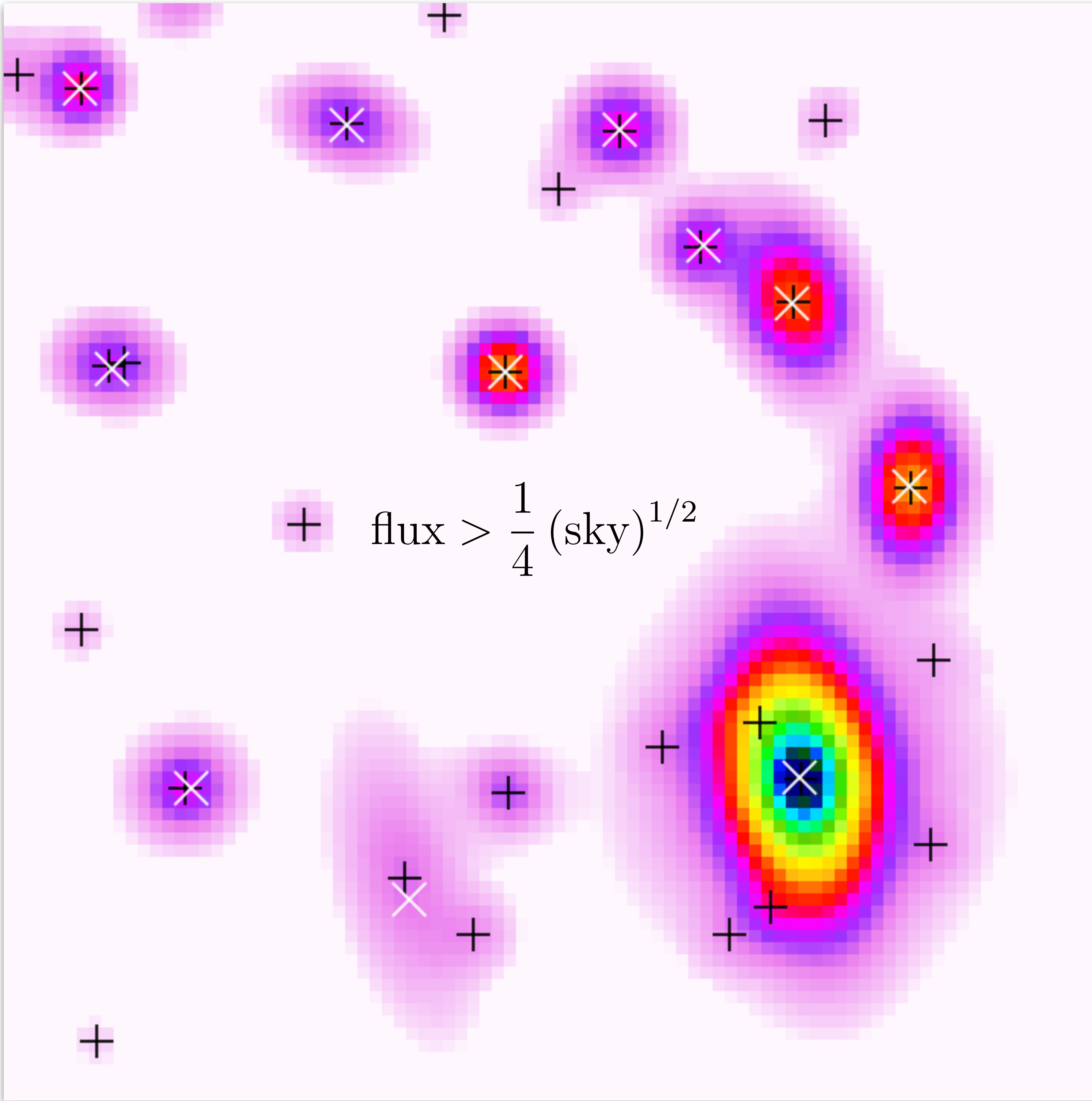


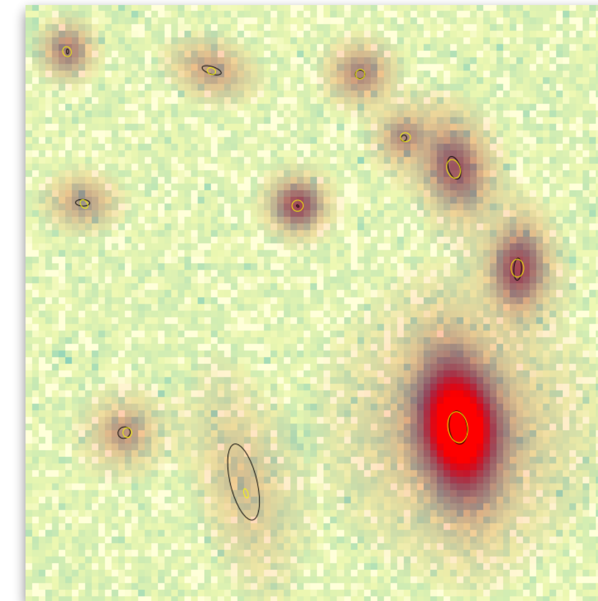


LSST i-band
full depth
(230 visits)

$n_{detected} = 11$
$n_{eff} = 6.47$

18" x 18"





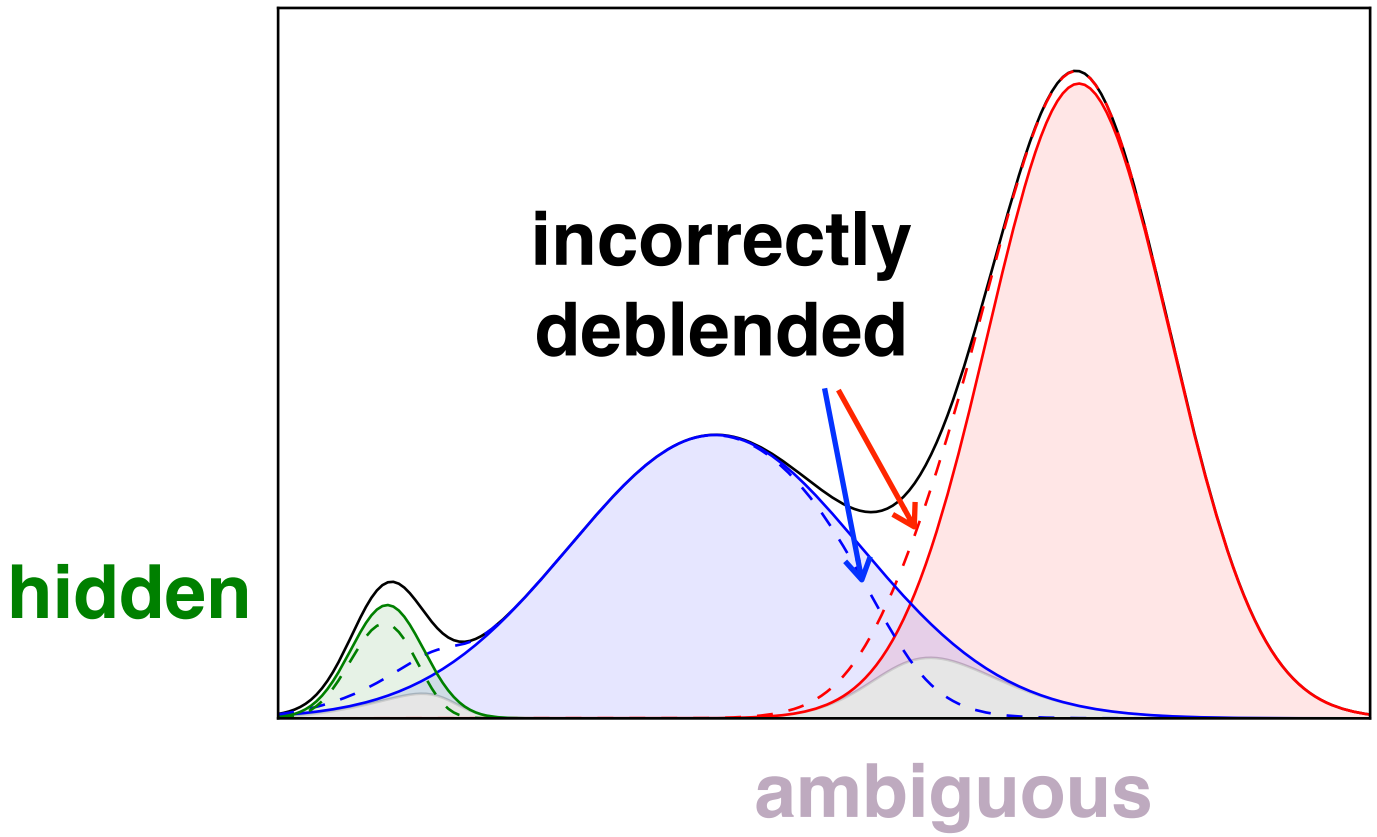
LSST i-band
full depth
(230 visits)

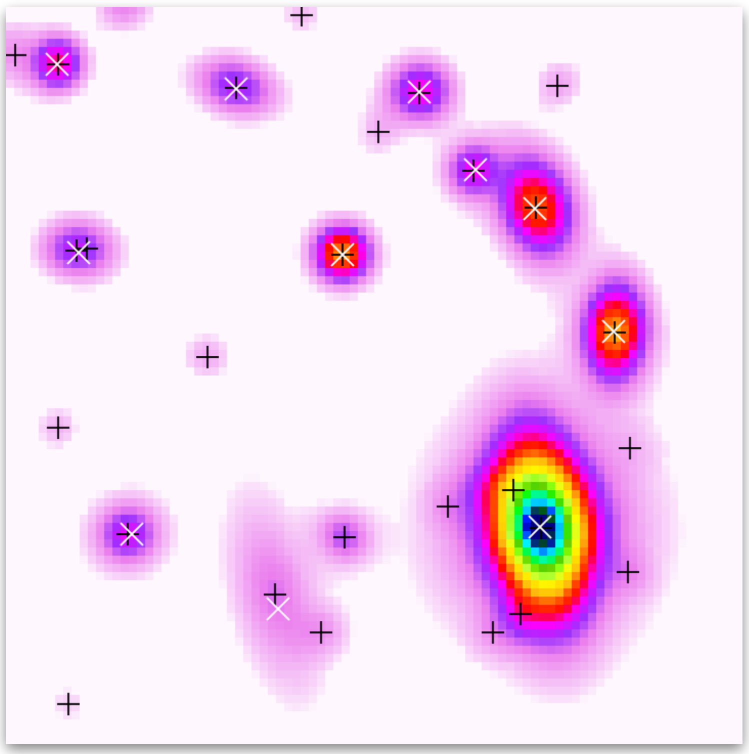
$n_{detected} = 11$
$n_{eff} = 6.47$
$n_{hidden} = 12$

18" x 18"

How will galaxy overlaps impact LSST weak lensing?

- with current algorithms, not feasible to perform optimal simultaneous analysis of overlaps for LSST.
- alternative is to use a “deblender” to partition flux, then measure each galaxy’s shape independently.





LSST DESC has released an open source simulation and analysis package to address these questions:

http://weaklensingdeblending.readthedocs.org/

https://github.com/DarkEnergyScienceCollaboration/WeakLensingDeblending

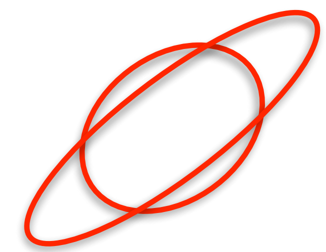
Fast pixel-level simulation (using GalSim) of weak lensing surveys:

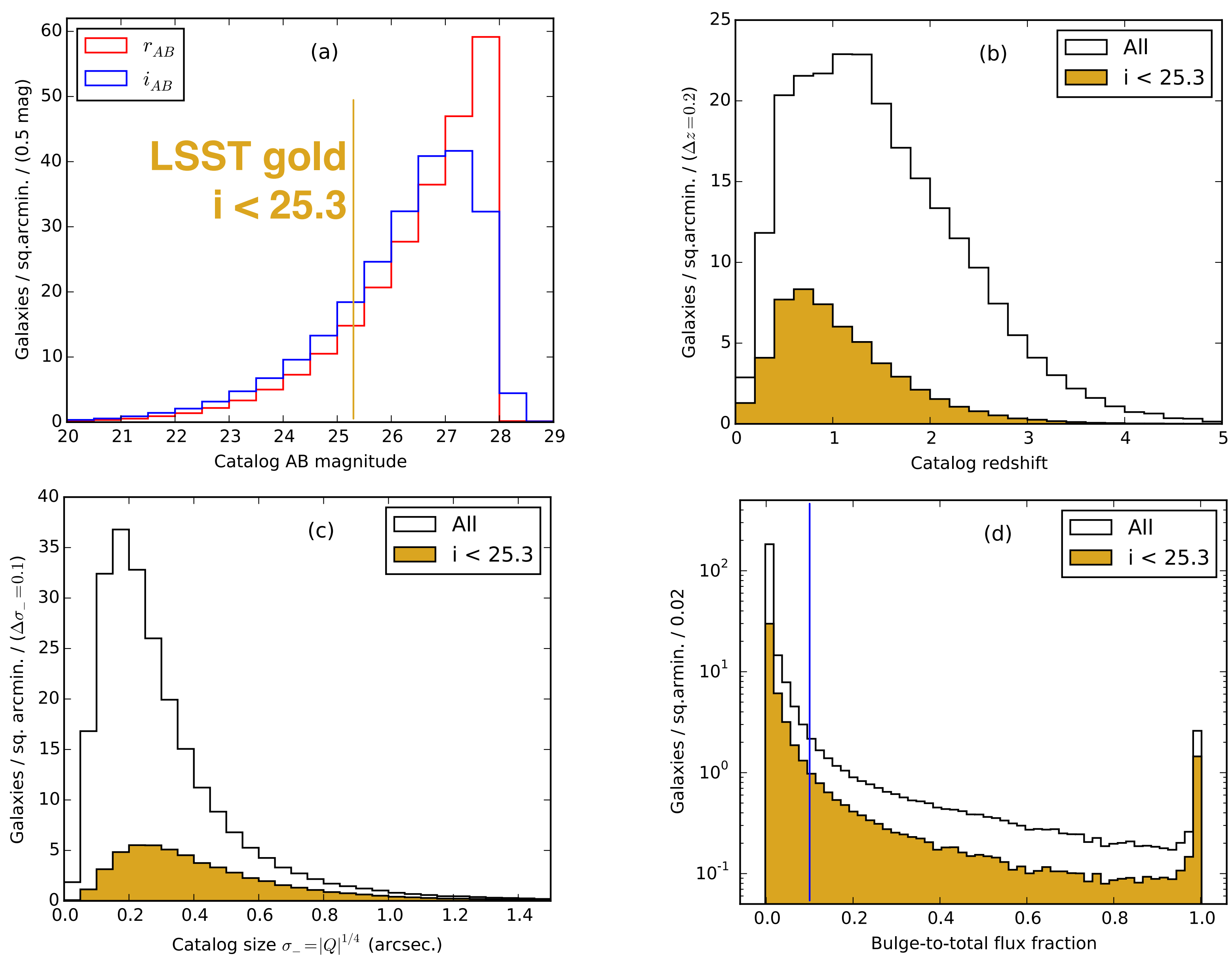
Survey	Effective Area(m^2)	Primary Diam.(m)	Pixel Size		Exp. Time	Sky Bright.	Atmos. FWHM	Zero Point
CFHTLS	8.022	3.592	0.185”	i	4300s	20.3	0.64”	10.0
				r	2000s	20.8	0.71”	13.5
DES	10.014	3.934	0.263”	i	1000s	20.1	0.79”	12.5
				r	800s	21.1	0.79”	16.8
LSST	33.212	8.360	0.200”	i	6900s	20.0	0.67”	41.5
				r	6900s	21.3	0.70”	55.8

(HSC, Euclid coming soon…)

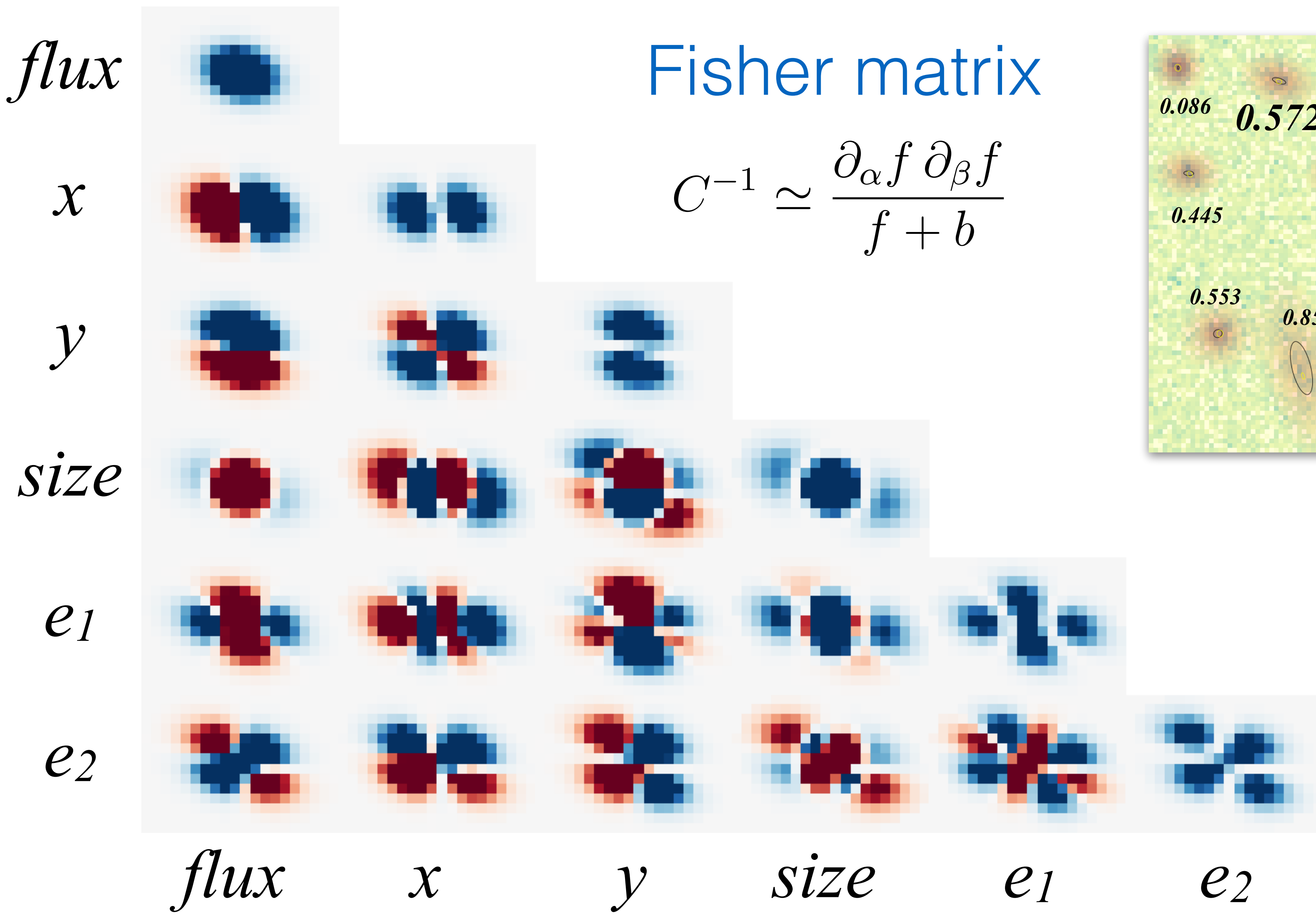
Simulate galaxy catalog from LSST sims group:

- Millenium DM simulation.
- baryonic physics from Kitzbichler & White (2007).
- SEDs from Bruzual & Charlot (2003).
- Bulge (n=4) + disk (n=1) morphology from Batissta et al (2006).



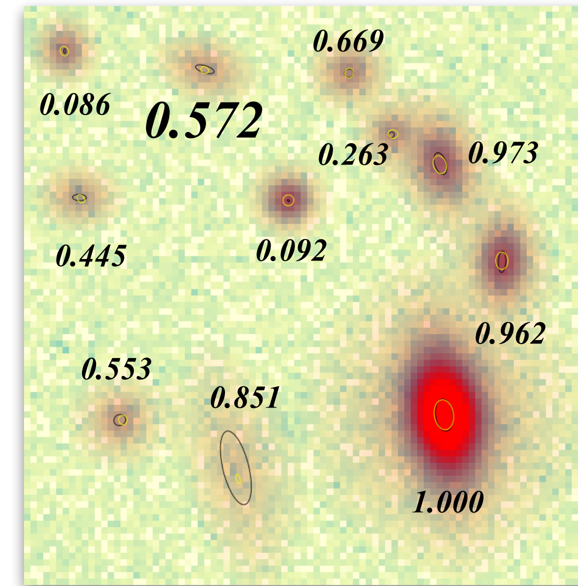


Estimate statistical power of each pixel (n_{eff}) with Fisher matrix of flux-size-shape covariances:

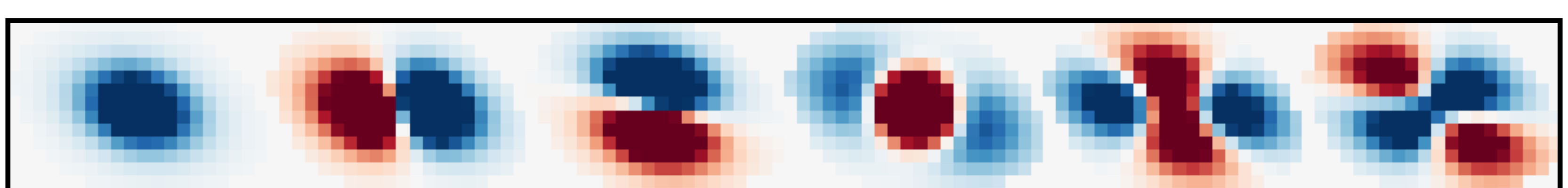


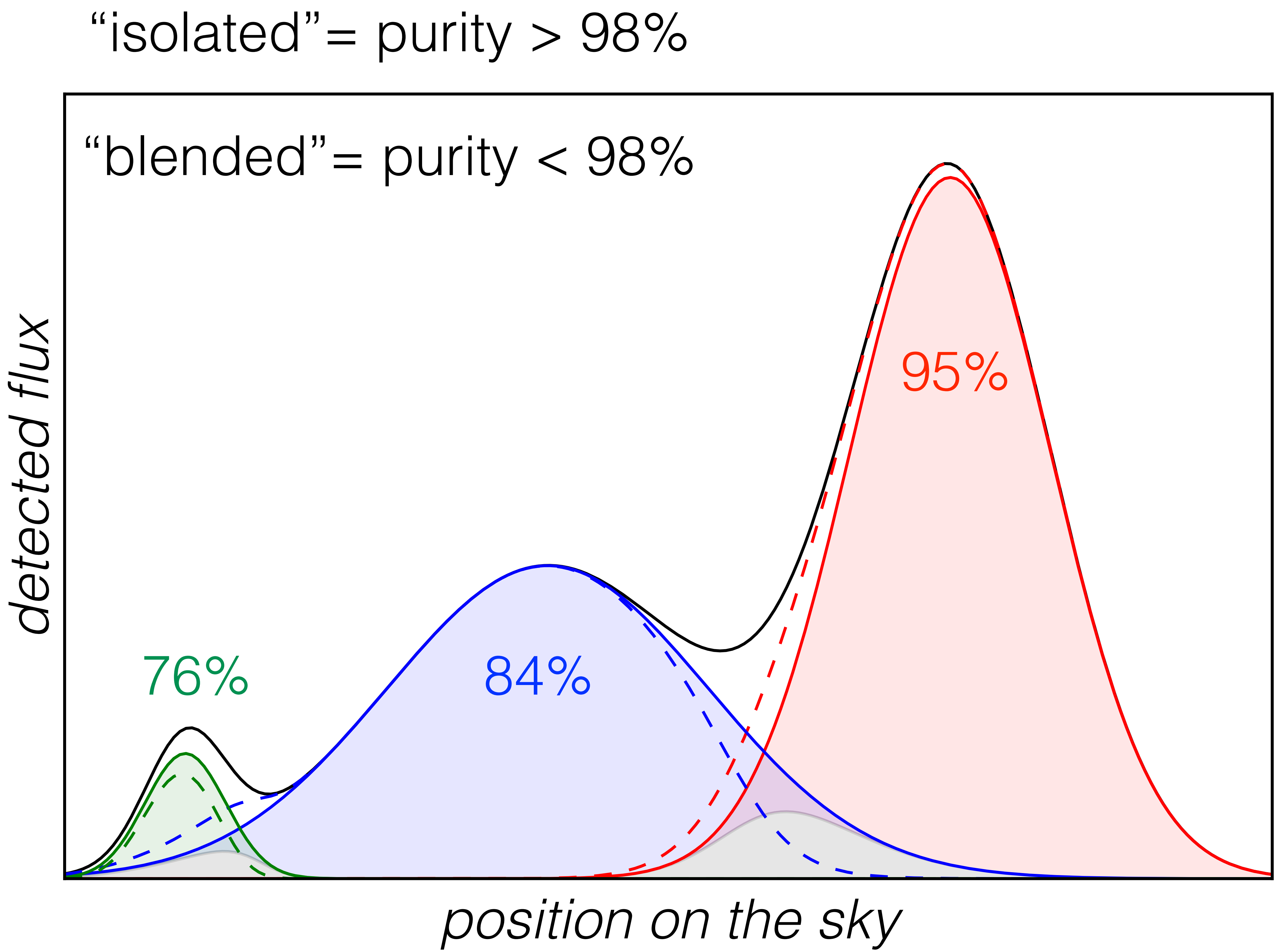
Fisher matrix

$$C^{-1} \simeq \frac{\partial_\alpha f \, \partial_\beta f}{f + b}$$

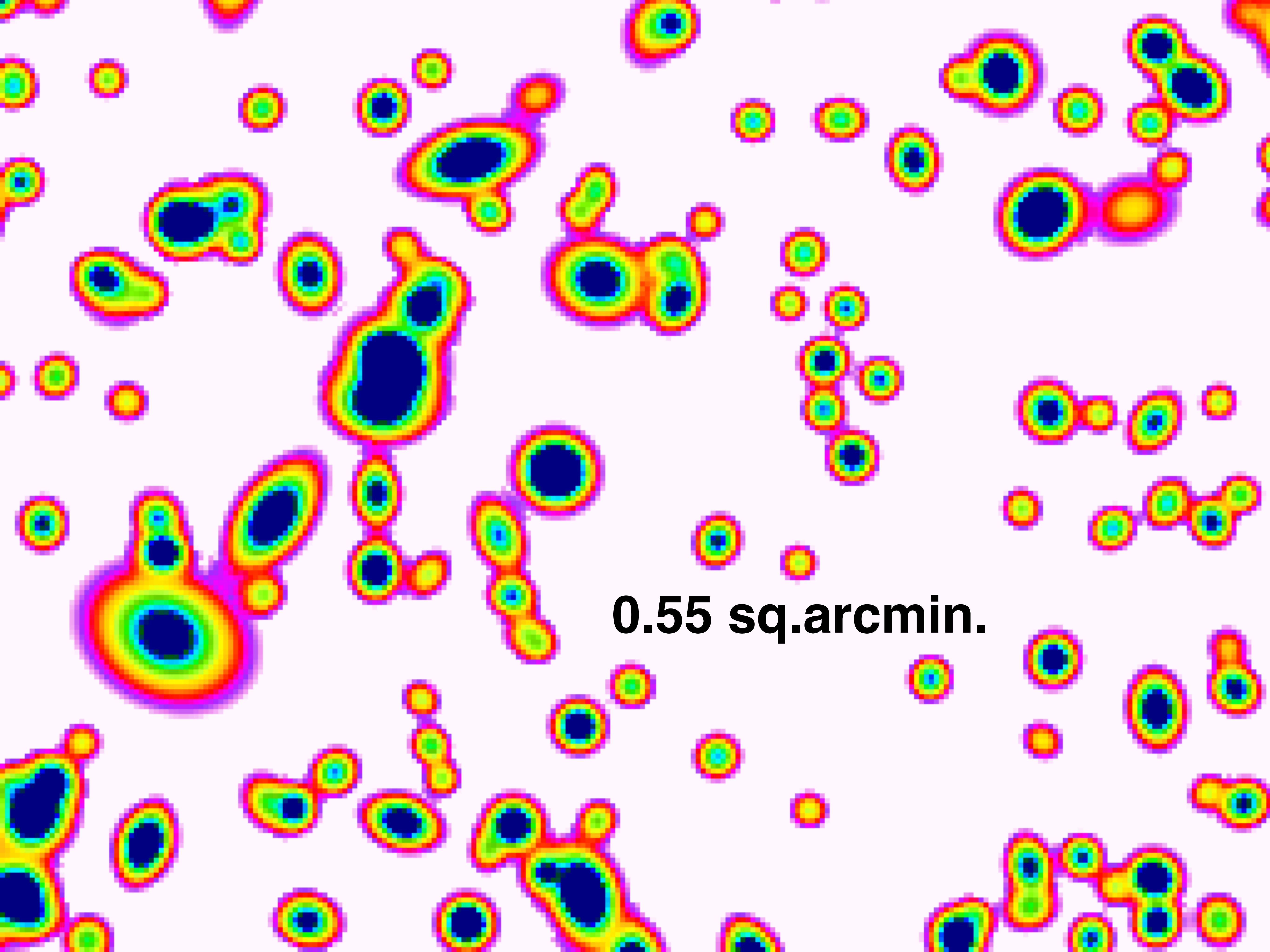


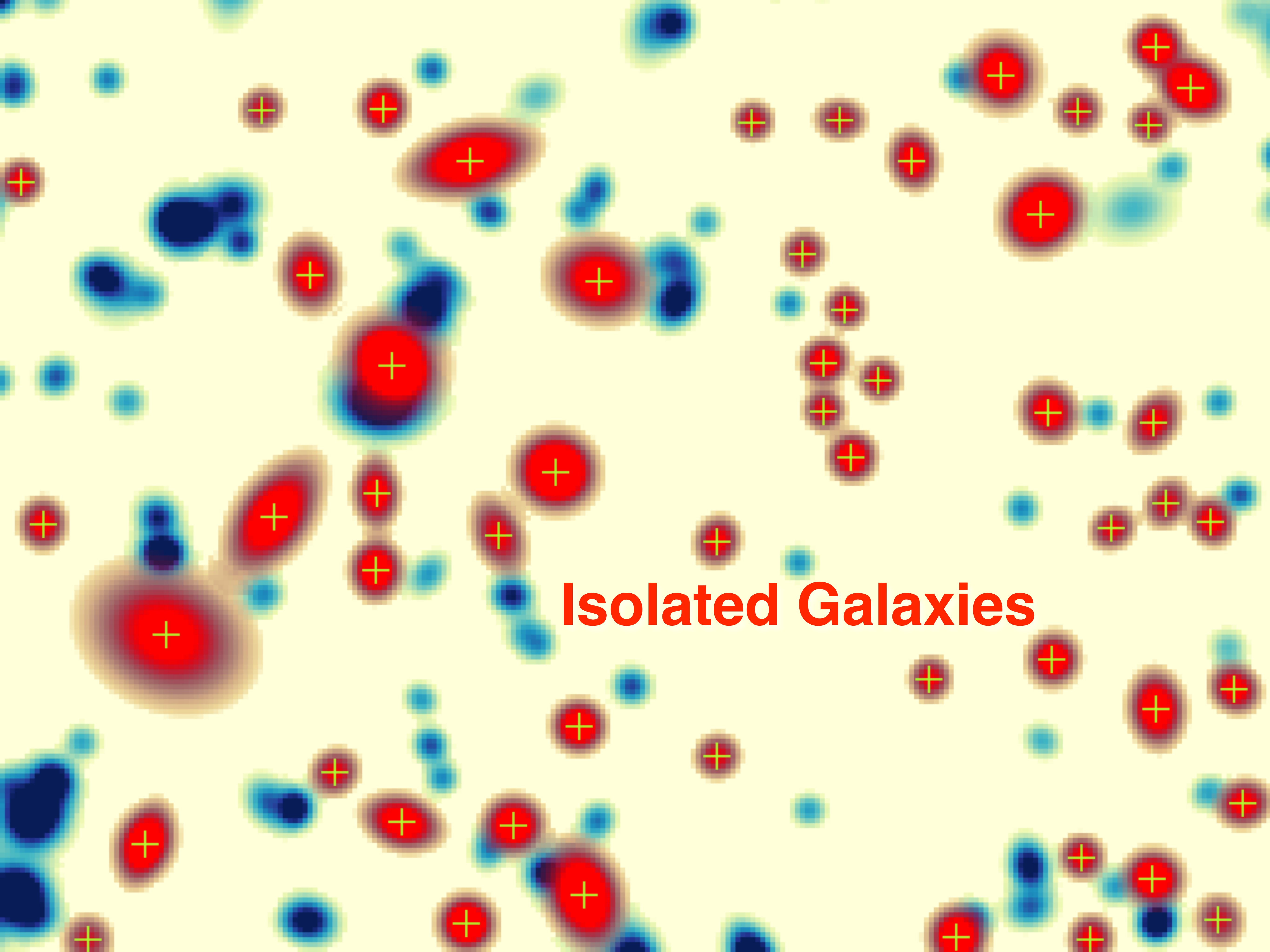
partial derivatives

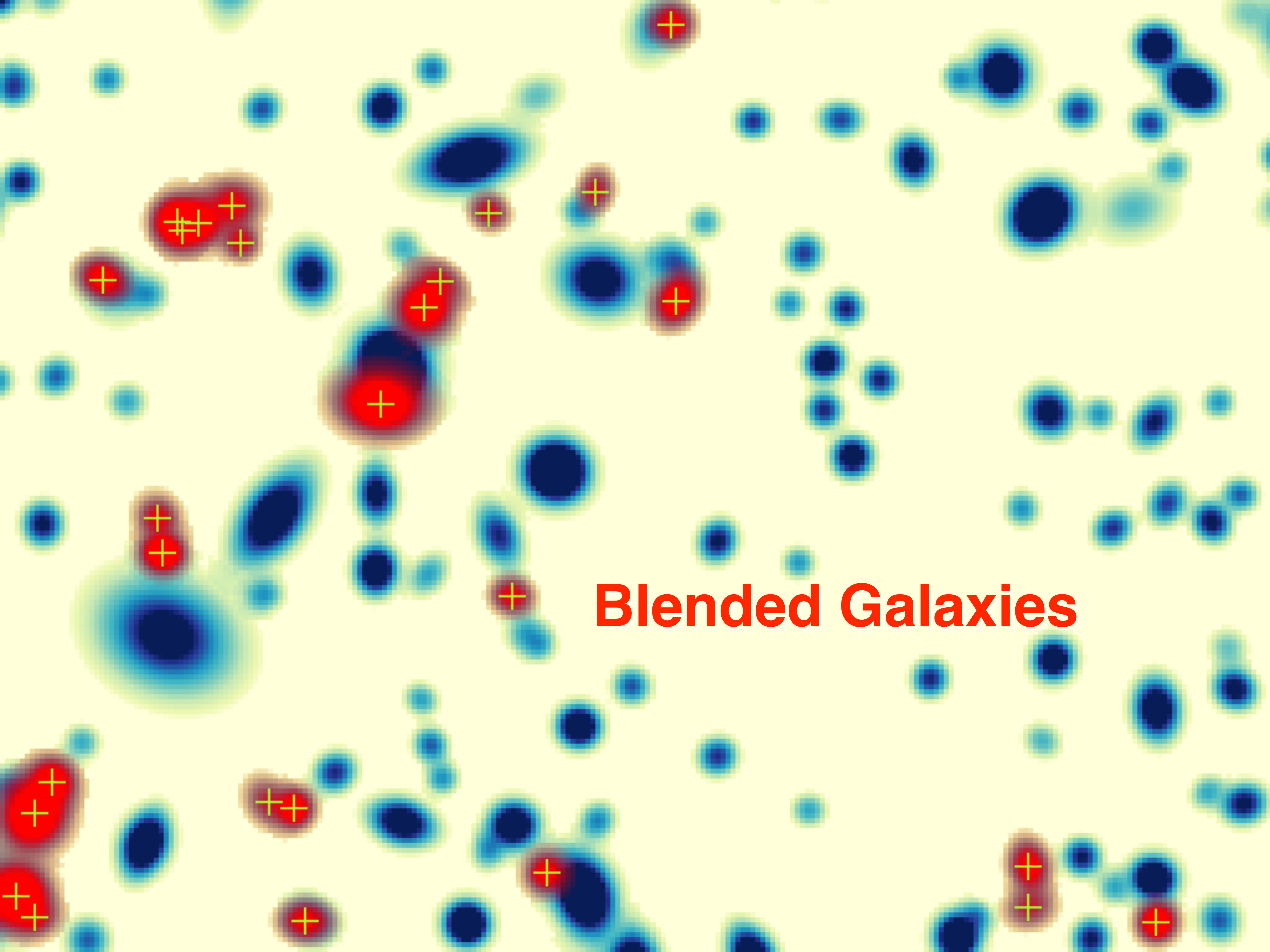


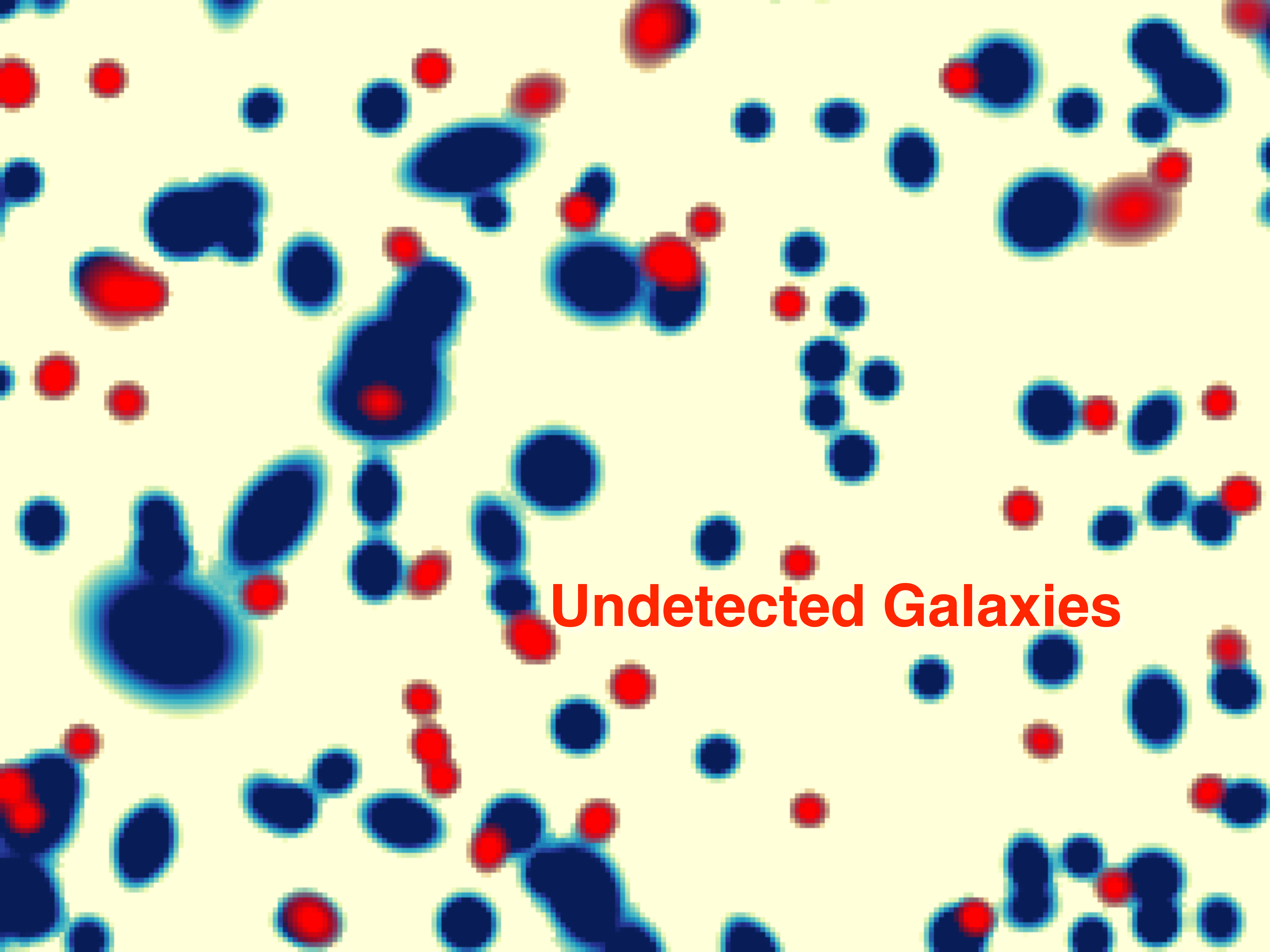


“isolated”= purity > 98%
“blended”= purity < 98%
95%
76%
84%
detected flux
position on the sky

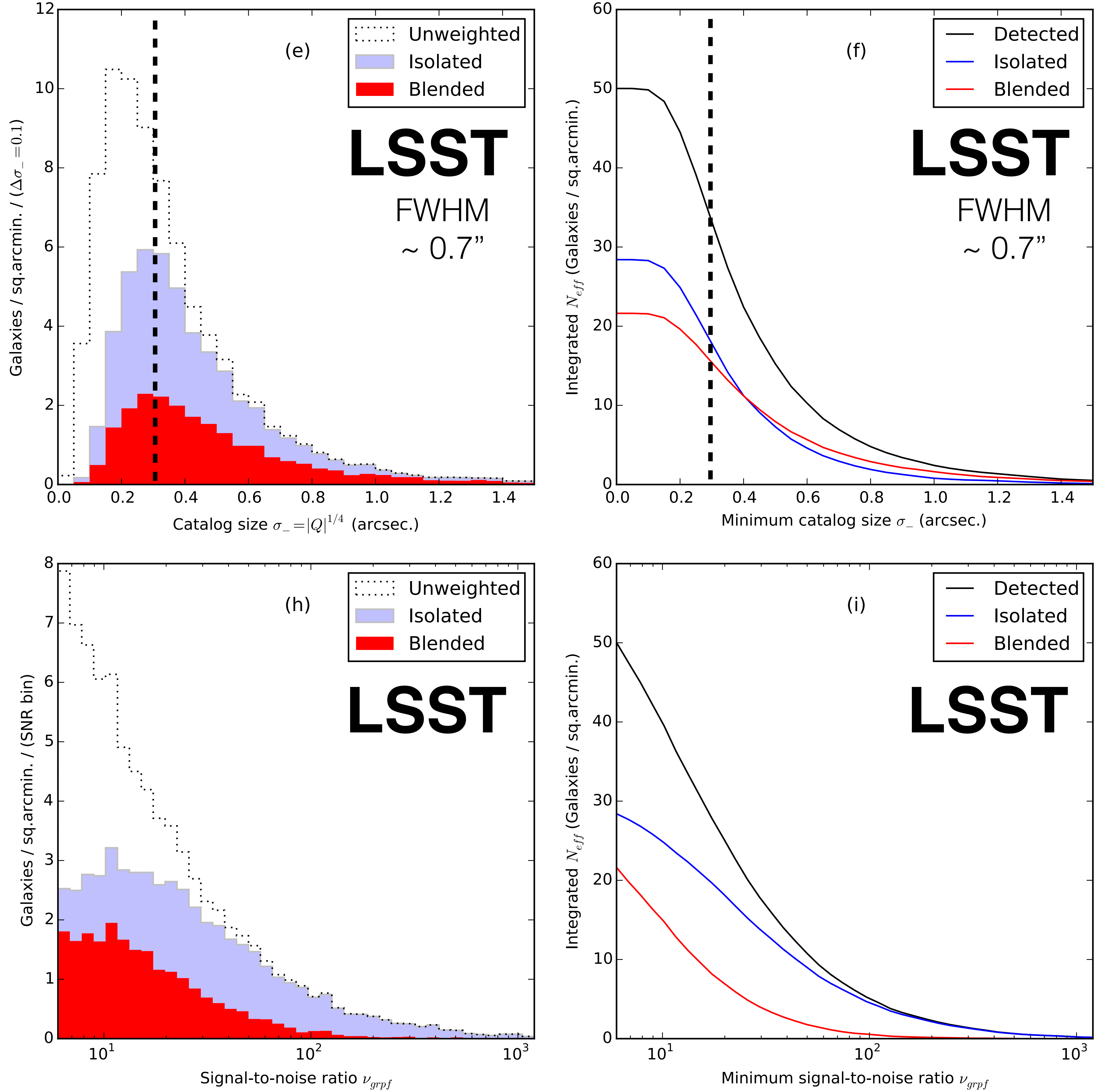

0.55 sq.arcmin.


Isolated Galaxies


Blended Galaxies


Undetected Galaxies

LSST r-band predictions



Summary

Most of the LSST weak-lensing signal is from:

- small galaxies with size / PSF ~ 1.
- low signal-to-noise galaxies: $\nu \lesssim 20$.
- need shape measurement algorithms for isolated galaxies that are sufficiently accurate in this regime.

About half of the LSST signal is in blended groups.

- need a sufficiently accurate algorithm for deblending (or fast simultaneous shape measurements).

We do not yet have the required algorithms.

Related work:

- Chang++ 2013, “The Effective Number Density of Galaxies for Weak Lensing Measurements in the LSST Project”, arXiv:1305.0793.
- Dawson++ 2014, “The Ellipticity Distribution of Ambiguously Blended Objects”, arXiv:1406.1506.

Accurate astrophysics:

- Blomqvist++ 2015, “Broadband distortion modeling in Lyman-α forest BAO fitting”, arXiv.org:1504.06656.
- Margala++ 2015, “Improved Spectrophotometric Calibration of the SDSS-III BOSS Quasar Sample”, arXiv.org:1506.04790.