Pan-STARRS1: Current Status and Early Large-Scale Structure Results

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Outline

- Introduce PS1 and its surveys
- Discuss the depth of PS1
- Present methods for star/galaxy separation
- Present methods to produce masks
- Show a recent science application of PS1 data

Pan-STARRS1 (PS1)

- A 1.8m on Haleakala, Maui
- ~3 deg. fov
- Designed for transients, my interest is large-scale structure
- 5 optical/NIR bands (roughly SDSS griz + y)
- Zeropoints: <10mmag scatter with SDSS. See Schlafly, Finkbeiner et al (2012)
- Photometric redshifts (see Saglia et al 2012)

Image Credit: Rob Ratkowski, copyright PS1SC

PS1 Surveys

3π Survey

- ~31,000 sq. deg.
- 2 exposures per epoch, 6 epochs over 3.5 yrs, total 12 exposures
- Exposure time in g,r,i,z,y are 43, 40, 45, 30 and 30 seconds
- See e.g. Metcalfe et al 2013 for more

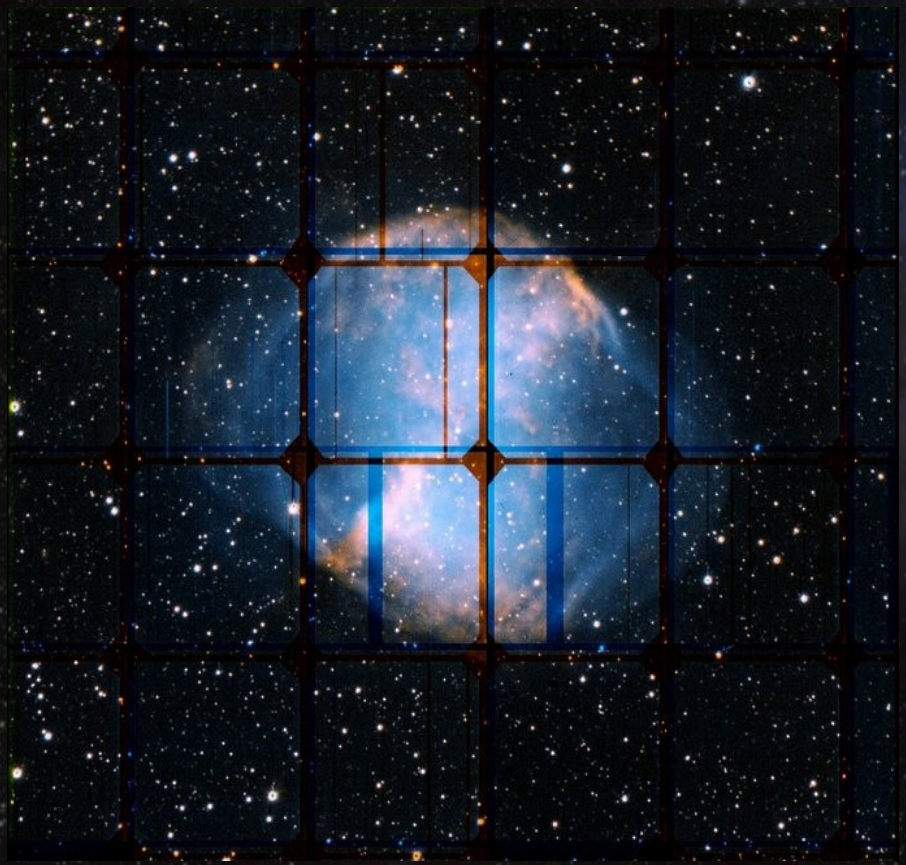
Medium Deeps

- 10 * ~7 sq. Deg. fields
- VST-ATLAS overlaps with Medium Deep 02
- Exposure times in g,r,i,z,y are 8*113, 8*113, 8*240, 8*240, 8*240
- See e.g. Tonry et al 2012
- Recent LSS science: Lin et al (2014)

LSS Science Goals (3π)

- Large area is biggest gain
- ISW effect
- Non-Gaussianities
- Cluster finding
- Testing galaxy formation models at higher redshifts

Observing Strategy

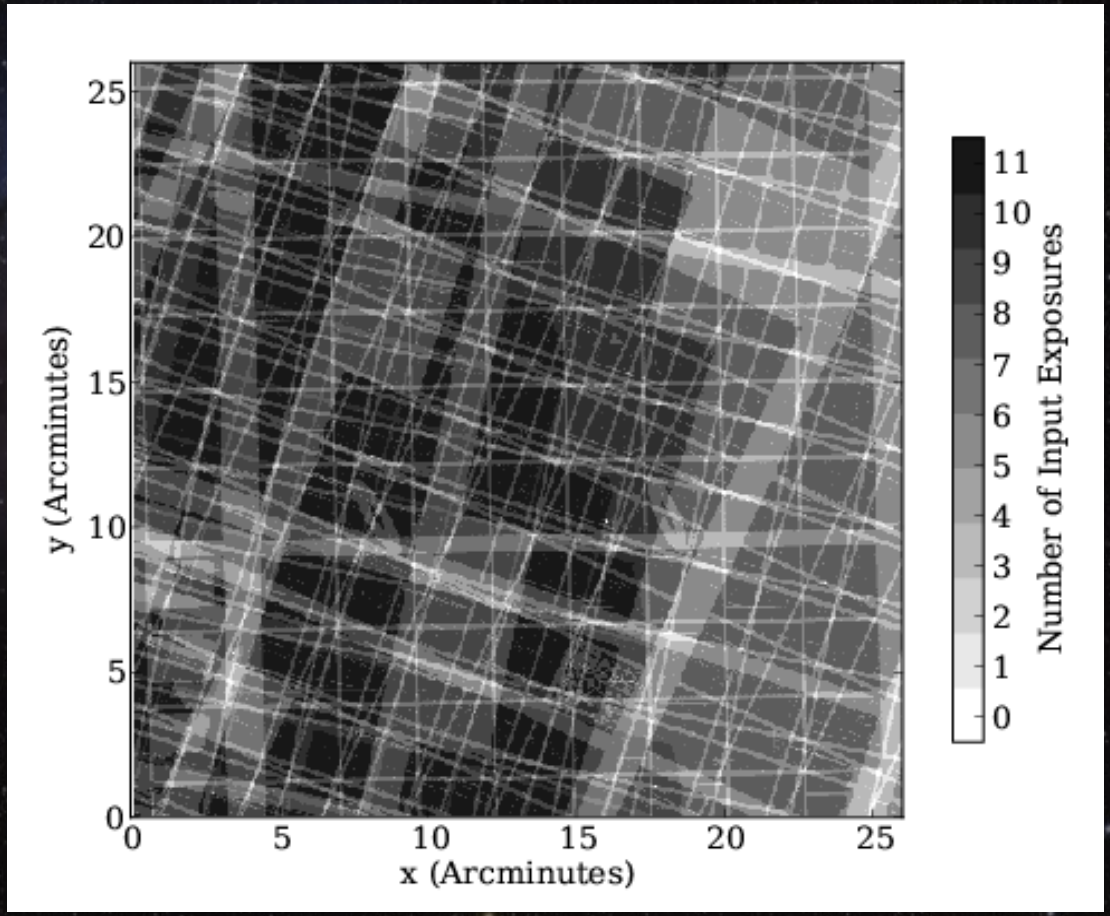


Stack images with different rotations & different centres to form the final picture.
Dithering and rotation more complex than VST ATLAS strategy.

Image Credit: Nigel Metcalfe (Durham)

PS1 Image Products

- Stacks – stacked exposures
- Coverage maps
- Variance maps
- Images are split into 20 * 20 arcminute 'skycells'



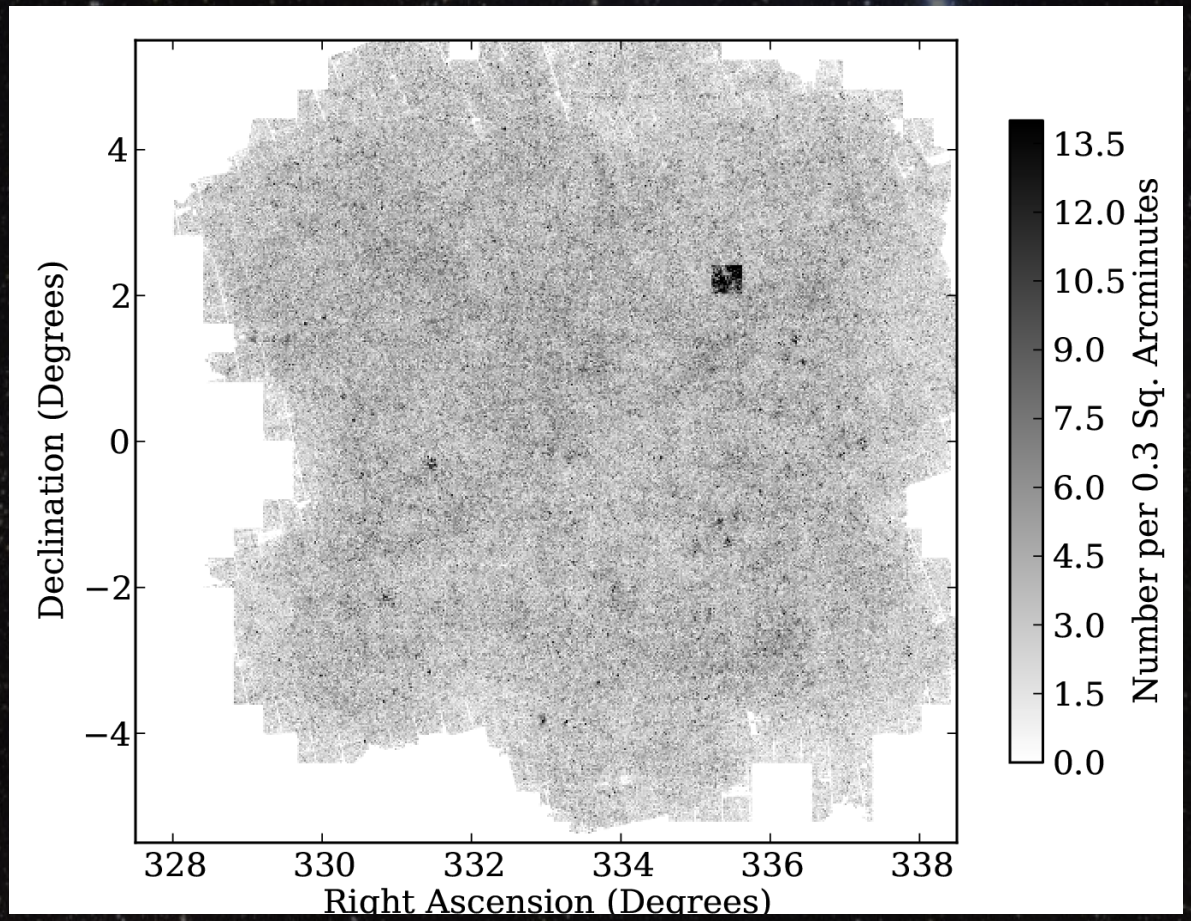
Farrow et al (2014)

PS1 Magnitudes

- PSF magnitudes → good for stars
- Aperture magnitudes → good for photometic redshifts *(still being tested)*
- Kron magnitudes → good for extended sources
- *Still in development: extended source fits and Petrosians*

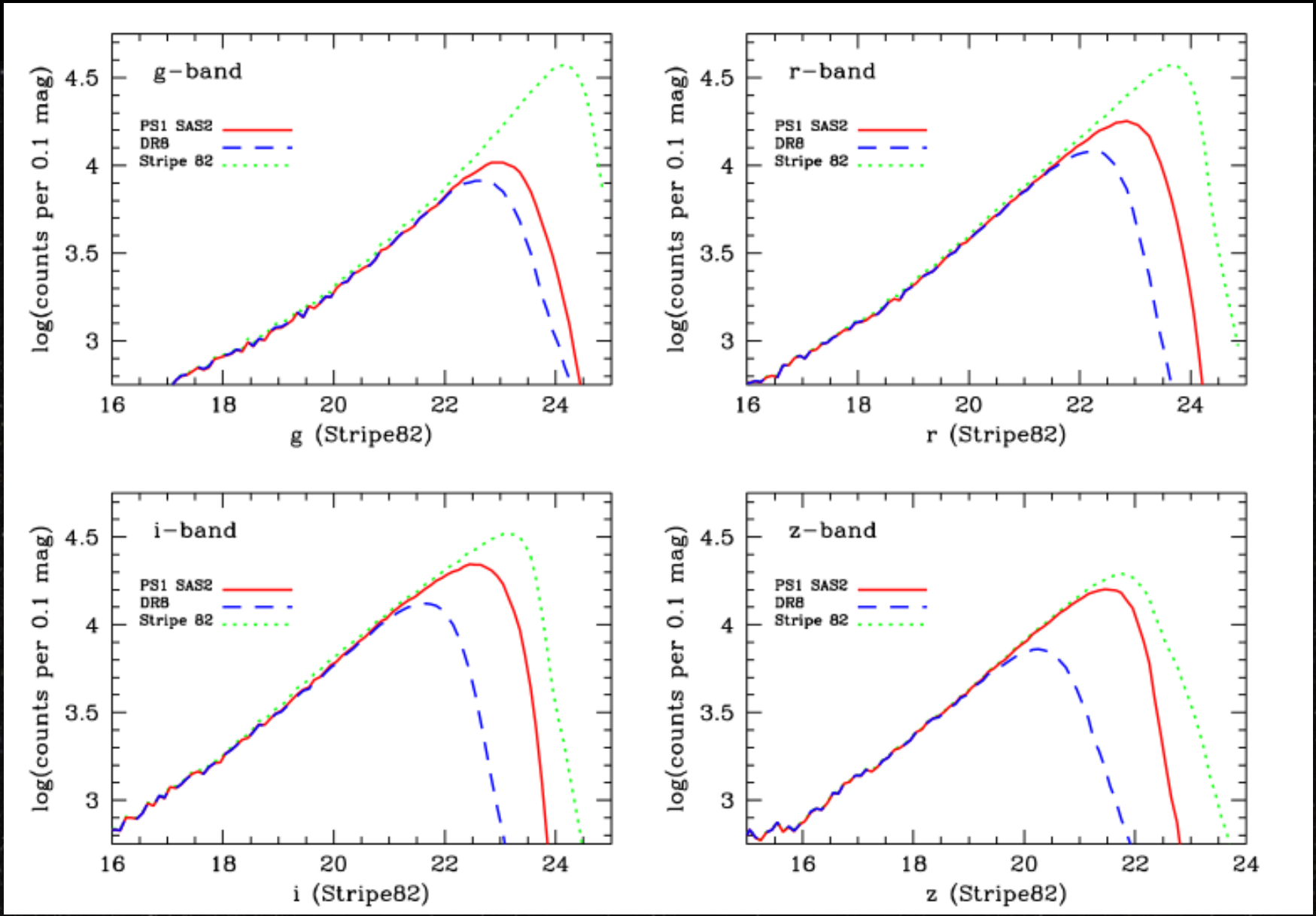
Small Area Survey 2

Density plot of PS1 detections over the small area survey:



Farrow et al (2014), see also
Metcalfe, Farrow et al. (2013)

3П Depth



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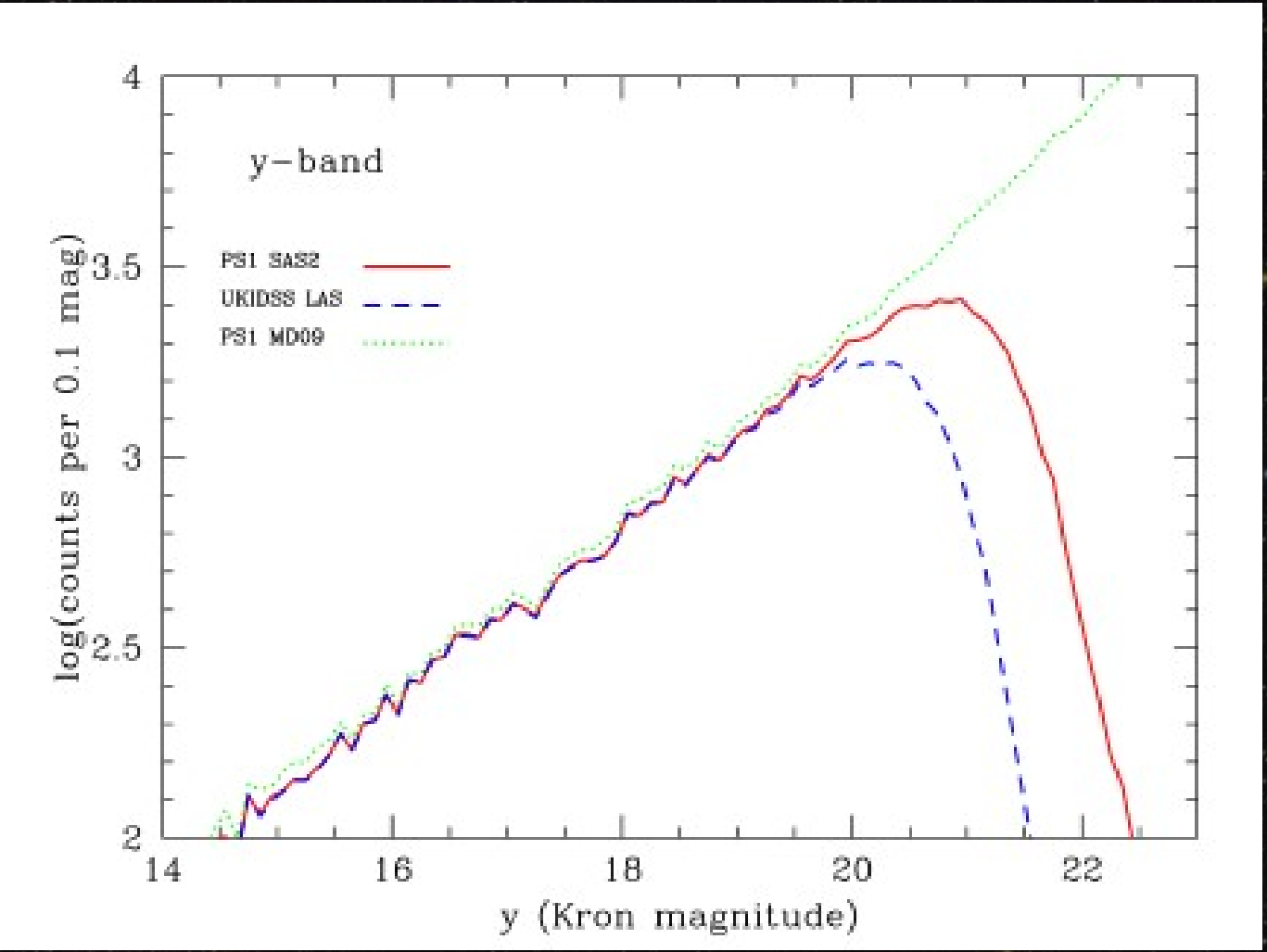
Metcalfe, Farrow et al. (2013)

3П Depth

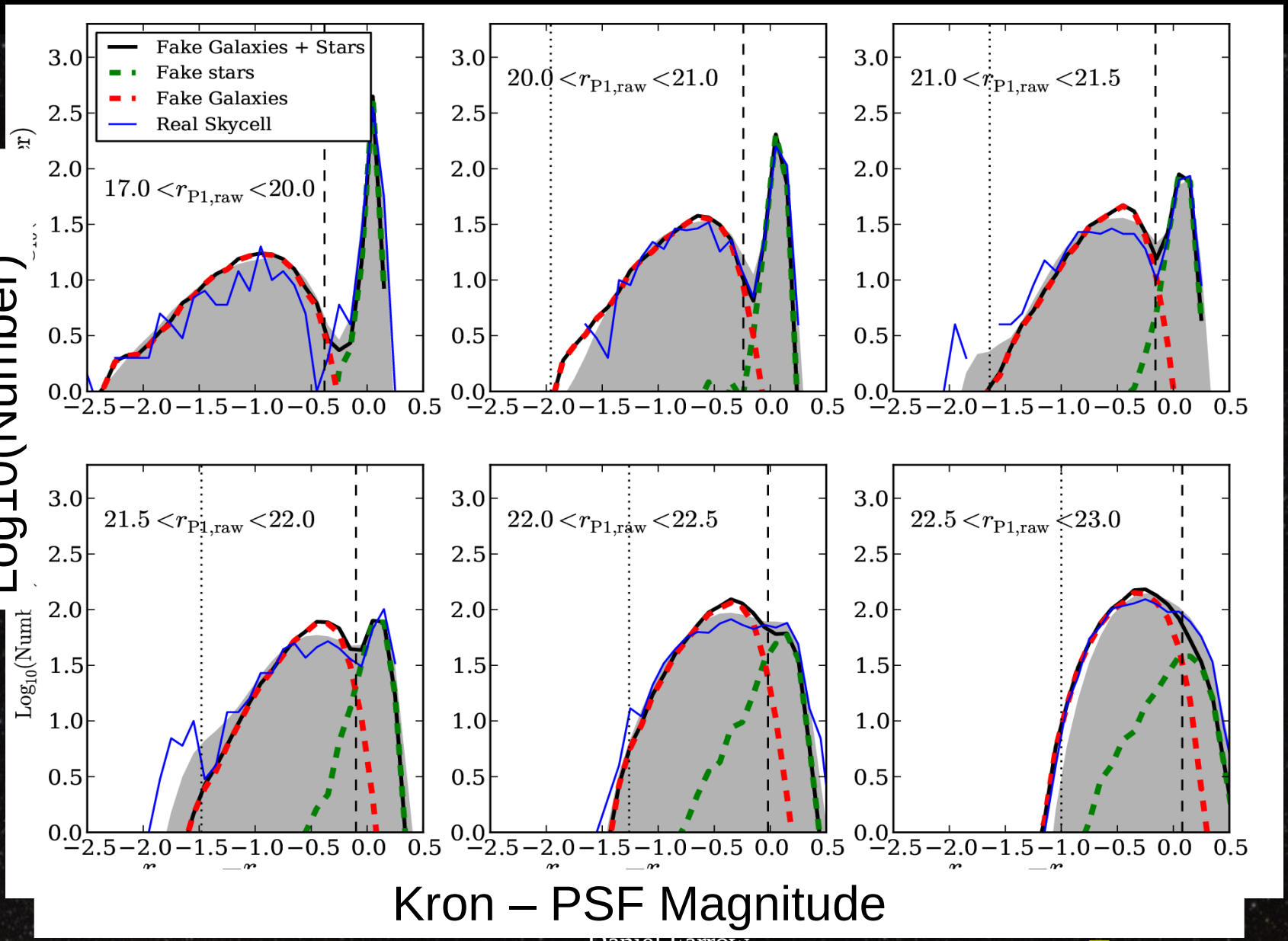


Metcalfe, Farrow et al. (2013)

Star/galaxy Separation

- Me: use Kron – PSF magnitude
- Nigel Metcalfe's: Use moments or size measurements too
- Nicolas Martin: Fit observed aperture – PSF magnitude
- Robert Saglia et al.: Use optical colours
- Others..
- Star/galaxy separation group is comparing approaches

Star/Galaxy Separation



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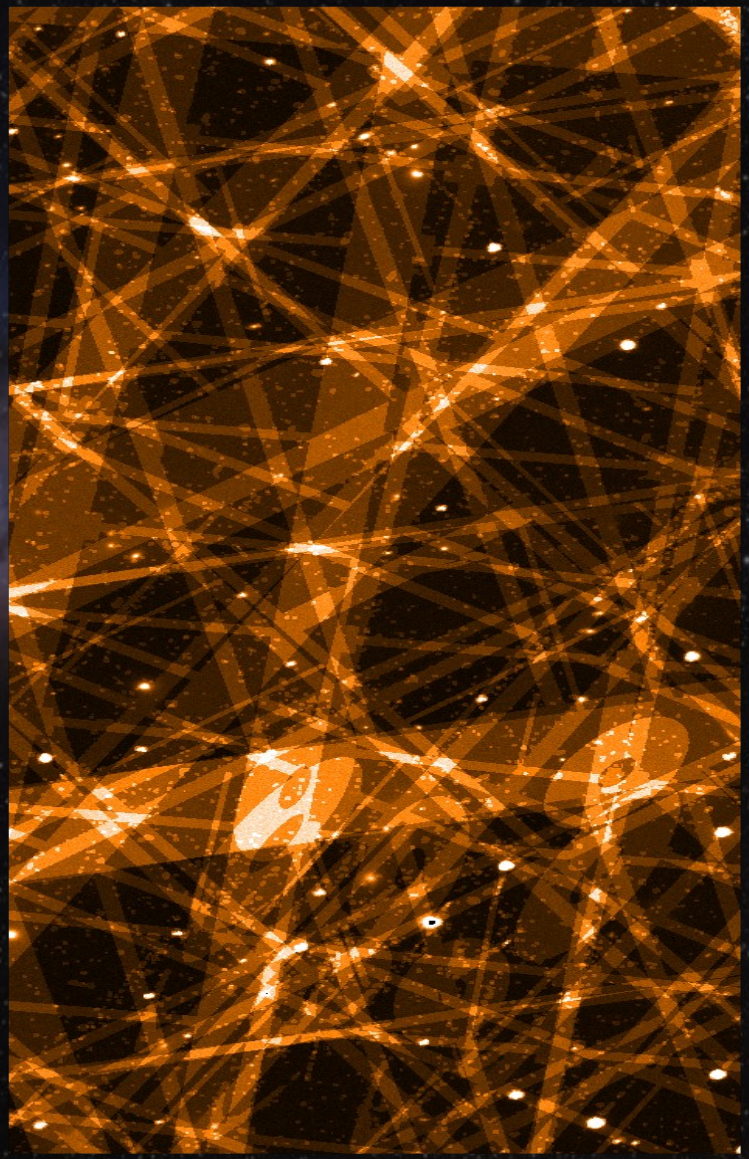
Farrow et al (2014)

Detection Efficiency

- Depth varies across the image
- Adds extra terms to the correlation function
- Need to remove this
- Produce maps of depth versus angular position



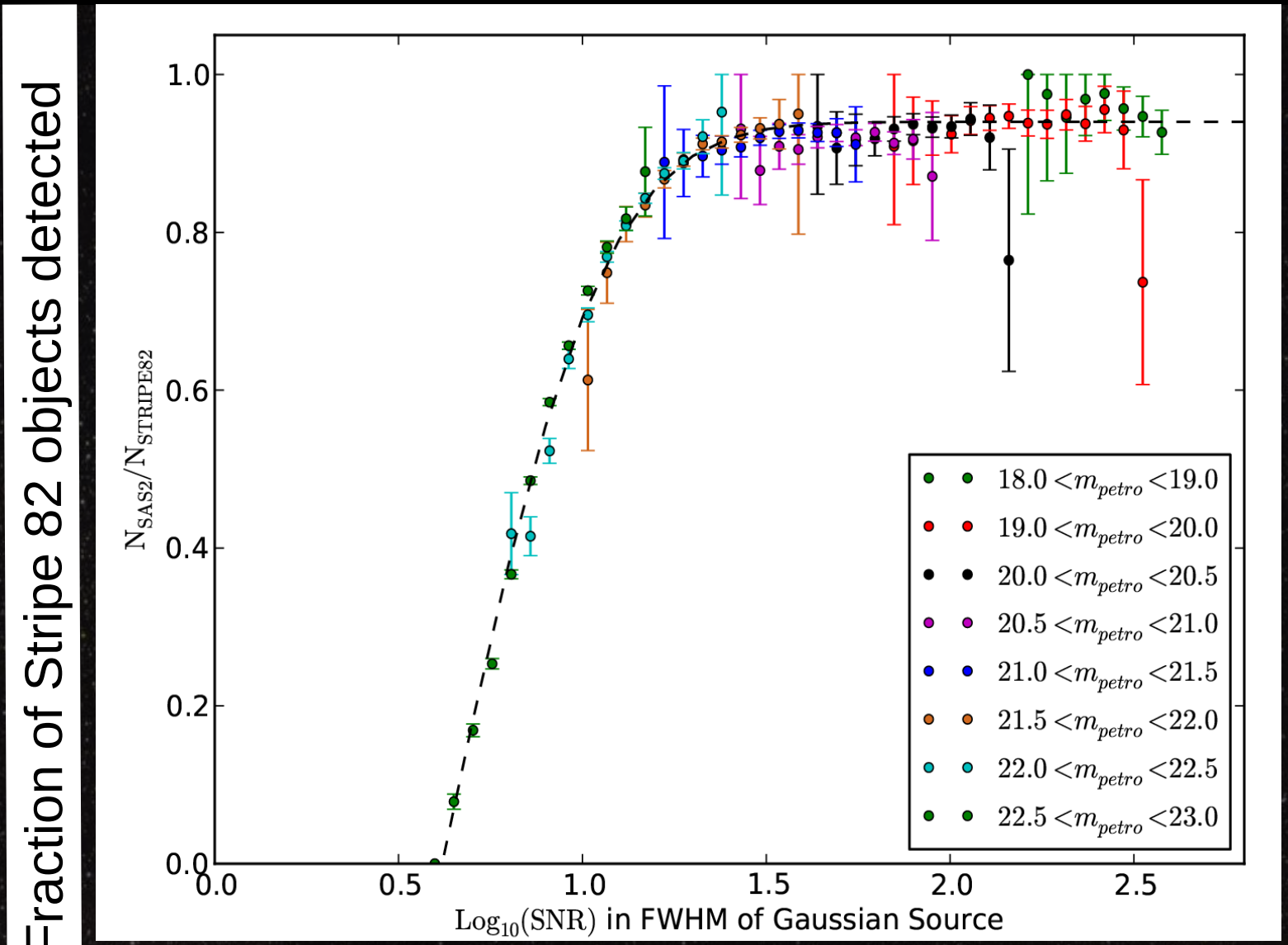
Spatially Varying Depth

- Depth varies with position on the sky
- I designed an estimator of depth, based on an empirical measure of SNR

$$SNR = F_{total} / \sqrt{\pi * d^2 * variance}$$

- Need to relate this SNR to detection probability, match PS1 detections to a deeper catalogue: Stripe 82

Calibrating the SNR method



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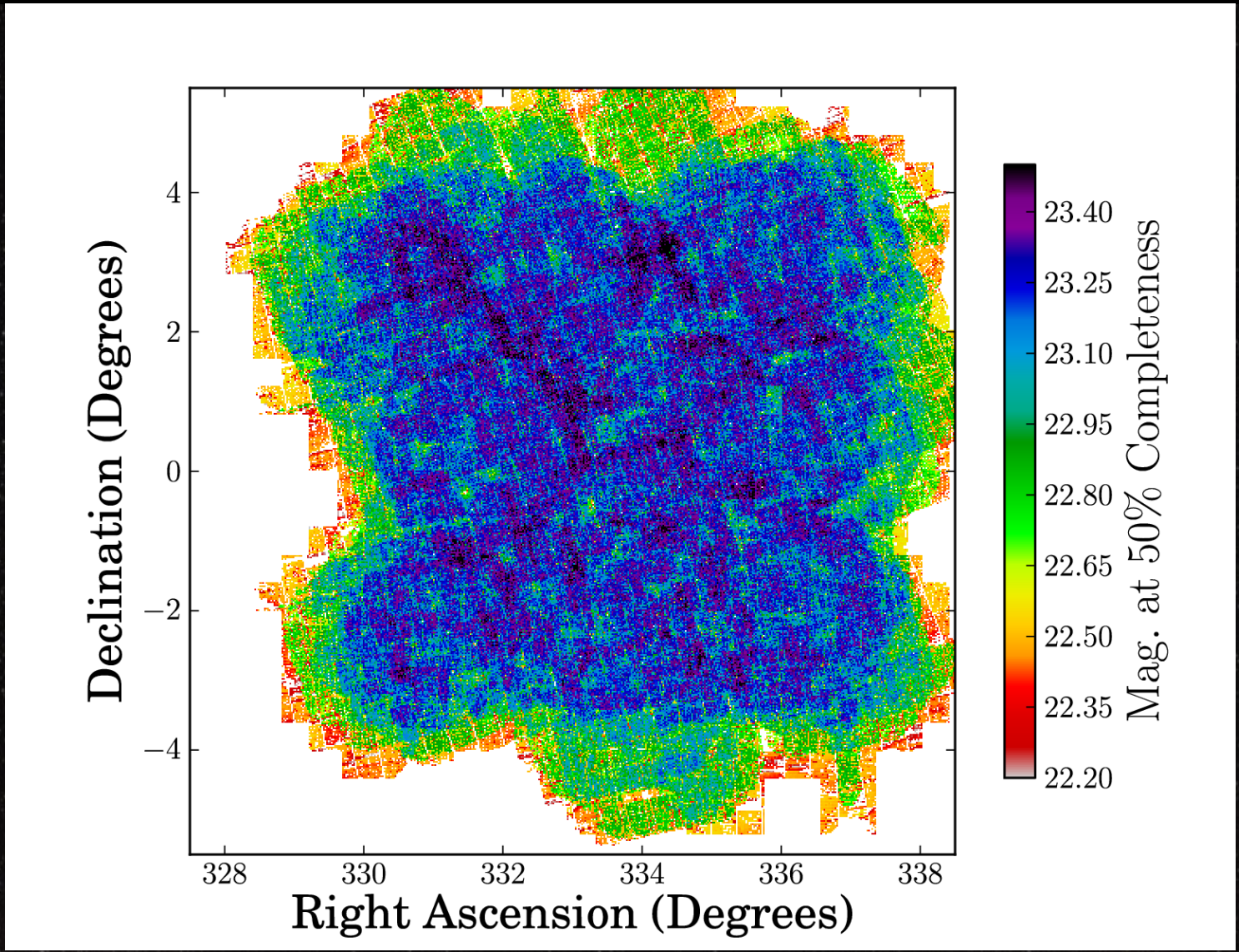
Farrow et al (2014)

Apply to full survey

- Once curved of detected fraction versus fiducial SNR is measure, variance map can be used to predict depth across the whole survey → even in regions without Stripe 82 overlap data

Depth Map



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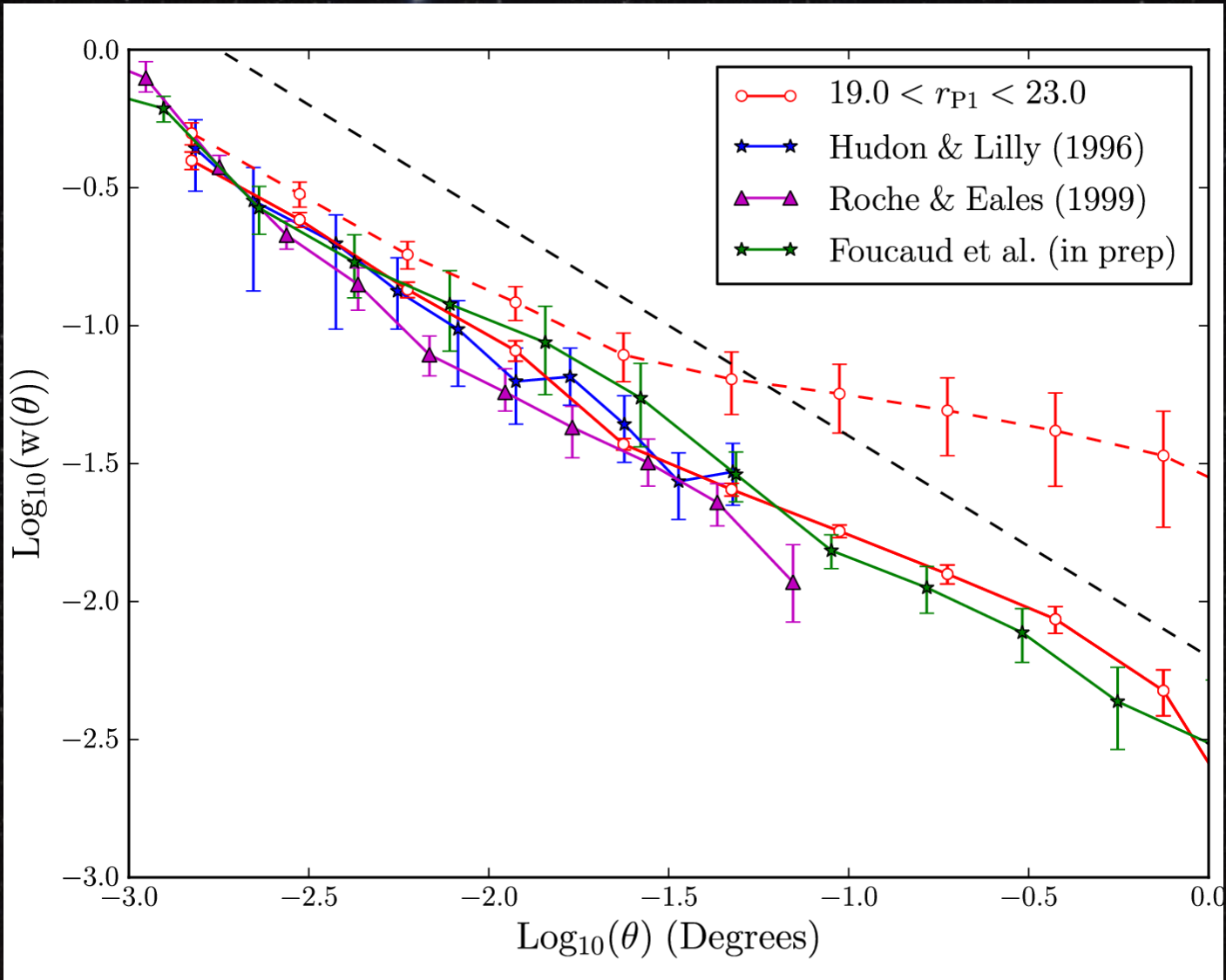
Corrected Angular 2PCF



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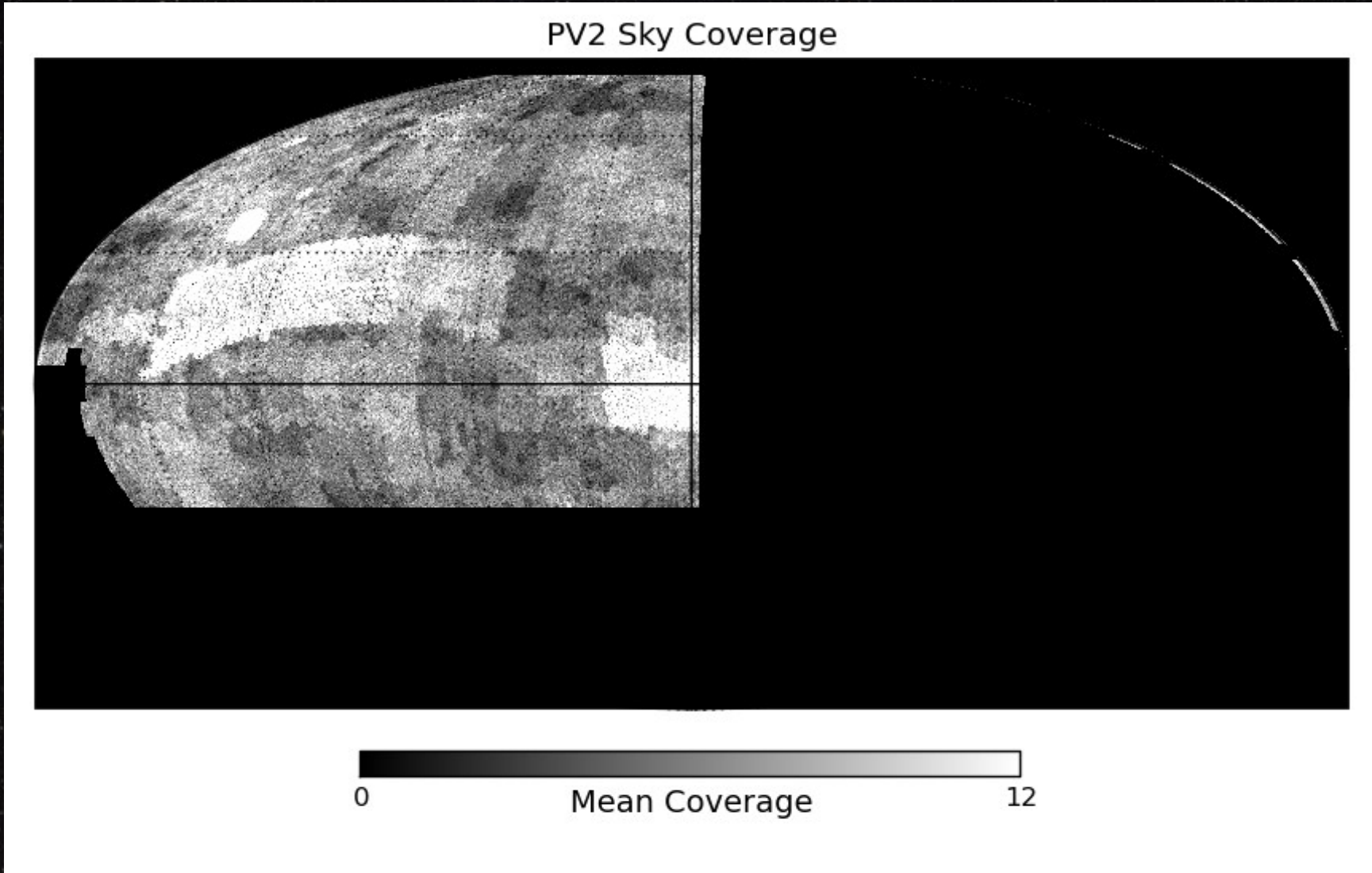
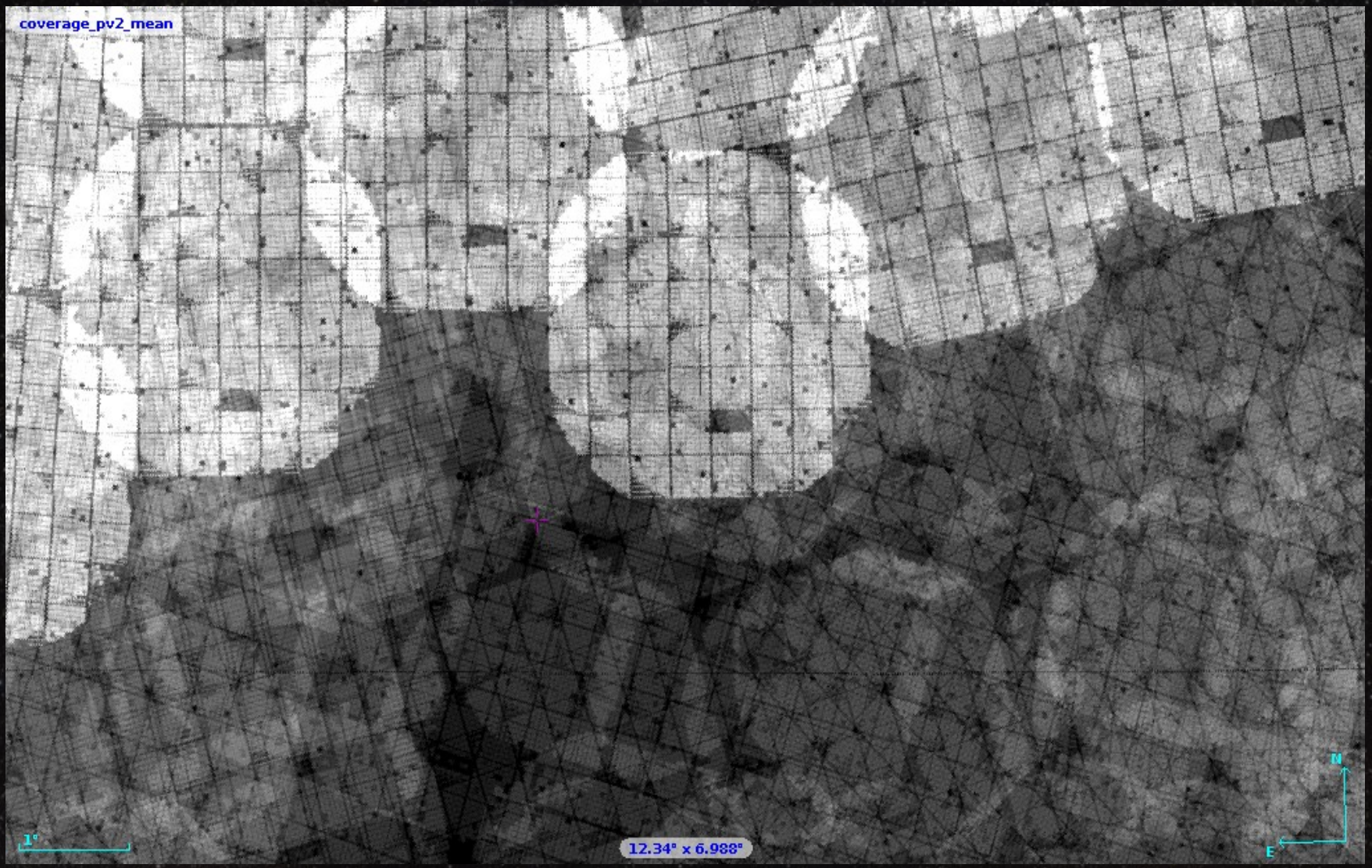
Extending to the full 3π



Extending to the full 3π



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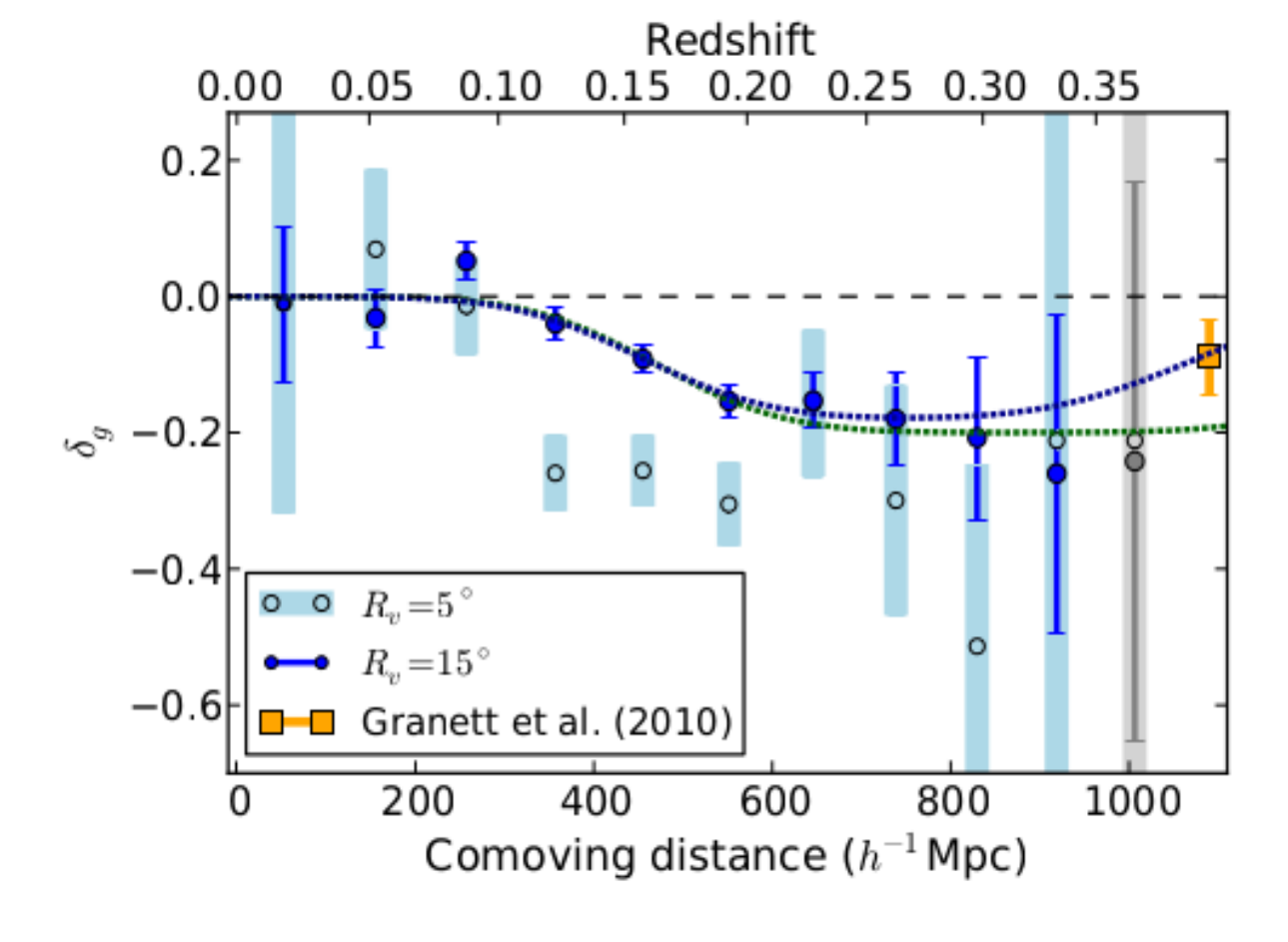
Recent Science Application



Kovács et al (submitted)

Conclusions

- Introduced PS1 and surveys
- Discussed typical depth
- Discussed star/galaxy separation
- Presented method of producing maps of the spatially varying depth
- Presented a recent science application
- Produce masks for full survey, utilise once processing is complete!