Effects of Tiling Sky on Weak-Lensing Correlation Analysis

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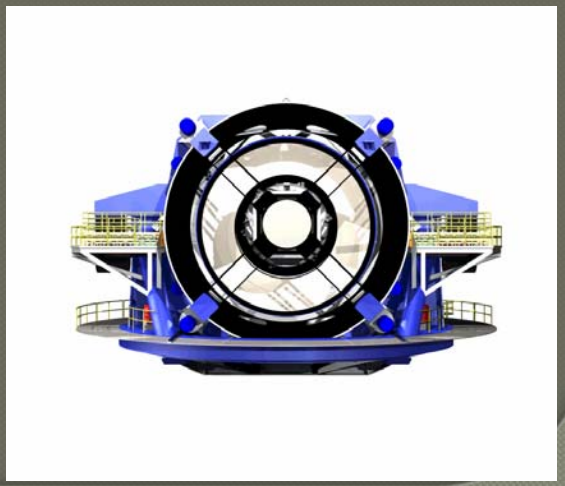
Picture is taken with Deep Lens Survey

Outline

- Introduction to Large Synoptic Survey Telescope
- What to study with LSST
- How the tessellation of the sky in LSST affects the correlation analysis



LSST

Large Synoptic Survey Telescope

Design of LSST Telescope dome and local facilities, current as of January 2007.

Google Inc. has joined with nineteen other organizations to build the Large Synoptic Survey Telescope, scheduled to see first light in Chile in early 2014.

LSST

Large Synoptic Survey Telescope

Diameter 8.4 m

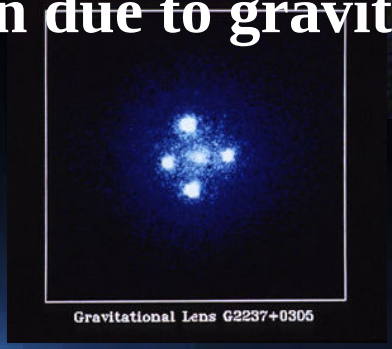
Gravitational Lensing

Effects :

- Einstein Ring
- Einstein Cross
- Ellipticity

Cause :

- **The space distortion due to gravity, (e.g. Dark Matter)**



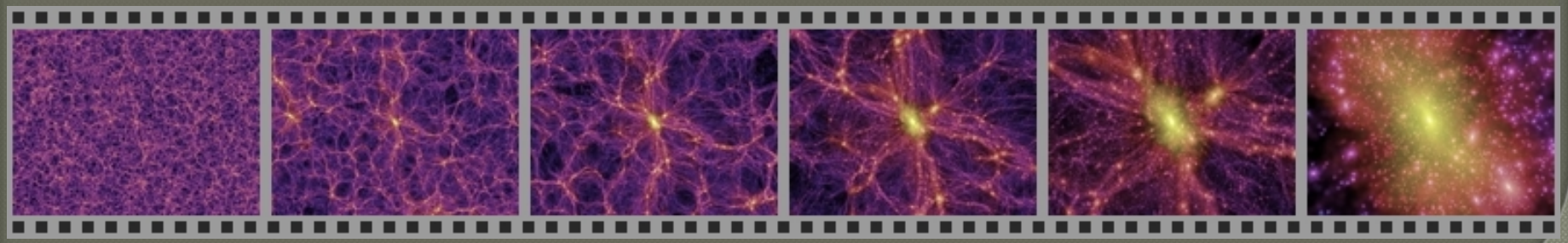
Fundamental Parameters

- For example, the rate of expansion of the universe:

$$E^2(z) = \Omega_r(1+z)^4 + \Omega_m(1+z)^3 + \Omega_k(1+z)^2 + \Omega_\Lambda f(z)$$

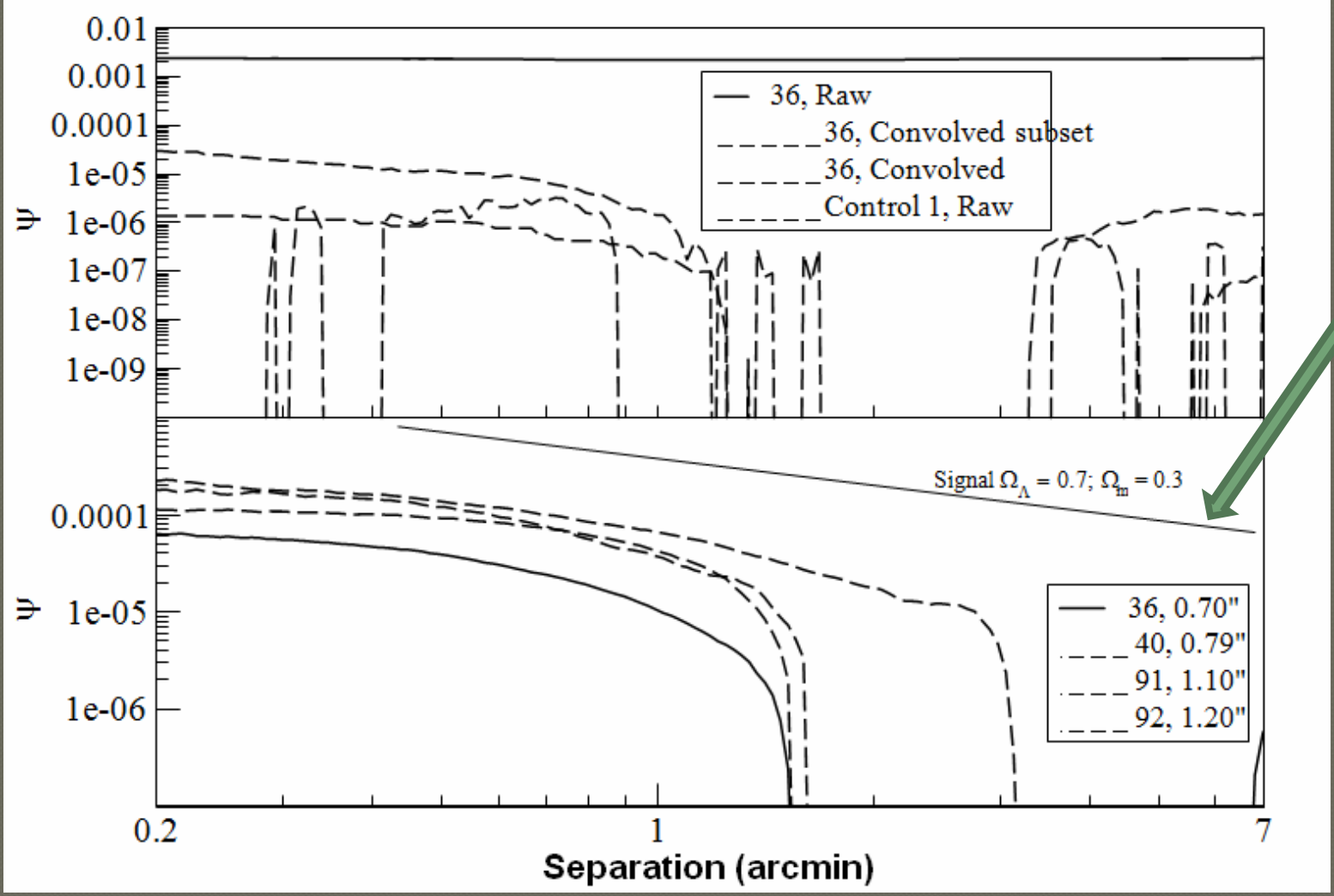
- Numerical simulation, ellipticity correlation for instance, requires cosmological parameters.

- Millennium Simulation

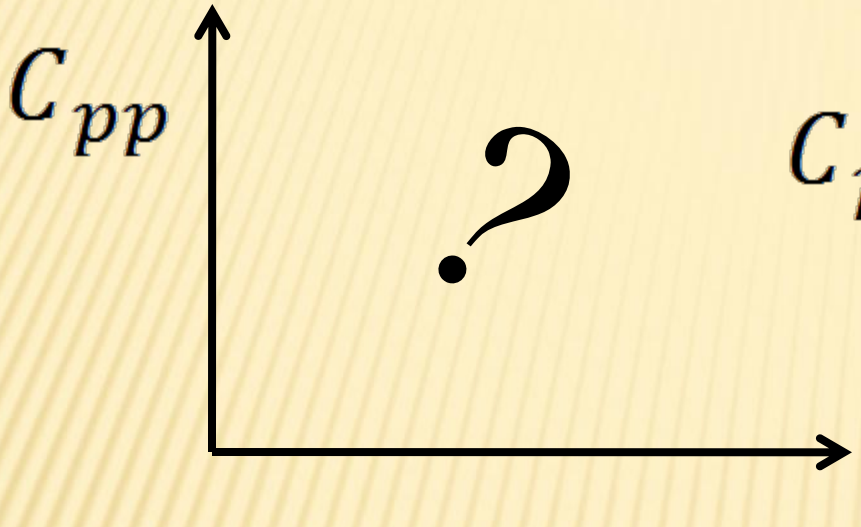


Cited from http://www.mpa-garching.mpg.de/galform/millennium/

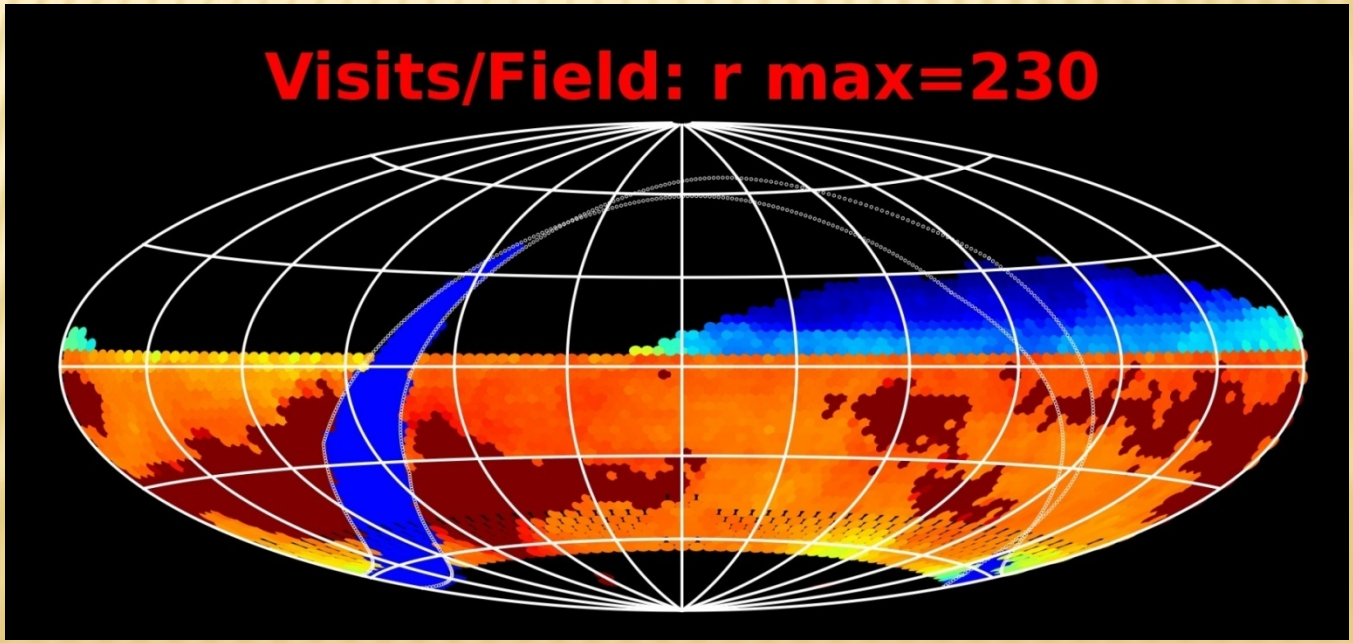
Cosmology Prediction



Ellipticity Two-point Correlation Function



$$C_{pp} = < e(0) \times e(\alpha) >$$



Perfect Hemisphere Simulation

9.6 square-degree in each image

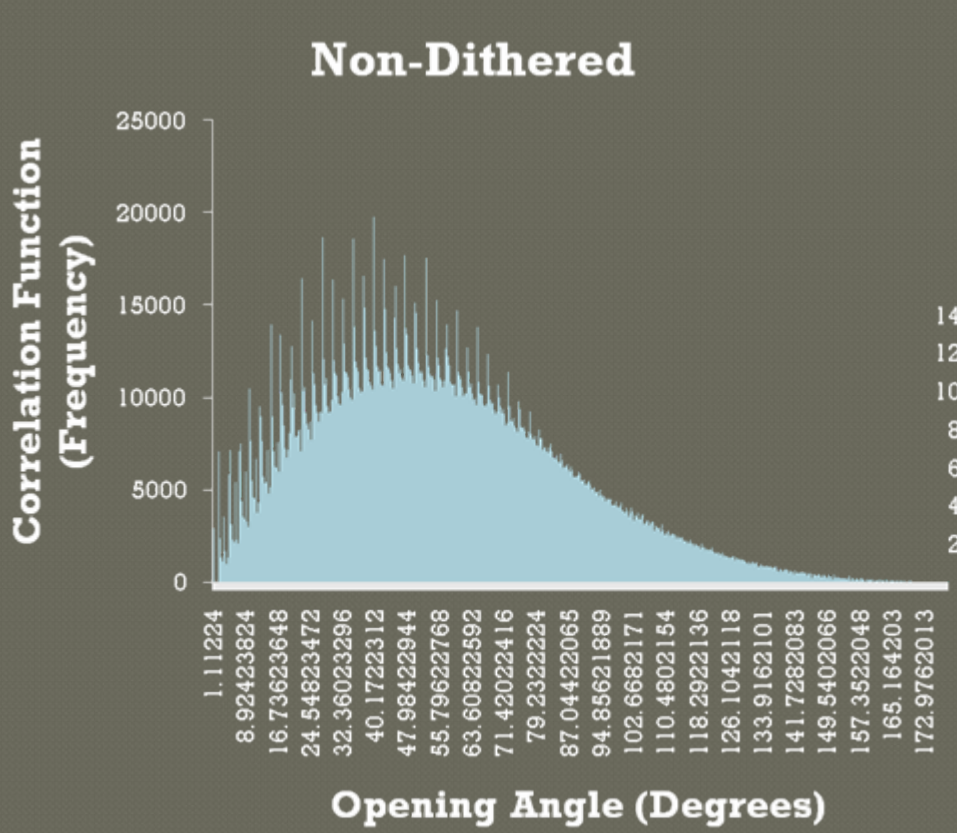
3,266 images, also so-called Field's Centers

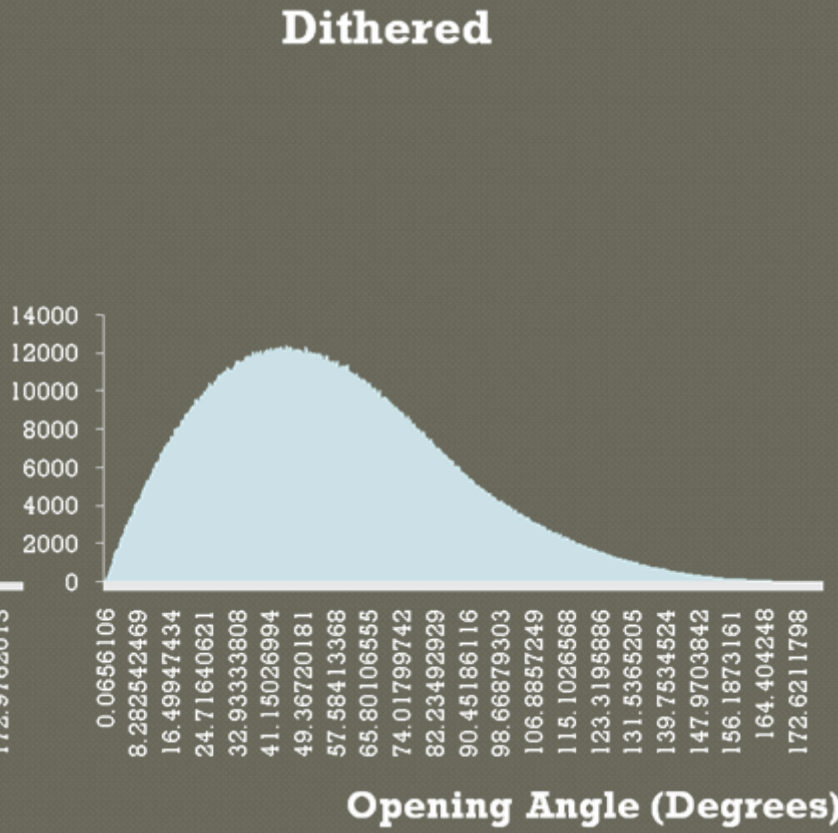
Simulate the enormous galaxies with field's centers

5,331,745 two-point correlation results
(Combination of 3,266 points)

Here initially sits a delta function
in each field's center

Correlation before Nomalization

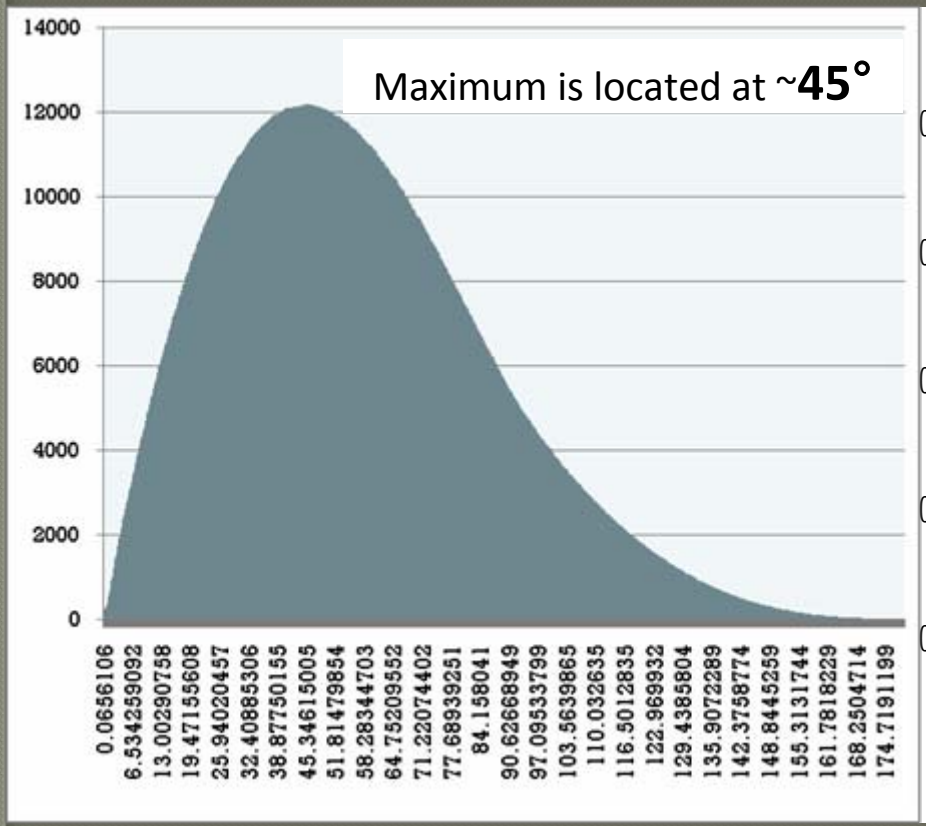




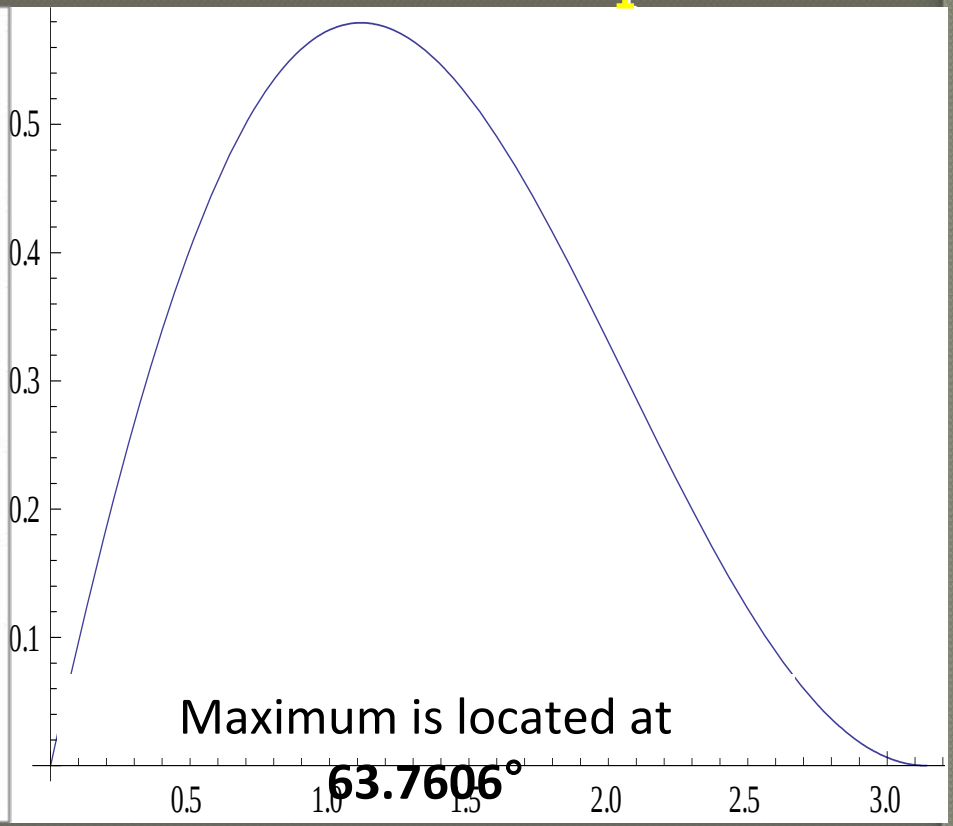
Thanks C++ & my little laptop for running for 2 hours!

Error from Running Average

Running Average ± 0.9 deg.

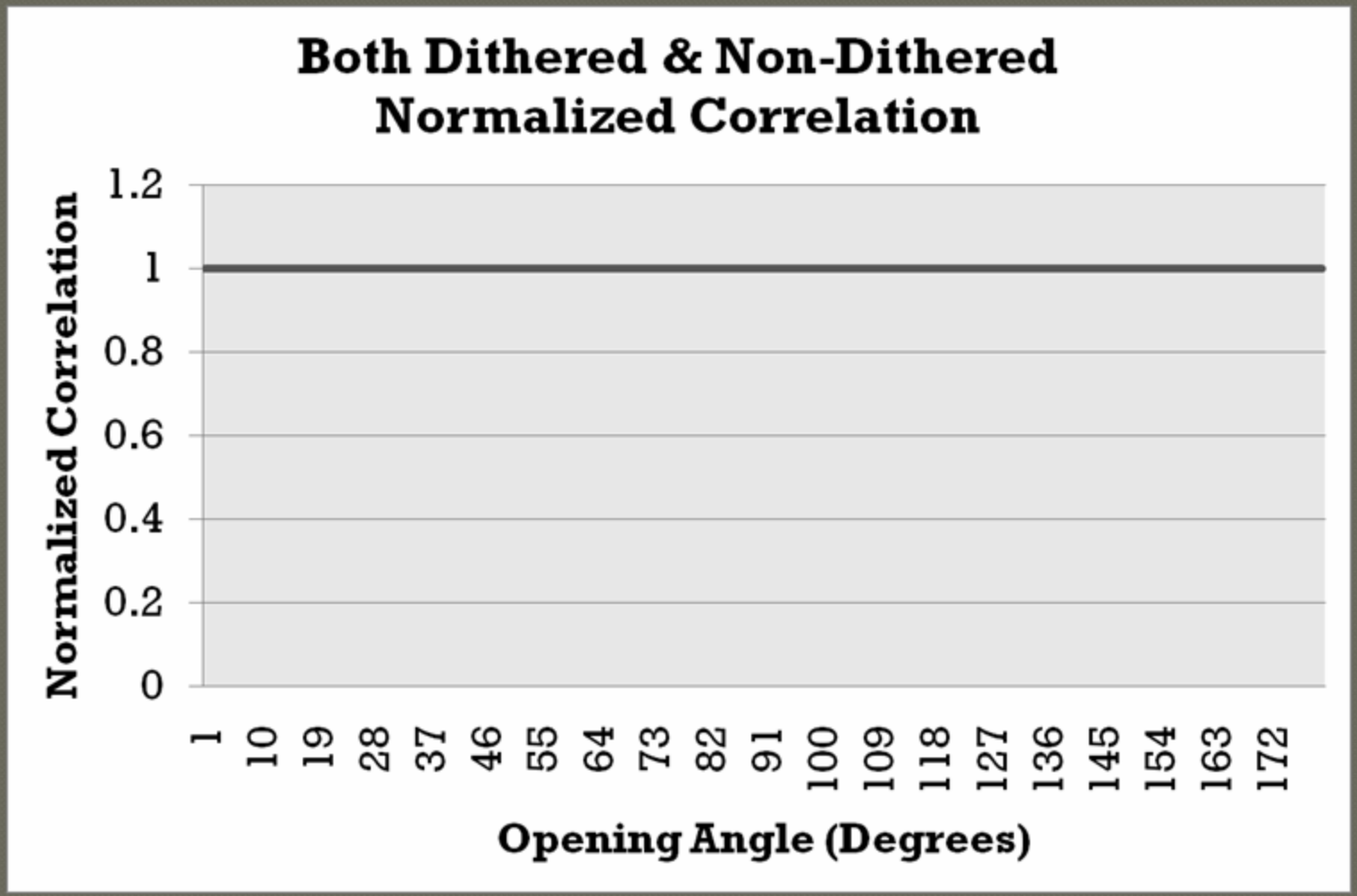


Even Distribution on a Perfect Hemisphere



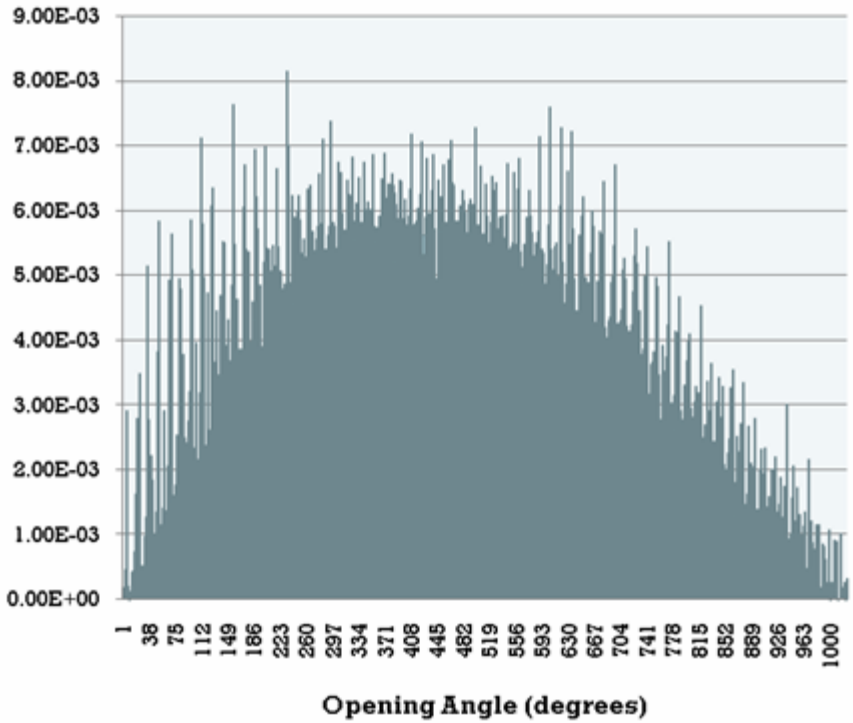
Thanks Chip for thinking about this problem for hours with me & showing me Mathematica !

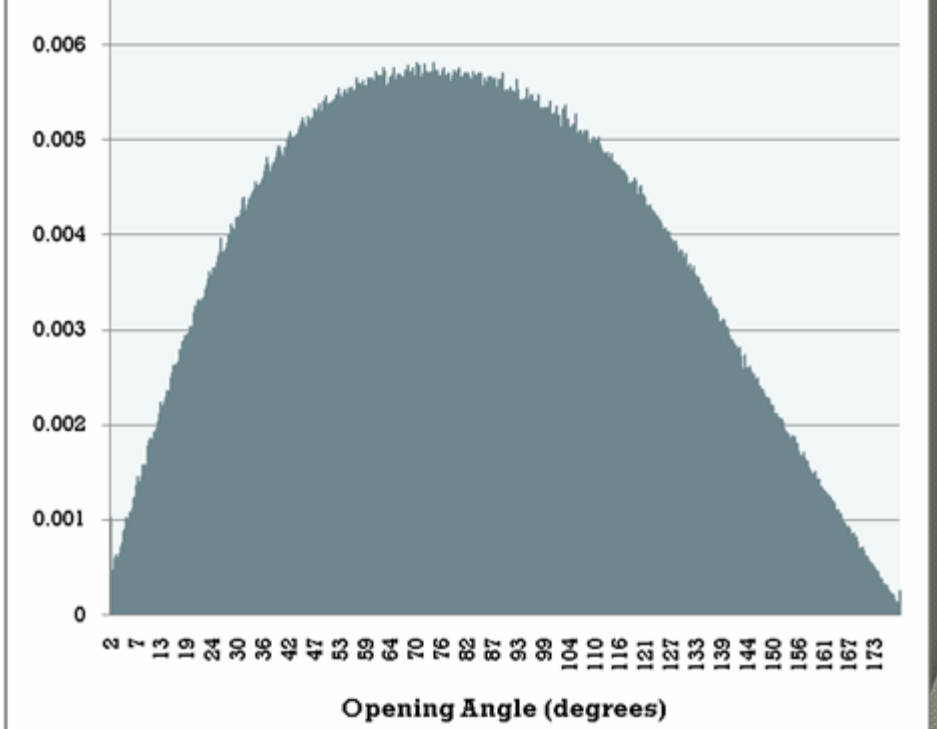
Normalization by Number of Pairs



LSST Cronos 92

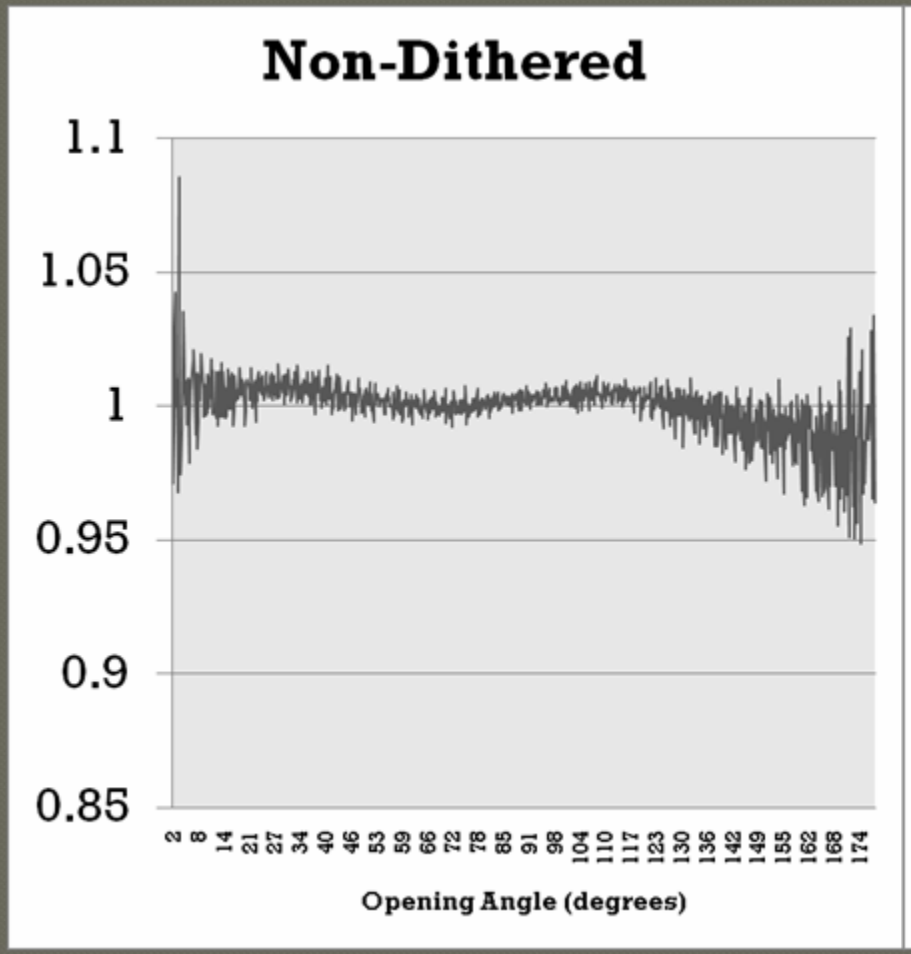
Effect of Seeing

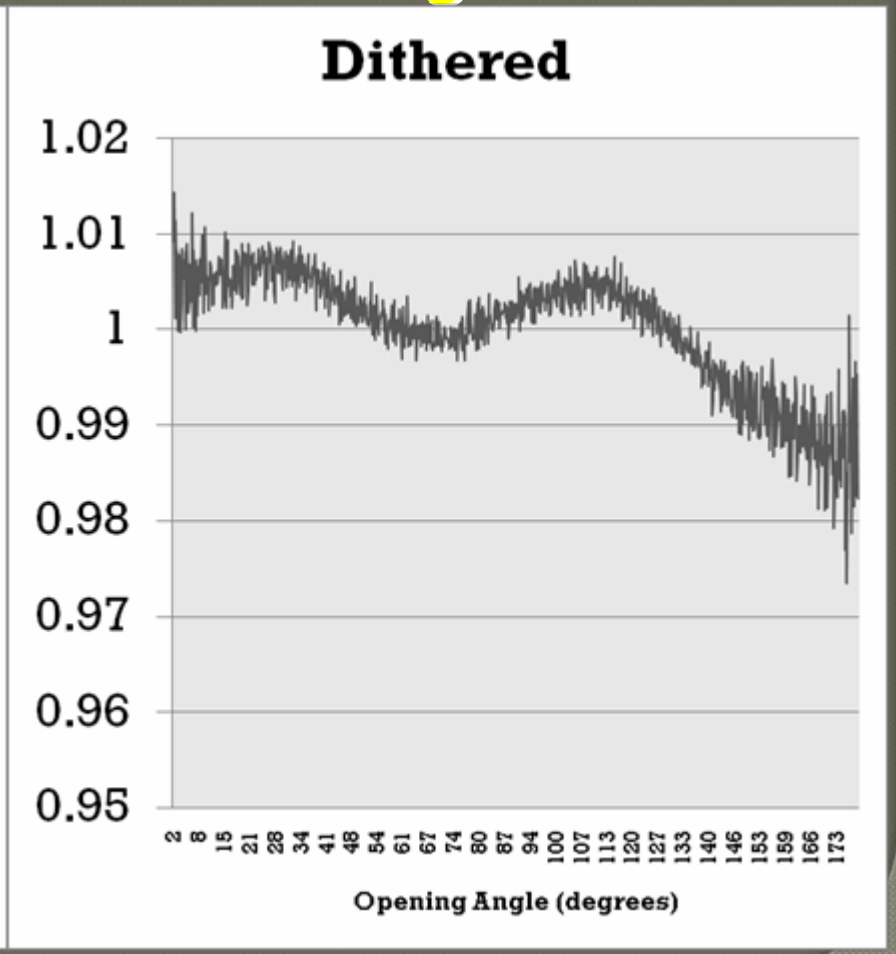




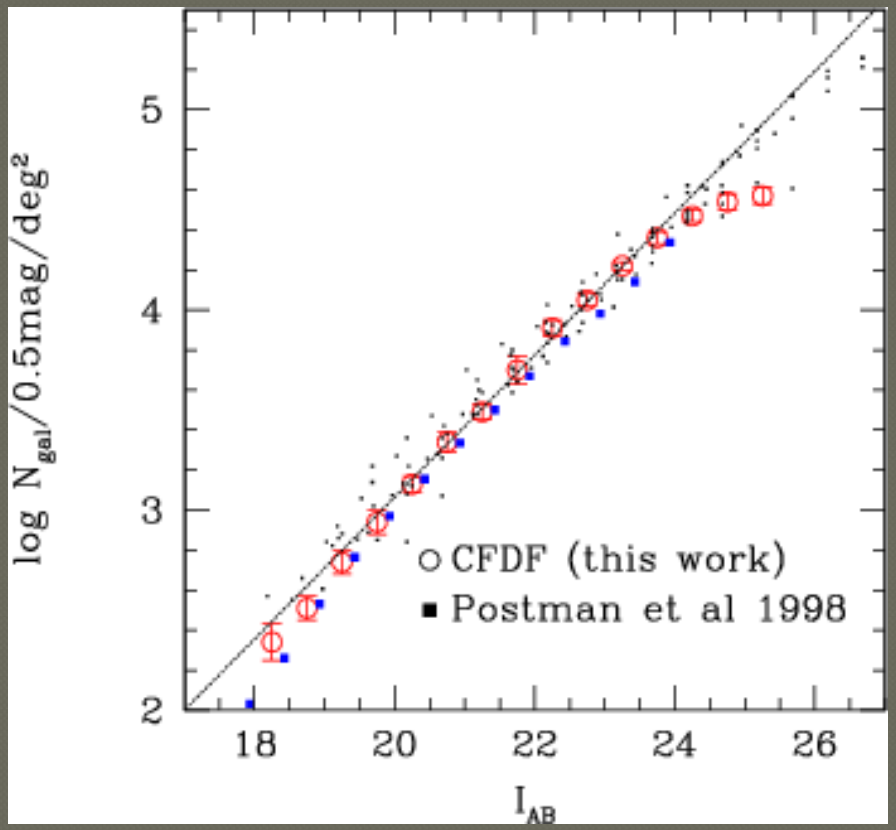
LSST Cronos 92

Effect of Seeing





Effect of Limiting Magnitude



Conversion from Limiting Magnitude to Number of Galaxies in each field

Ideas involved:

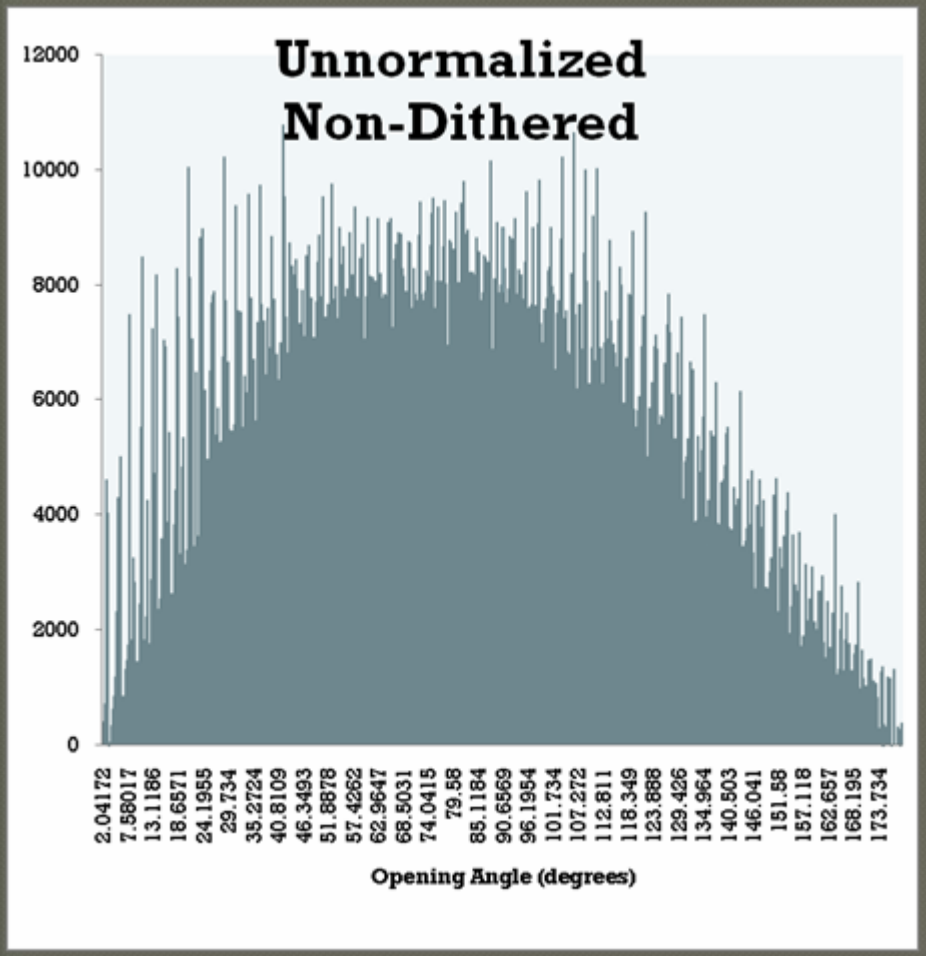
Coadded Depth

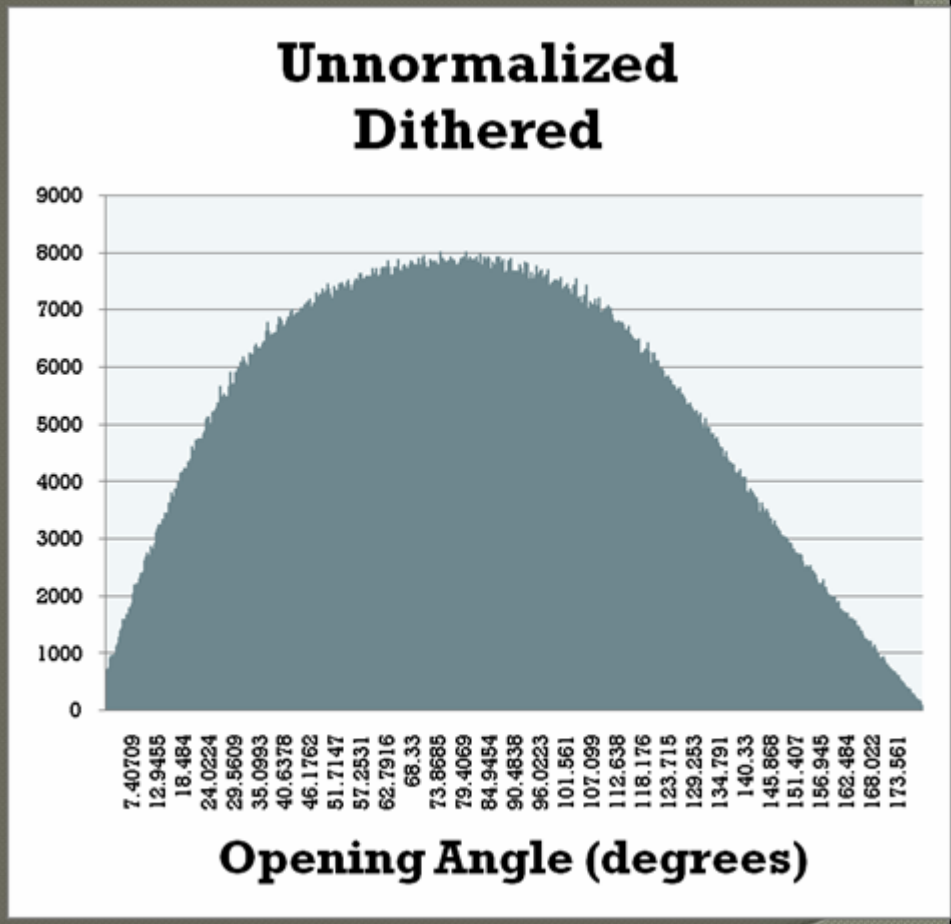
Malmquist Bias (Eddington Bias)

$$\text{Limiting Magnitude} = \frac{\text{Signal}}{\text{Noise}}$$

LSST Cronos 92

Effect of Limiting Magnitude





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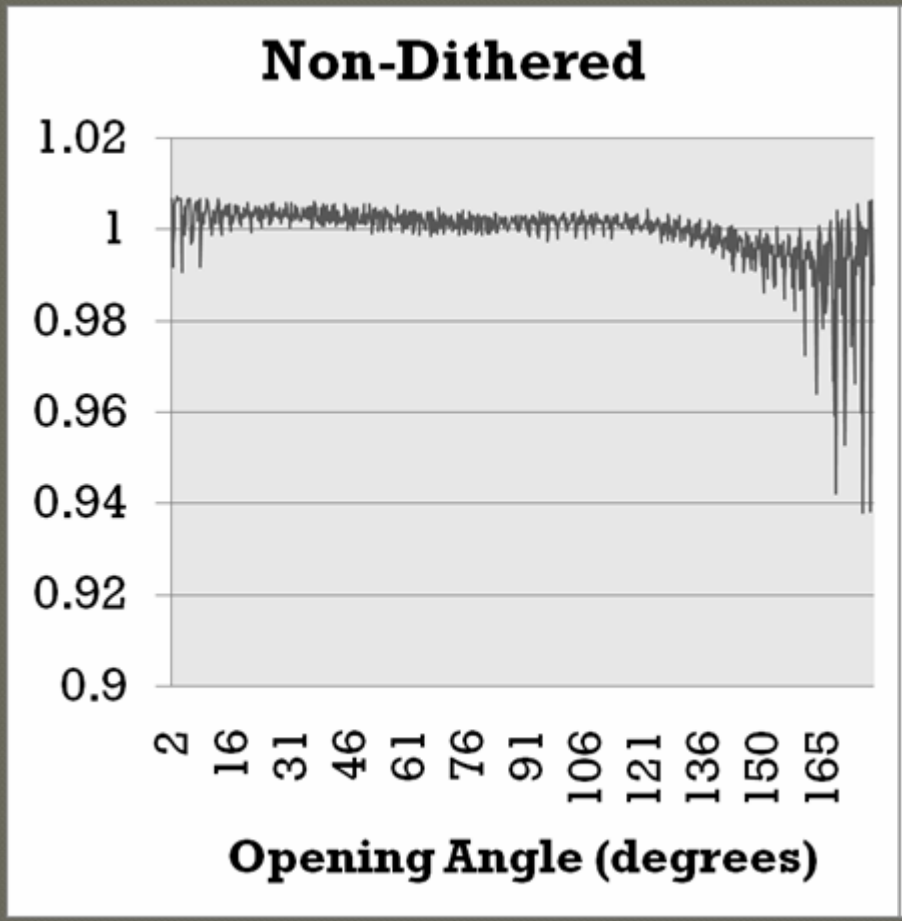
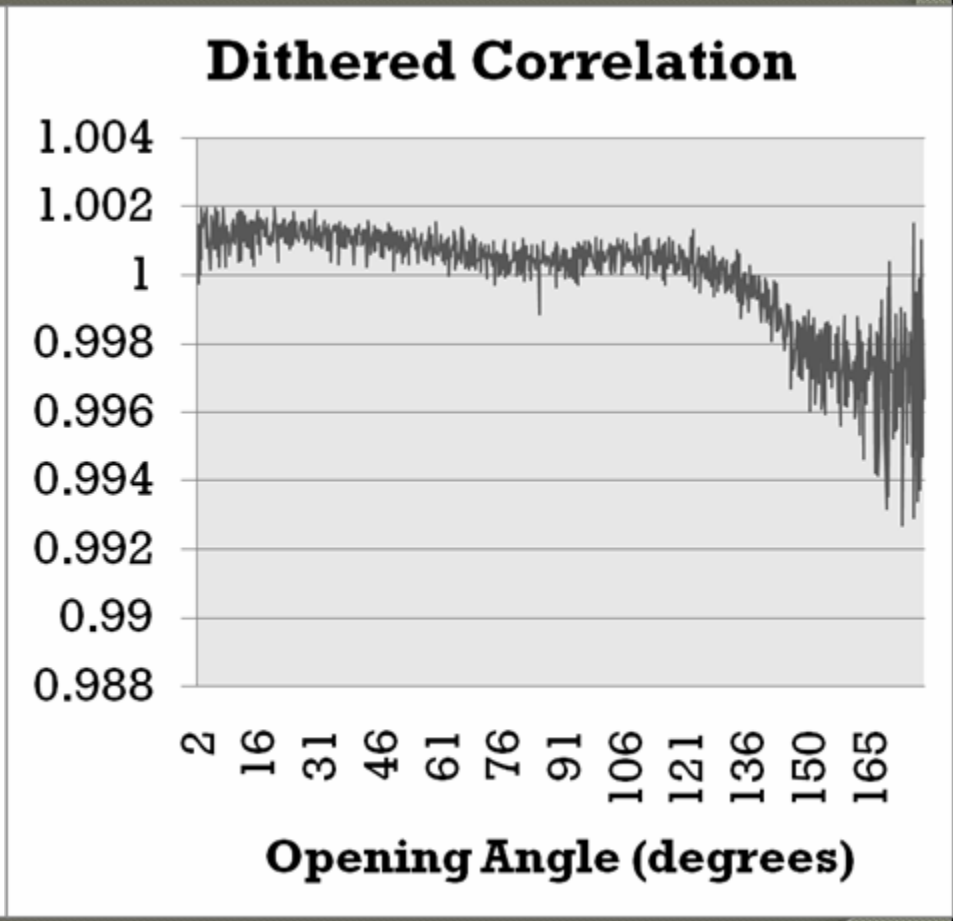
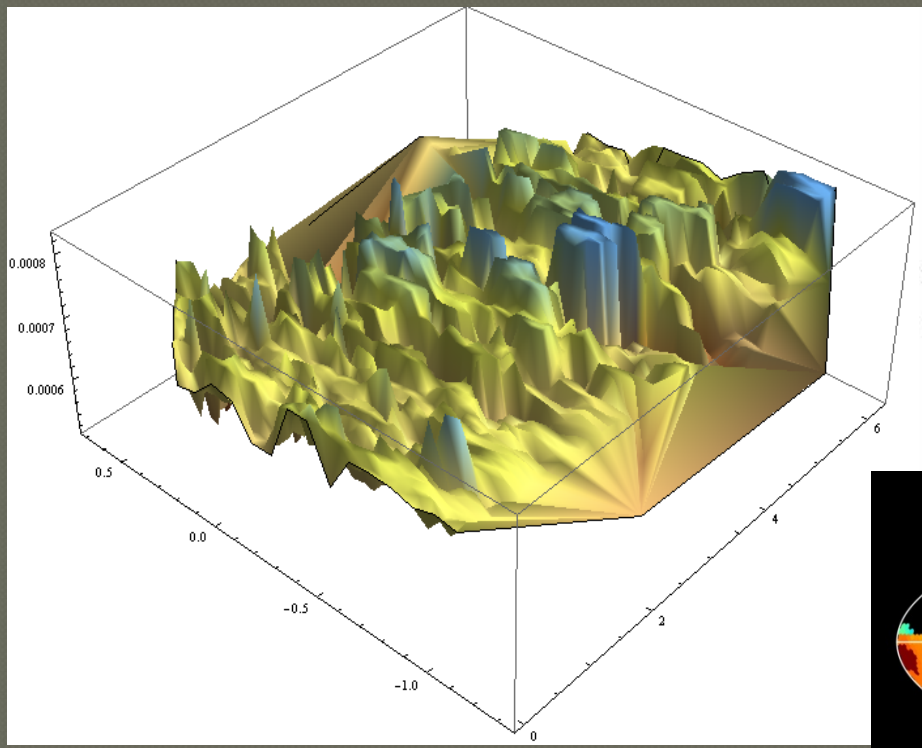


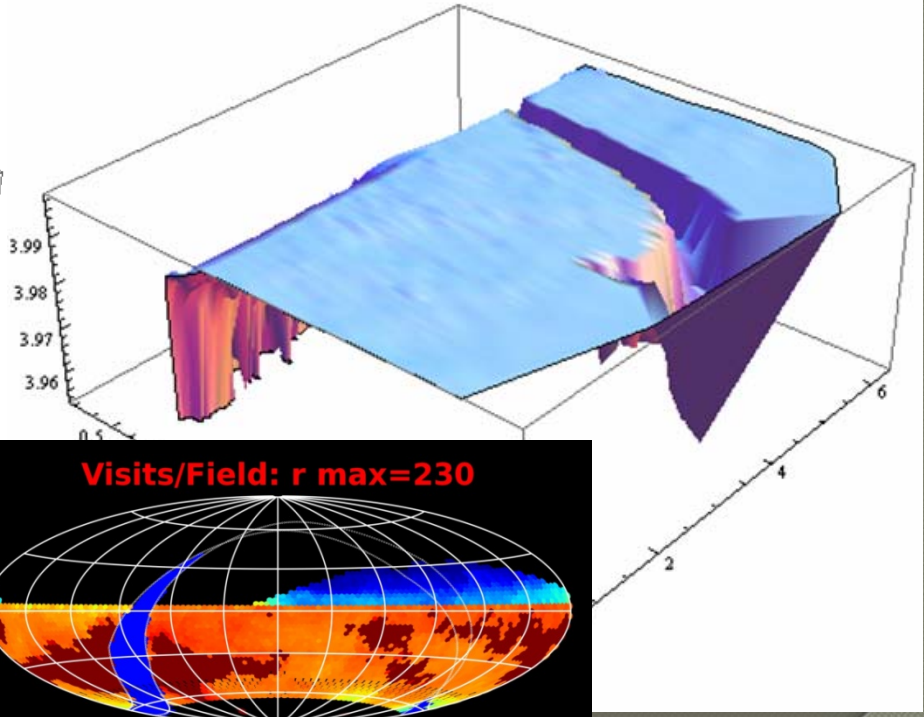


Comparison of Seeing & Limiting Magnitude

Ellipticity
(Derived from seeing)

Numbers of Galaxies
(Derived from m_coadded)



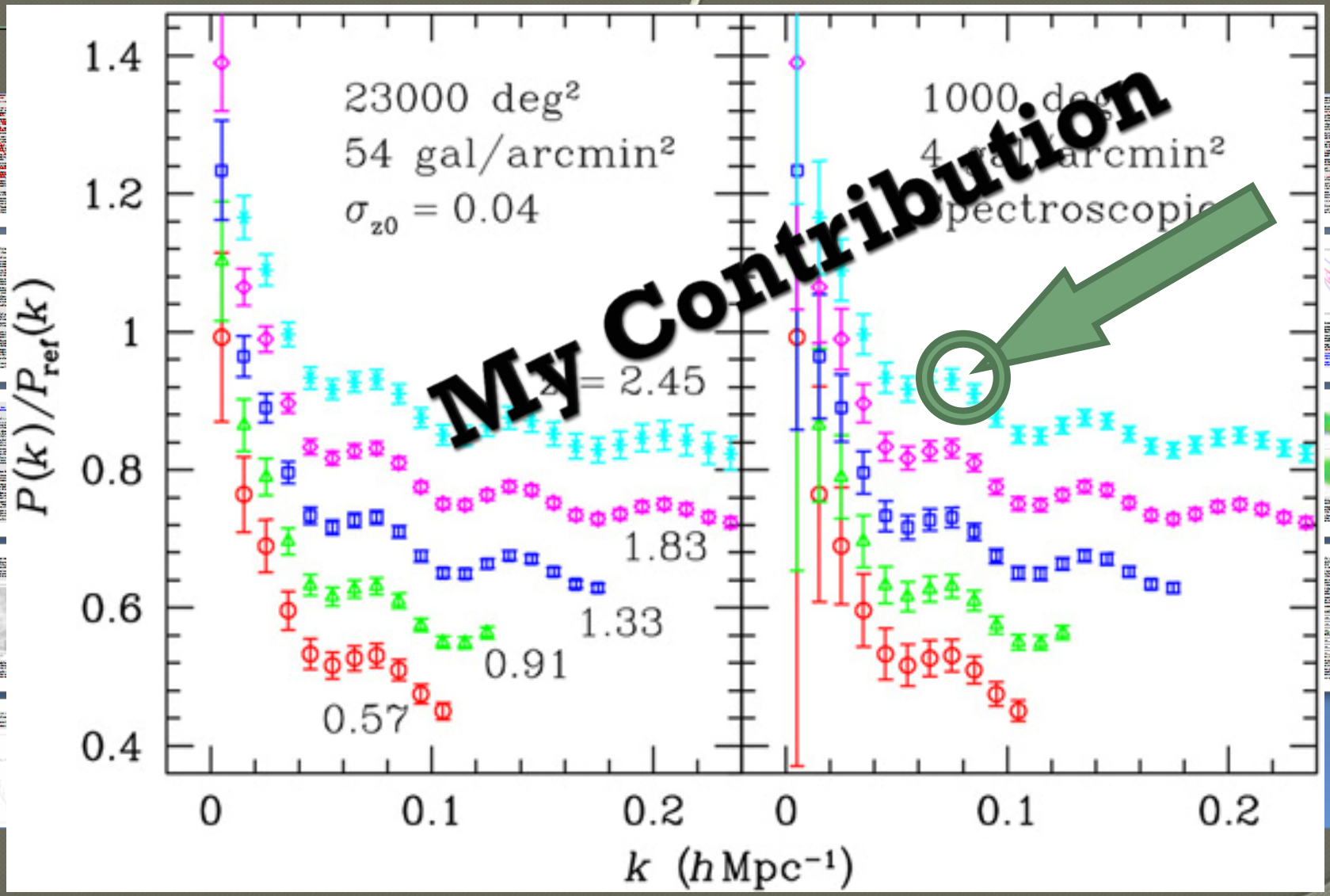


Conclusion

- The limiting magnitude (affecting # of galaxies) and seeing (affecting accuracy of ellipticity) will both cause the fluctuation in the correlation with magnitude of **1%**,which is lower limit of the error caused by the tessellation of the sky on galaxy count and ellipticity correlation analysis.

- To dither all the field's centers can only minimize the fluctuation of the fine structure. Hence, the residual main structure still has to be taken into account in correlation analysis whether or not we dither all the fields centers.

My Contribution



Future Research

- Treat the ellipticities as spatial vectors, therefore through a different way of normalization, to recalculate the correlation function.
- To well simulate the LSST correlation analysis, we also need to use smaller regions on the sky to compute the correlation function.

Special Acknowledgements

- Thanks
  - Prof.

    Leslie Rosenberg
  - Postdoc.

    Gray Rybka
  - Prof.

    Warren Buck & Wick Haxton
  - All REU Colleagues, especially Chip
  - UW & REU program & NSF

Thank You for Your Kind Attention!