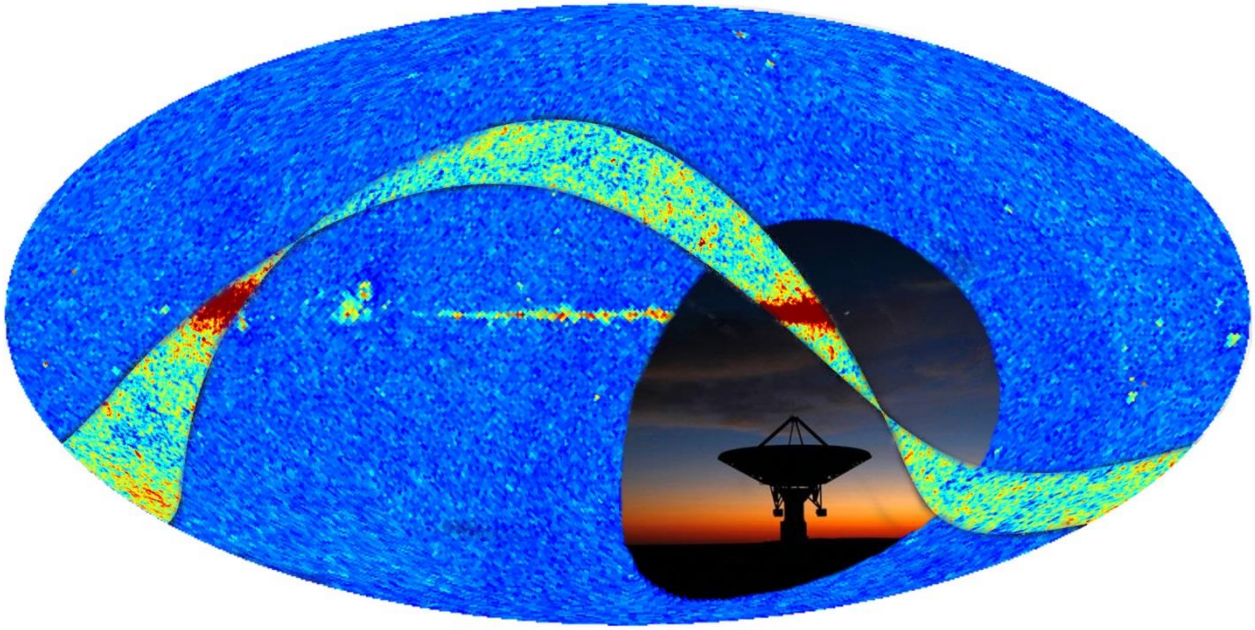
UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Universität Bielefeld

Radio continuum survey and Non-Gaussianity



Song Chen

University of the Western Cape

The Abdus Salam International Centre for Theoretical Physics

UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Outline:

NVSS catalogue and previous studies

systematics and mask

__ effect looks like non-Gaussianity

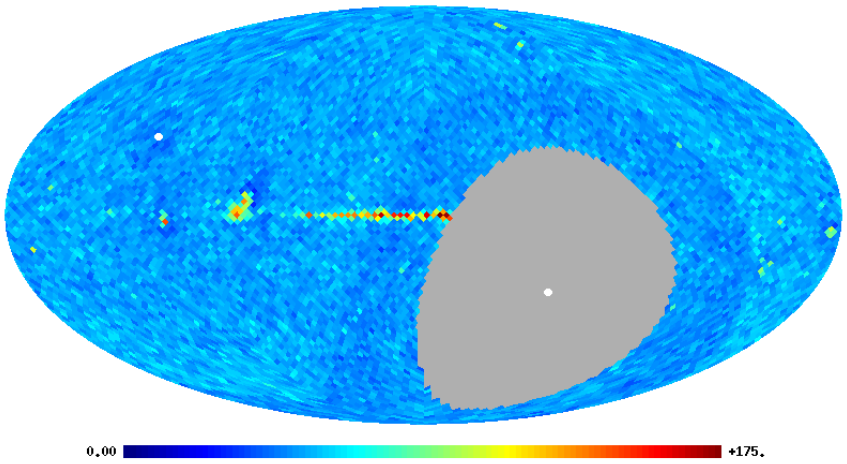
systematic again

UNIVERSITY of the WESTERN CAPE

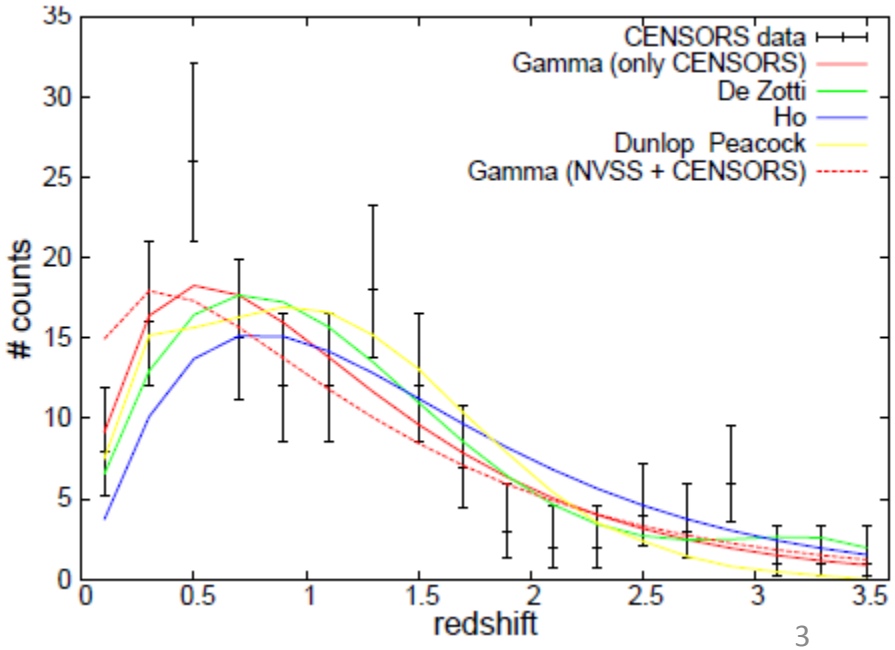
CRC
Where dreams come true

Our advantage:

Continuum radio galaxy surveys can probe large cosmic volumes.



S. Chen & D.J. Schwarz 2015



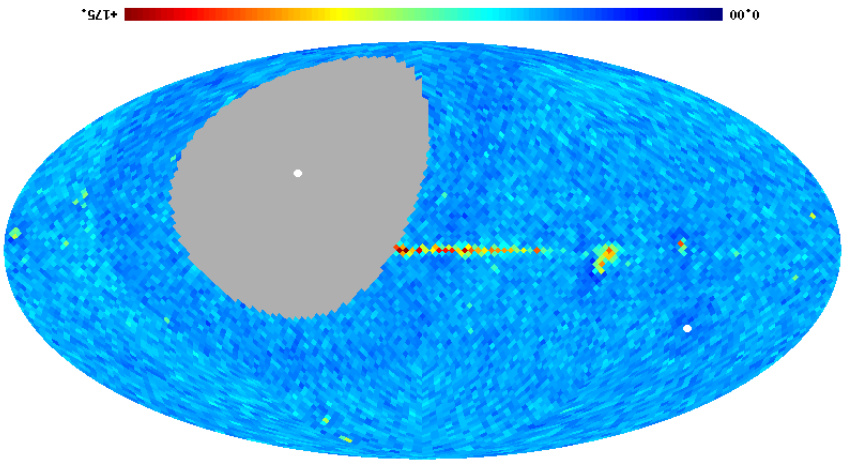
A. Marcos-Caballero et al. 2013

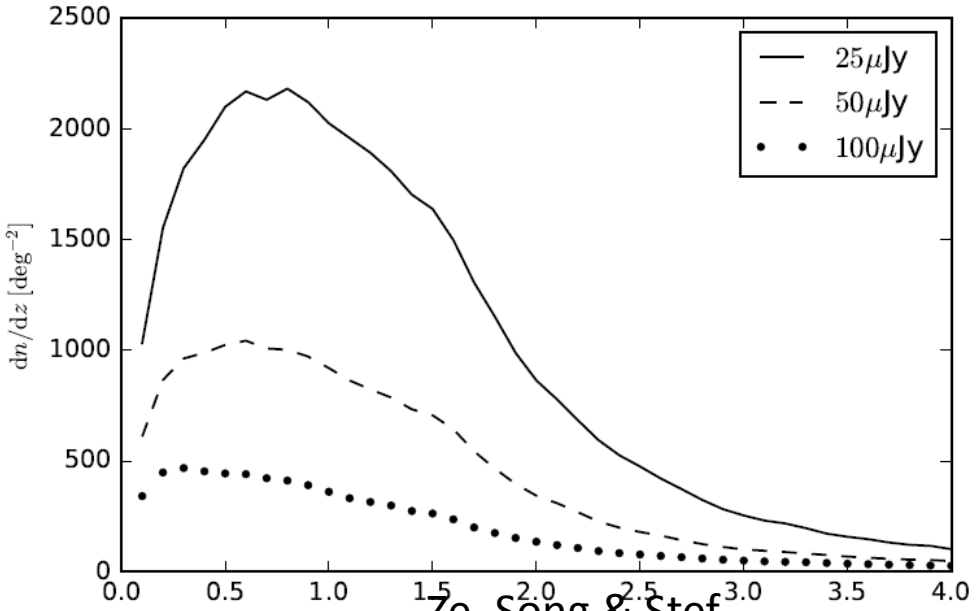
UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Our advantage:

Continuum radio galaxy surveys can probe large cosmic volumes.





Ze, Song & Stef

UNIVERSITY of the WESTERN CAPE

CRC

Where dreams come true

Our advantage:

Continuum radio galaxy surveys can probe large cosmic volumes.

Our Disadvantage:

Hard to get redshift
Low source density
Many open issues about source (AGNs)
……

UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Ekers and Miley 1977

Test	Advantages	Difficulties
Source counts[1] N(s)	Only requires information from a radio source survey.	i) Survey must be complete and unbiased with s. ii) Interpretation depends on the radio luminosity function (RLF).
Hubble relation[2] for radio sources s(z)	Independent of the RLF.	i) Knowledge of z requires complete optical identifications to avoid bias on z with s. ii) RLF is broad and very nearly critical.[3]
Angular size - redshift[4,5,6] θ(z)	i) Complete sample is not critical unless its incompleteness is a function of θ. ii) Independent of the RLF.	Requires a large sample of objects with both θ and z measured.
Angular size - flux density[7,8] θ(s)	i) Complete sample in s is not critical. ii) Only requires a radio catalogue of angular sizes.	i) Interpretation depends on both the RLF and the linear size distribution function.
Angular size[8] distribution N(θ,s)	i) Includes N(s) relation but θ gives additional constraints.	Will be affected by any correlation between radio power and linear size.

UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Current studies:

NVSS

Minimum flux	about 2.5 mJy
Total sources	about 10^6
Sky coverage	about 82%
Mean redshift	about 1.0

cosmic dipole, angular clustering, **Non-Gaussianty**, Cross-correlation with CMB, Cross-correlation with CMB lensing

UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Using angular correlation:

The Astrophysical Journal Letters, 717:L17–L21, 2010 July 1 doi:10.1088/2041-8205/717/1/L17

PRIMORDIAL NON-GAUSSIANITY AND THE NRAO VLA SKY SURVEY

Jun-Qing Xia[1], Matteo Viel[2,3], Carlo Baccigalupi[1,2,3], Gianfranco De Zotti[1,4], Sabino Matarrese[5,6], and Licia Verde[7]

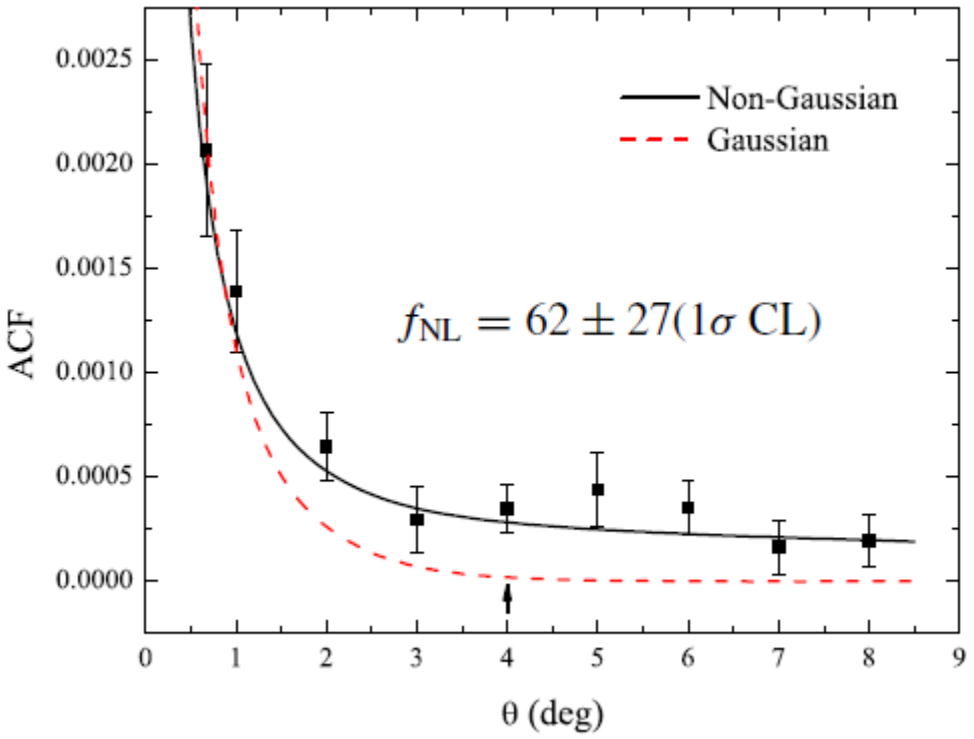
[1] Scuola Internazionale Superiore di Studi Avanzati, Via Bonomea 265, I-34136 Trieste, Italy; xia@sissa.it
[2] INAF-Osservatorio Astronomico di Trieste, Via G.B. Tiepolo 11, I-34131 Trieste, Italy
[3] INFN/National Institute for Nuclear Physics, Via Valerio 2, I-34127 Trieste, Italy
[4] INAF-Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, I-35122 Padova, Italy
[5] Dipartimento di Fisica "G. Galilei," Università di Padova, Via Marzolo 8, I-35131 Padova, Italy
[6] INFN, Sezione di Padova, Via Marzolo 8, I-35131 Padova, Italy
[7] ICREA (Institució Catalana de Recerca i Estudis Avançats) and Instituto de Ciencias del Cosmos, Universidad de Barcelona, Marti i Franques 1, 08028 Barcelona, Spain
Received 2010 March 17; accepted 2010 May 26; published 2010 June 9

ABSTRACT

The NRAO VLA Sky Survey (NVSS) is the only data set that allows an accurate determination of the auto-correlation function (ACF) on angular scales of several degrees for active galactic nuclei at $z \simeq 1$. Surprisingly, the ACF is found to be positive on large scales while, in the framework of the standard hierarchical clustering scenario with Gaussian primordial perturbations, it should be negative for a redshift-independent effective halo mass of order of that found for optically selected quasars. We show that a small primordial non-Gaussianity (NG) can add sufficient power on very large scales to account for the observed NVSS ACF. The best-fit value of the parameter $f_{\rm NL}$, quantifying the amplitude of primordial NG of local type, is $f_{\rm NL} = 62 \pm 27$ (1σ error bar) and $25 < f_{\rm NL} < 117$ (2σ confidence level), corresponding to a detection of NG significant at the $\sim 3\sigma$ confidence level. The minimal halo mass of NVSS sources is found to be $M_{\rm min} = 10^{12.47 \pm 0.26}\, h^{-1}\, M_{\odot}$ (1σ) strikingly close to that of optically selected quasars. We discuss caveats and possible physical and systematic effects that can have an impact on the results.

Key words: cosmological parameters – cosmology: theory – galaxies: clusters: general – galaxies: halos – large-scale structure of universe

$$b_{\rm NG}^{\rm eff}(M_{\rm min}, z, k, f_{\rm NL}) = \frac{\int_{M_{\rm min}}^{\infty} b_{\rm NG} n_{\rm NG}\, dM}{\int_{M_{\rm min}}^{\infty} n_{\rm NG}\, dM}$$

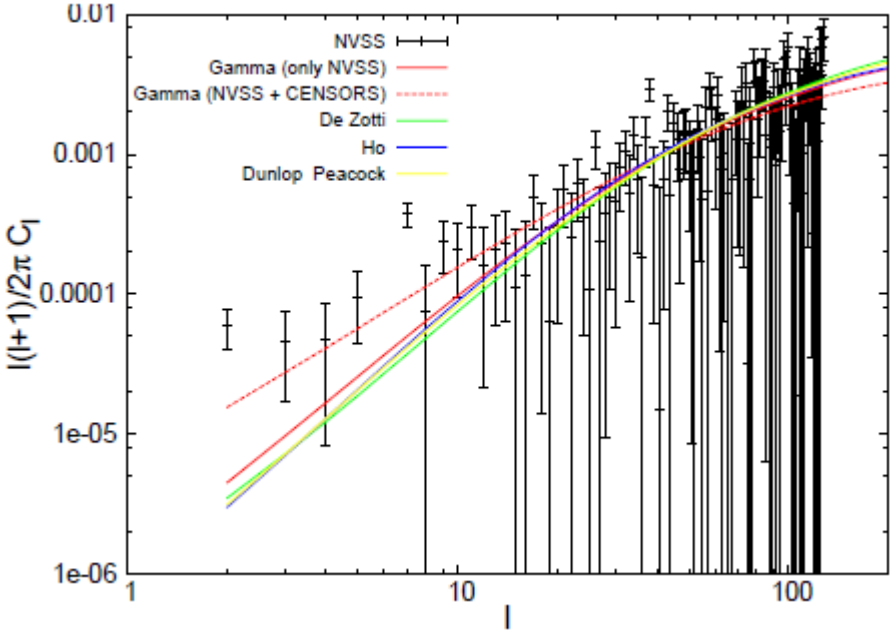


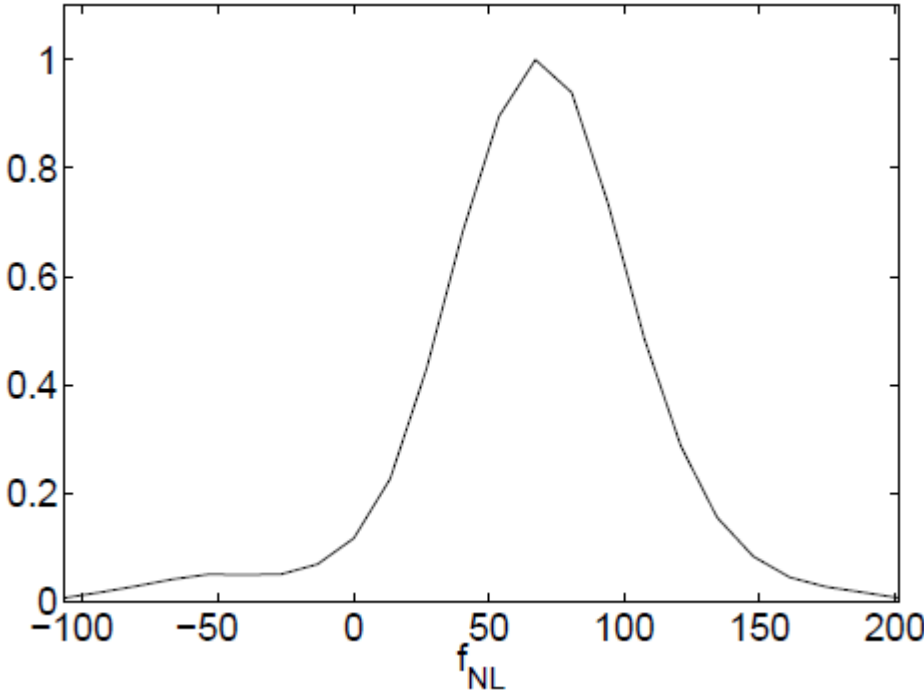
Xia et al. 2010

UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

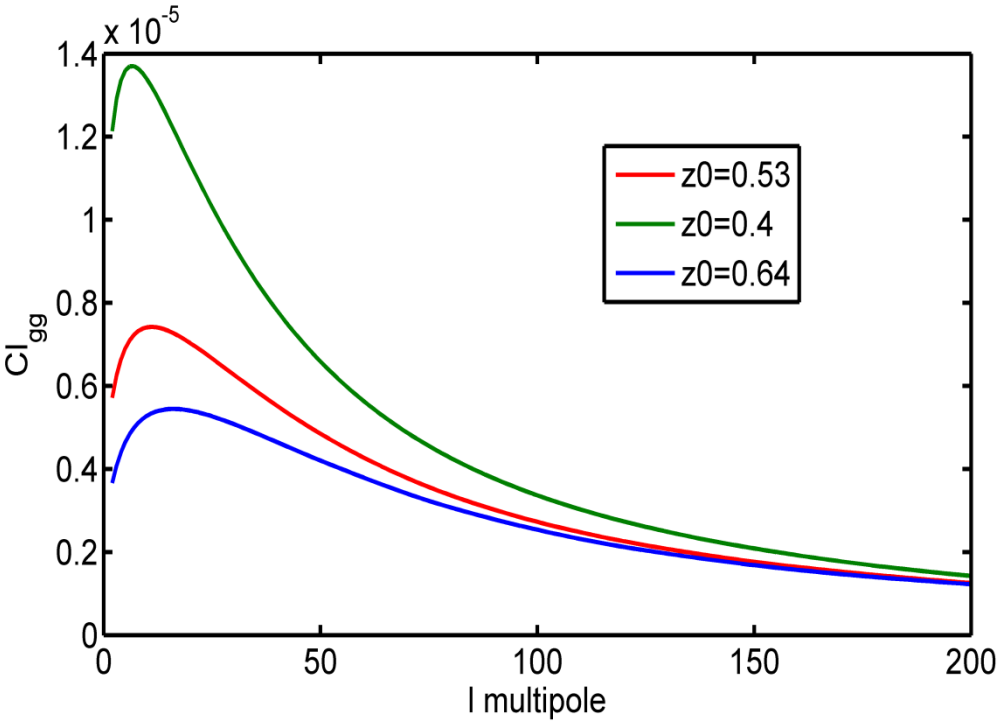
Using angular power spectrum:



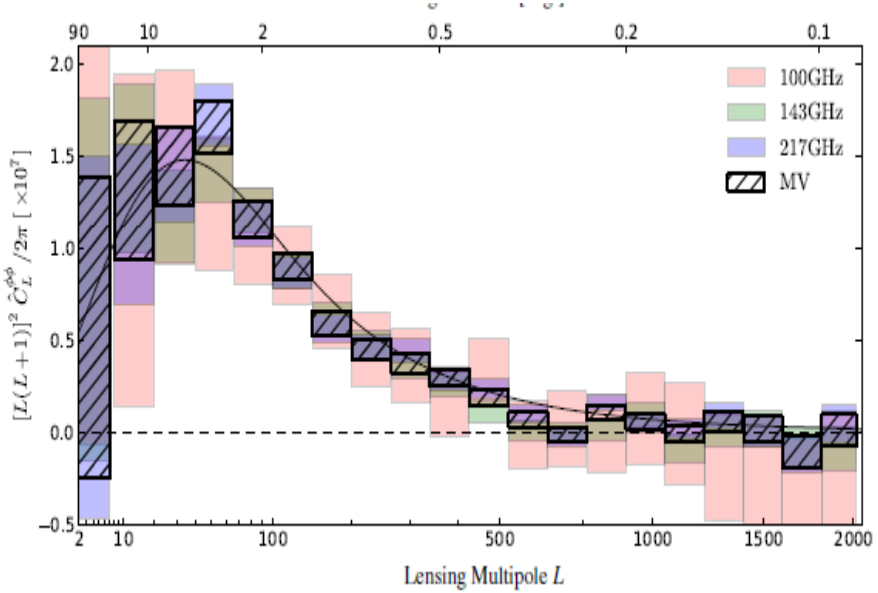


A. Marcos-Caballero et al. 2013

It is more convenient to plot Cl instead of l(l+1)/2π Cl .



Planck 2013 XVII

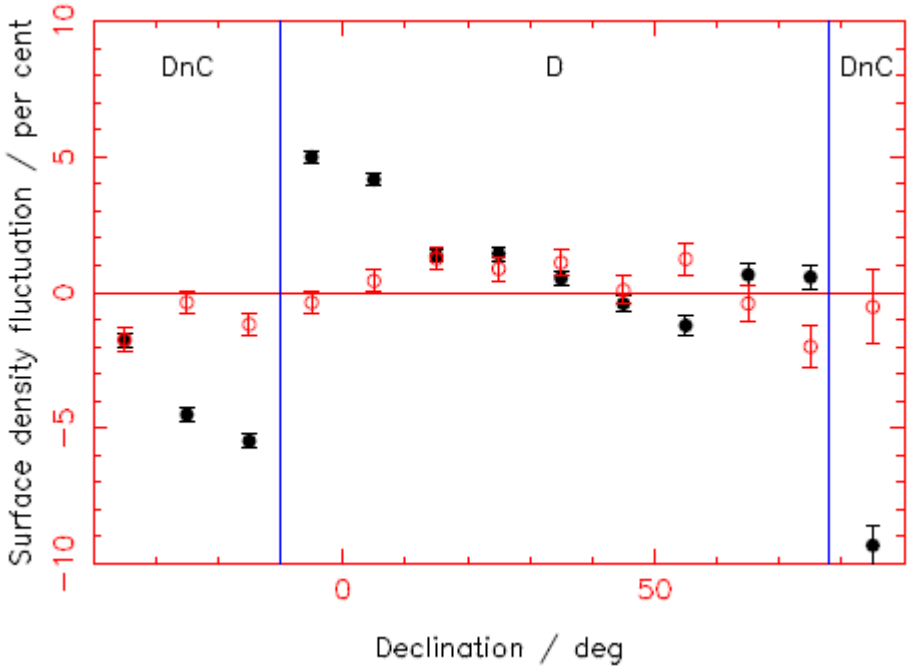


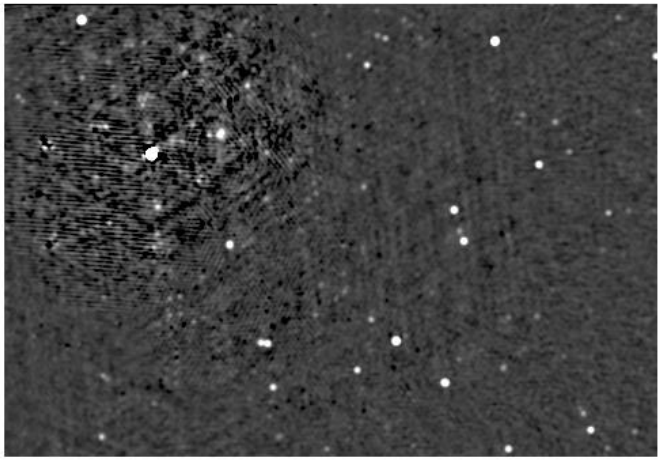
UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

However, NVSS is “noisy”

C. Blake & J.Wall 2004
C. Hernández-Monteagudo 2010

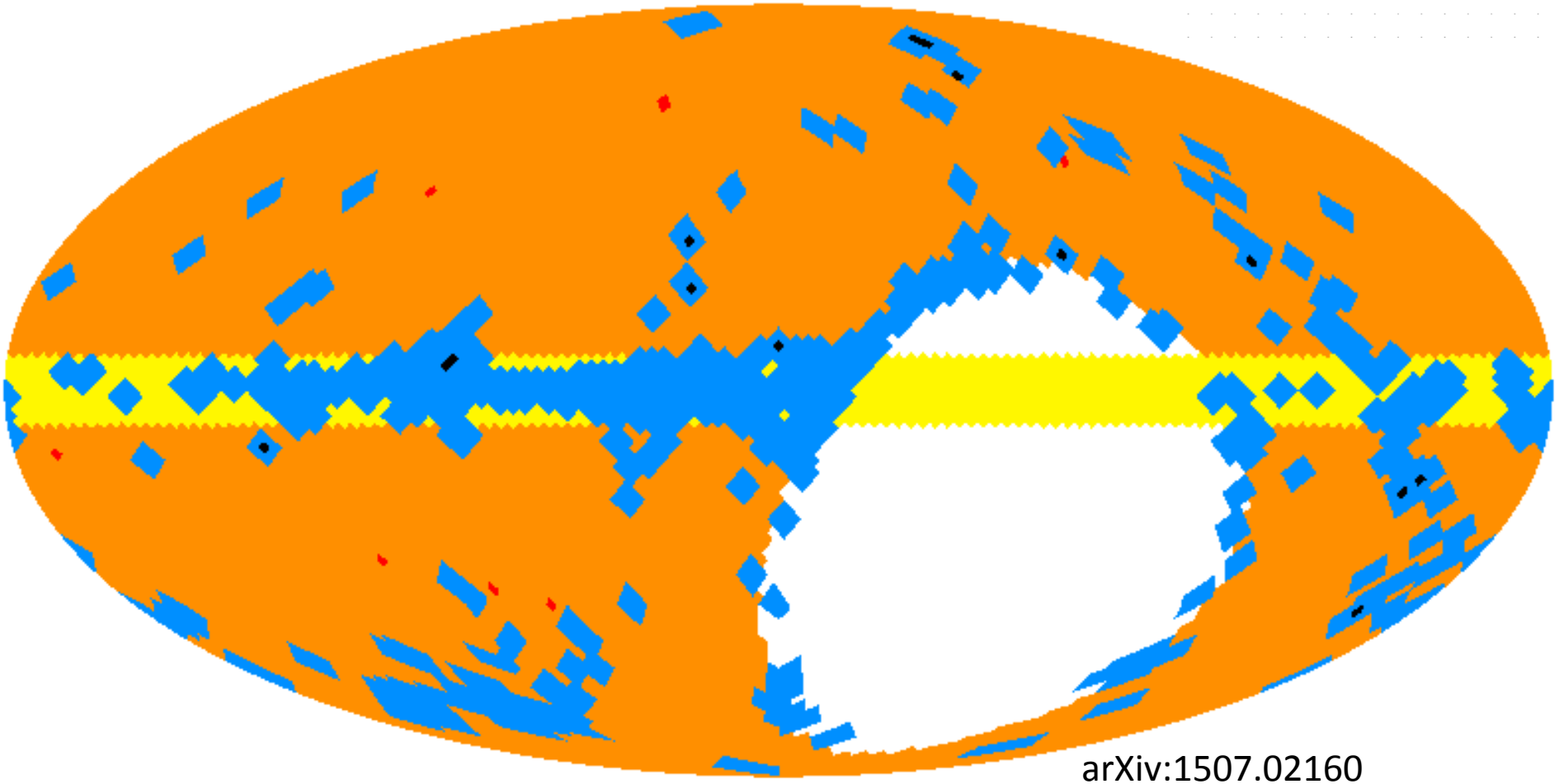




UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

NVSS65

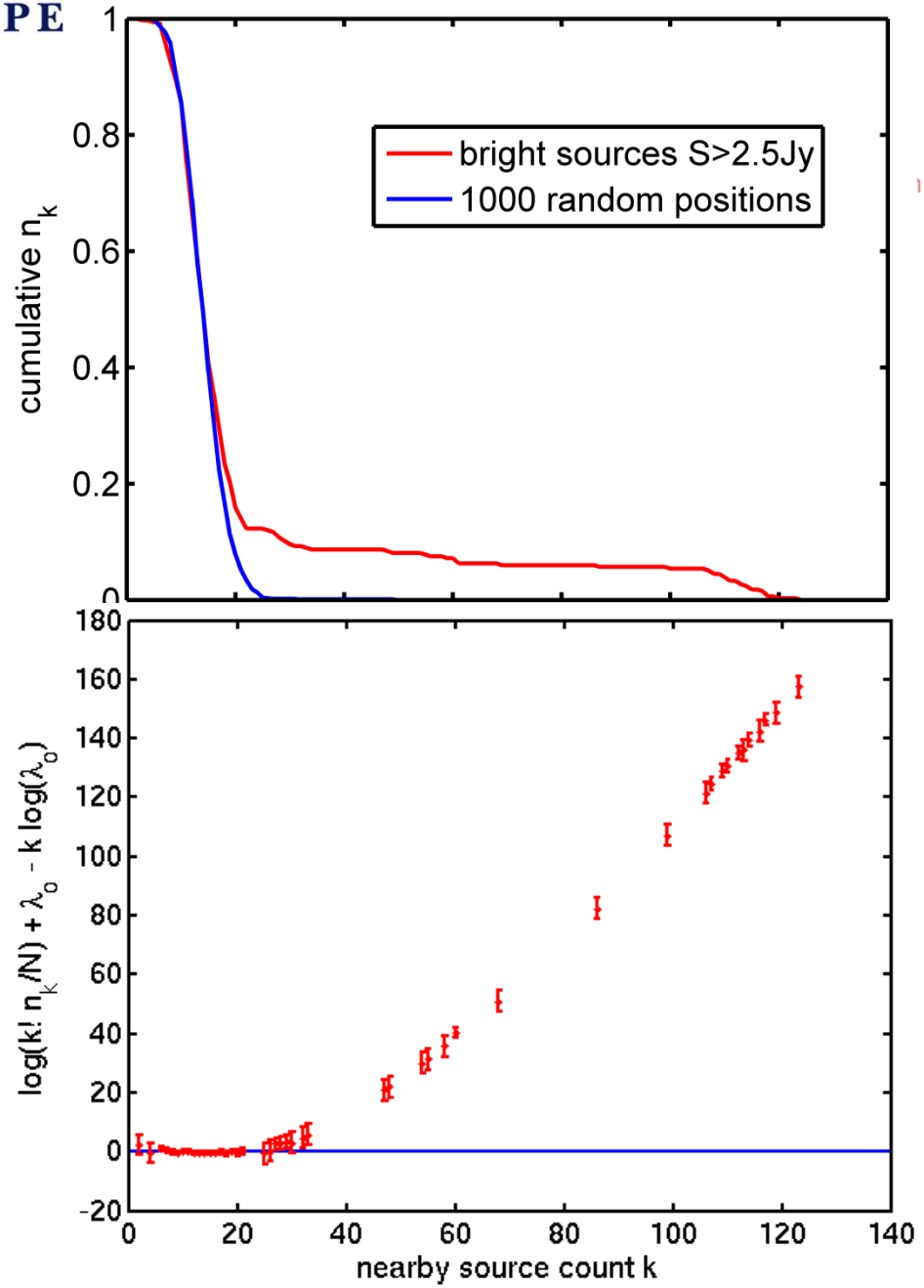


arXiv:1507.02160

UNIVERSITY of the WESTERN CAPE

CRC
ıere dreams come true

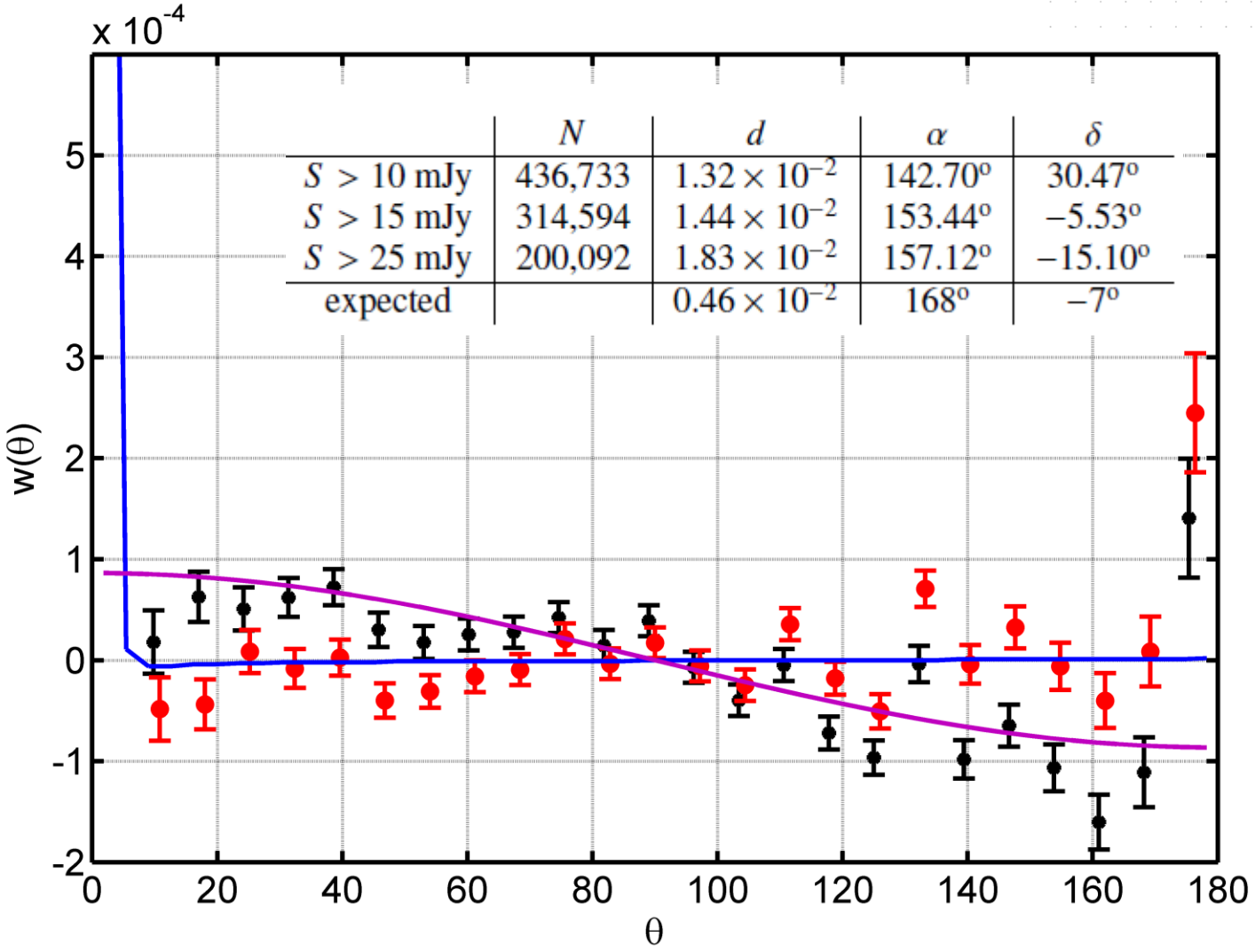
Finding side lobe residues with Possionness test



UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

Our peculiar motion

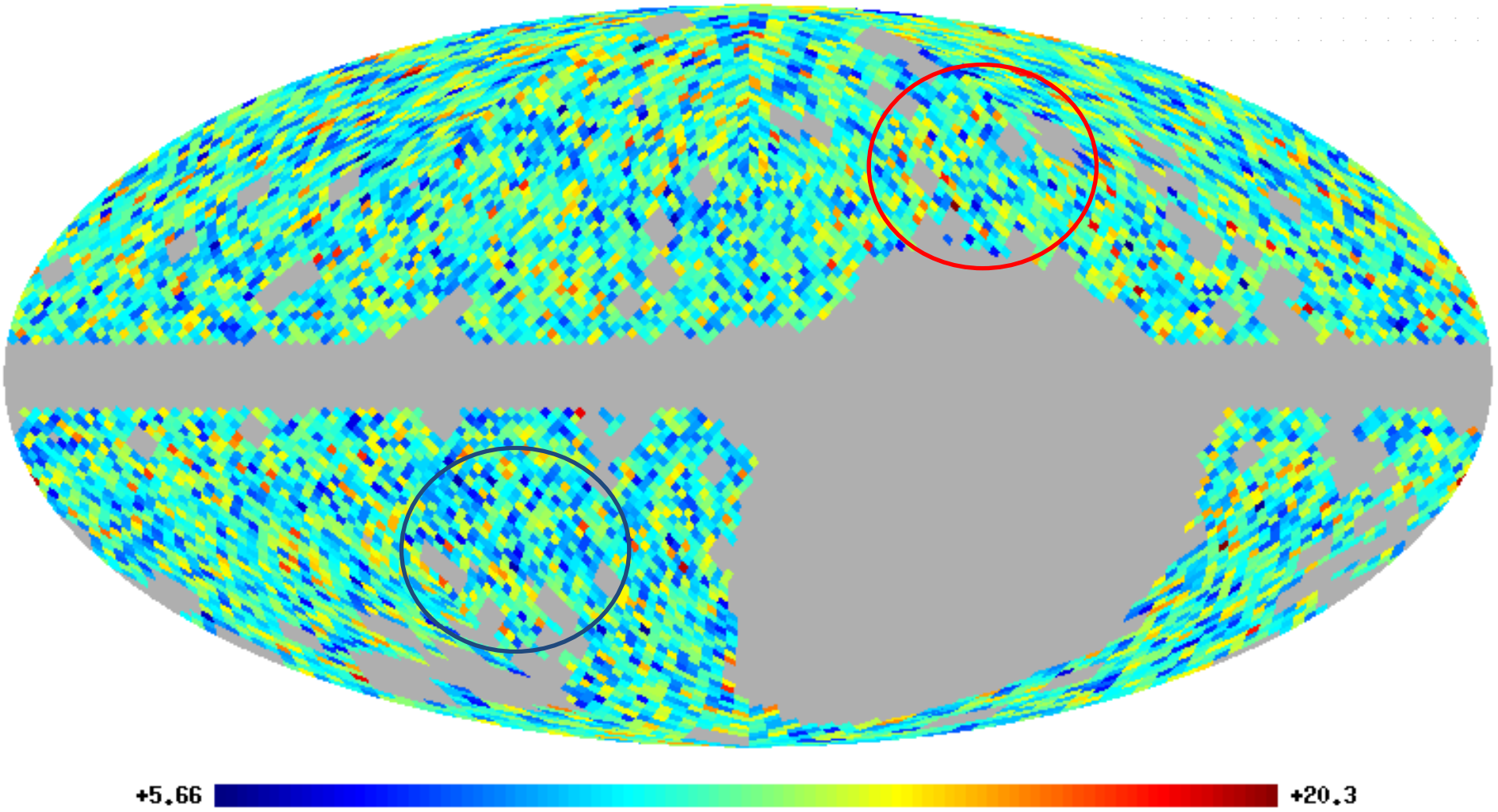


	N	d	α	δ
$S > 10$ mJy	436,733	1.32×10^{-2}	142.70°	30.47°
$S > 15$ mJy	314,594	1.44×10^{-2}	153.44°	−5.53°
$S > 25$ mJy	200,092	1.83×10^{-2}	157.12°	−15.10°
expected		0.46×10^{-2}	168°	−7°

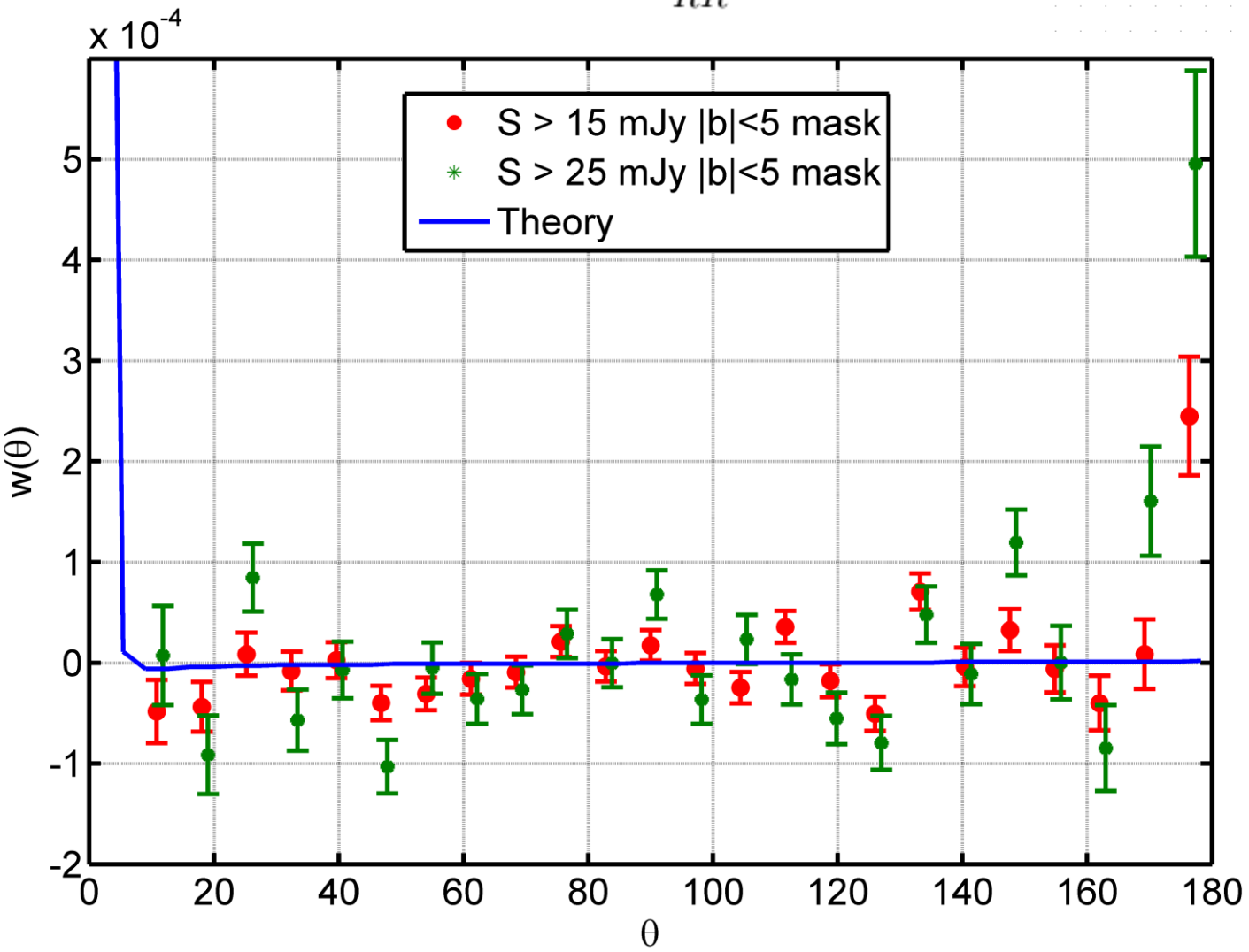
UNIVERSITY of the WESTERN CAPE

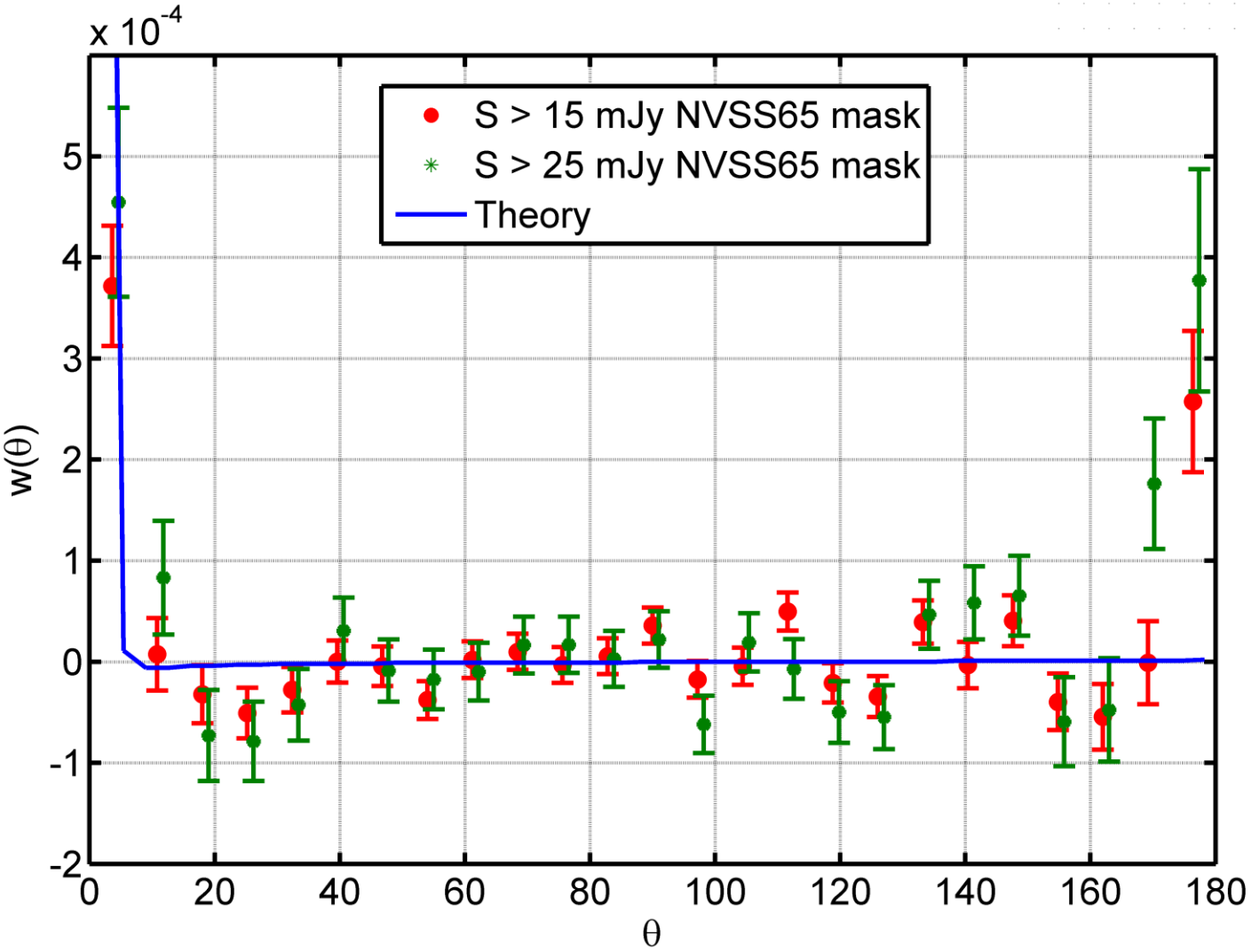
CRC
Where dreams come true

NVSS S > 15mJy



$$w(\theta)_{\rm sub} = \frac{DD - 2DR_{\rm d} + R_{\rm d}R_{\rm d}}{RR}$$

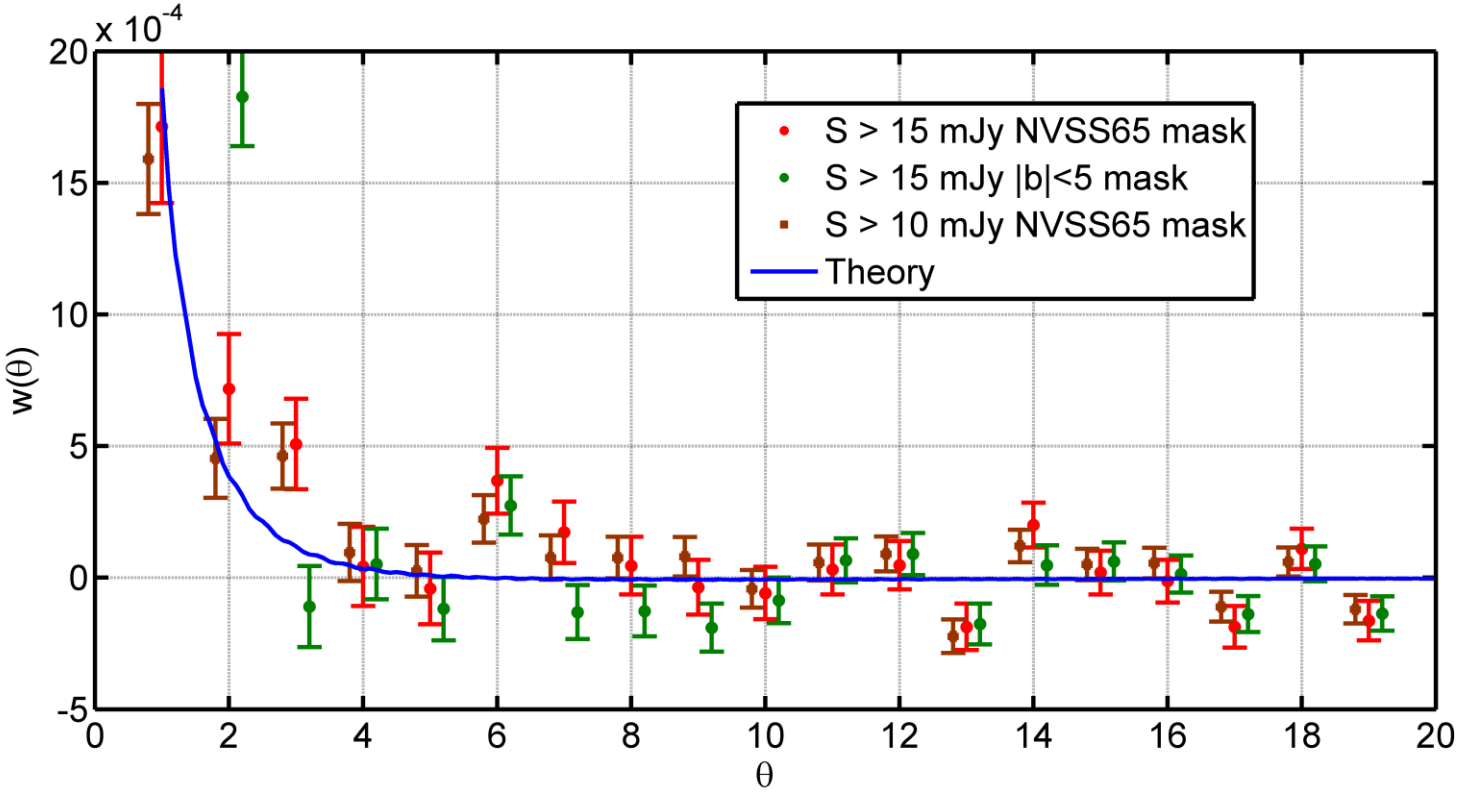


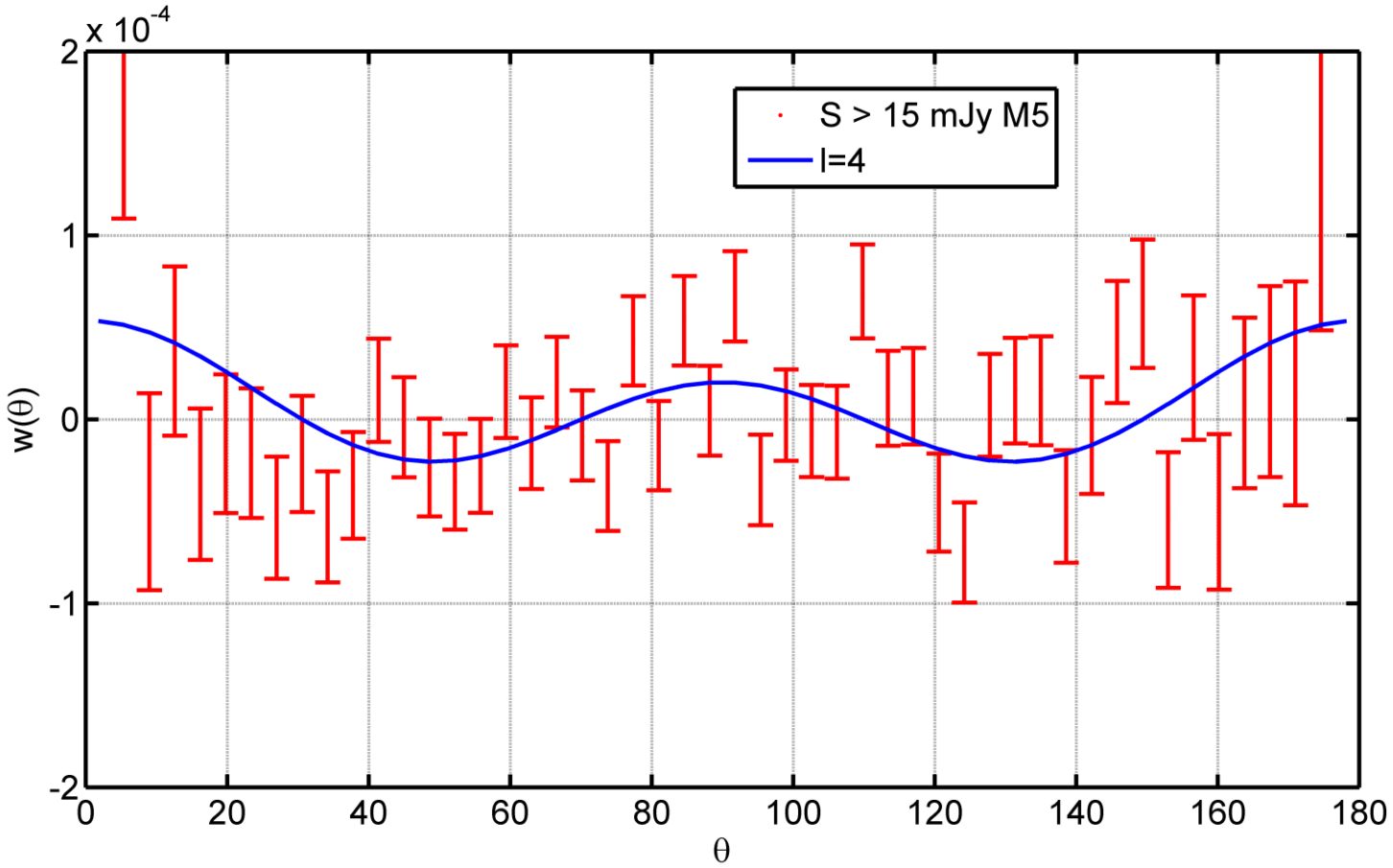

x 10^-4
S > 15 mJy NVSS65 mask
S > 25 mJy NVSS65 mask
Theory
w(θ)
θ
5
4
3
2
1
0
-1
-2
0
20
40
60
80
100
120
140
160
180

The different flux cut angular correlations are more consistent with each other after using new mask.

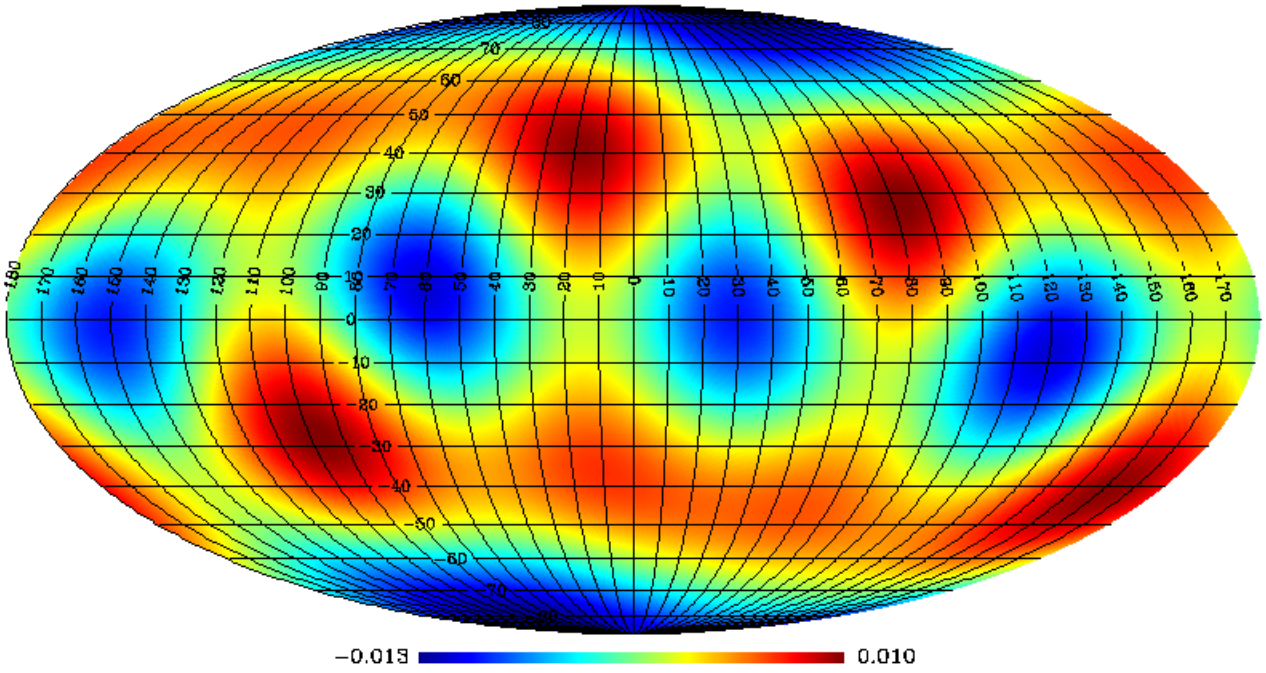
Their deviations from the theoretic values reduced.

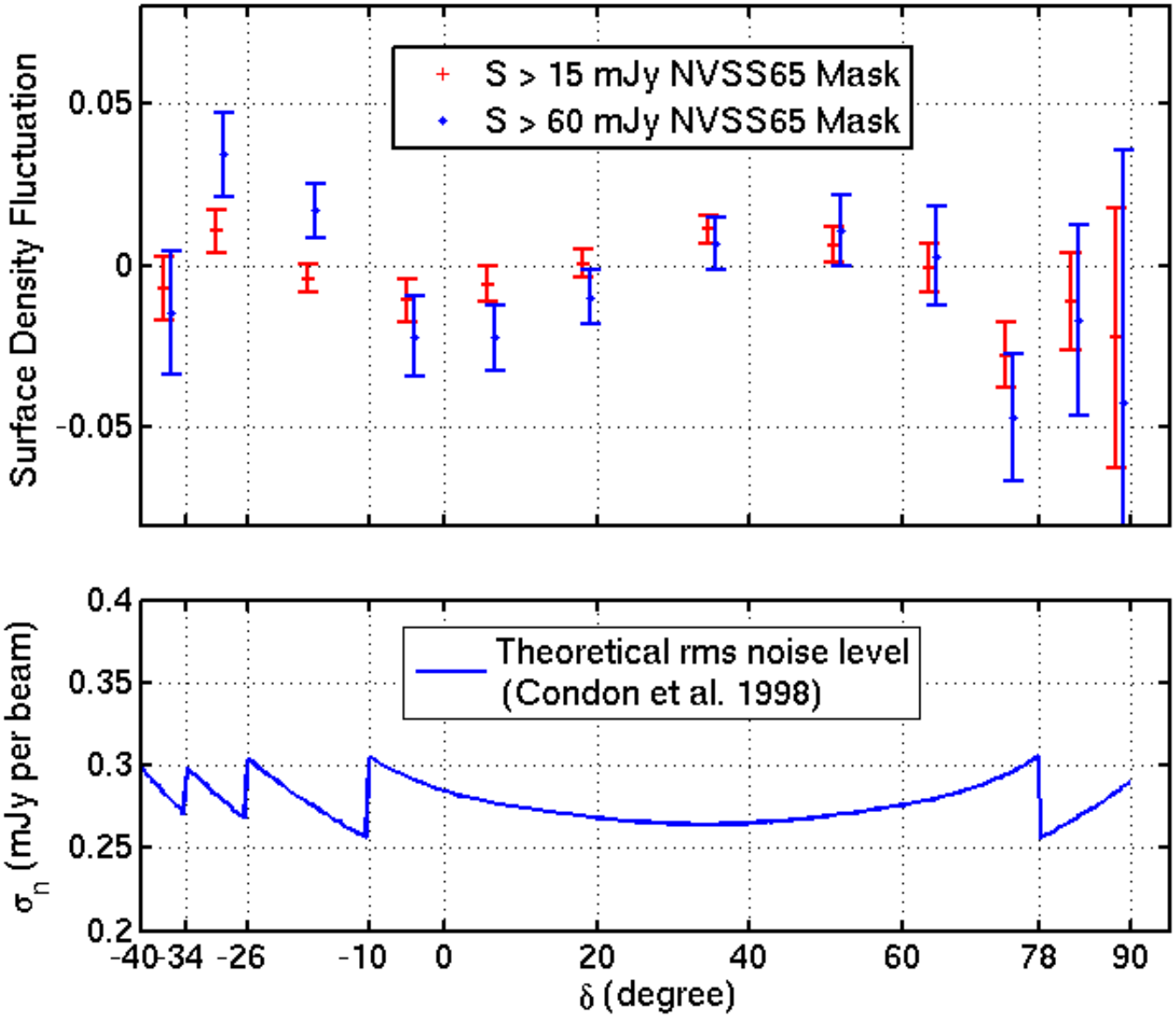
	$\|b\| < 5^o$		NVSS65	
	N	χ^2	N	χ^2
$S > 15$ mJy	377,739	165.96	322,557	94.08
$S > 25$ mJy	240,872	222.49	205,103	99.80


x 10^-4
20
15
10
5
0
-5
w(θ)
0
2
4
6
8
10
12
14
16
18
20
θ
S > 15 mJy NVSS65 mask
S > 15 mJy |b|<5 mask
S > 10 mJy NVSS65 mask
Theory


x 10^-4
2
1
0
-1
-2
w(θ)
S > 15 mJy M5
l=4
0
20
40
60
80
100
120
140
160
180
θ

l=4 mode alone
Equatorial coordinate system




S > 15 mJy NVSS65 Mask
S > 60 mJy NVSS65 Mask
Surface Density Fluctuation
0.05
0
-0.05
Theoretical rms noise level
(Condon et al. 1998)
σn (mJy per beam)
0.4
0.35
0.3
0.25
0.2
-40 -34 -26 -10 0 20 40 60 78 90
δ (degree)

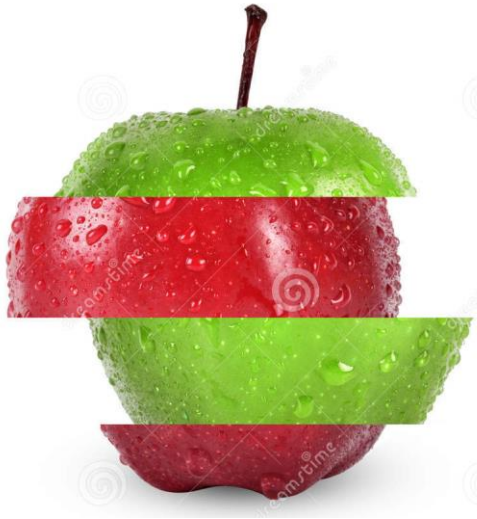
UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

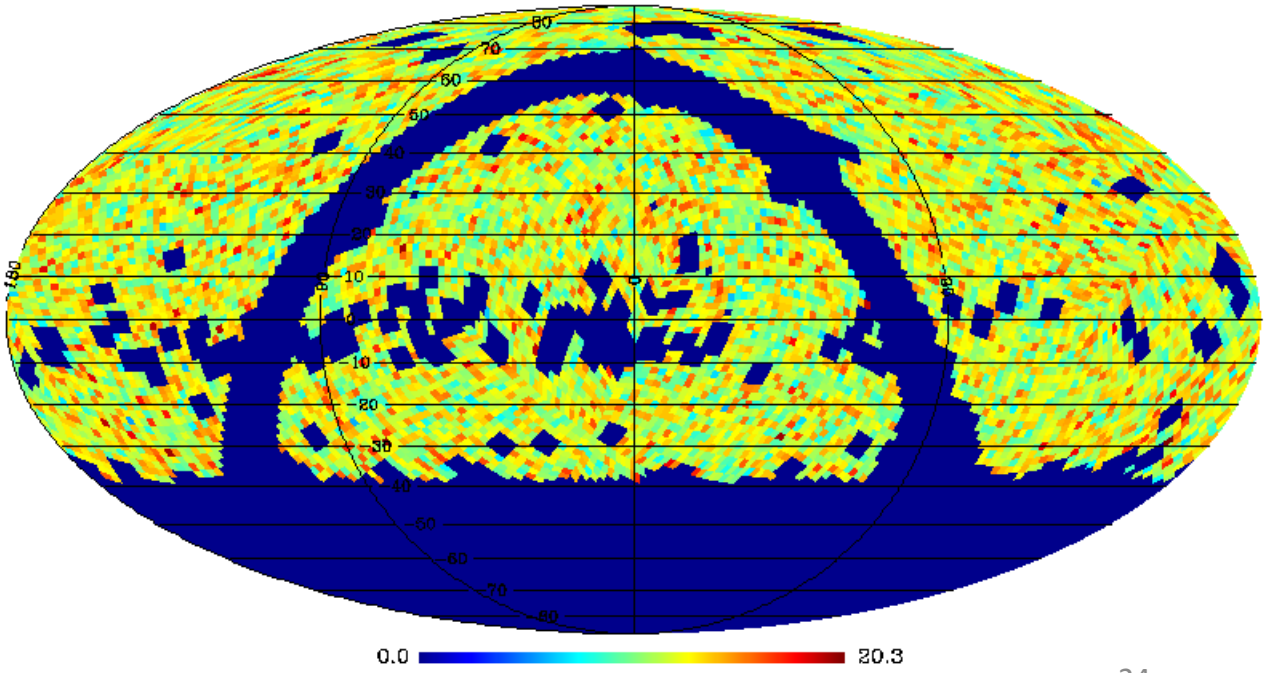
Previously, we normalize the pixel count with the mean of full survey.

Motivated by Vielva et al. 2006, Now we exchange the mean of full survey by the mean of declination strips.

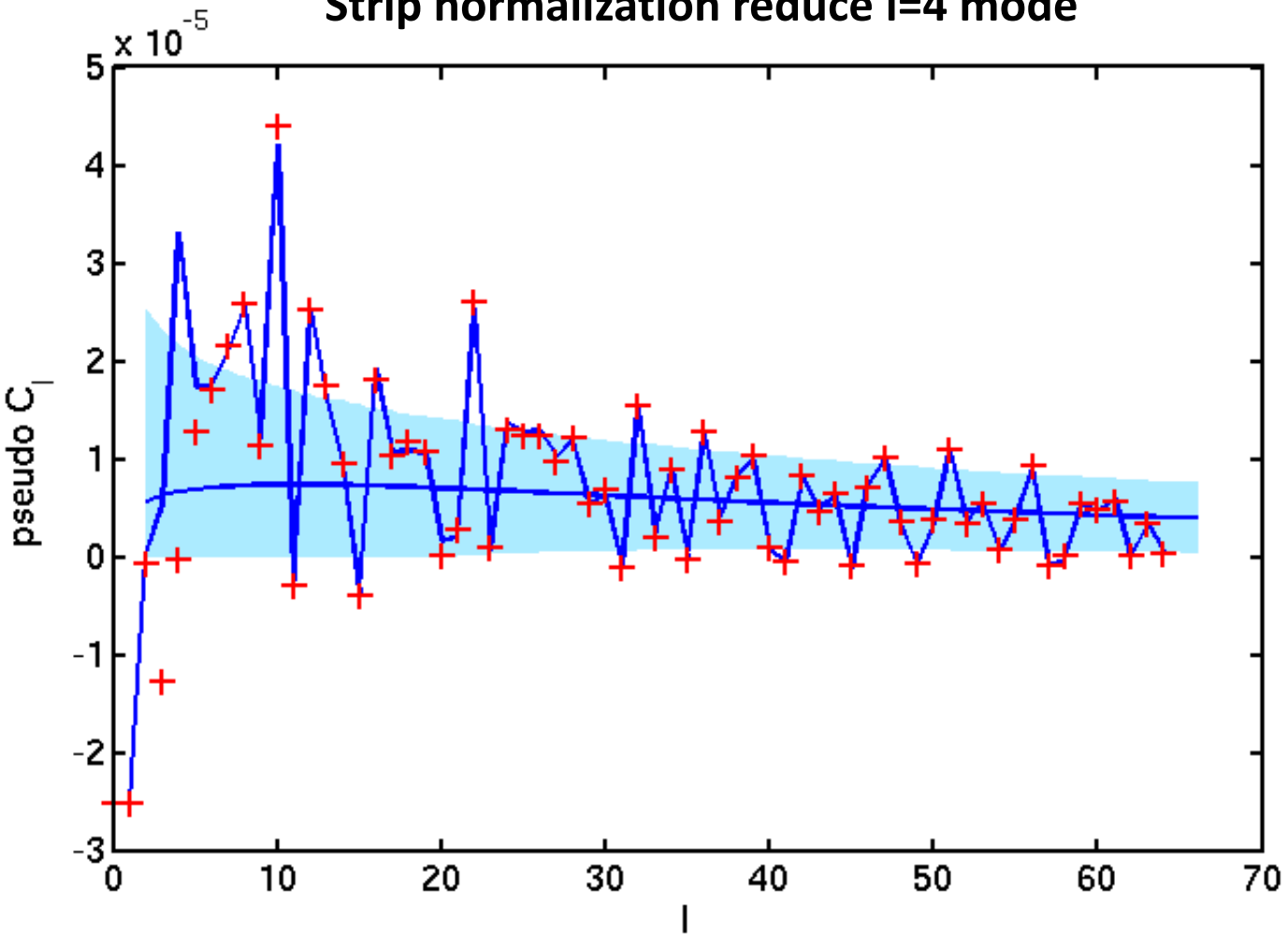
$$x_i = \frac{n_i - \bar{n}_{\delta_i}}{\bar{n}}$$



on line processing :



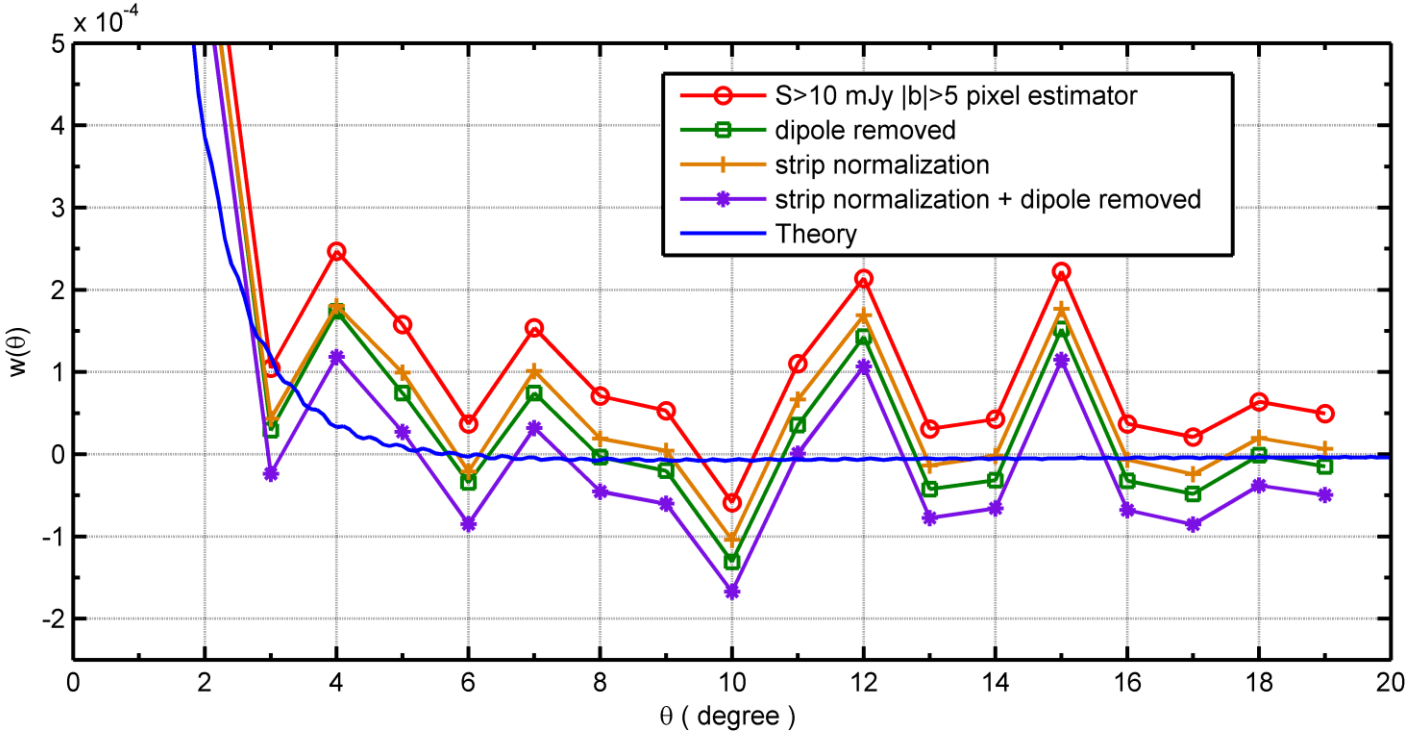
Strip normalization reduce l=4 mode



UNIVERSITY of the WESTERN CAPE

CRC
Where dreams come true

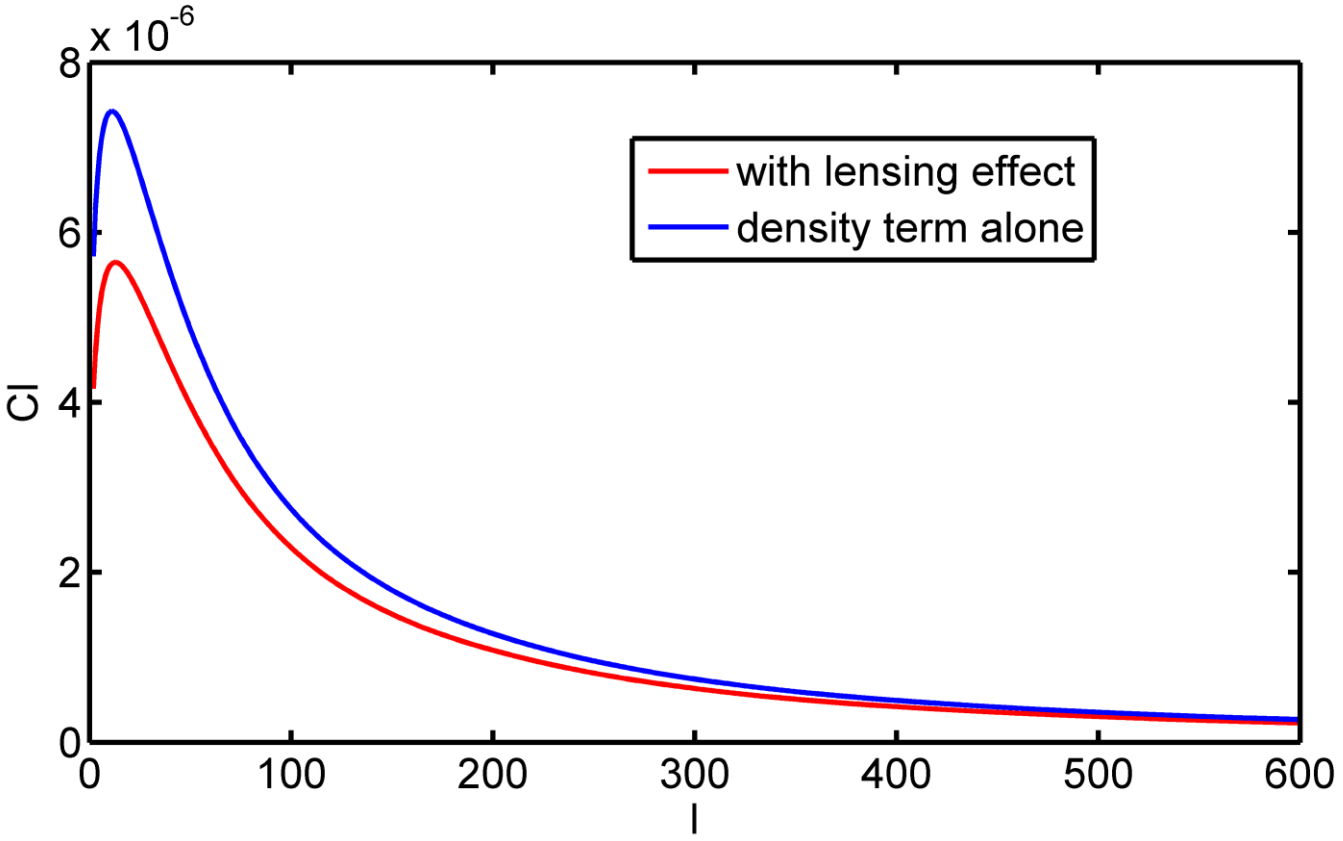
Which clean process is the most important ?



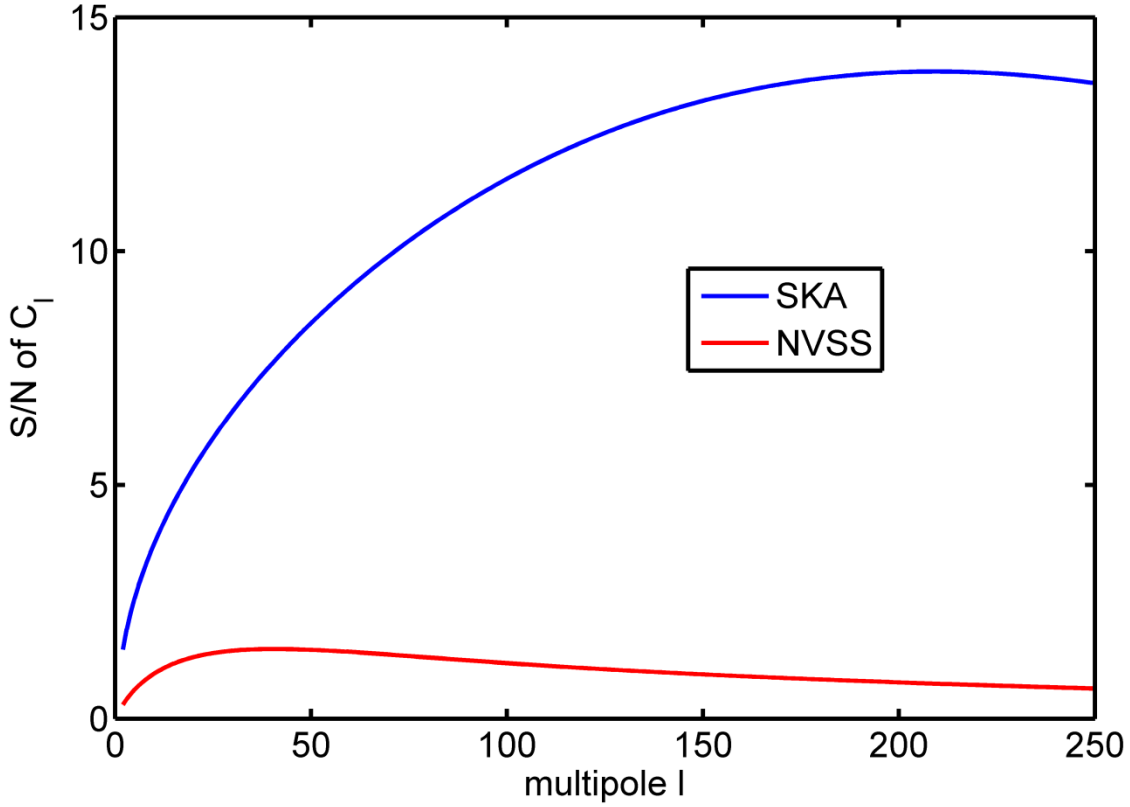
There are some relativistic effects can modify the large scale fluctuation.

$$\frac{-1}{r_S}\int_0^{r_S} d\lambda \frac{r_S - r}{r}\Delta_\Omega(\Phi + \Psi)$$

Lensing effect
In radio continuum auto power spectrum



Next Generation surveys will have much better sensitivity on auto power spectrum.



Summary:

Non-Gaussianity mainly affect the large scale number density fluctuations via bias.

To constrain large scale number density fluctuations, we need large volume observation i.e. sky coverage and high redshift.

Cosmic dipole and systematics can power-up the large angular scale fluctuations , which need to pay attentions in the future radio surveys.

Prina Patel

to Mario, Marta, José, me

CRC

Where dreams come true

I found a logo maker online....

Marta Spinelli

to Prina, Mario, José, me

where dreams come true is a not too much?

Mario Santos

to Marta, Prina, José, me

Come on Marta - don't tell me your dreams aren't coming true...

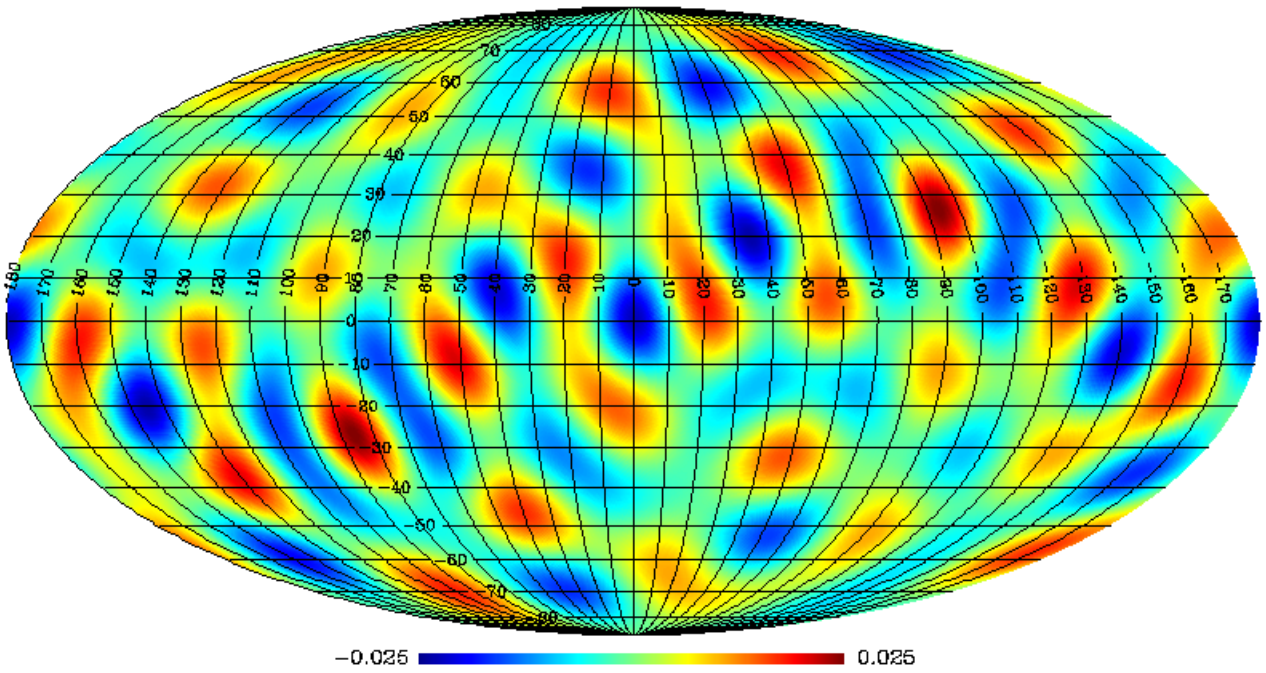
Prina Patel

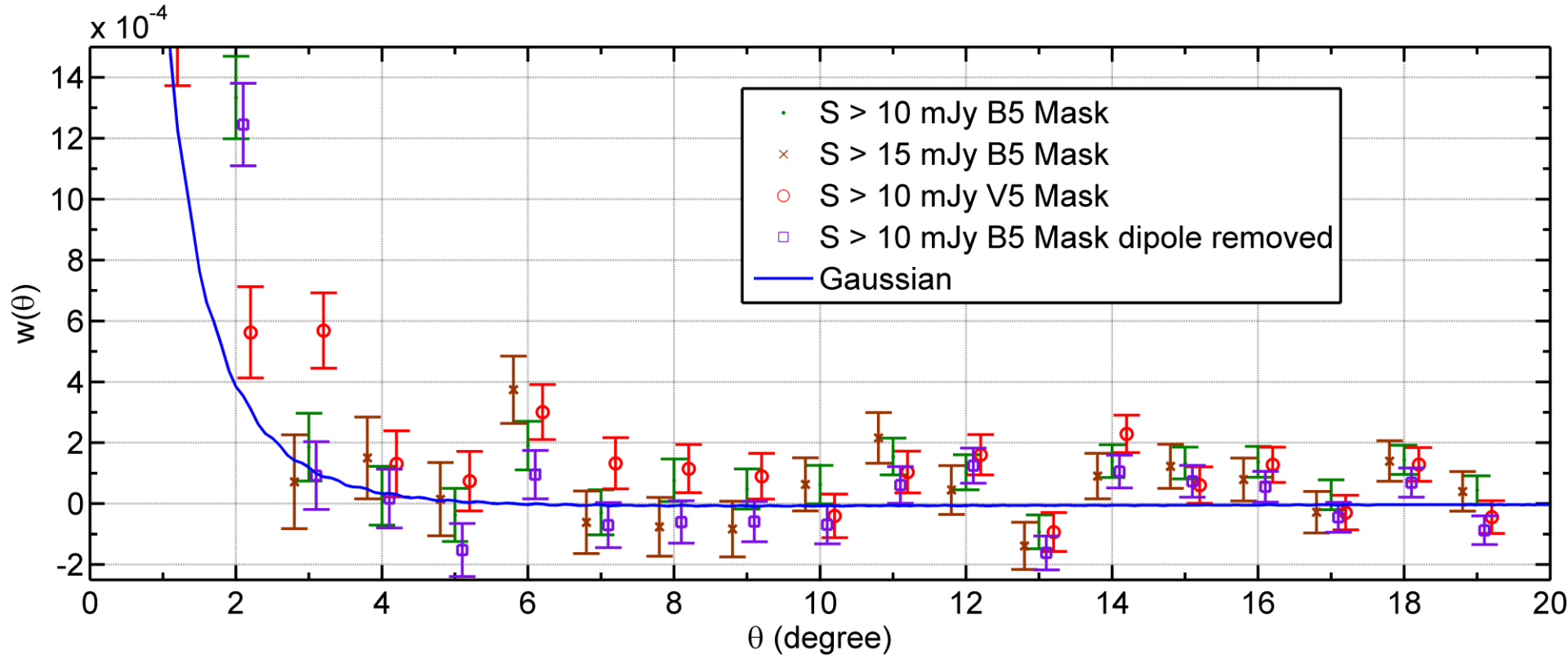
to Mario, Marta, José, me

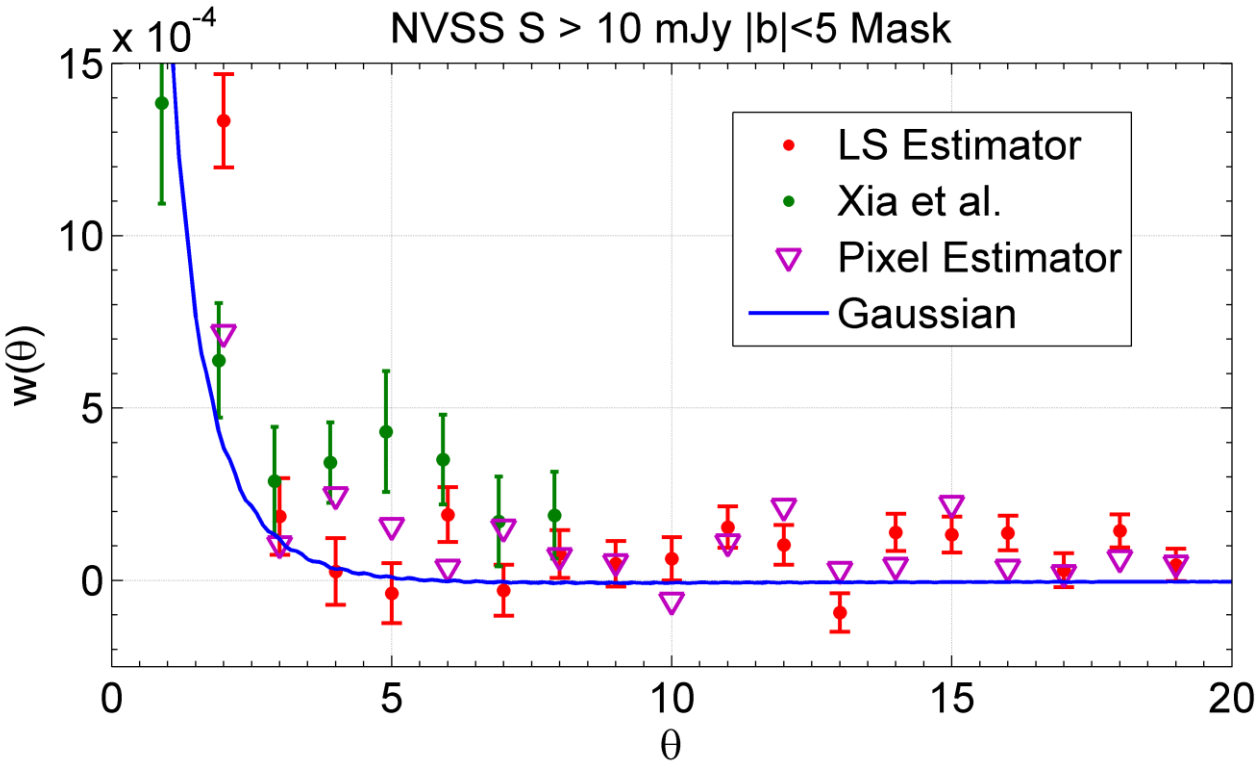
very good boss.

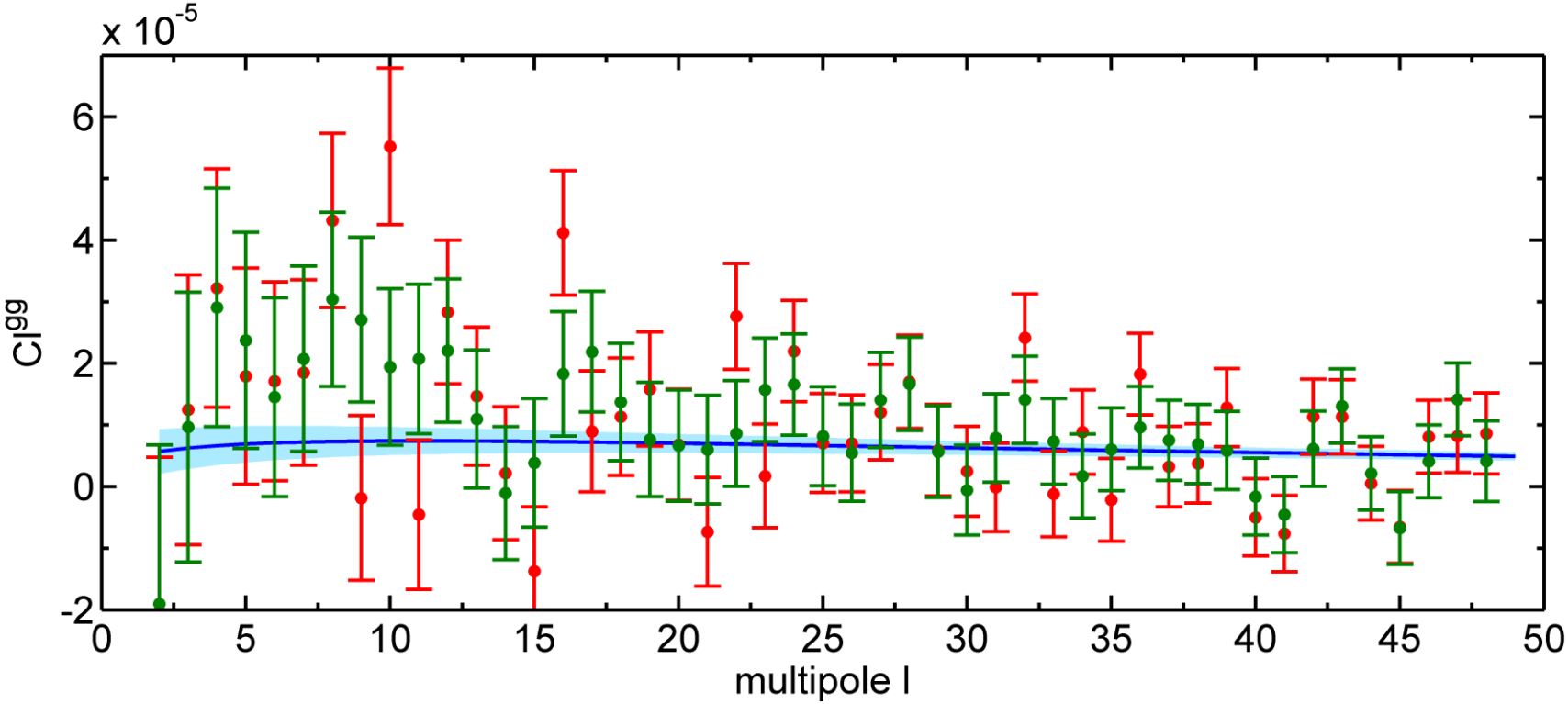
Thank you for your attention

on line processing :




x 10^-4
14
12
10
8
6
4
2
0
-2
w(θ)
0
2
4
6
8
10
12
14
16
18
20
θ (degree)
S > 10 mJy B5 Mask
S > 15 mJy B5 Mask
S > 10 mJy V5 Mask
S > 10 mJy B5 Mask dipole removed
Gaussian


NVSS S > 10 mJy |b|<5 Mask
x 10^-4
15
10
5
0
w(θ)
0
5
10
15
20
θ
LS Estimator
Xia et al.
Pixel Estimator
Gaussian


x 10^-5
6
4
2
0
-2
Cl^gg
0
5
10
15
20
25
30
35
40
45
50
multipole l