Measuring Magnification Bias in Photometric Galaxy Surveys

Rafael Ponce, Eusebio Sanchez, Ignacio Sevilla
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Madrid, España

In this contribution, we analyze how cosmic magnification may be detected in upcoming large photometric galaxy surveys and how some systematic effects can affect it. Magnification manifests itself as an enhancement or decrease of galaxy/quasar number counts at very high redshifts due to the magnifying weak lensing effect of intervening matter in the line of sight. It usually shows up in observations as a correlation or anti-correlation at low angular scales in the cross-correlation function. Its amplitude is directly related to the galaxy bias and cosmological parameters. We focus on three particular systematics and we are carrying out this study in the context of the Dark Energy Survey (DES) that will cover 5000 square degrees and reach i_{AB}<24 making measurements up to z~1.4 with a photo-z resolution of 0.03(1+z).

Dark Energy Survey

The dark energy Survey is one of the upcoming photometric galaxy surveys specially designed to study the dark energy. The project has designed and built the camera DECam, which has 70 CCDs and five wide filters. This camera is being installed in the Observatory of Cerro Tololo in Chile and it is about to begin its commissioning time. In order to prepare the software which is going to study the upcoming data, several institutions in the DES-Collaboration have developed N-body simulations. In this work we have used the “Stanford mock catalogs” (200 sqr. deg.), provided by Michael Busha (University of Zürich), Matthew Becker (University of Chicago) and Risa Wechsler (Stanford University).

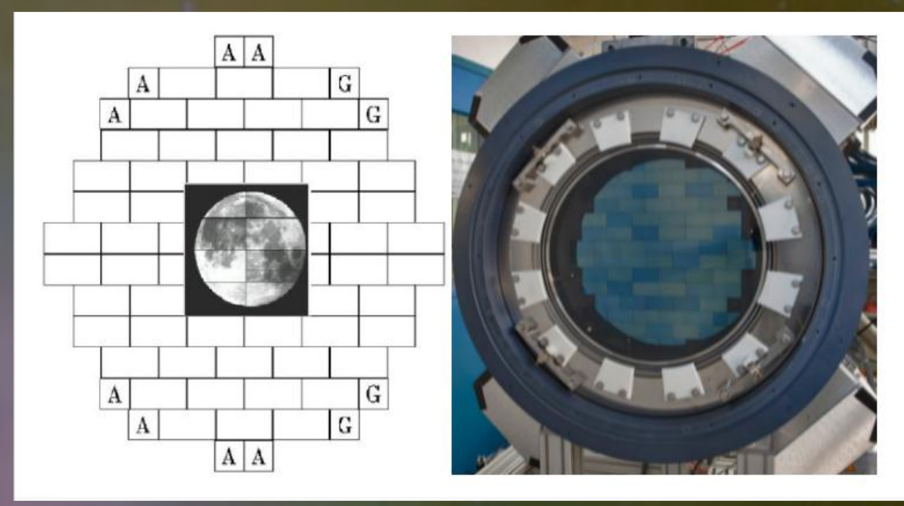

Figure 1: Left Panel, Schema of the DECam focal plane Right Panel, real camera.

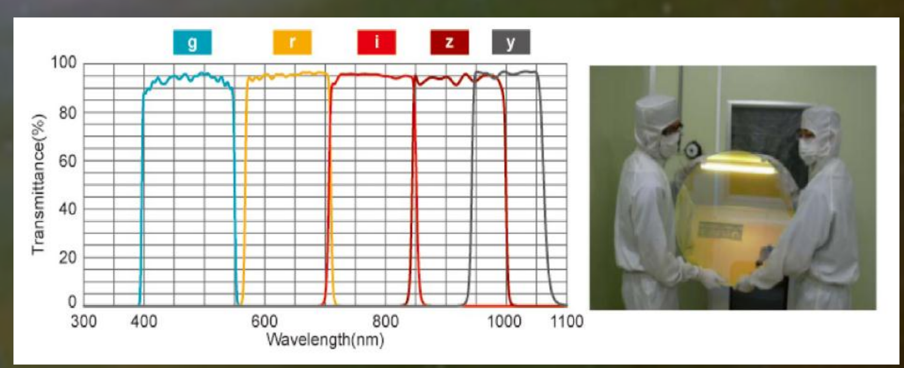

Figure 2: Filter system will be used on DES according to the wavelength. Right, one of these filters.

Magnification Bias

Magnification bias or cosmic magnification is a well-know effect containing information about the matter density and galaxy bias. To measure it in a photometric survey, we try to detect non-zero values in the angular cross-correlation function at low scales (Hildebrandt et al. 2009), between galaxy populations in well separated redshift bins.
We study three systematic effects: the photometric redshift, the star contamination and the mask effects.
In order to do that, we have selected three samples, one “close” and two “far” samples,
,

Close Sample	0.2 < Z < 0.4
Far Samples	1.1 < Z < 1.2 - 1.2 < Z < 1.3

Table 1: Galaxy samples used to compute the angular cross-correlation functions.

We computed the angular cross-correlation function for every combination of close and far samples, and compared the not magnified functions with the magnified functions.

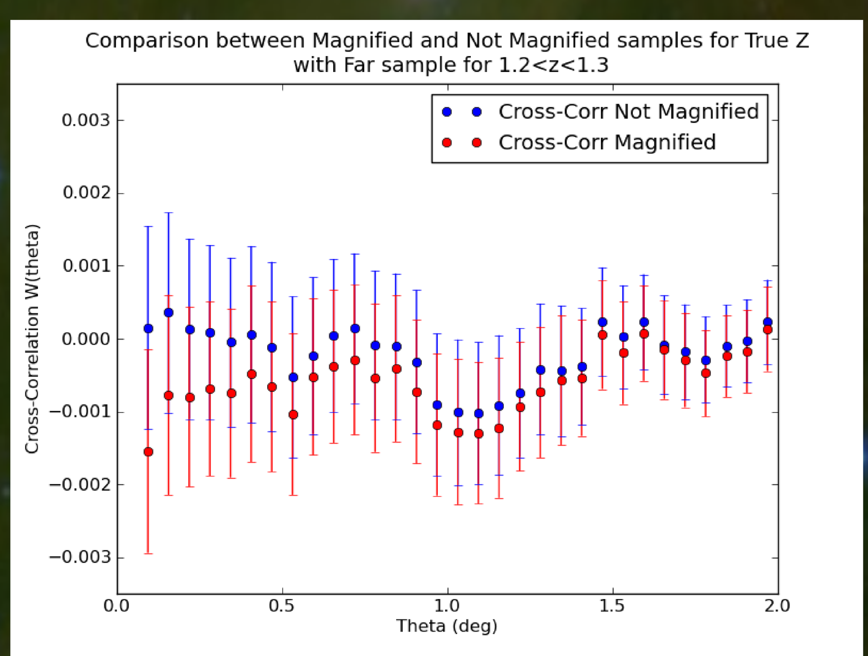

Figure 3: Magnification Signal for true redshift.

Systematics

Since the magnification signal is very small, we need a good of control the systematic effects. In this work we have studied the main systematic effects, mentioned above.

Photometric Redshift

The catalog contains four different photometric redshifts and the true redshift. The photometric redshifts included in the catalog are based on “boosted decision trees” (Arborz), “neural networks” (Annz), “nearest neighbor”s (Cz) and an “ideal Gaussian photoz” (Gz, σ=0.03(1+Z)).

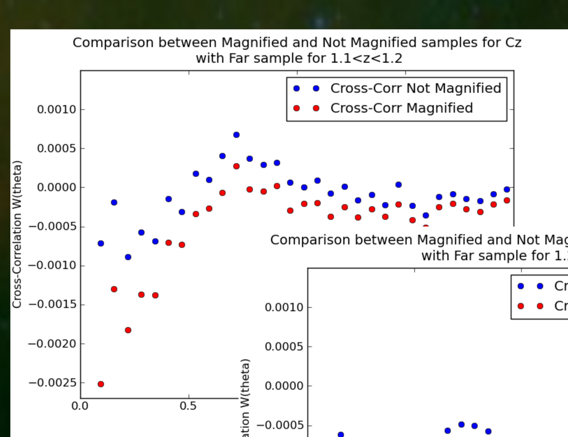

Figure 4a: Left Panel, “Nearest Neighbor” (Cz).

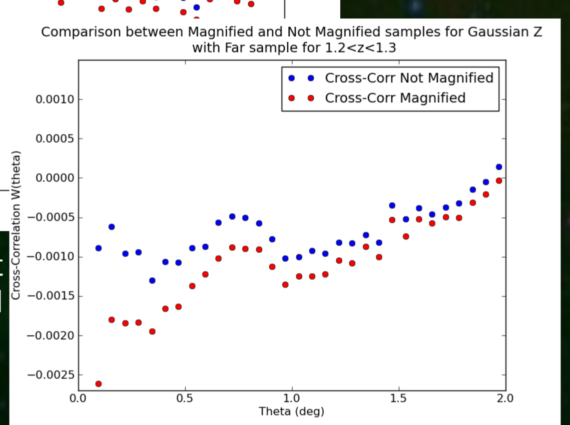

Figure 4b: Right Panel, “Ideal Gaussian Photoz”.

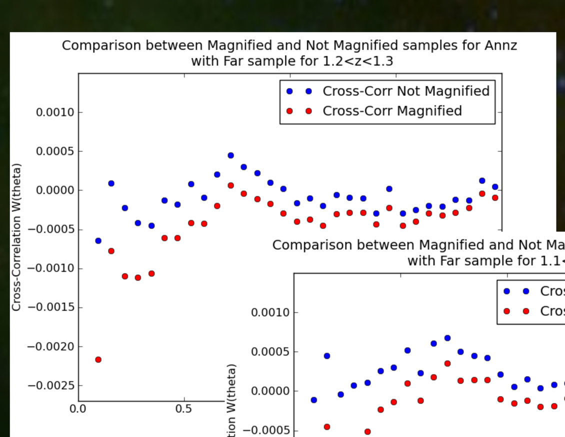

Figure 4c: Left Panel, “Neural Network” (Annz).

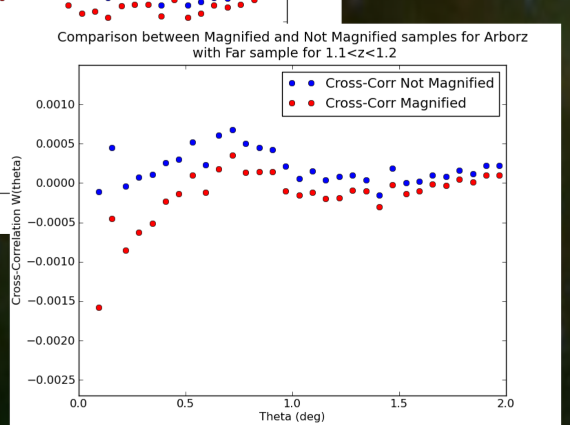

Figure 4d: Right Panel, “boosted decision tree” (Arborz).

Figure 4: Comparison between magnified and not magnified cross-correlation functions for every photometric redshift in the catalog.

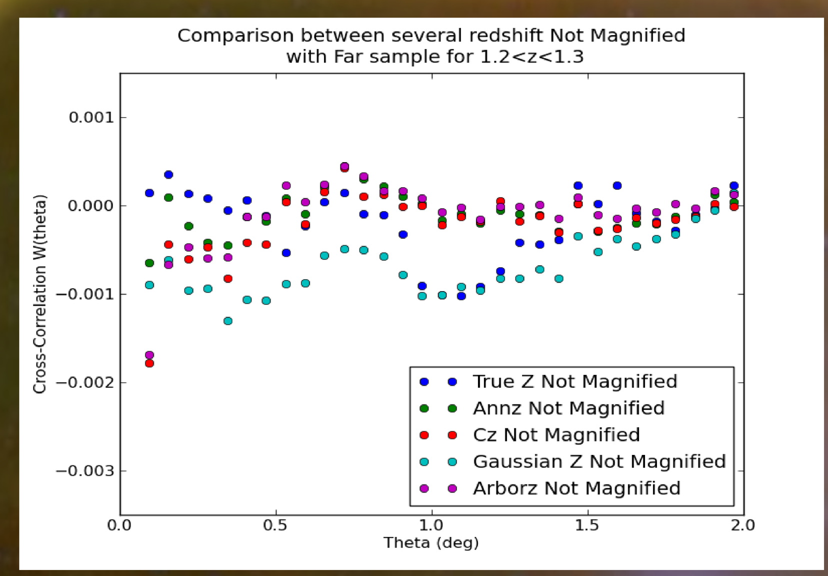

Figure 5: Angular cross-correlation functions for every redshift, algorithm. The shape of the ACCF has some dependence on the used photoz.

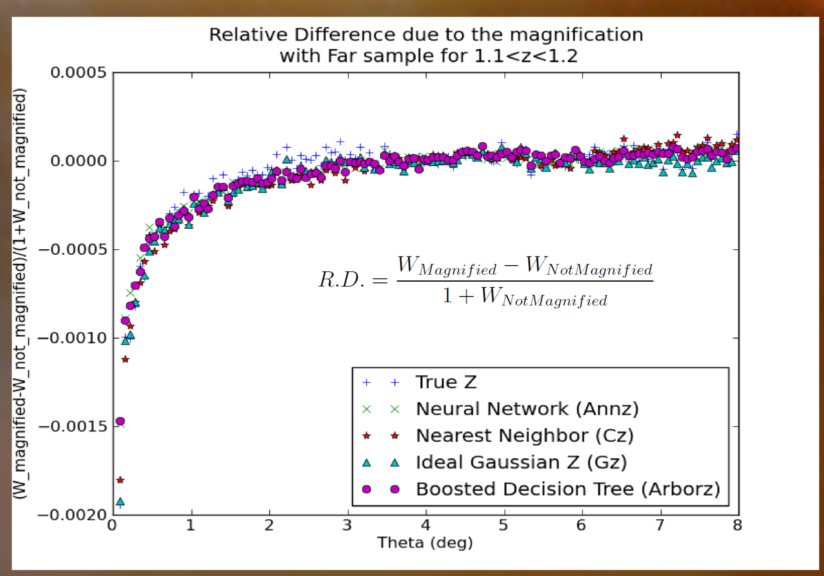

Figure 6: Relative difference between the magnified and not magnified cross-correlation functions for every redshift in the catalog. The magnification signal is the same for every algorithm

Star contamination

In order to study this systematic, we have contaminated the galaxy samples with different percentages of stars according to table 2, these percentages were chosen following the expected percentages on DES (around 5% for the close sample and 1.7% for the far sample), and then we did every cross-correlation between the contaminated samples.

Close Sample	1%, 3%, 5%, 7%, 9%
Far Samples	0.7%, 1.2%, 1.7%, 2.2%, 2.7%

Table 2: Star contaminations have been introduced in galaxy samples

Fixing the close sample contamination to its expected value (5%), we obtain the same cross-correlation functions no matter what the far sample contamination is, but varying the close sample contamination and fixing the far one (1.7%), we see that the higher the contamination in the close sample is, the worse is the agreement with the uncontaminated cross-correlation, due to the larger amount of objects in the close sample.

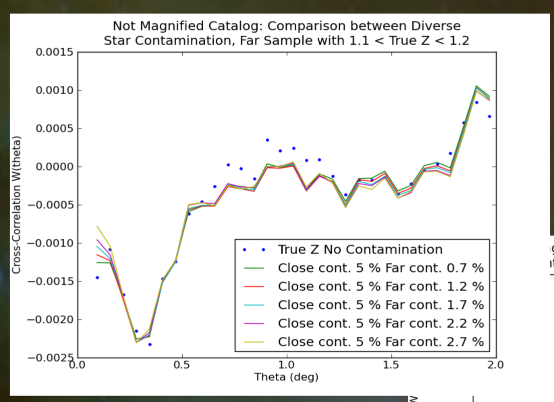

Figure 7a: Left Panel, Angular cross-correlation functions, fixing close sample star contamination.

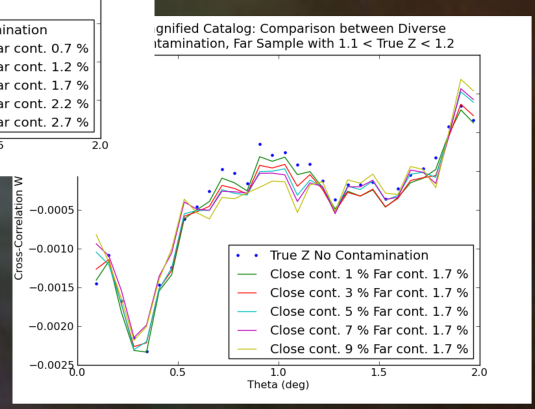

Figure 7b: Right Panel, Angular cross-correlation functions, fixing far sample star contamination.

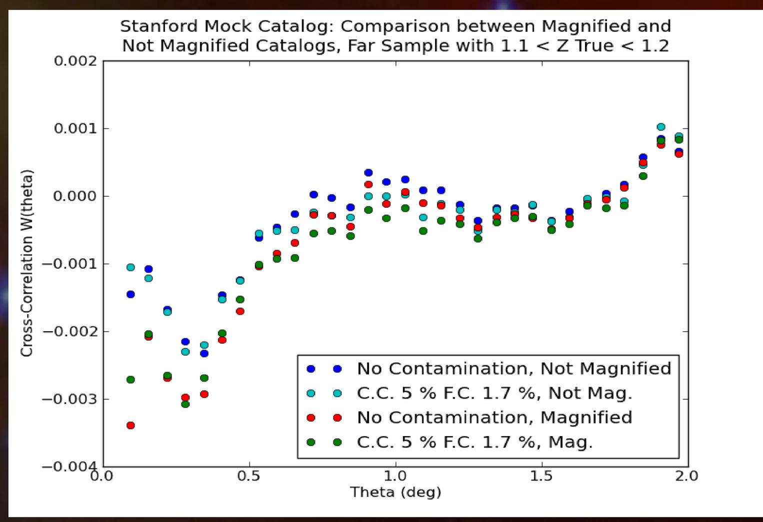

Figure 8: Comparison between contaminated (expected on DES), not contaminated, magnified and not magnified cross-correlation functions.

Mask Effect

This effect has been studied considering a bad region in the mask, in which we have missed a percentage of total objects, the region size in around 2.5% of the total catalog area (less than we expect on DES).

Missing objects		
	Close sample	10%, 25%, 50%, 75%, 100%
	Far sample	10%, 25%, 50%, 75%, 100%

Table 3: Percentages of the missing objects we have introduced on Close and Far samples.

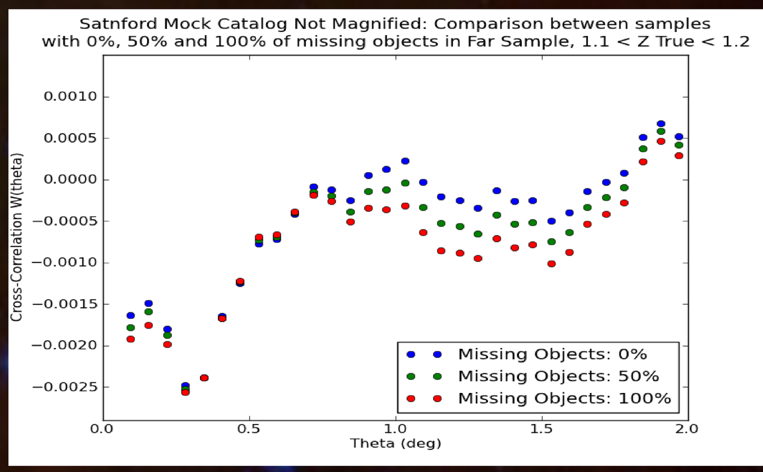

Figure 9: Missing object effect over the cross-correlation function shape.

Preliminary Results

In order to figure out what is the most important studied systematic, we have measured the relative difference between the magnified cross-correlation function with every systematic and the magnified cross-correlation function no systematics.

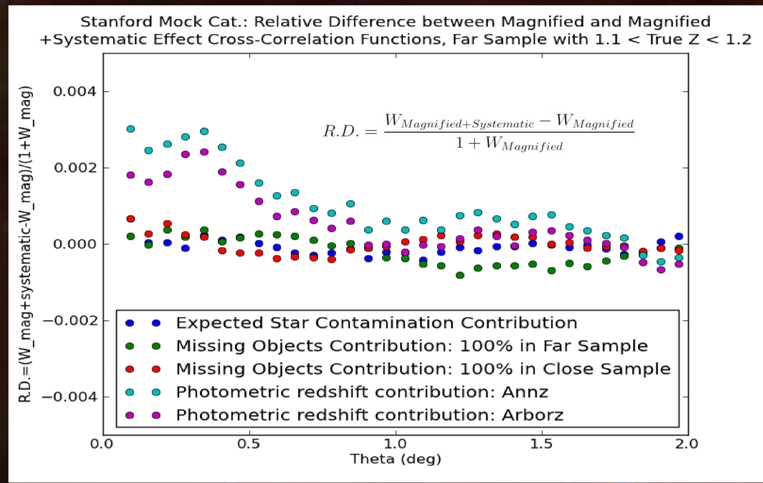

Figure 10: Comparison between relative differences due to the systematic effects.

GPU Code

Every angular cross-correlation function has been done using “GP2PCF: a code for brute-force computation of 2 point correlation functions” (Ponce 2012), which was programmed by Miguel Cárdenas-Montes and Rafael Ponce and it is available from http://wwwae.ciemat.es/cosmo/gp2pcf/
This code offers a 100-fold increase in speed with respect to a single CPU.

GPU Code

Conclusions

We have studied the most important systematic effects in order to control the magnification signal in two well separated samples. We have seen that the photometric redshift algorithm affects the global shape of the correlation function, but leaves unaffected the magnification signal. A good control of the star contamination in the close sample is very important to extract a good magnification signal. However, the influence of the star contamination in the far sample is much less important. Finally, we studied the mask effect and it is important for scales larger than those relevant for the magnification signal scales. The most important systematic in our study is the photometric redshift error.

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD
Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
THE DARK ENERGY SURVEY