DARK ENERGY SURVEY

DESGW Galaxy Catalog

March 11, 2016

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The DESGW Galaxy Map

Premise: it is sufficient to know where the stellar mass is in the universe.

The GAMA mass function from Baldry et al (2012)
Defined so that $\alpha_2 > \alpha_1$; the second term dominates at low masses.

$$\phi_M \, dM = e^{-M/M^*} \left[\phi_1^* \left(\frac{M}{M^*} \right)^{\alpha_1} + \phi_2^* \left(\frac{M}{M^*} \right)^{\alpha_2} \right] \frac{dM}{M}$$

Integrating down the mass function one finds that
95% of the stellar mass in the universe lives in galaxies with $M_{95\%} > 0.04\ M^*$,
with a space density of 9.6×10^{-3} Mpc^{-3}.

We space density match these against the SDSS i-band luminosity function of Blanton et al (2003)
and find $M_{95\%}$ corresponds to 0.4 L^*; for the Blanton et al $i^*_{z=0} = -21.8$ and a distance of 200 Mpc, the limiting i-band magnitude is i=15.9.

This is a bright magnitude, and if one demands only $M_{90\%}$ one finds an even brighter i=15.1.

Our program is then to construct an i-band < 15.9 catalog of galaxies over the whole sky,

The base distance catalog

Start with 2MPZ photometric redshift catalog of Bilicki et al (2014)
Each galaxy has photometric-z, with an uncertainty of 0.015
Some galaxies have spectroscopic z, tiny measurement error.

Will tabulate distance, need uncertainty in distance
$d = cz/H_o$, H_o= 70 kms/s/Mpc
$\sigma_d = c\sigma_z/H$ for photometric redshift $\sigma_z = 0.015$, σ_d = 64 Mpc
$\sigma_d = c\sigma_z/H$ for spectroscopic redshift, $c\sigma_z$ = 600 km/s, σ_d = 9 Mpc
600 km/s is ~Virgo cluster velocity dispersion

Retain all galaxies which do contribute probability at < 200 Mpc => z= 0.0467
$z_{spec} < 0.0467 + 3\sigma_z = z\sim0.053$ or, if there is no z_{spec} :
$z_{phot} < 0.0467 + 3\sigma_z = z\sim0.09$

DARK ENERGY SURVEY

Update the distances

There are 4 catalogs we will use to update the distances in this catalog:

EDD: The 8162 galaxies of the Extragalactic Distance Database (aka Cosmicflows) have real distances, known by a variety of methods but most often Tully- Fisher measurements (Tully et al., 2009, 2013, 2105).

NED-D: The "Master List of Redshift-Independent Extragalactic Distances" may be more up to date than EDD, though we believe EDD distances are to be preferred. Our NED-D list is all objects on NED-D that are galaxies, have d<250 Mpc, and not in Cosmicflows.

NED: The spectroscopic redshifts in NED will be the most up to date repository of the world's redshifts, modulo large data releases from surveys like SDSS and Oz-DES. Unfortunately, NED is a mess. We match all galaxies from NED at z <0.092 to the 2MASS XSC catalog for J < 15.1, removing matches against NED-D and Cosmicflows.

SDSS DR12 : We then use the SDSS DR12 z <0.1 . catalog. Our SDSS catalog removed matches against NED, NED-D, and Cosmicflows.

Fix 2MPZ incompleteness

The 2MPZ catalog systematically misses low redshift bright galaxies.
For example, the central galaxy of the Coma Cluster is not in 2MPZ.
This is due to image processing problems on the optical data underlying the 2MPZ and the conservative approach to it Bilick et al took.

Our approach is to use the objects from Cosmicflows, NED-D, NED-z and SDSS that are not matched to the 2MPZ catalog.

We will add these into the catalog, using optical data from the SDSS and the COSMOS SSA and infrared data from the 2MASS XSC.

In the next version we will use data from SDSS, DES, DECals both here and to replace the optical data in the 2MPZ catalog.

Build the catalog

The catalog has:

1) ra, dec, z
2) distance and distance error
3) i magnitude, g-i color,
4) 2MASS J, radius, position angle, b/a
5) absolute magnitude
6) stellar mass

The i magnitude and g-i color are necessary for computing the stellar mass:

mass = (M/L) - 0.4(M - 4.58)

M/L = -0.68 + 0.7(g-i)

where M means both mass and absolute magnitude, and 4.58 is the absolute i-band magnitude of the sun. This is from Taylor et al (2011)

The total catalog has 435,294 galaxies:
- 7866 of which have distance measurements
- 59% of which have spectroscopic redshifts
- 39% of which have photometric redshifts

The i < 15.9 catalog has 320,192 galaxies:
- 5906 of which have distance measurements
- 43% of which have spectroscopic redshifts
- 55% of which have photometric redshifts

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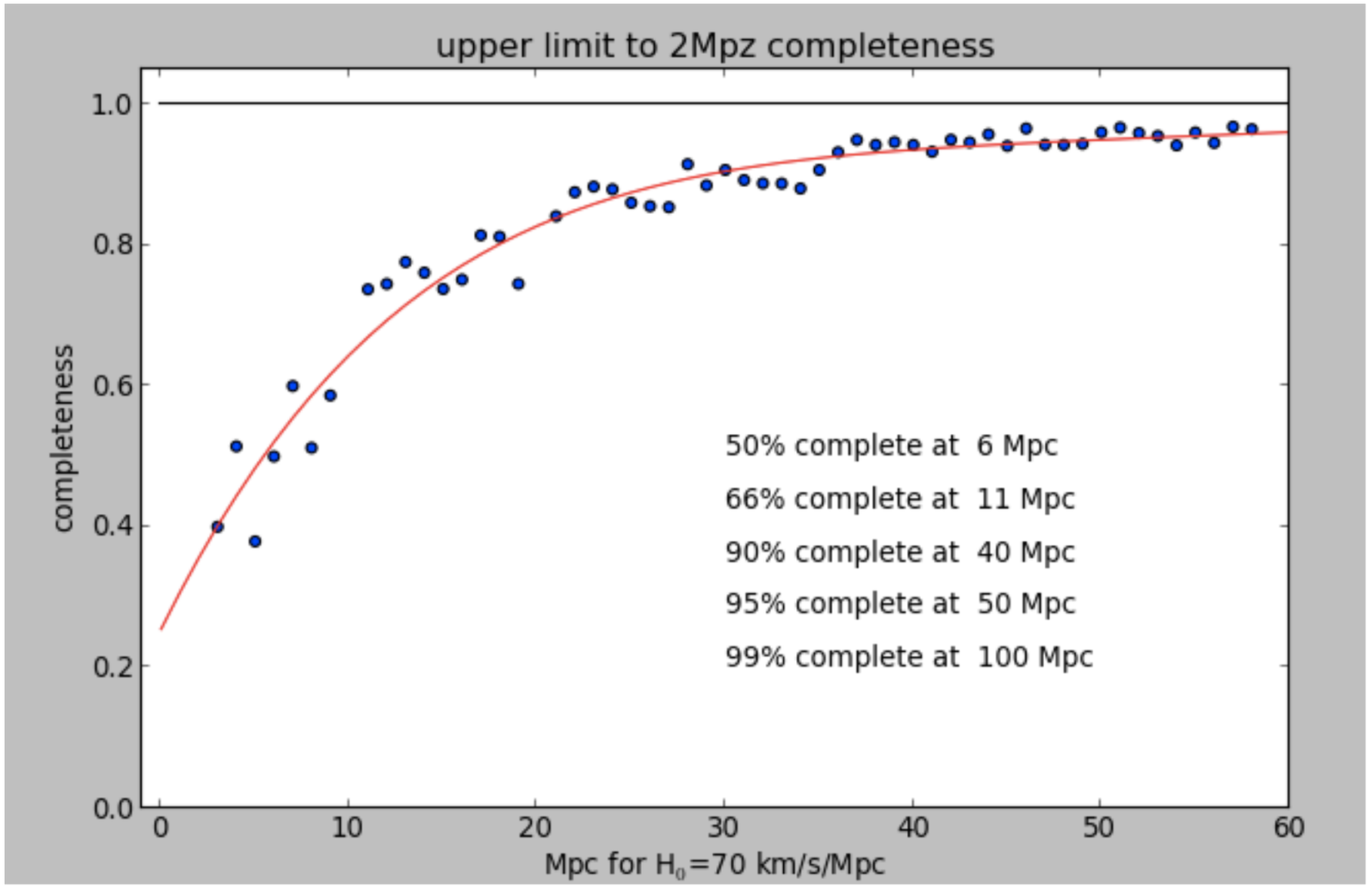
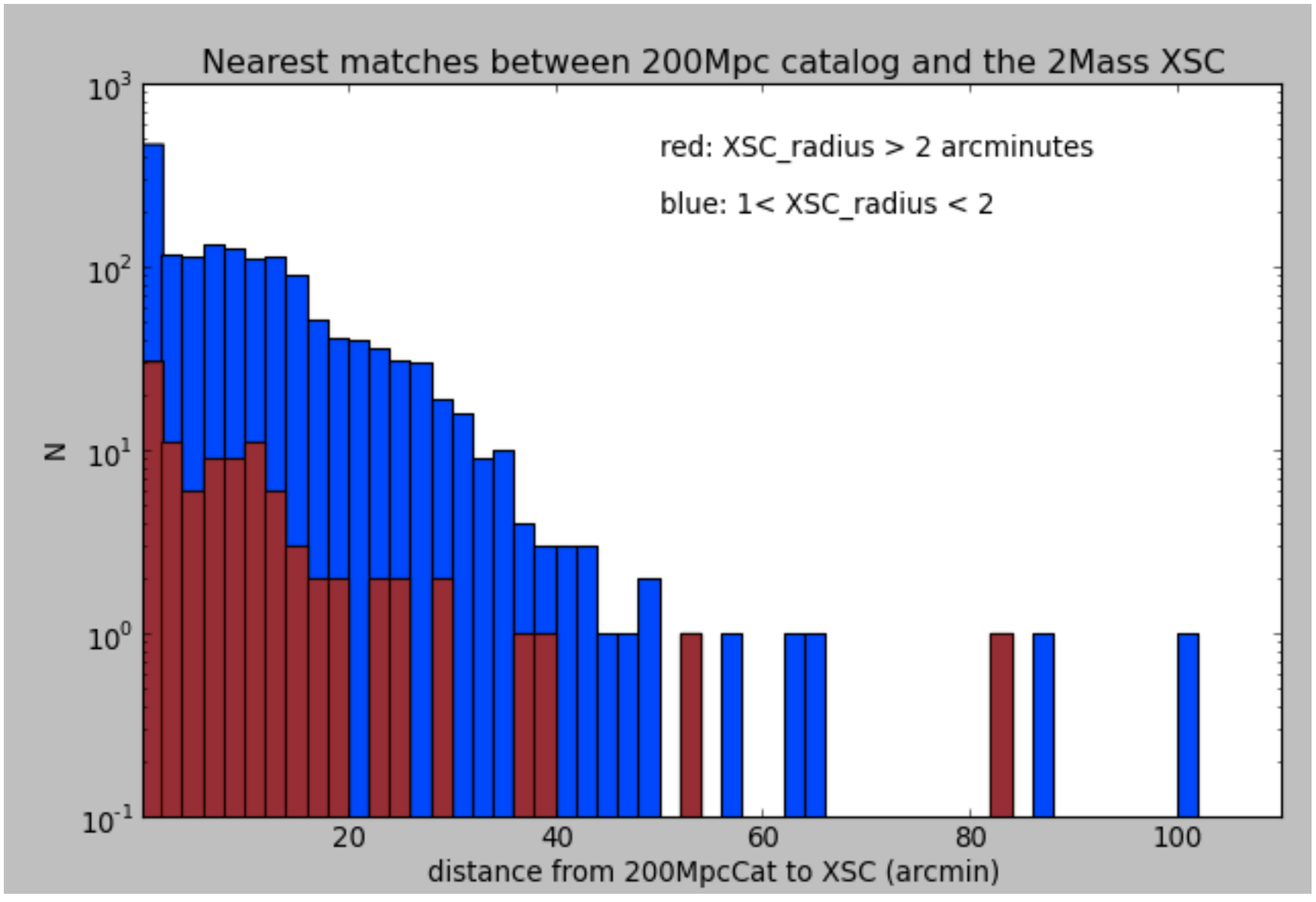


Completeness estimated from the number of galaxies added back into the base catalog. This is a strict upper limit; the catalogs that were used to add back in are likely incomplete to varying degrees. The next thing to check is a diameter limited sample from the 2Mass XSC.

DARK ENERGY
SURVEY



Using the catalog

For the distance range of interest, integrate the probability density function that the galaxy is inside that distance, add the value to the map, and proceed for all galaxies. This is necessary because of the many galaxies in the photo-z catalog that could be at d< 200Mpc with a 1 or 2 σ error in the photo-z. As the volume increases dramatically, these are quite numerous. For a stellar mass map use the probability as a weight when adding to the pixel.