Galaxies: Structure, formation and evolution

Lecture 6

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Large scale structure of galaxies

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Large scale structure of galaxies

So far, we have looked at galaxies and their components from a structural point of view. The physical scale is a few 10s of kiloparsecs. Now we look at the large scale structure of baryons in the universe on Mpc scales. Just as stars are the individual building blocks of galaxies, galaxies are building blocks of the *cosmic web* of large scale structure. Remember, however, that galaxies are *biased* tracers of the underlying DM distribution i.e. M/L ratio is not constant!

Why conduct galaxy redshift surveys?

- Density fluctuations evolve into structures we observe: galaxies, clusters, etc.
- On scales $>$ galaxies, we talk about the Large Scale Structure (LSS); groups, clusters, filaments, walls, voids, superclusters are the elements of LSS
- To map and quantify the LSS (and compare with the theoretical predictions of cosmological models), we need redshift surveys: mapping the 3-D distribution of galaxies
- Today we have redshifts measured for $>$ 2 million galaxies
- While the existence of clusters was recognized early on, it took a while to recognize that galaxies are not distributed in space uniformly randomly, but in coherent structures.

Galaxy imaging surveys

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Galaxy imaging surveys

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1995	DPOSS	50 M
2005	SDSS	200 M
2024	Rubin/LSST	10000 M

Galaxy redshift surveys

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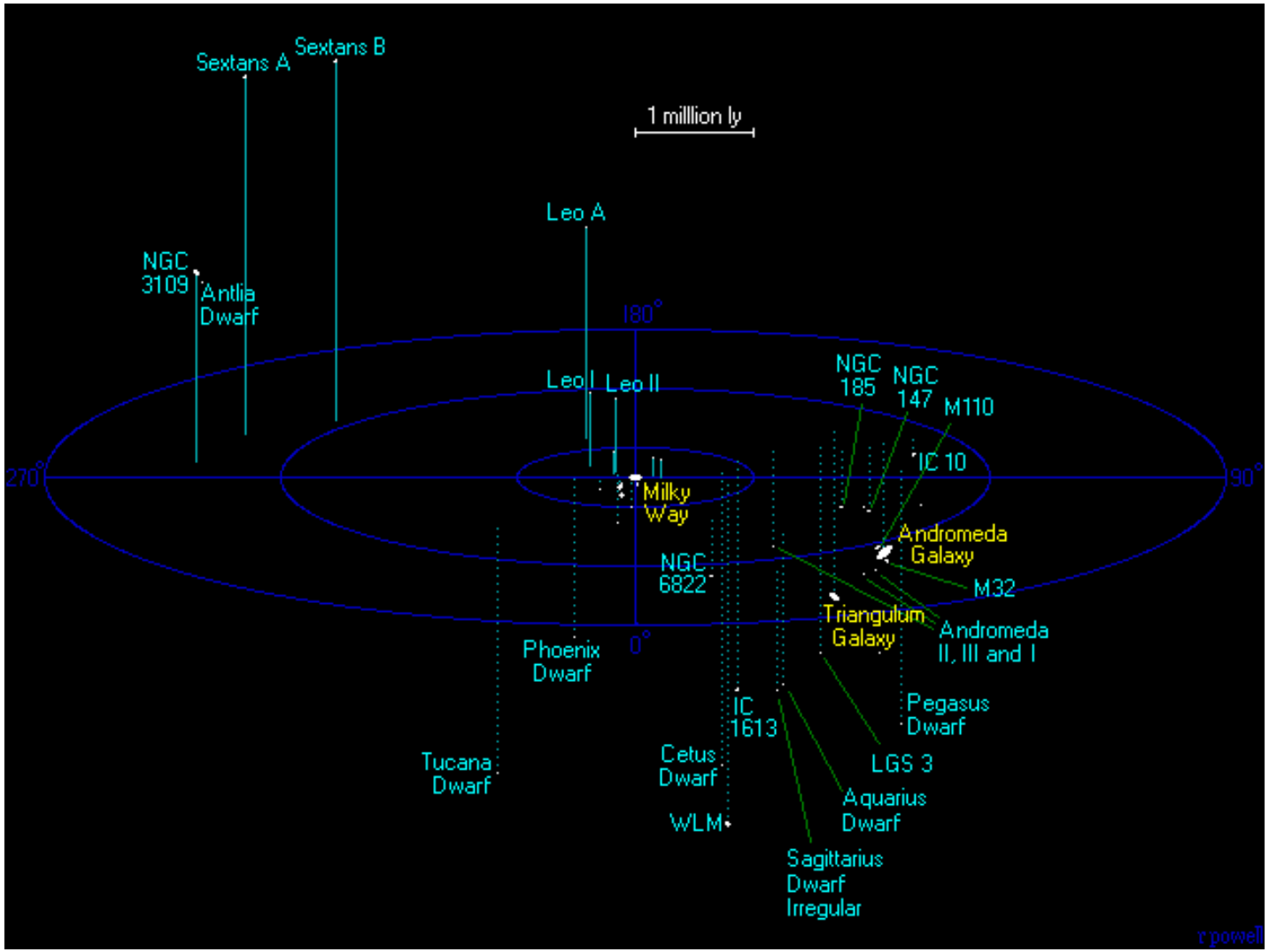
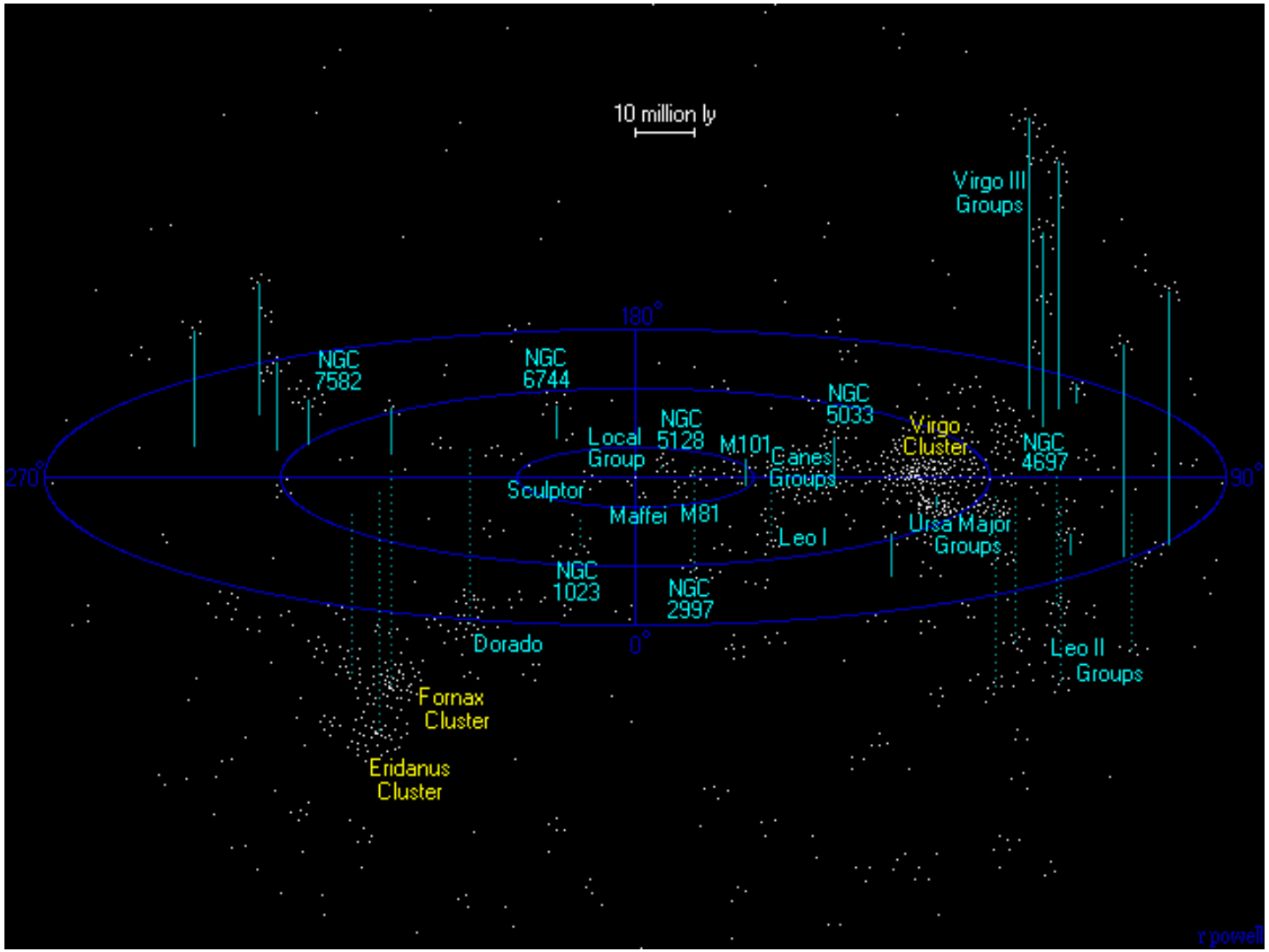
2005	SDSS	800k
2021	SDSS DR17	3m

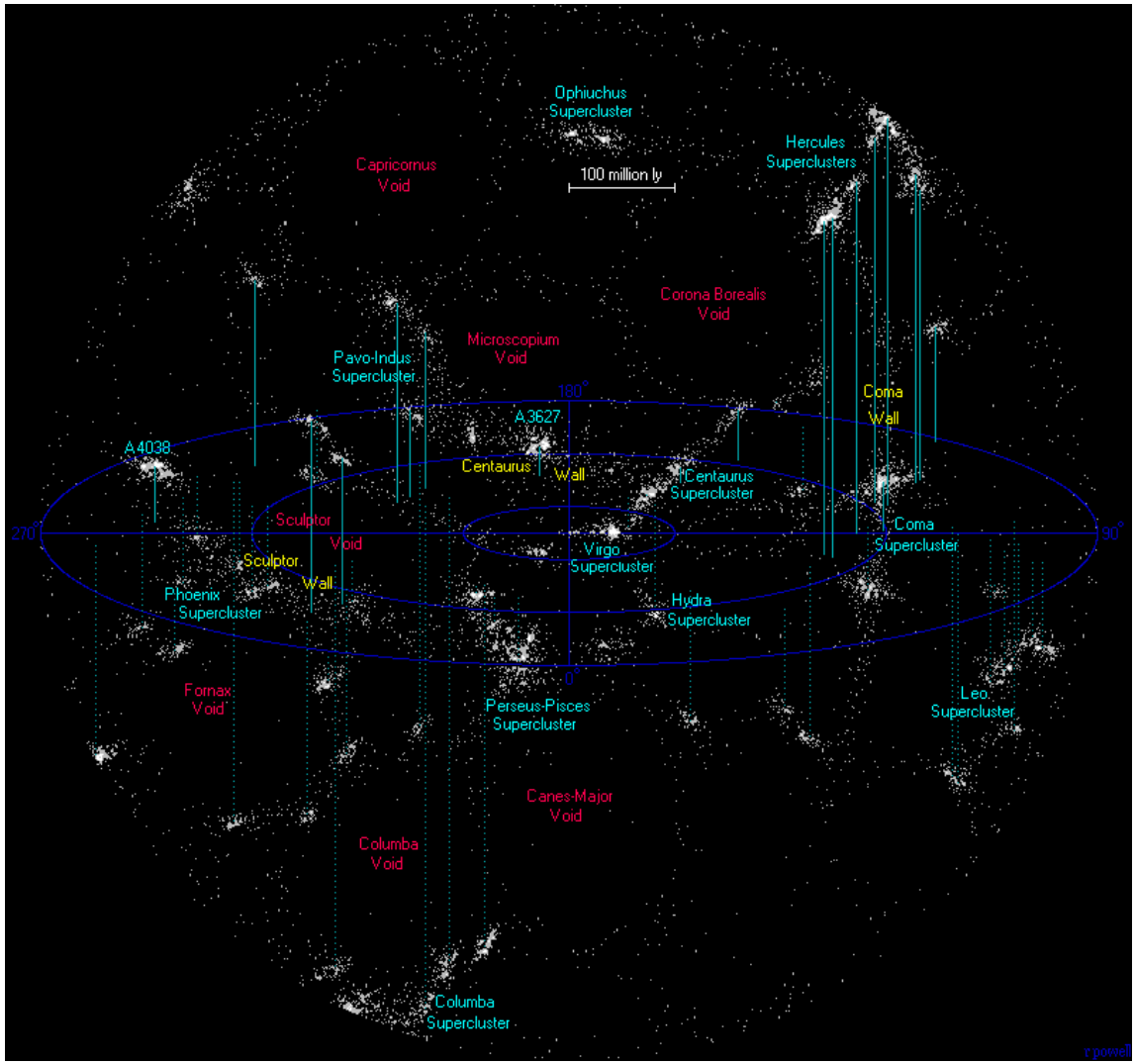
The Local group



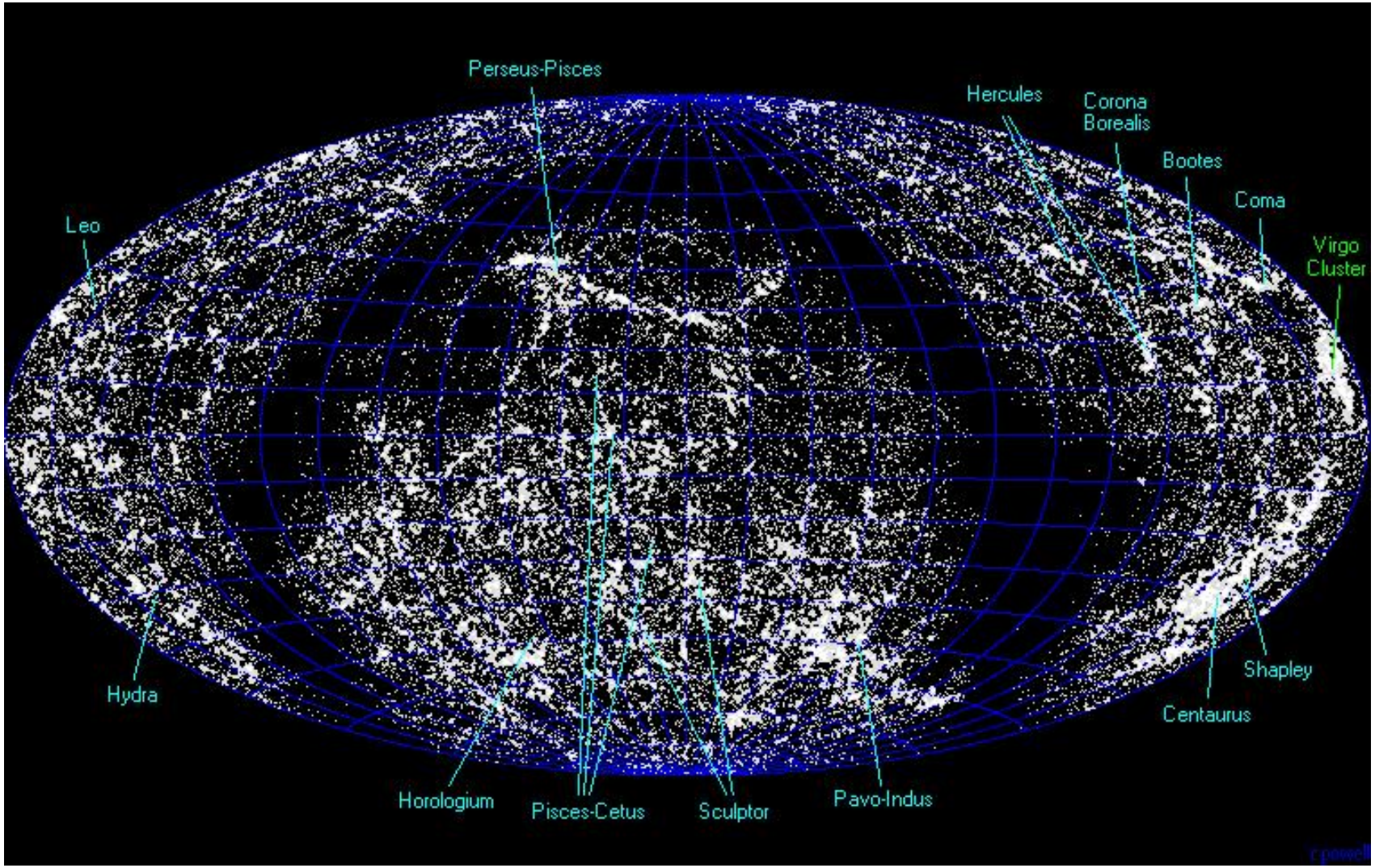
The local supercluster



Nearby superclusters

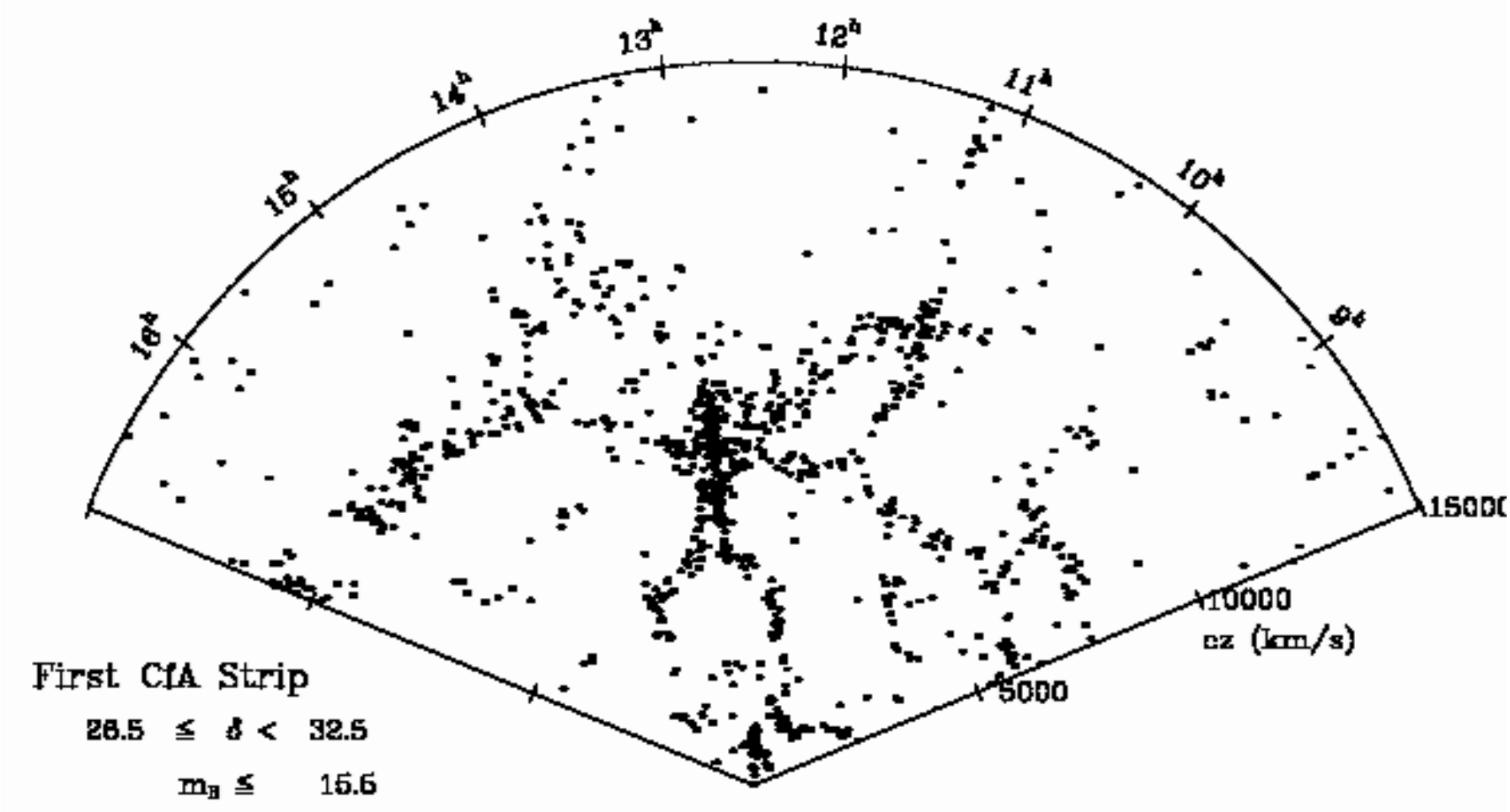


6000 Brightest galaxies

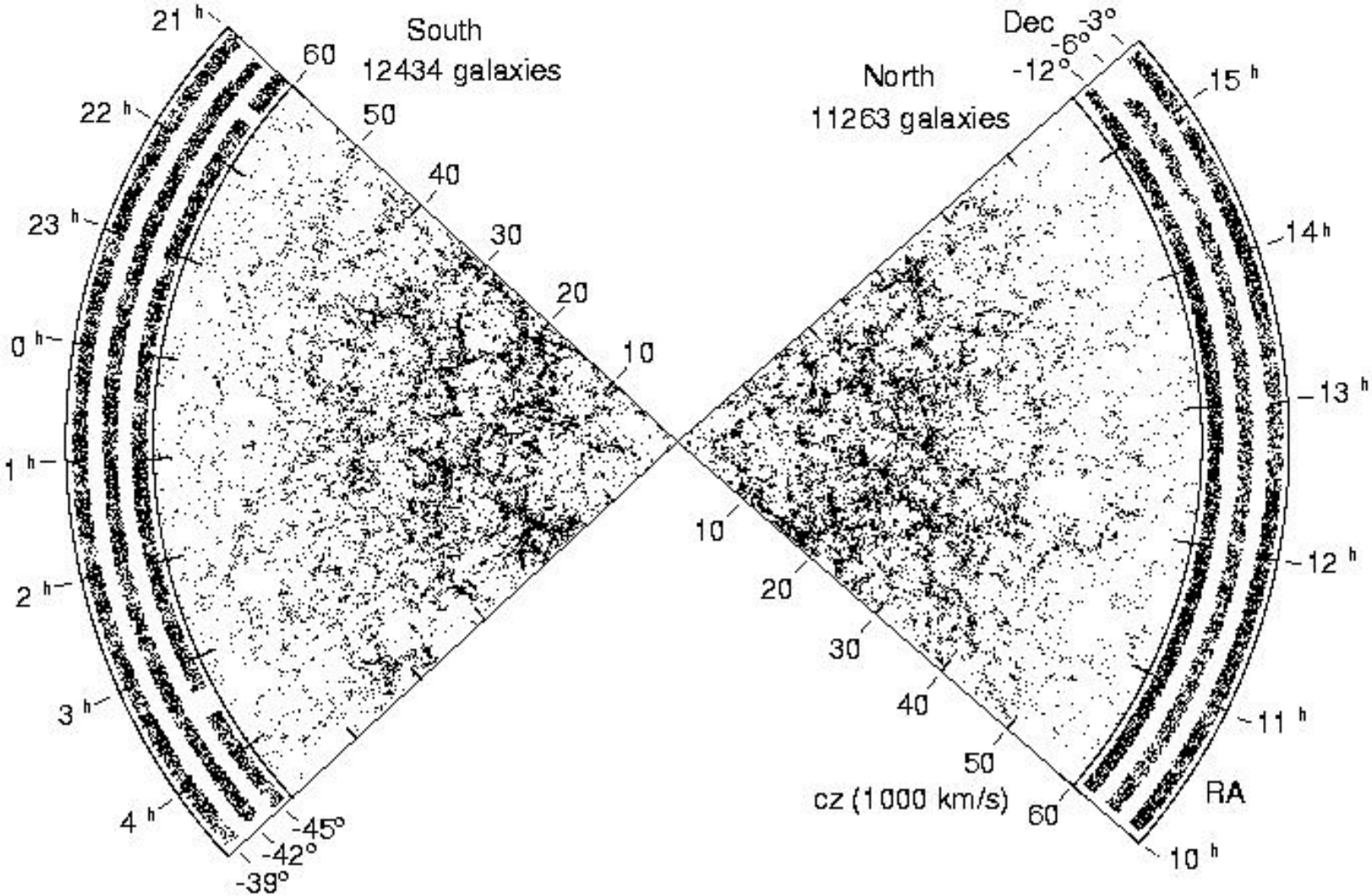


Where would the 6000 brightest stars lie?

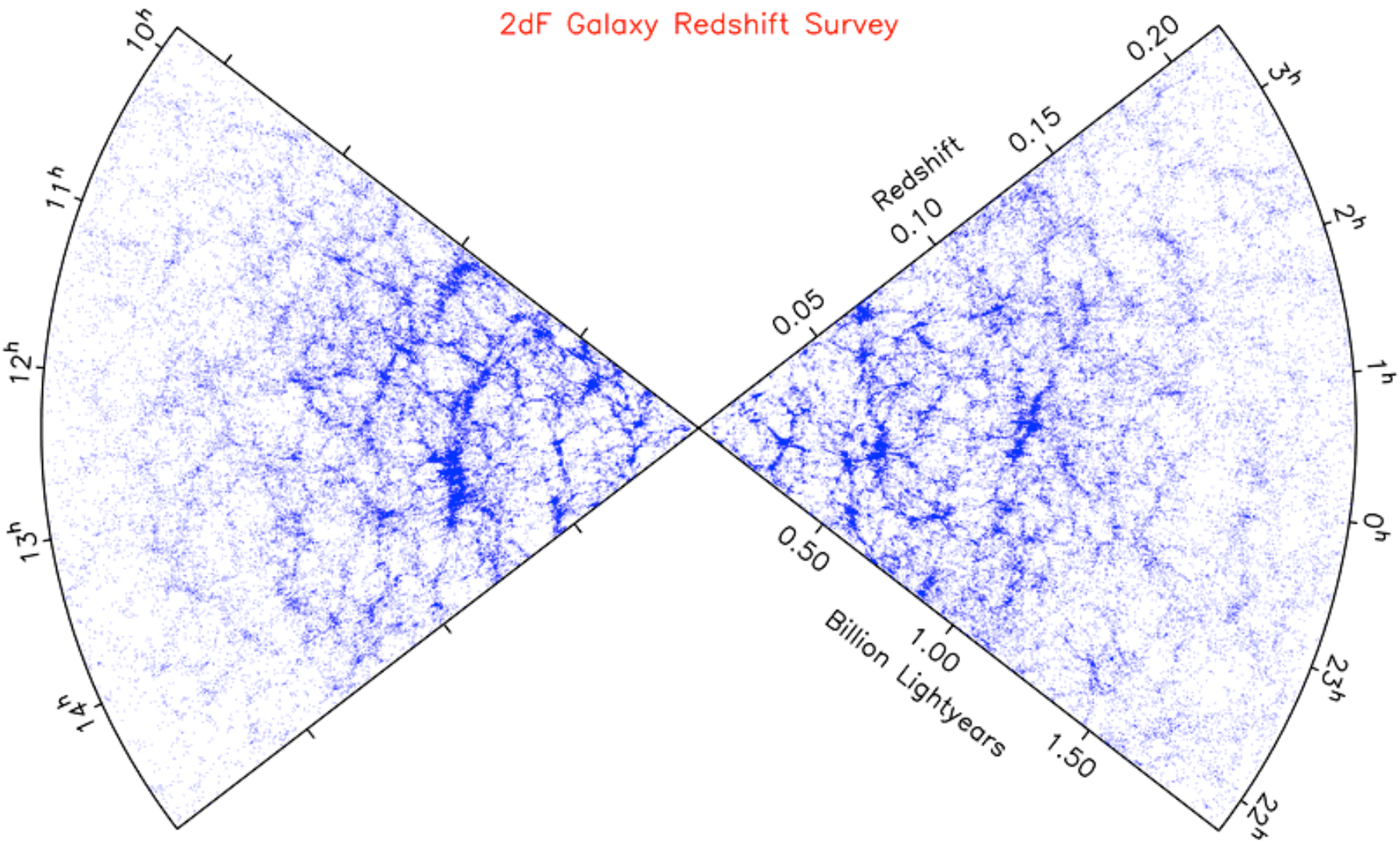
CFA stickman - Coma cluster, peculiar velocity biases



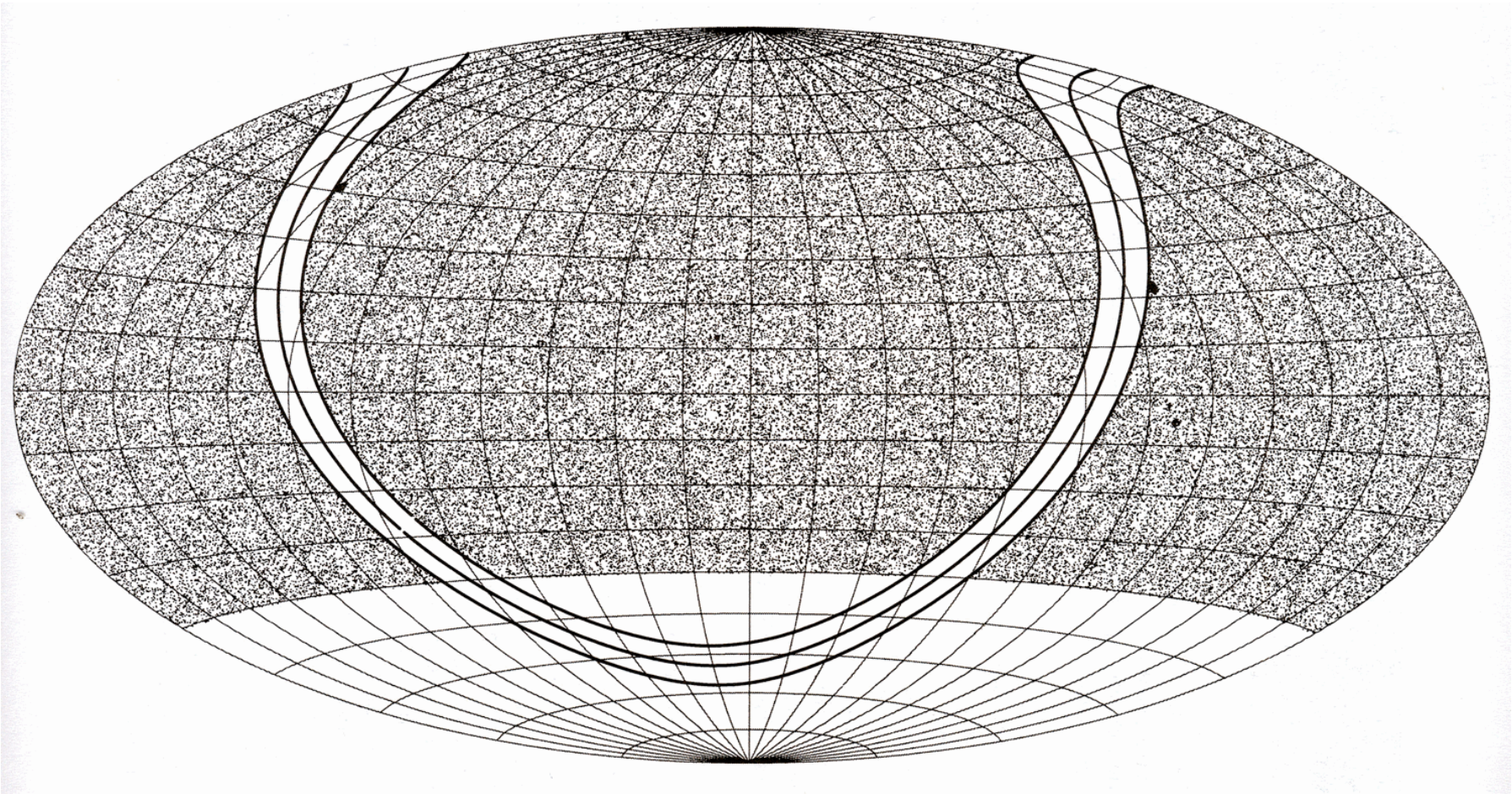
Las Campanas Redshift survey



2dFGRS

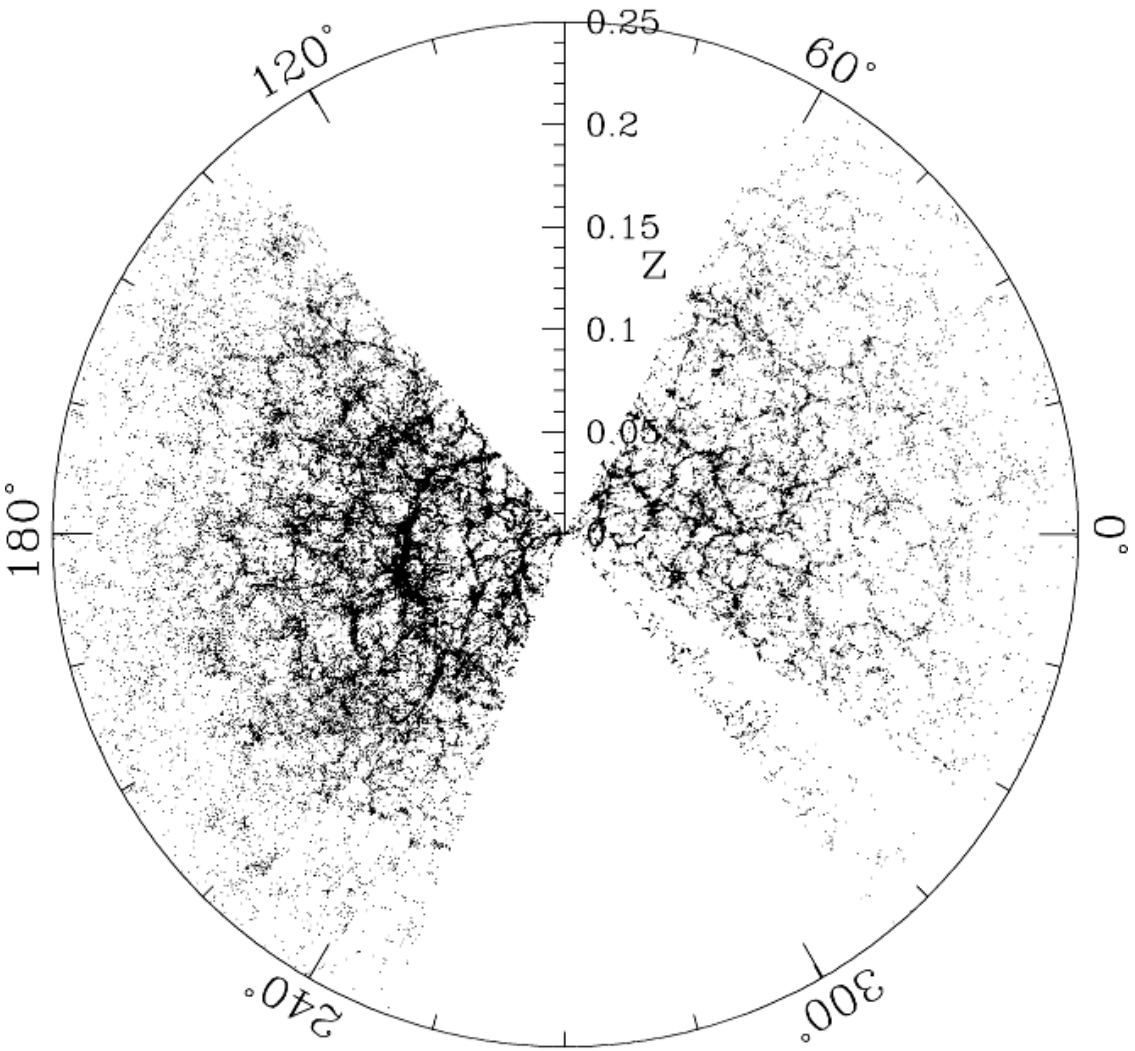

2dF Galaxy Redshift Survey
10h
11h
12h
13h
14h
Redshift
0.05
0.10
0.15
0.20
0.50
1.00
1.50
Billion Lightyears
3h
2h
1h
0h
23h
22h

NVSS source count distribution

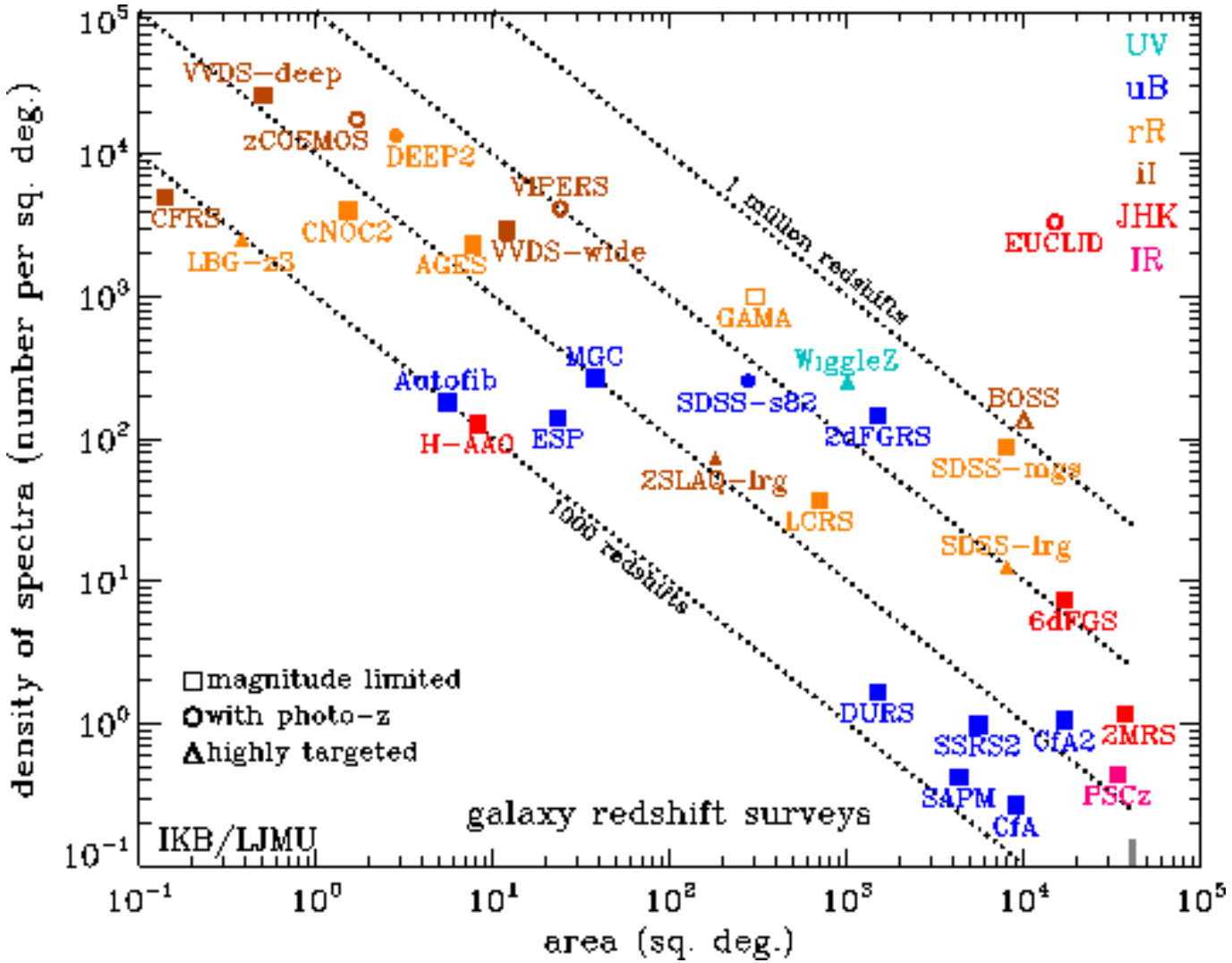


Why is this distribution much less clustered than the optical surveys?

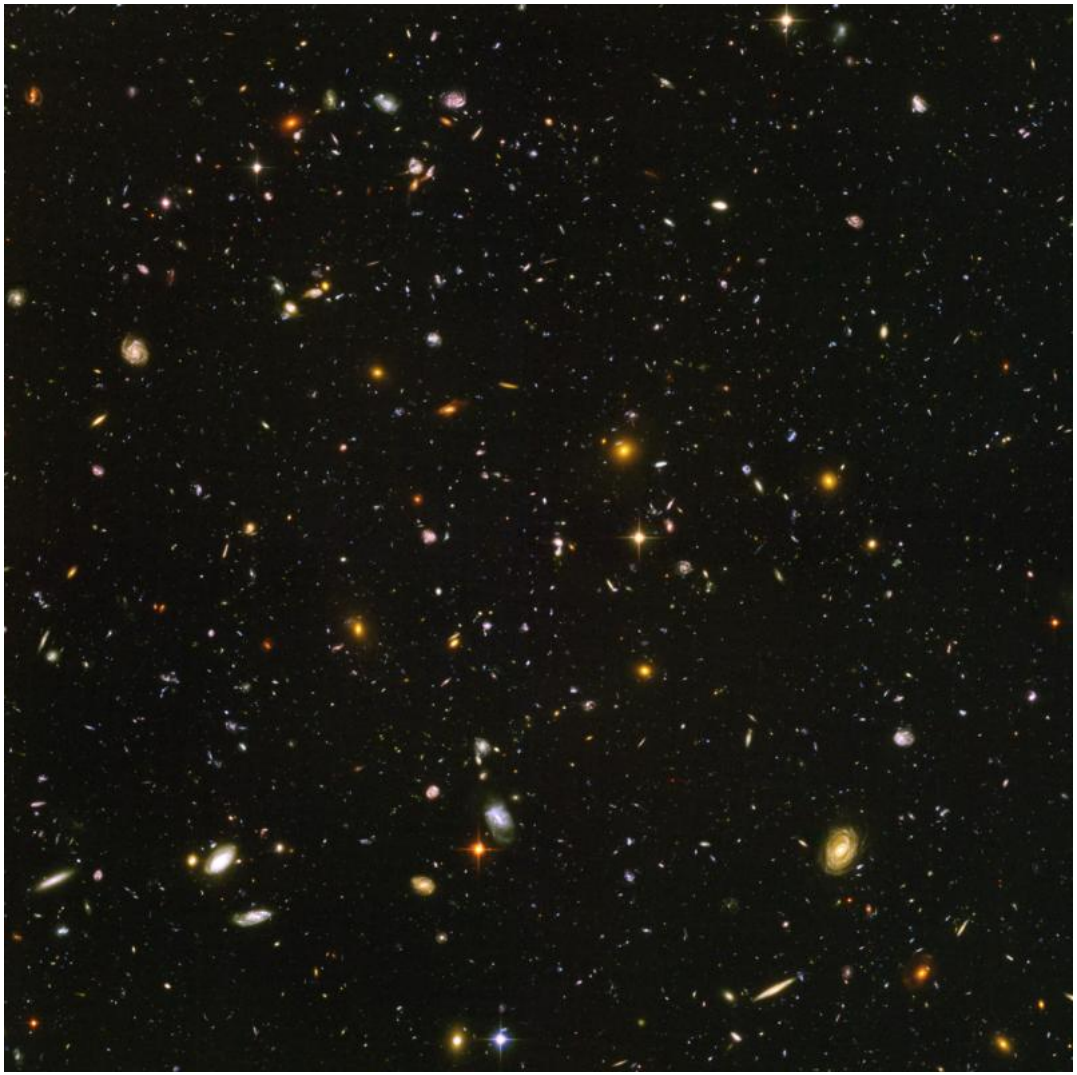
Sloan digital Sky Survey (SDSS)



Optical surveys compared

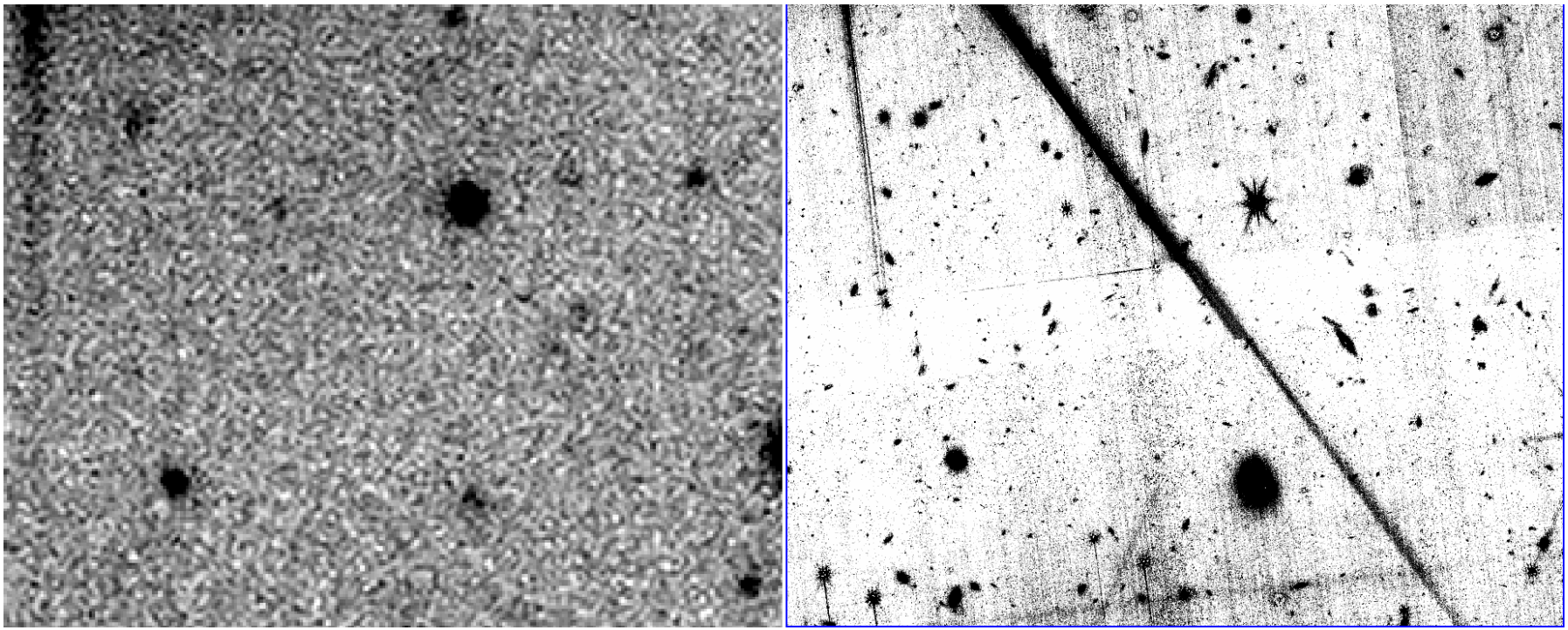


Pencil beam surveys e.g. Hubble Ultra Deep Field



These surveys map out evolution of field galaxies and LSS out to $z \sim 1 - 2$ and beyond.

The future of pencil beam surveys



DESI *r*-band (left) and JWST NIRCam (right)