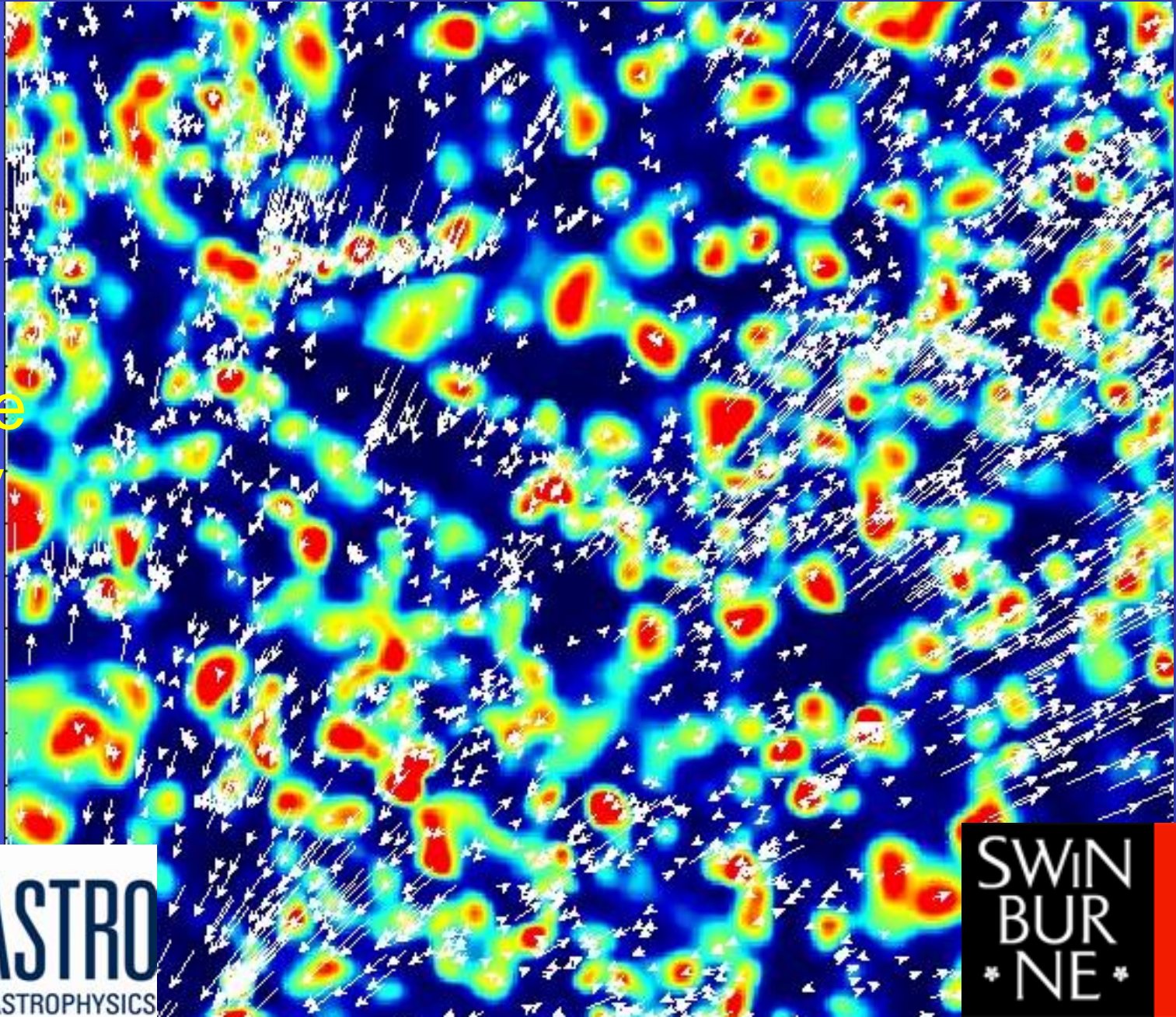


The 6dF Galaxy Survey & its successor, Taipan

Jeremy
Mould
Swinburne
University

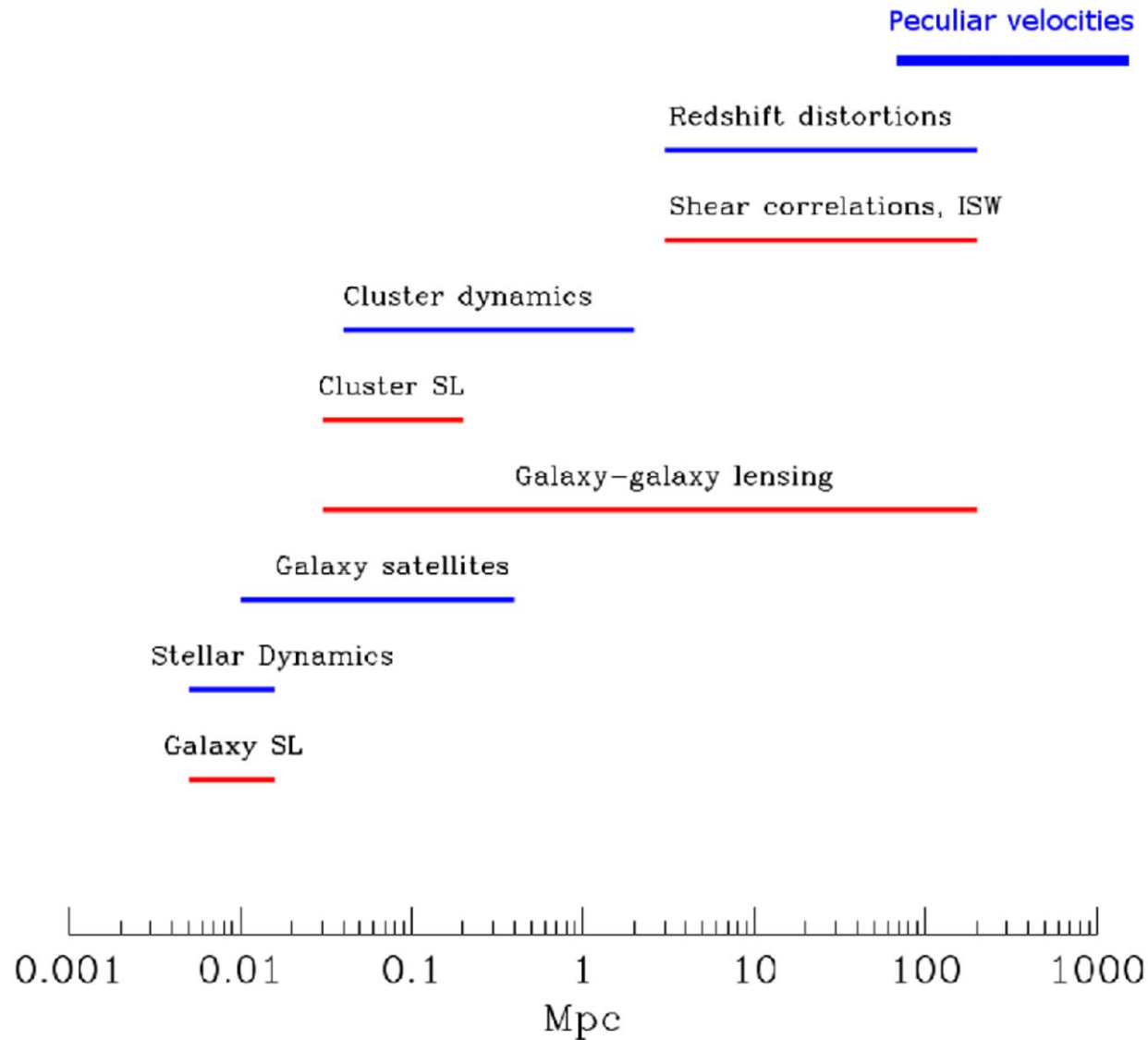
ICISE
July 2014



SWIN
BUR
NE

SWINBURNE
UNIVERSITY OF
TECHNOLOGY

Scales probed by different methods to constrain gravity.



Andrew Johnson et al. MNRAS 2014;444:3926-3947

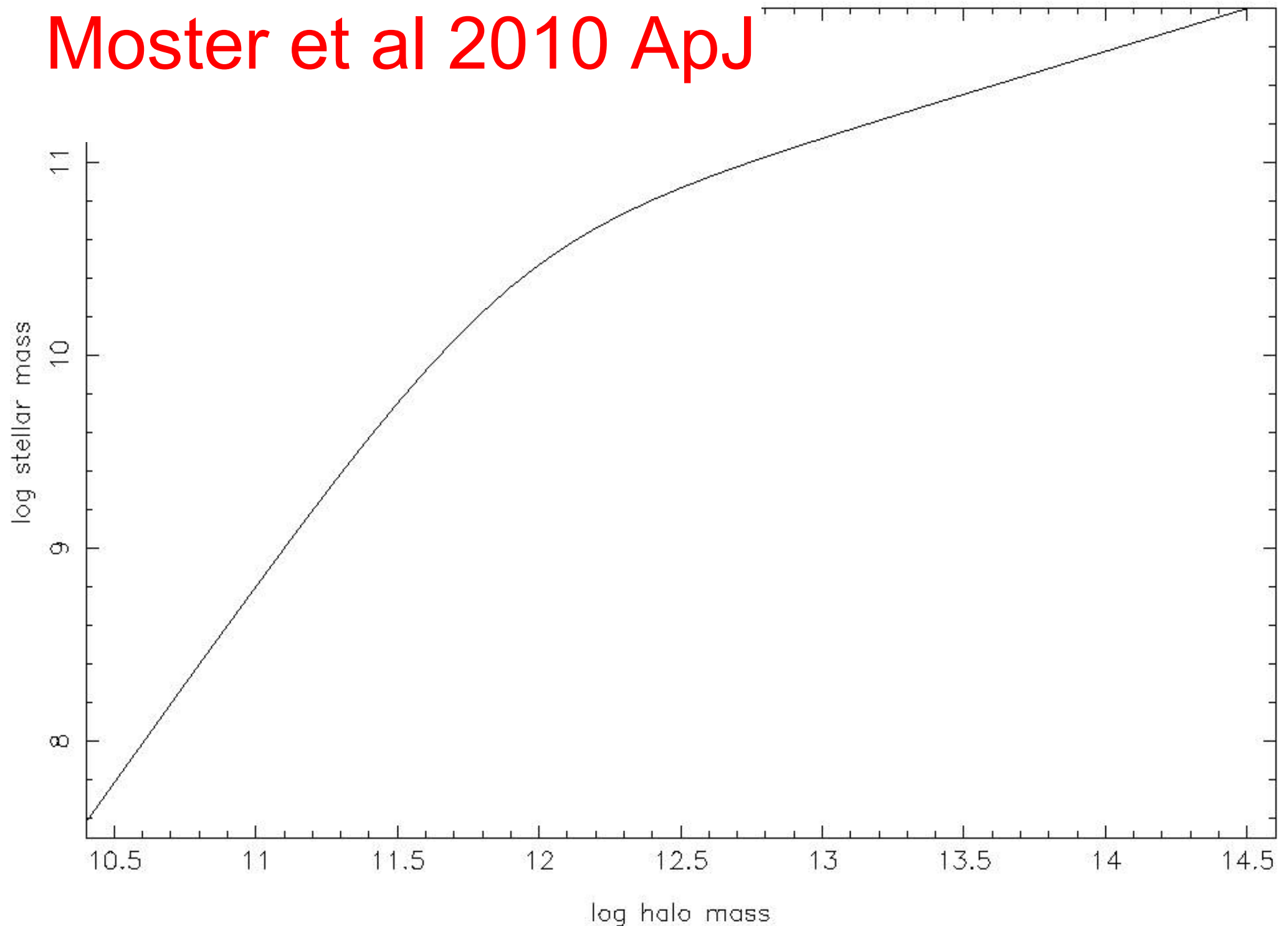
Literature PV results

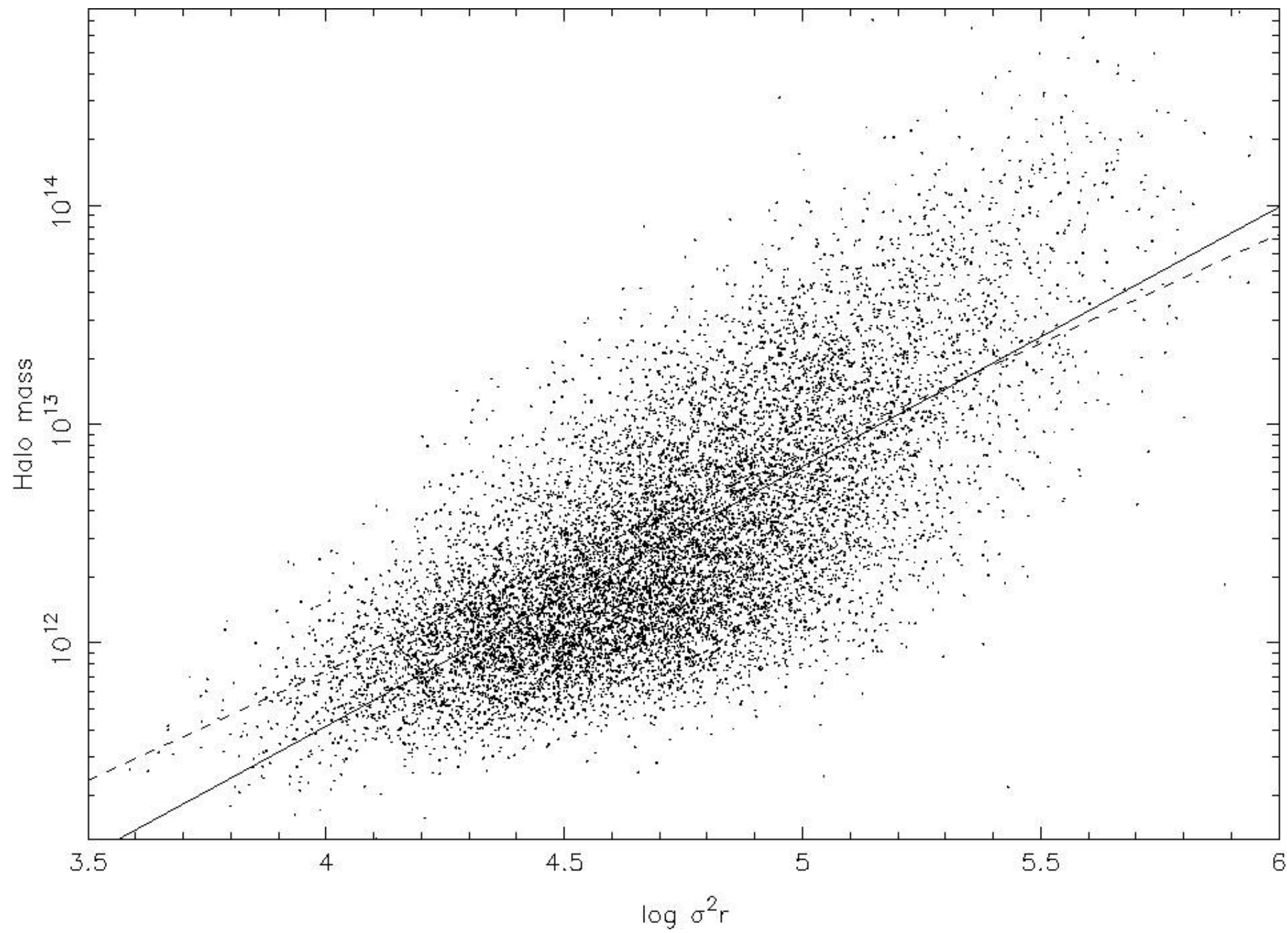
- Watkins & Feldman 2014 MN
 - distribution of errors in SFI++ survey not centred on zero.
 - can be explained by $\sim 400 \text{ km s}^{-1}$ coherent outflow in the survey volume or systematic error in scaling distances of $\sim 5\%$
- Courtois, Hoffman, Tully 2015 IAU
 - estimated bulk flow is consistent with the LCDM model
 - At $R=50\text{-}150 \text{ Mpc/h}$ estimated bulk velocity is $250 \pm 21 \text{ km/s}$
- Branchini, Davis, Nusser 2012
- Carrick, Turnbull, Lavaux, Hudson 2015
 - estimated bulk flow is consistent with the LCDM model
- Kashlinsky (KABKE) “dark flow”
 - SZ cluster sample moving $\sim 600\text{--}1,000 \text{ km/s}$ towards CMB dipole

Peculiar velocities from 6dF

- What is 6dFGS ?
- Fundamental plane is a relation between halo mass measured by s & r_e and galaxy luminosity
- L can be converted to stellar mass by M/L
- M/L is deduced from Springob et al population age, Z , using Maraston models
- Halo mass and stellar mass are related by HOD e.g. Moster et al 2010
 - HOD is accounting, not physics

Moster et al 2010 ApJ

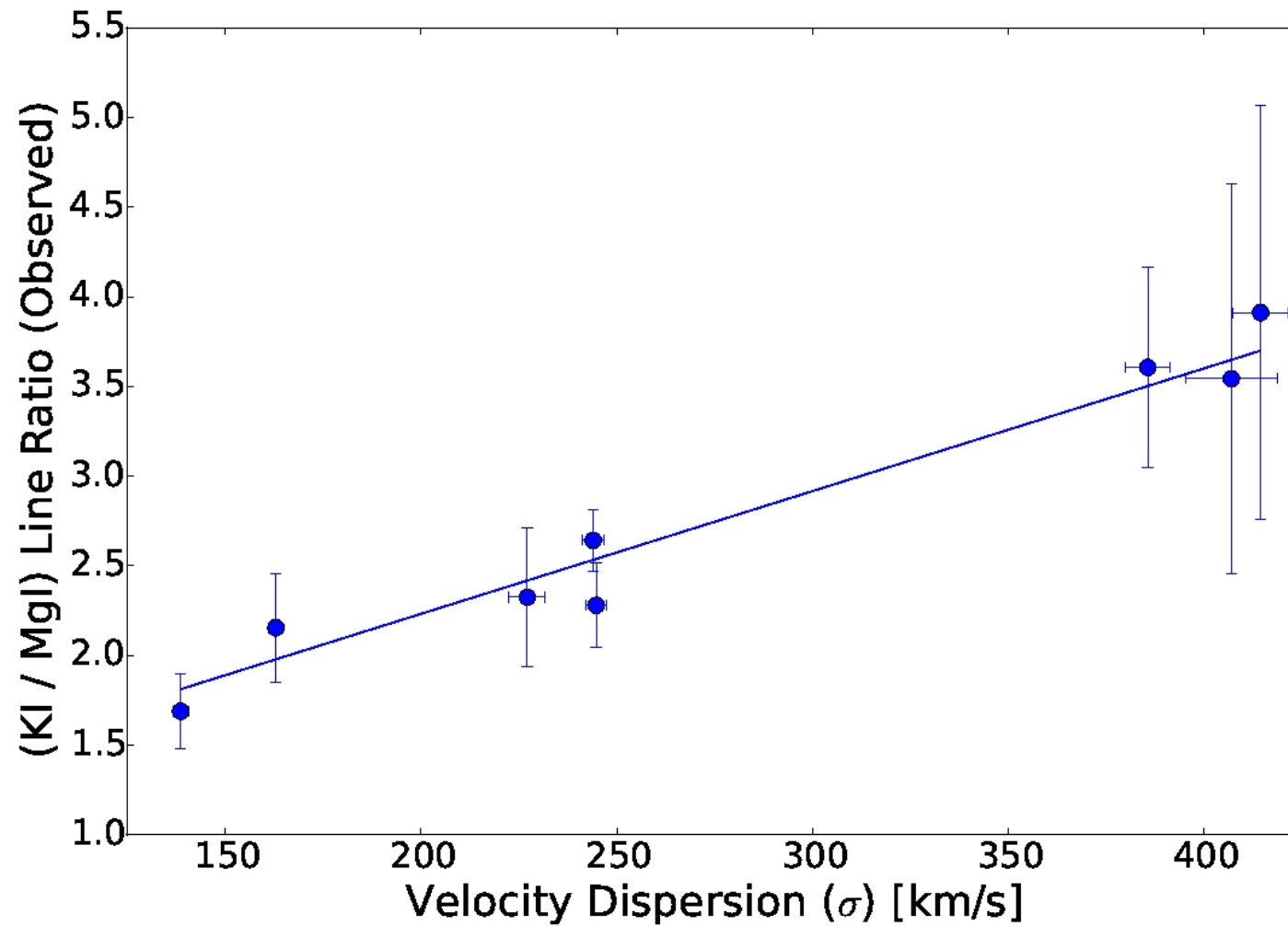




Tilt of the fundamental plane

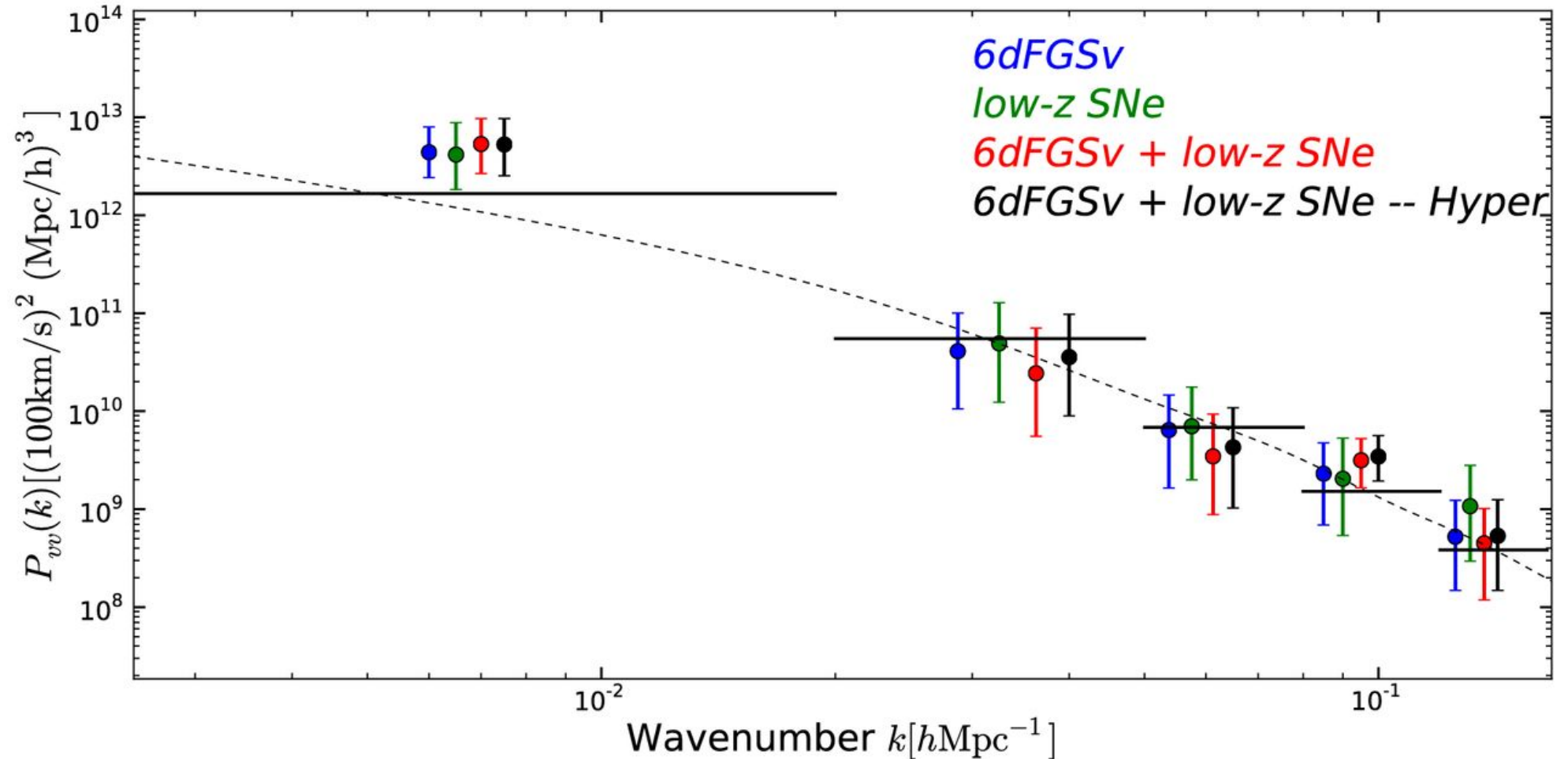
- This is mostly explained by the previous slide:
- M^* vs M_{halo}
- Another factor is IMF(Z)
- See Lagattuta et al submitted to ApJ

IMF(s) from FIRE KI EWs



Amplitude of the velocity power spectrum

68 per cent confidence intervals for the amplitude parameters A_i scaled by the mean power within each bin for the 6dFGSv data, SNe data and the combined constraint.



Andrew Johnson et al. MNRAS 2014;444:3926-3947

Springob et al 2015, MN

- compare observed velocity fields (6dFGS & 2MTF)
- with reconstructed peculiar velocity field models derived from redshift surveys
- do galaxies trace mass ?
- do observed velocity fields show "residual bulk flow" not predicted by the models ?
- note that just multiplying Shapley's M/L by a factor of a few doubles the predicted local motion

Christina Magoulas will talk about this

Calculate the velocity field from the density field

$$\vec{v} = \frac{Hf}{4\pi} \int \frac{\delta(\vec{x}')(\vec{x} - \vec{x}')d^3x'}{(|\vec{x} - \vec{x}'|)^3}$$

It is also possible to go in the reverse direction and calculate the density field from the velocity field

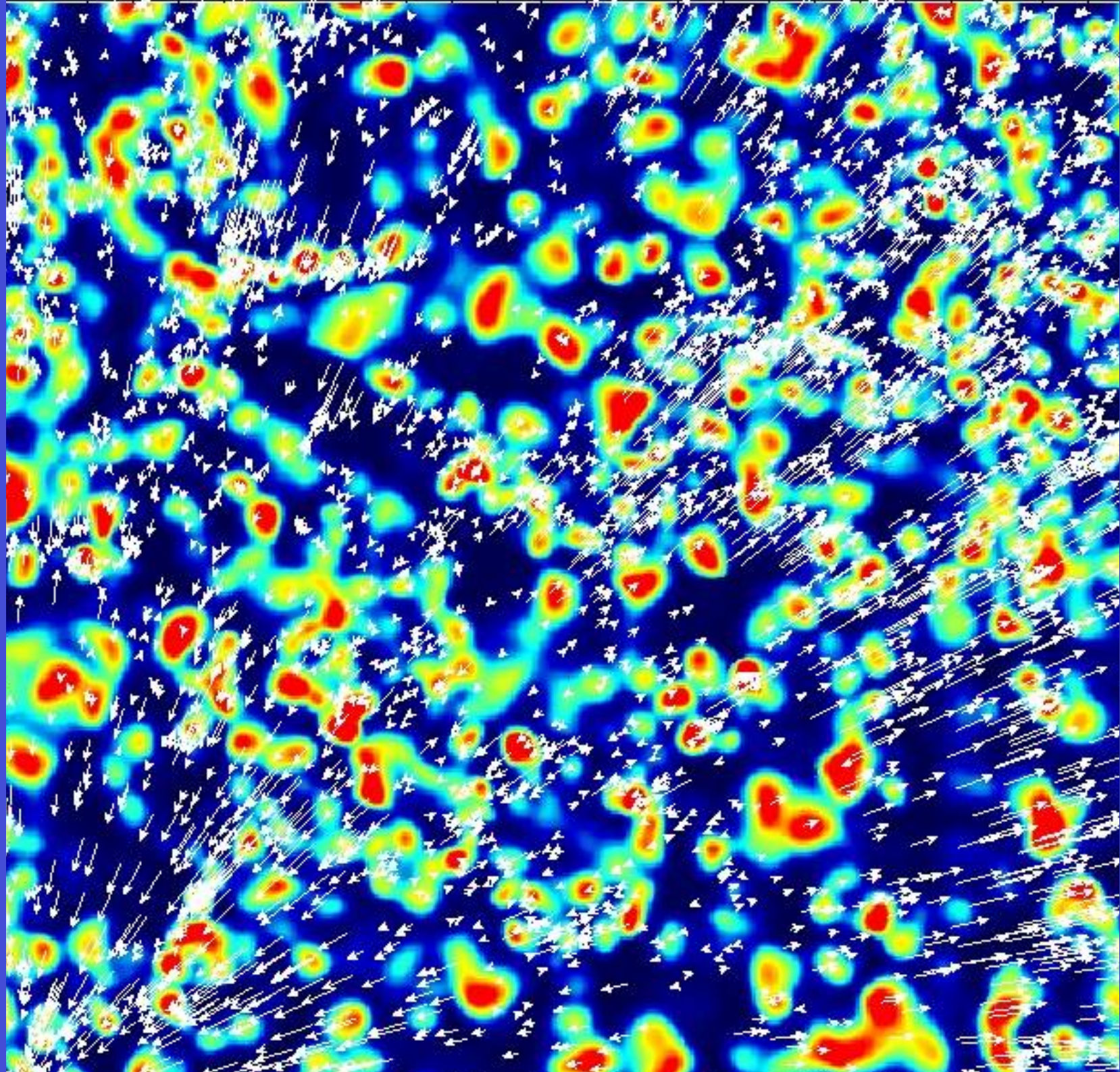
- Smooth and integrate the velocity field to get the potential
- Then recover the density field from the potential

$$\mathbf{v} = \nabla \Phi$$

Summary of cosmic flow (linear approximation)

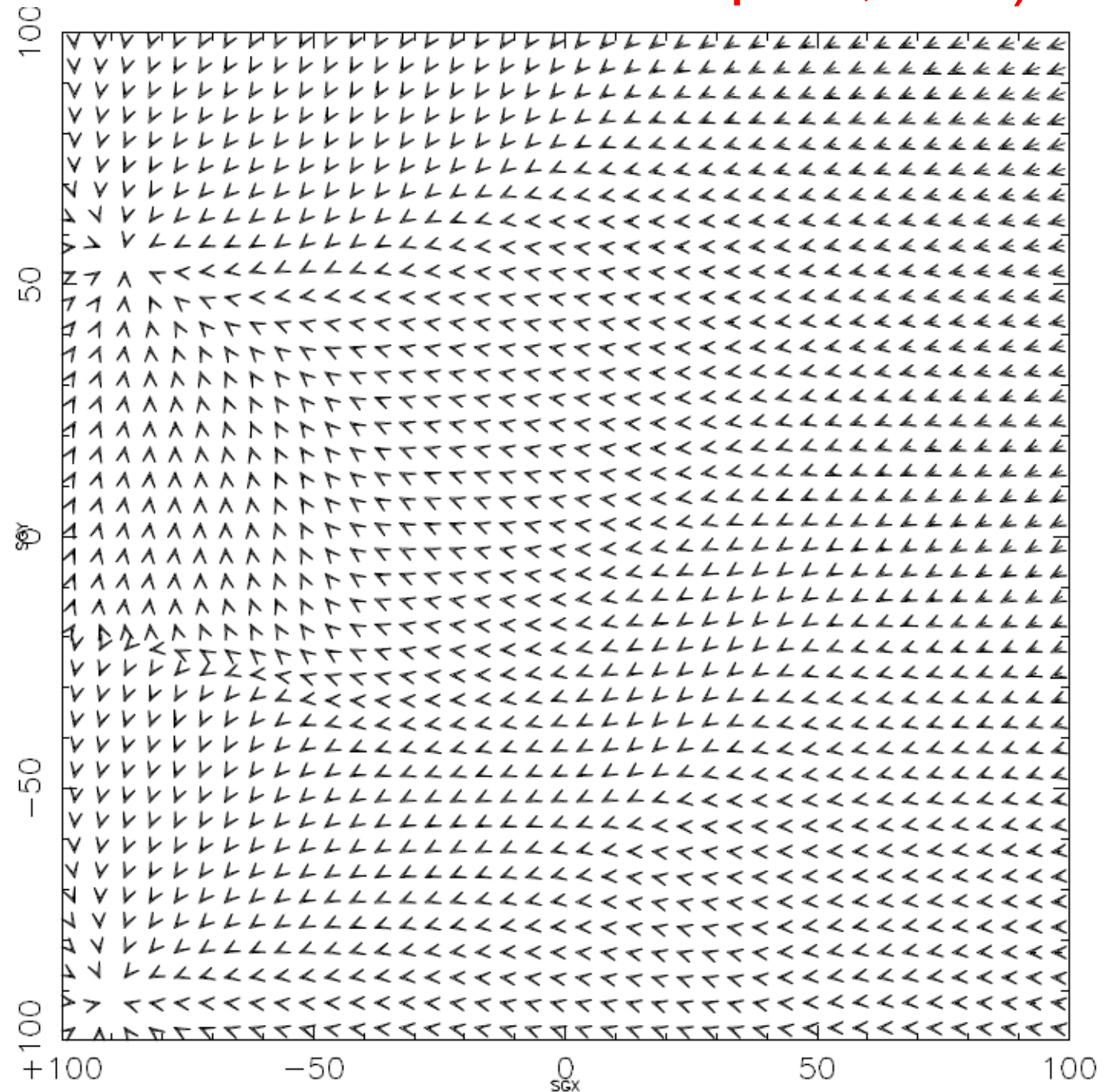
$$\vec{\nabla} \cdot \vec{v} = -\frac{\delta\rho}{\rho} f(\Omega)H \qquad \vec{\nabla} \times \vec{v} = 0$$

200 Mpc
square,
20 Mpc
slice



MOND (Mould & 6dF team 2015 ApSS, 357)

A MOND
consistent with
observed LSS
would need to
asymptote to
zero at large
distances more
like r^{-2} than r^{-1}



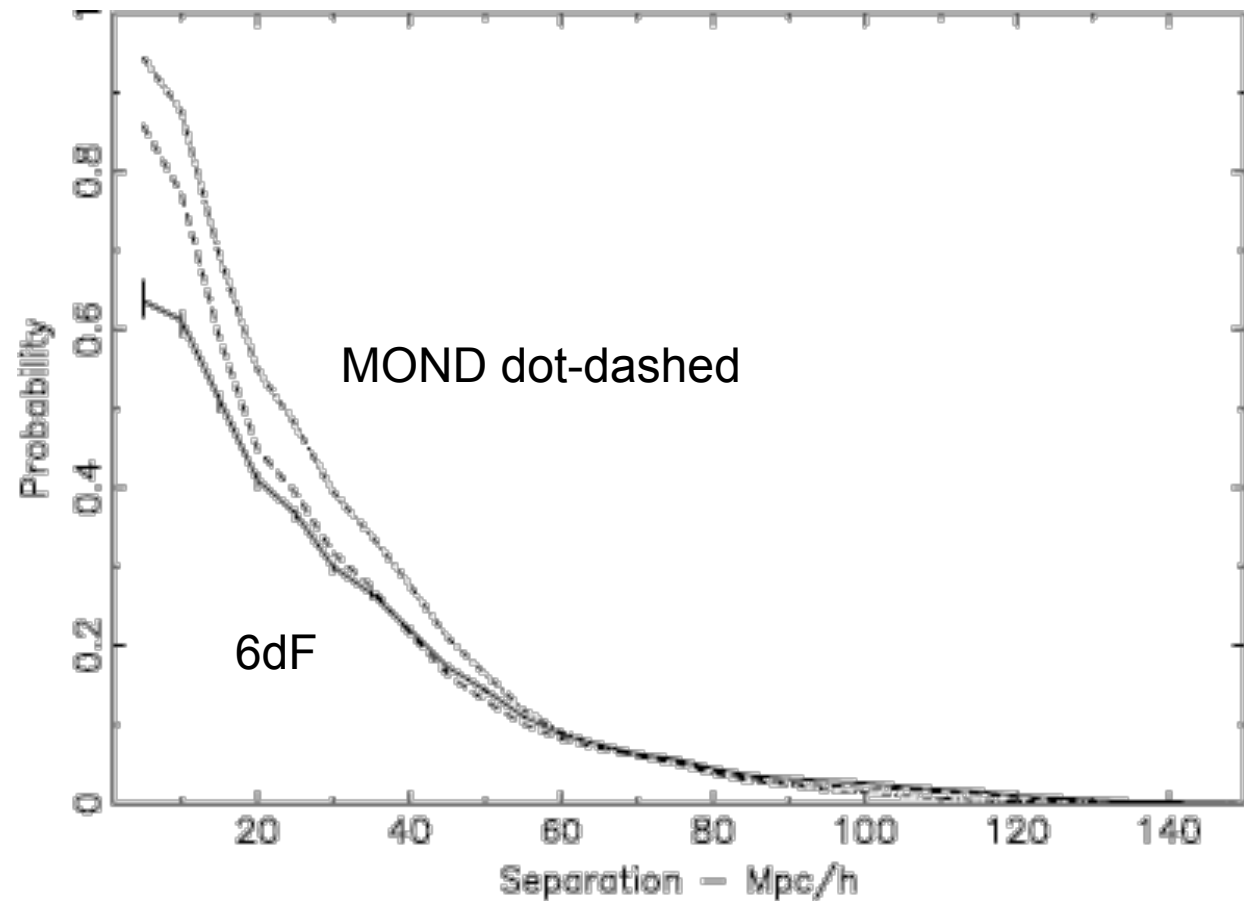
Velocity angular correlation function

For every pair of galaxies in the 6dFGS peculiar velocity sample the angle between the radial peculiar velocities is θ

Figure shows probability θ is small ($\cos\theta > 0.9$) as a function of separation.

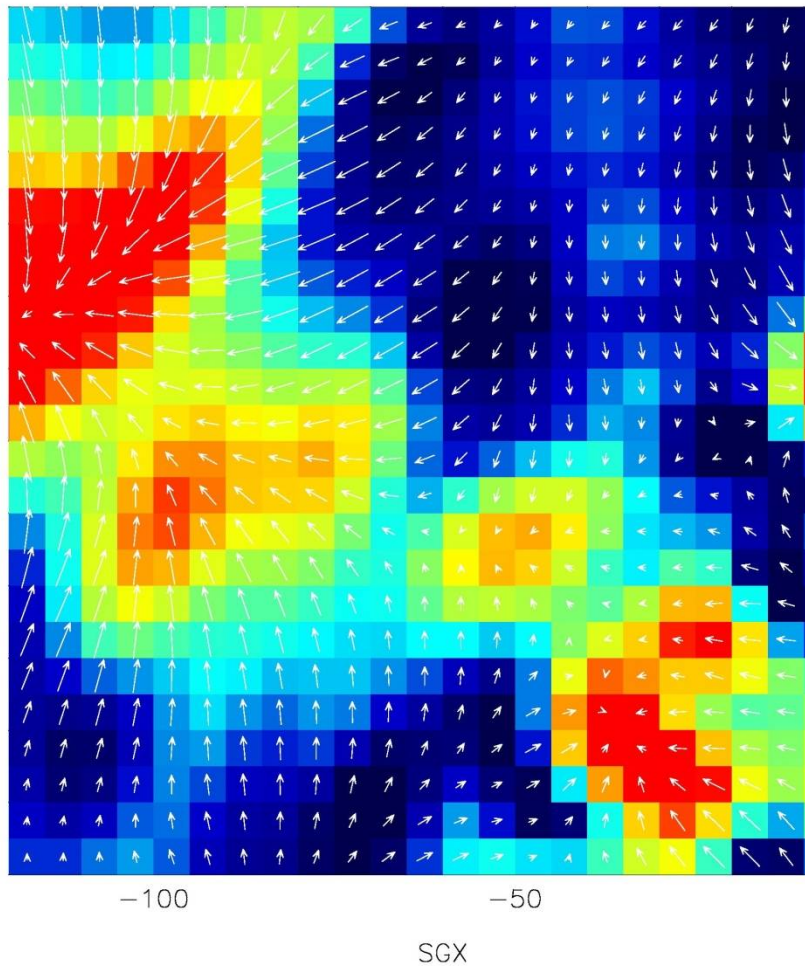
In MOND small misalignments continue to large galaxy separations.

In our Erdoğdu model the fall off is more rapid.

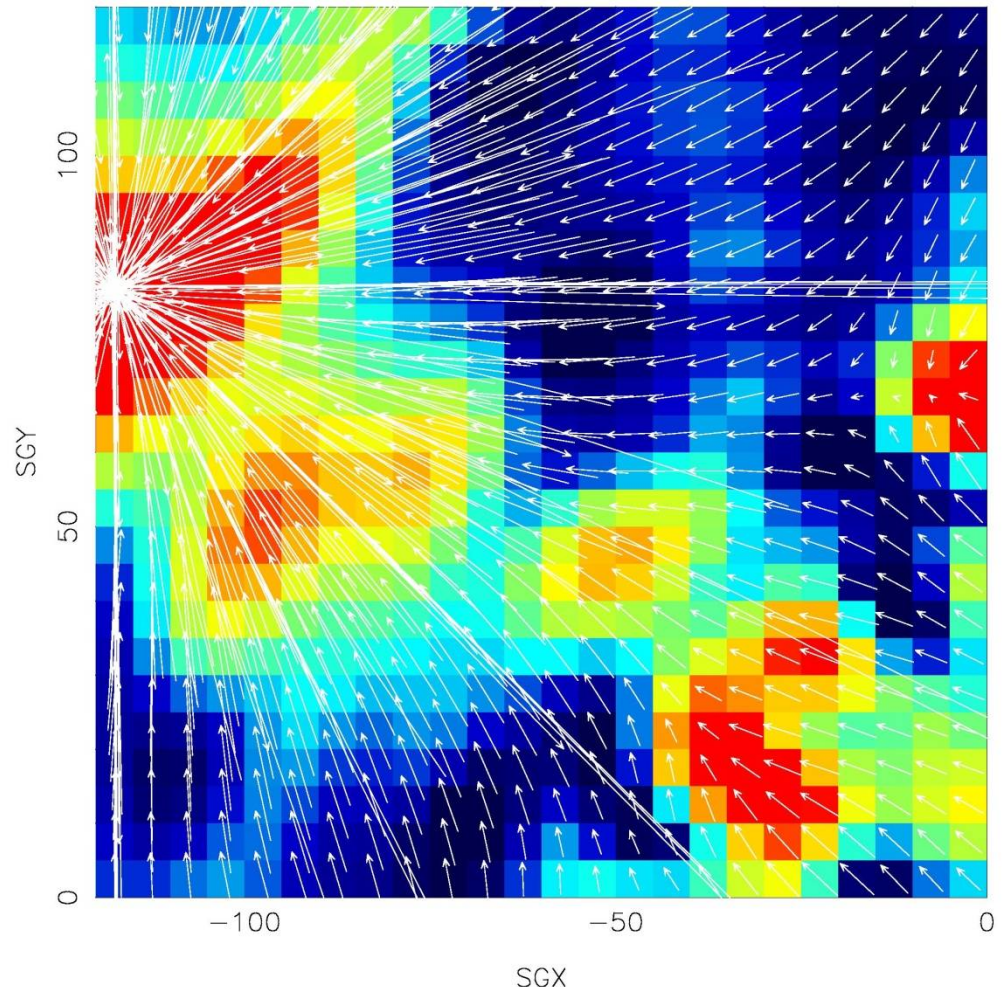


Sensitivity of bulk flow to Shapley

2MRS flow into Shapley



Shapley mass increased by 2.7



How Taipan will build on Johnson et al / Magoulas et al

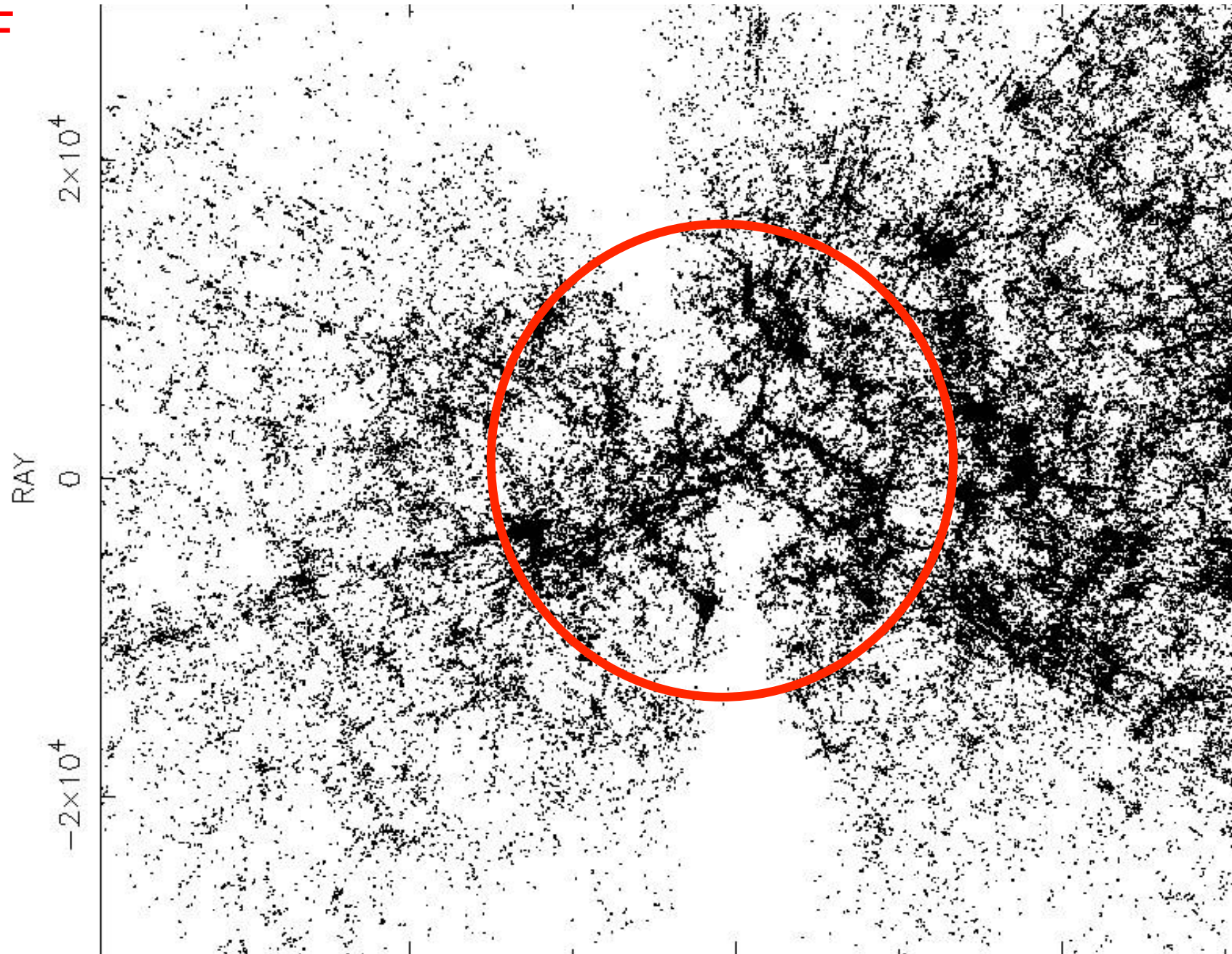
- Larger volume (see next two slides from NED+2MRS-II (Macri et al., in prep))
- 10^5 galaxies instead of 10^4
- higher spectral resolution will elongate the s axis of the 3D gaussian
- improved mass model
- Bulk flow: $> 2s$

Matthew Colless will talk
about how Taipan will do this

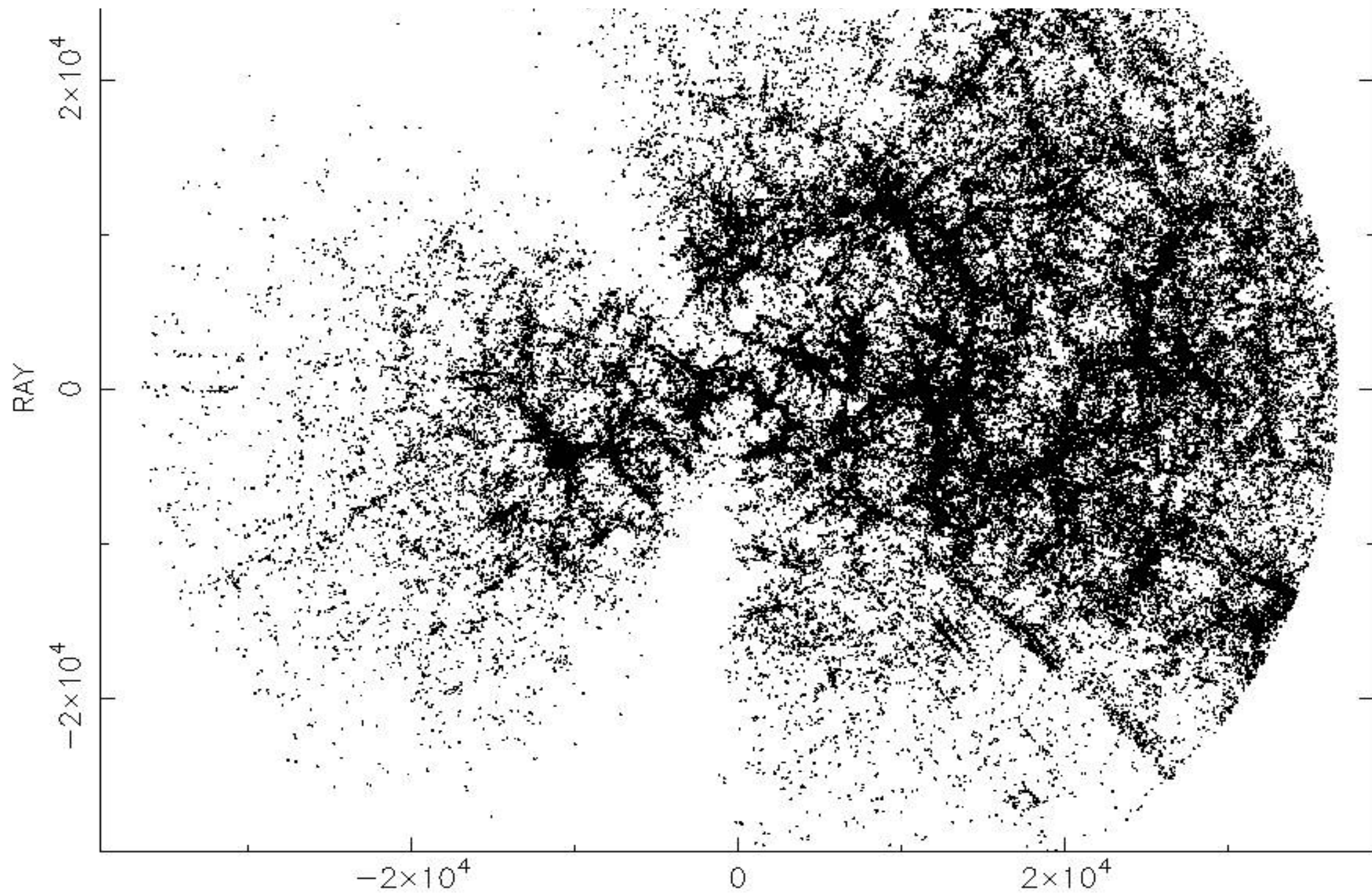
NED redshifts $z < 0.15$ d: -20

thanks Lucas Macri

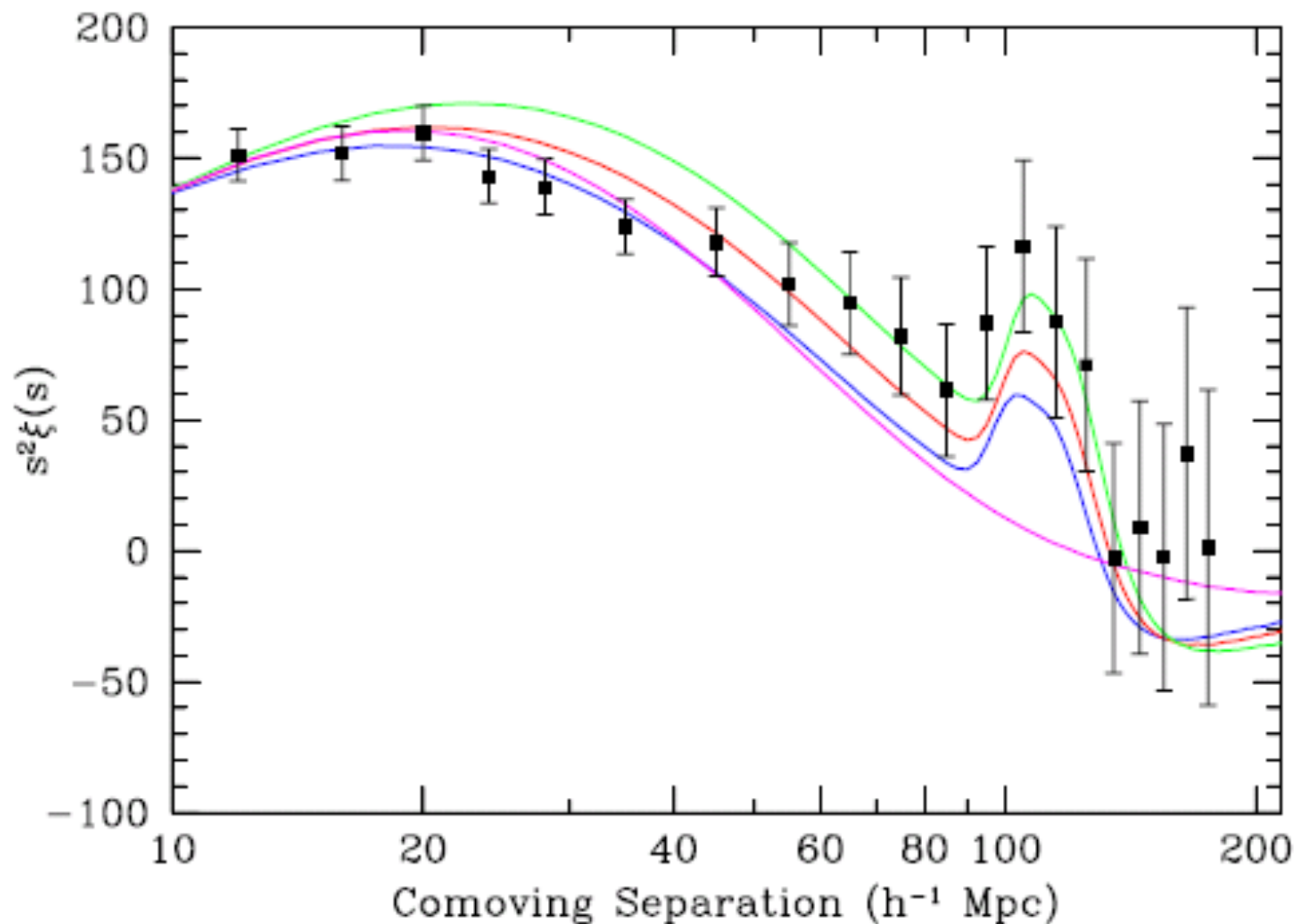
6dF



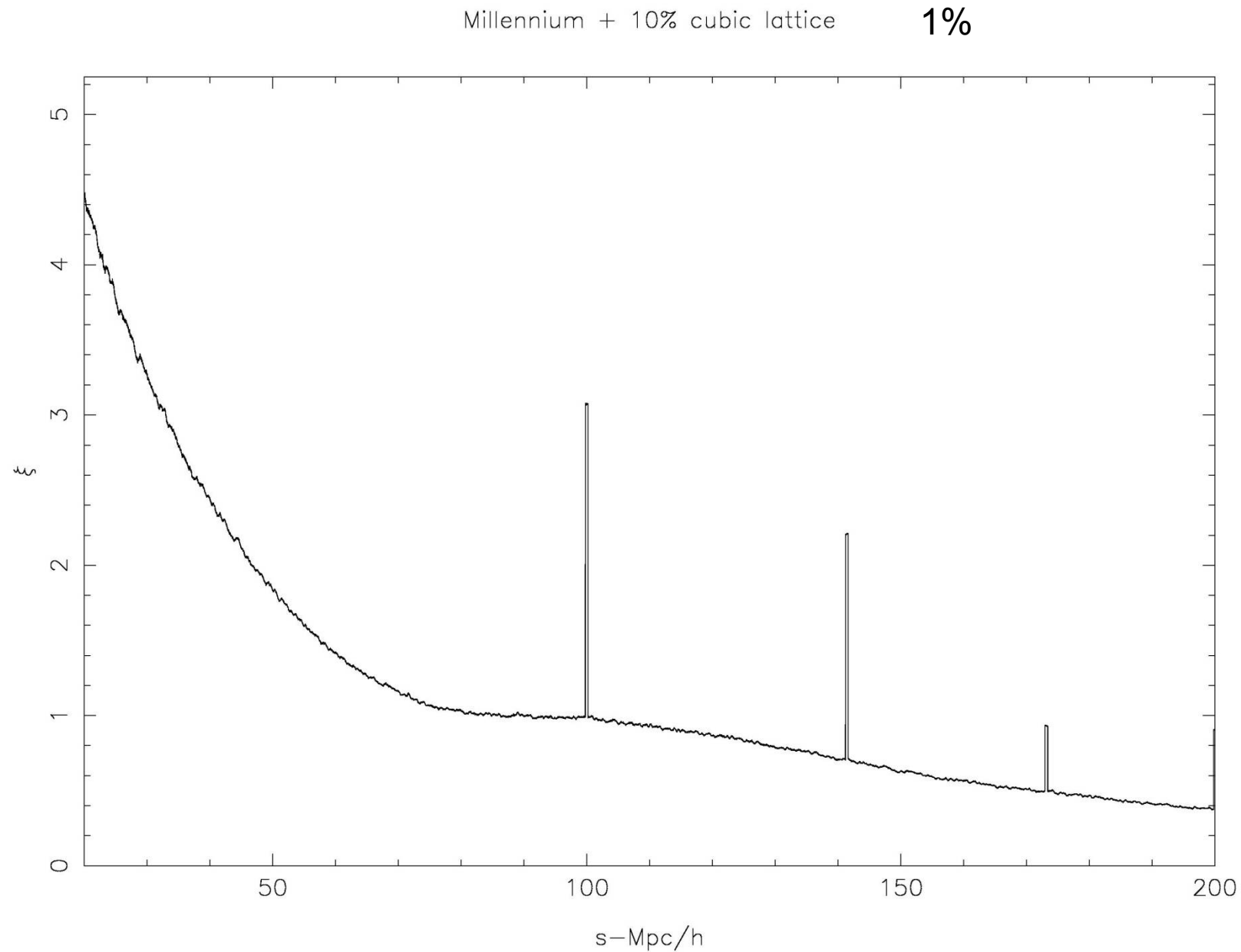
NED redshifts $z < 0.15$ d: -40



BAO in SDSS (Eisenstein et al)



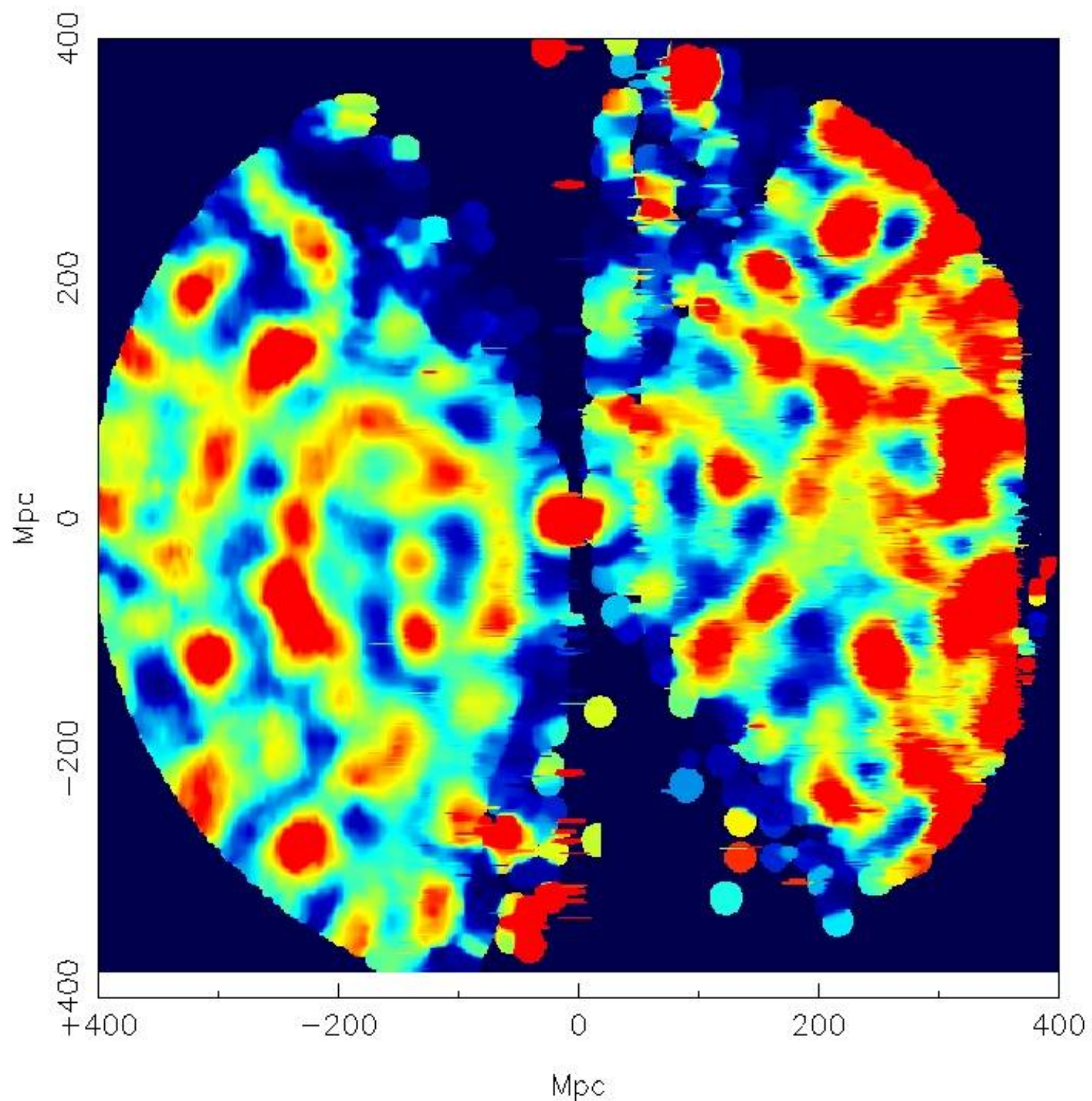
Correlation function with 'BAO' signal injection



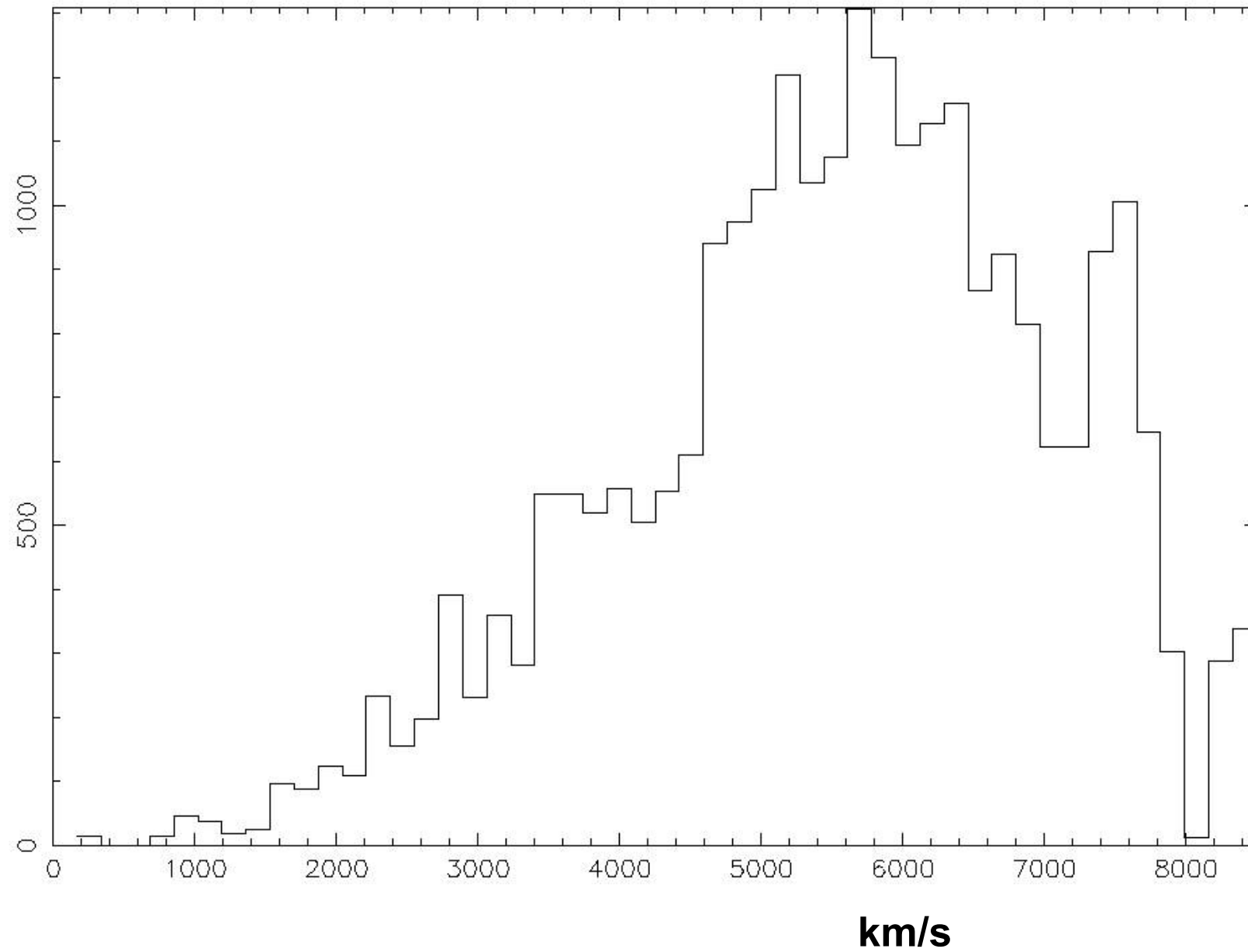
Preview of Taipan: (from NED)

- Baryon acoustic oscillation measurements are traditionally derived from pairwise correlation function ξ
- but BAO can also be measured by finding 3D voids
- Suitable software is VIDE Sutter et al 2014
- Experimental home grown software produced next slide
- New work on BAO/voids, see Aчитouv & Blake
[1606.03092](#)

Zero dec void map

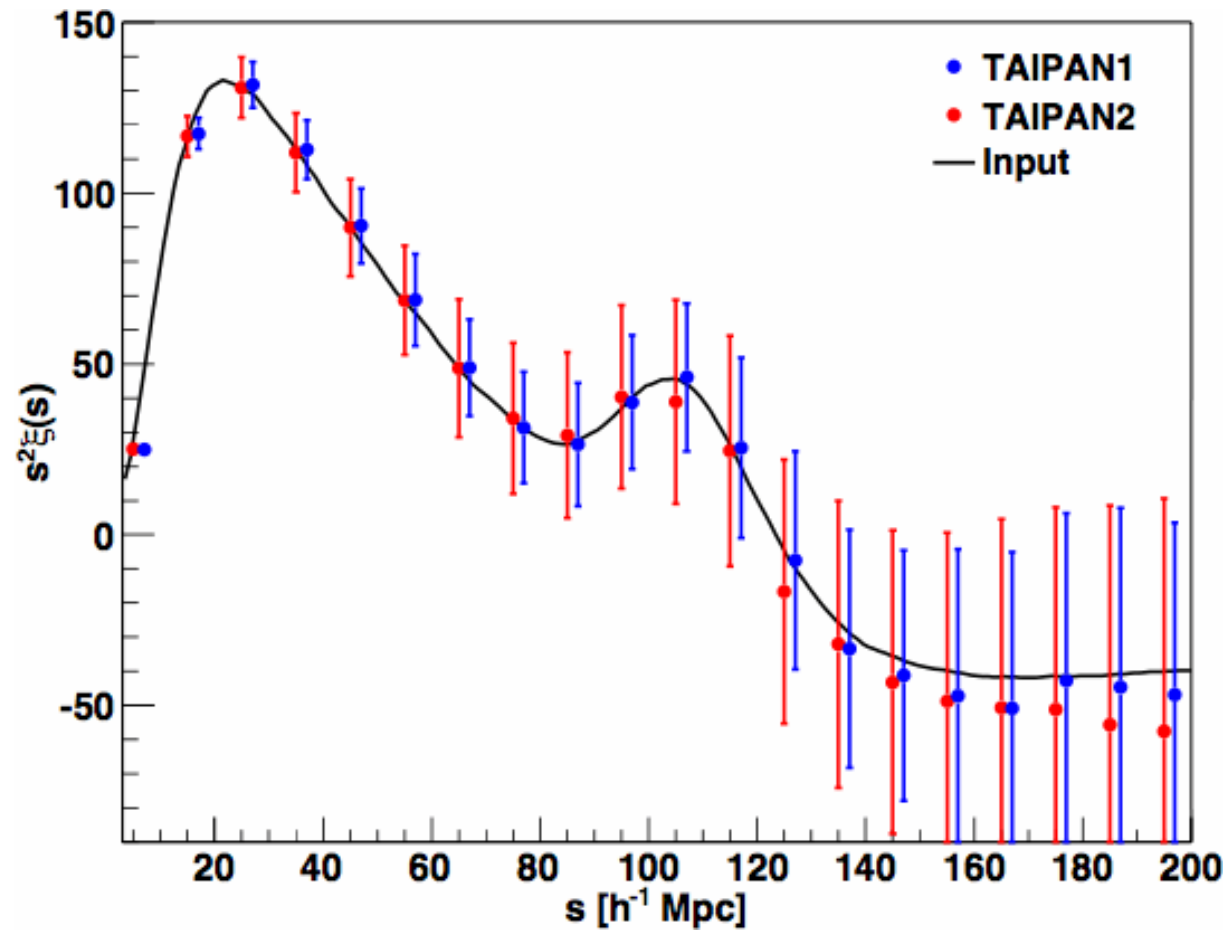


BAO radius from 10 voids





TAIPAN cosmology



Beutler et al., 2011, MNRAS, 416, 3017

Five questions

- Does the light follow the mass?
 - Current model parameter b is physics free
 - physical approach would require knowing nature of DM
- How do we do the northern hemisphere?
 - Is it too hard?
 - Low galactic latitudes
- Is BAO a perfect measuring stick?
- What's the best large scale flow statistic?
 - Bulk flow
 - Coherence length
- Which modified gravity theories are worth testing?

Summary

Many thanks to the whole 6dF team and Taipan community

Taipan is the project to

- (1) test for unpredicted structure on the largest scales
(1% in dv/v)
- (2) amplify/diffuse tension between CMB H_0 and SNIa H_0
(1% in H_0)