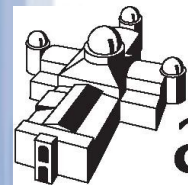


Systematic variations of the Hubble flow



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EWASS 2015 talk
Special Session 2
June 22, 2015



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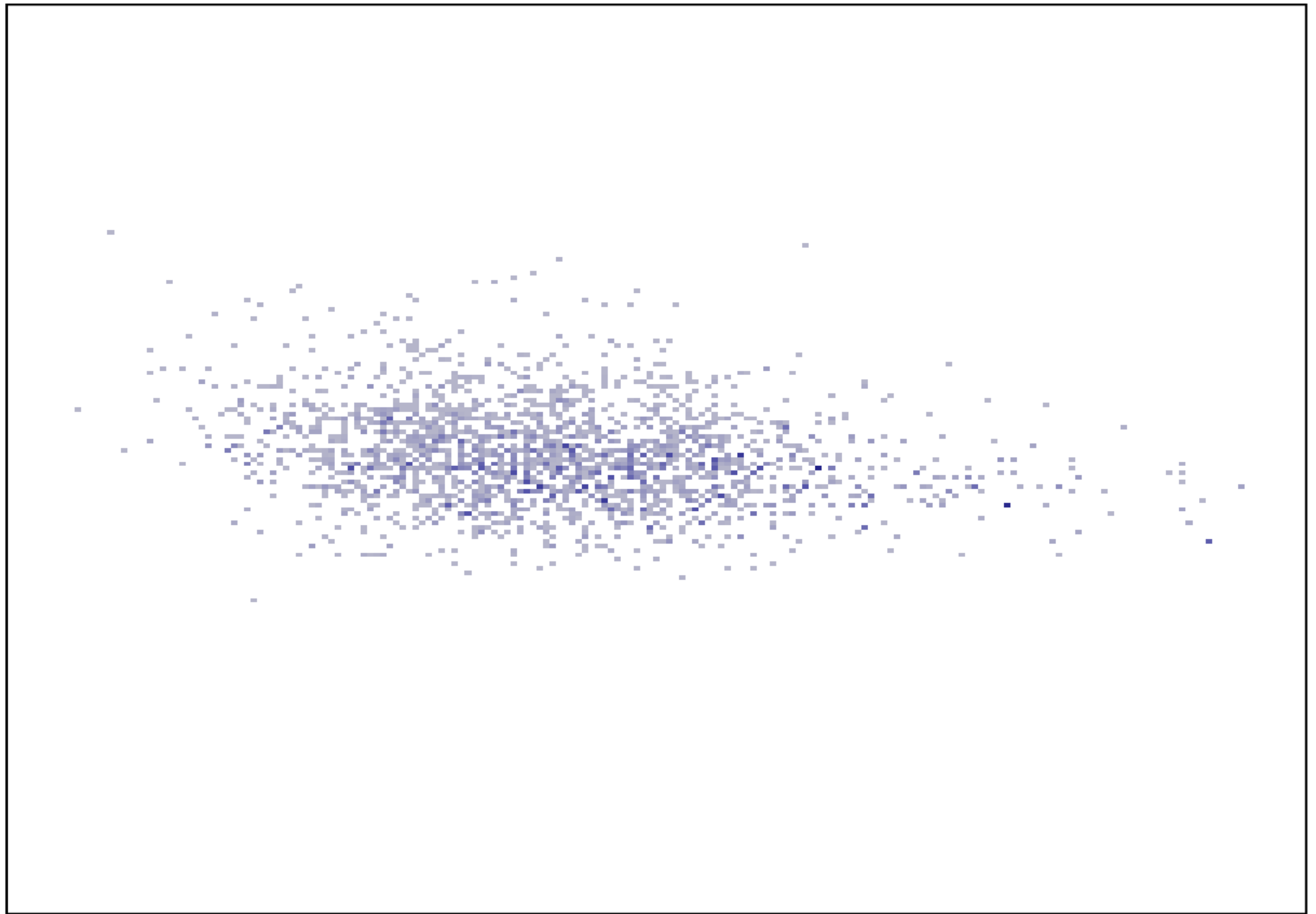
by
Christoph Saulder
(University of Vienna)



in collaboration with

Steffen Mieske (ESO Chile), Eelco van Kampen (ESO Garching), and Werner Zeilinger (University of Vienna)





Why do we need Dark Energy?

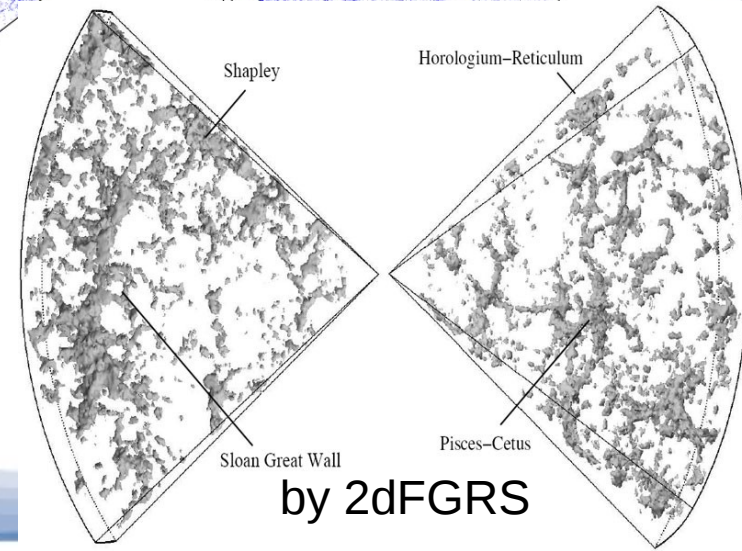
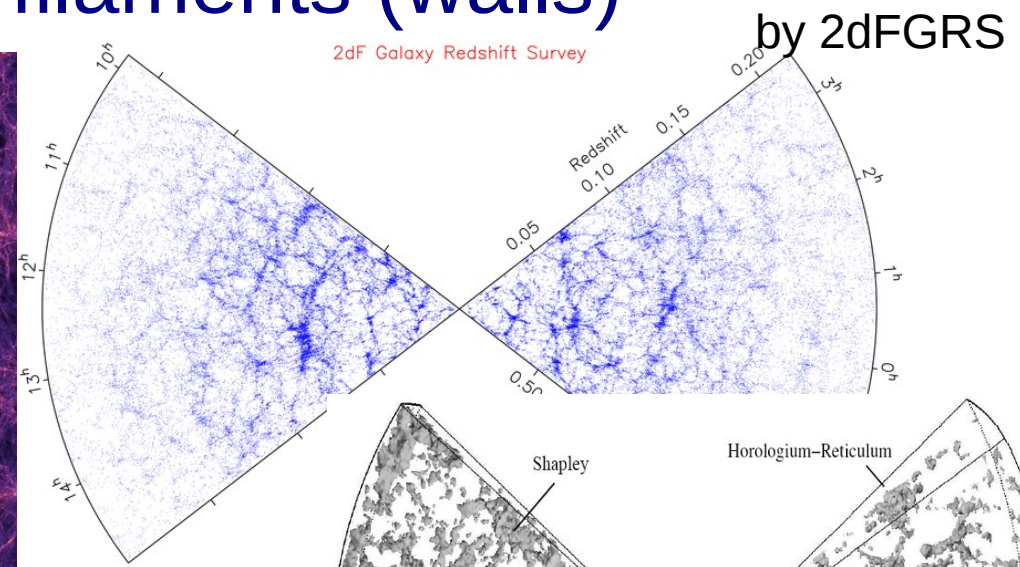
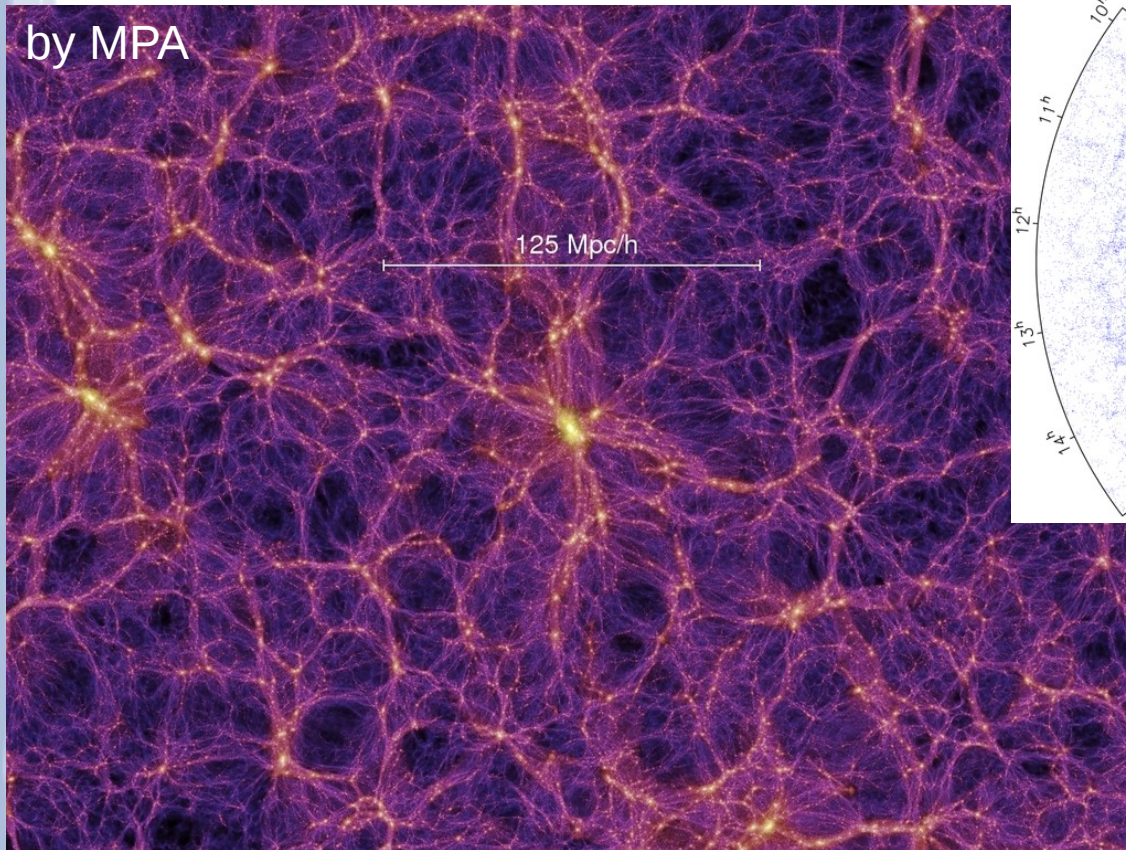
- Mainly to explain the **accelerated expansion** of the universe (distant supernovae type Ia – Nobel prize 2011)

What is Dark Energy?

- We do **not know!!!**
 - Simplest assumption: cosmological constant Λ
 - Phantom dark energy or quintessence
 - Many other models without any proof
- **But** it fits our data well, if we assume isotropy and **homogeneity** (FLRW-metric).

Timescape Cosmology

- cosmological model based on the assumption that the universe is **NOT** homogeneous at all scales
==> voids and clusters+filaments (walls)



- General Relativity is a non-linear theory (**FACT**).
- At last scattering the universe was very close to homogeneity (**FACT**).
- Today the matter distribution in the universe has void-dominated fractal bubble structure (**FACT**).
- ==> averaging over large scale and high density contrast has to be modified.
- Back-reactions from inhomogeneities expected
- Wiltshire, 2007 model: dropping the cosmological time parameter and assuming a two phase model (voids and walls) with a fractal bubble structure.

Consequences of this theory

- Voids expand faster than walls
- Structure formation made the universe inhomogeneous and caused the apparent accelerated expansion.

Consequences of this theory

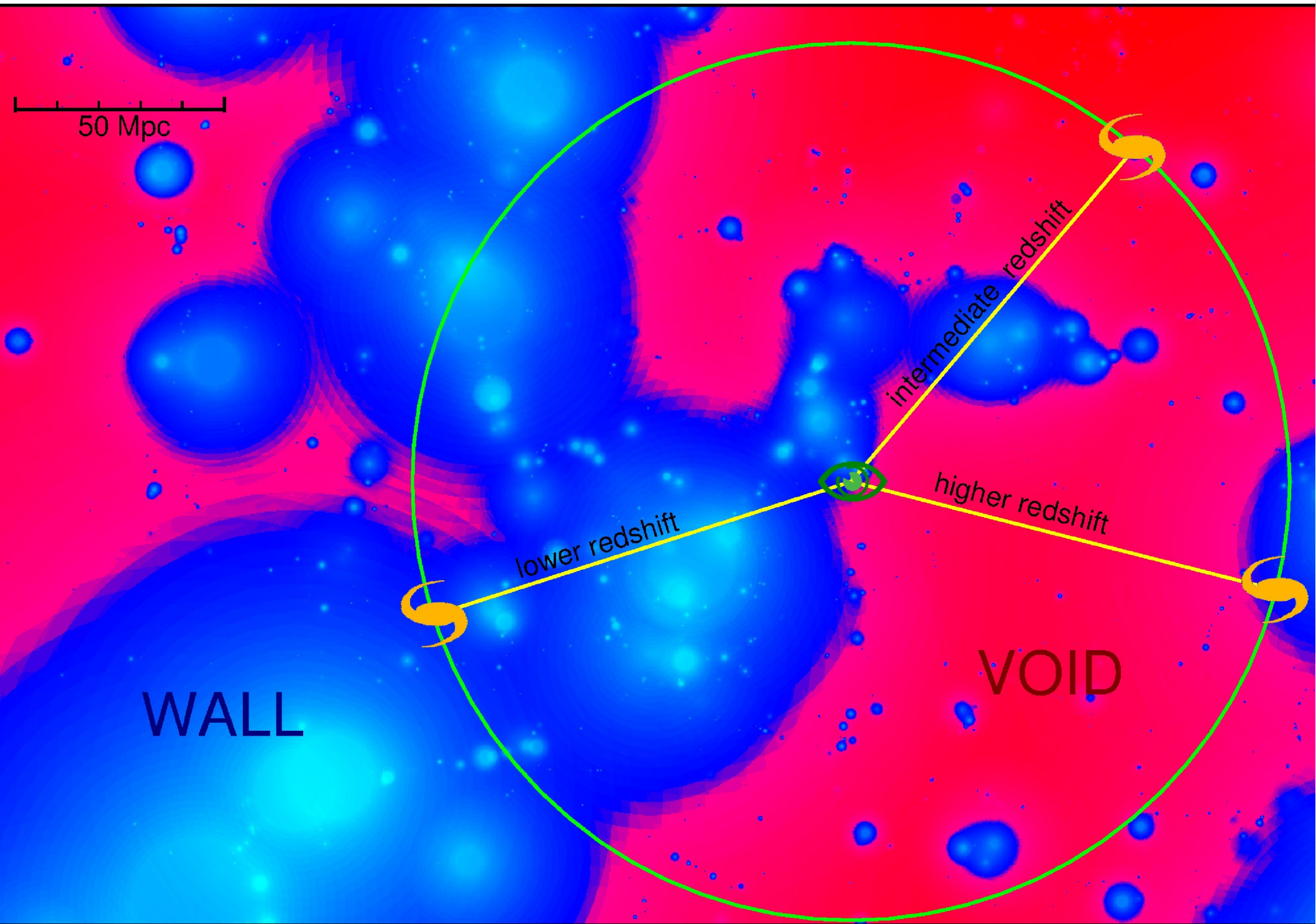
- Voids expand faster than walls
- Structure formation made the universe inhomogeneous and caused the apparent accelerated expansion.
- Thereby, one naturally gets an

accelerated expansion

without

the need for

Dark Energy!



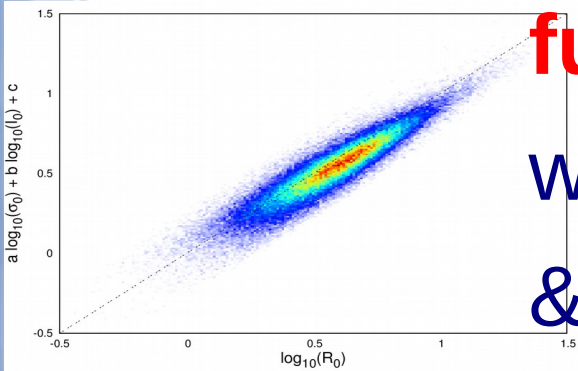
Testing the theory

- Idea: Search for systematic variations of the Hubble flow depending on the structure in the line of sight, because **voids expand faster than walls** in timescape cosmology.

- We need:

- A redshift independent **distance indicator**:

fundamental plane of elliptical galaxies with calibrations of Saulder+2013 & updated values from Saulder+2015a

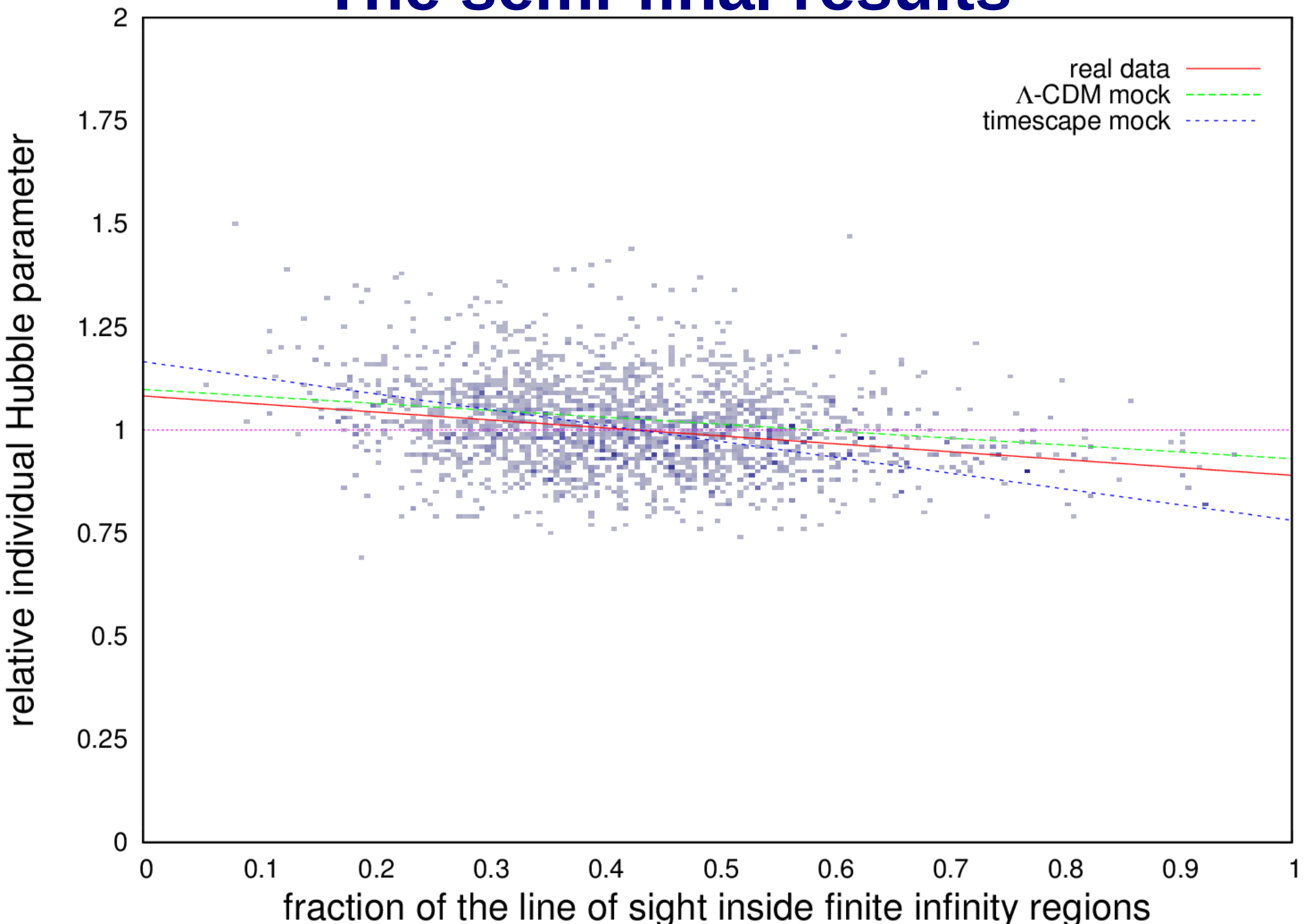


- **Large sample** distributed over a large area of the sky to avoid biases and get good statistics.

==> **SDSS DR10 + 2MRS**

- A complete model of **matter distribution** in the local universe: Saulder+2015b, submitted
- Simulated data for both theories to estimate potential biases and compare the observations to
==> wide angle mock catalogues based on the **Millennium simulation**:
Saulder+2015b, submitted & Saulder+2015c, in prep.

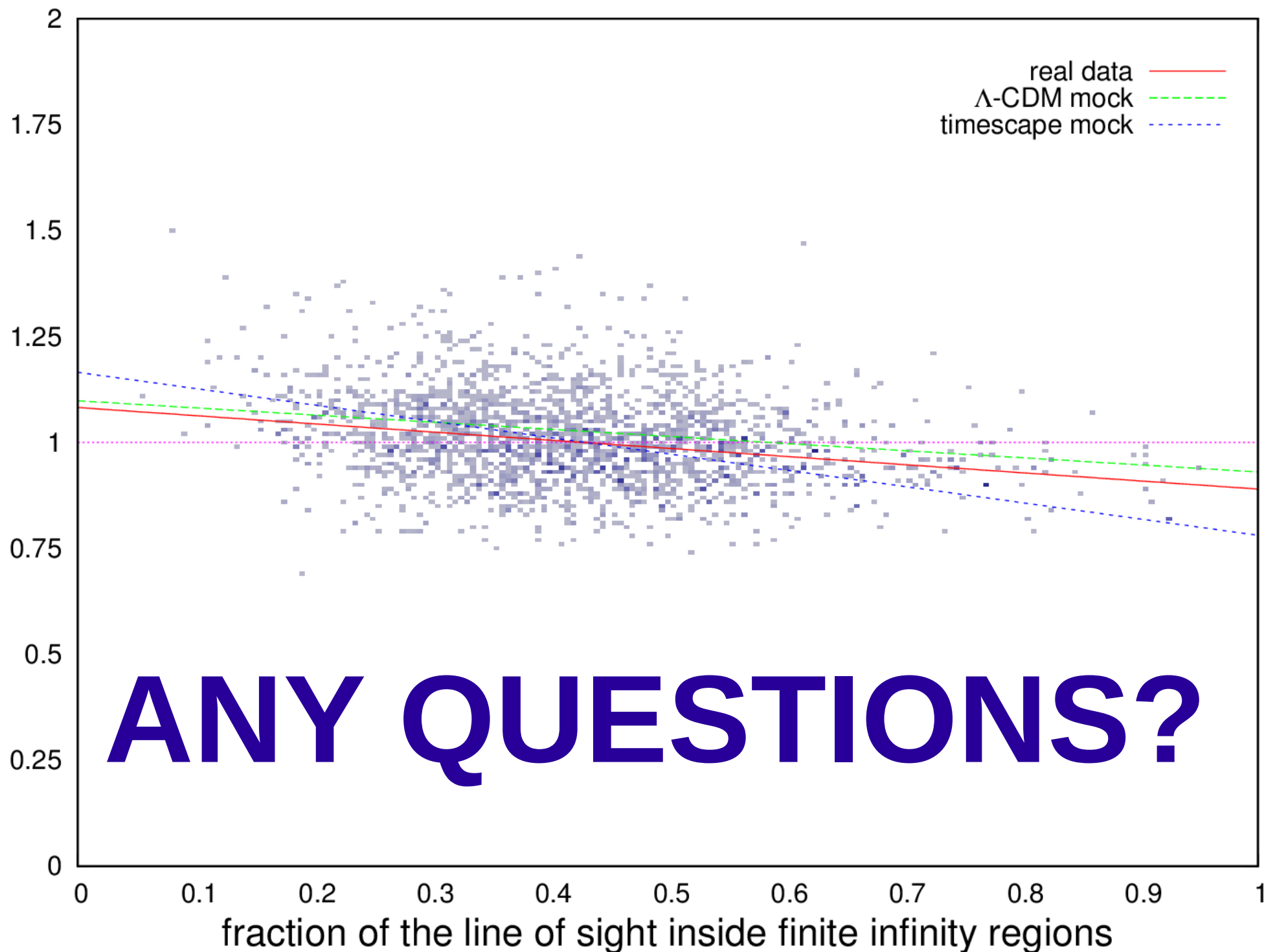
The semi-final results



Conclusions & Summary

- We managed to perform a meaningful test for timescape cosmology against the standard model with **public survey data** and **simulated data** only.
- Surprising diversity of our observational parameters between the different mock catalogues for the same cosmological model.
- **Final results in preparation** (Saulder+2015c, in prep.)
- **Statistical analysis** is still work in progress (least squares, binning, KS-test, etc.)
- So far, the data seems to **favour Λ -CDM**, but its significance depends on the analysis method.

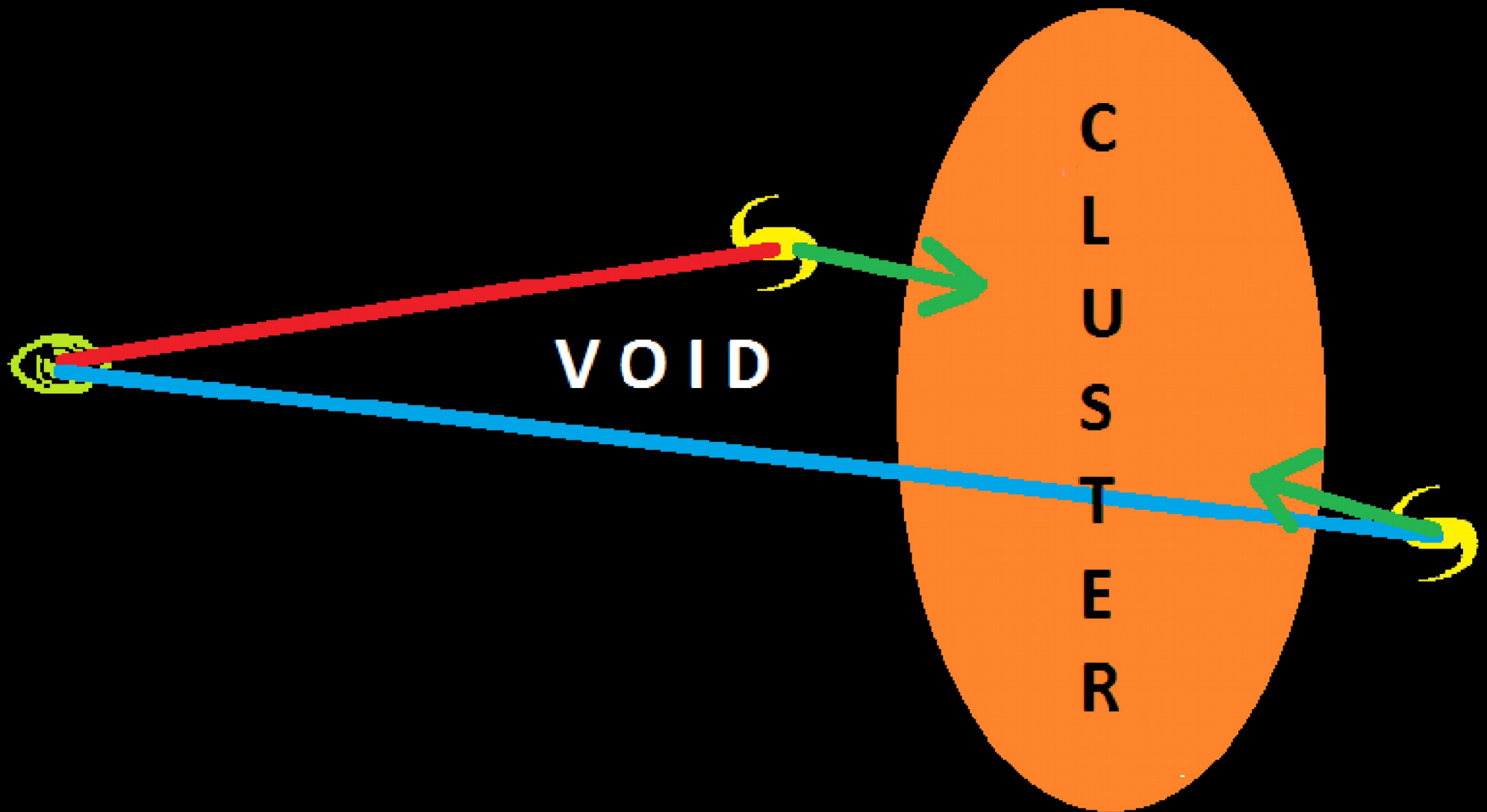
relative individual Hubble parameter



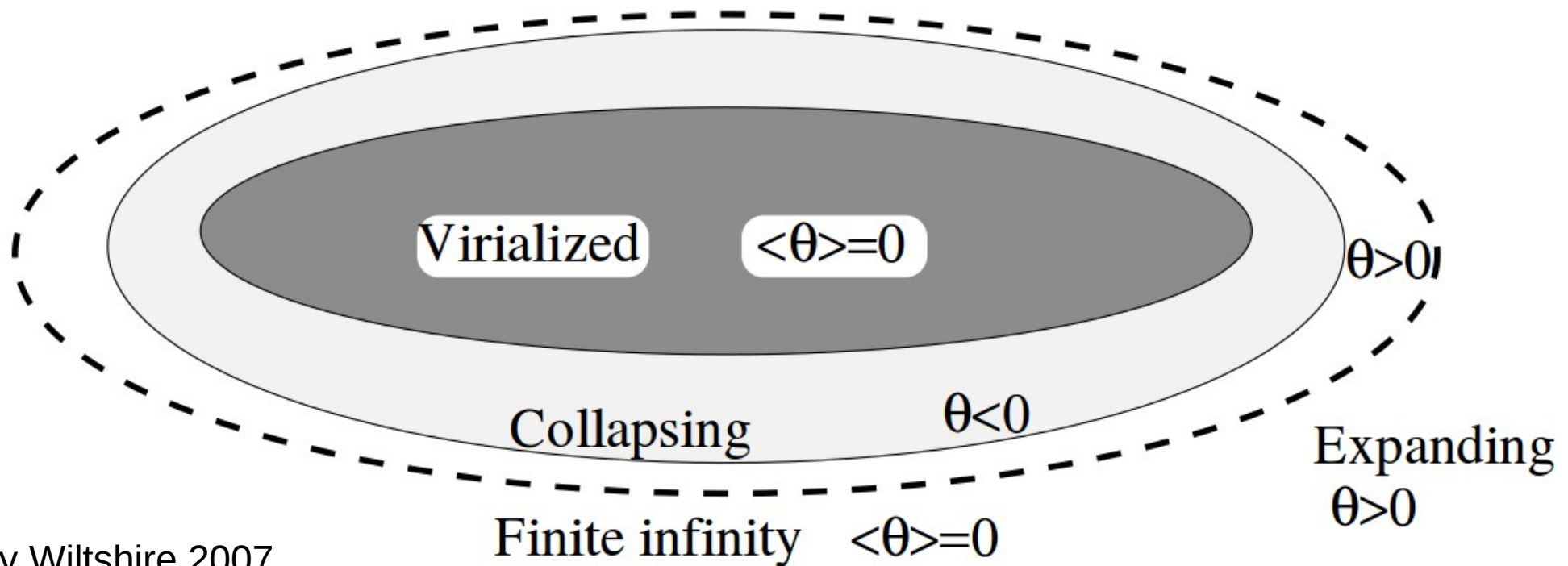
Supplementary slides

Only for Q&A ... if asked for.

Λ -CDM bias due to coherent infall



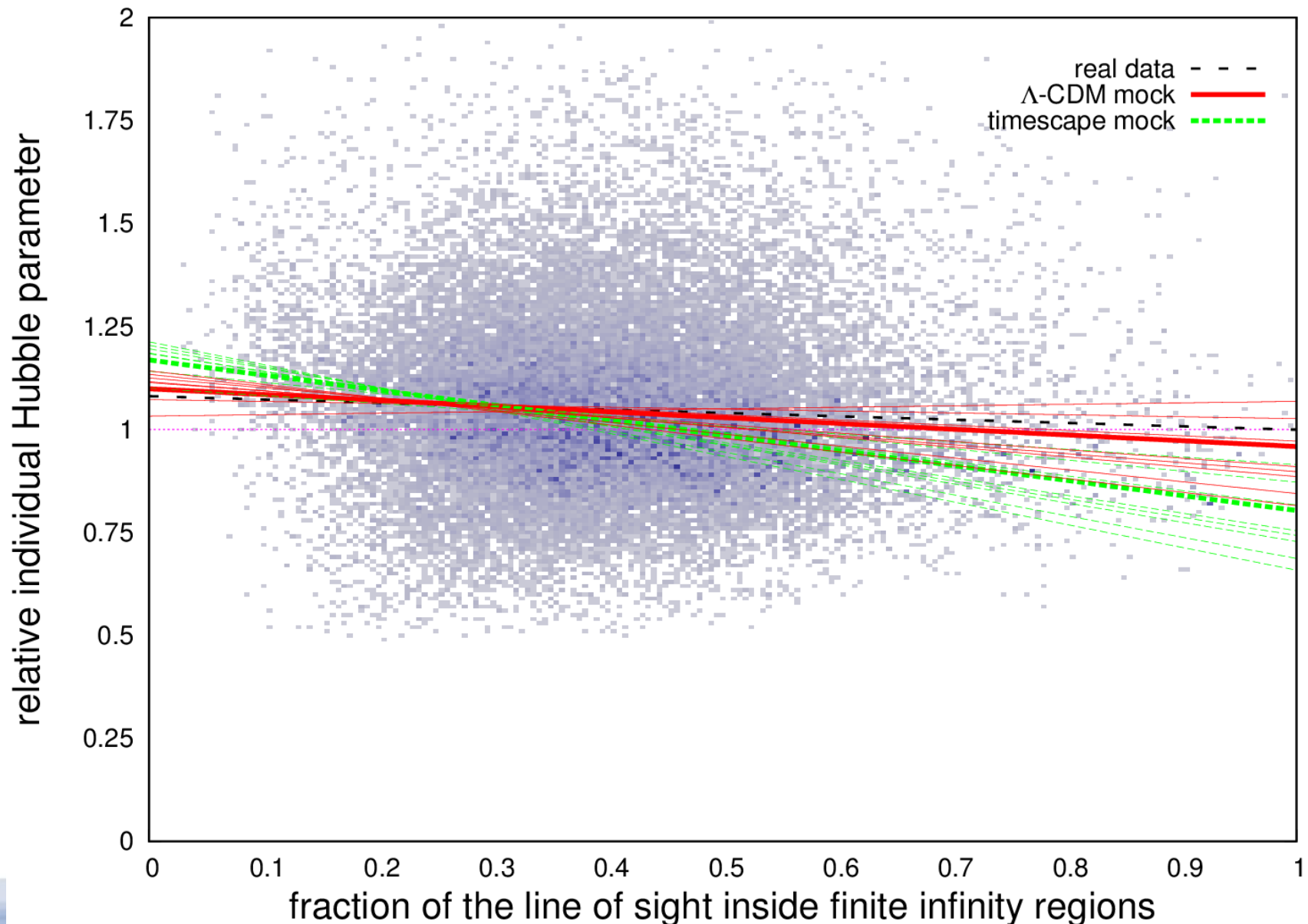
Finite infinity regions



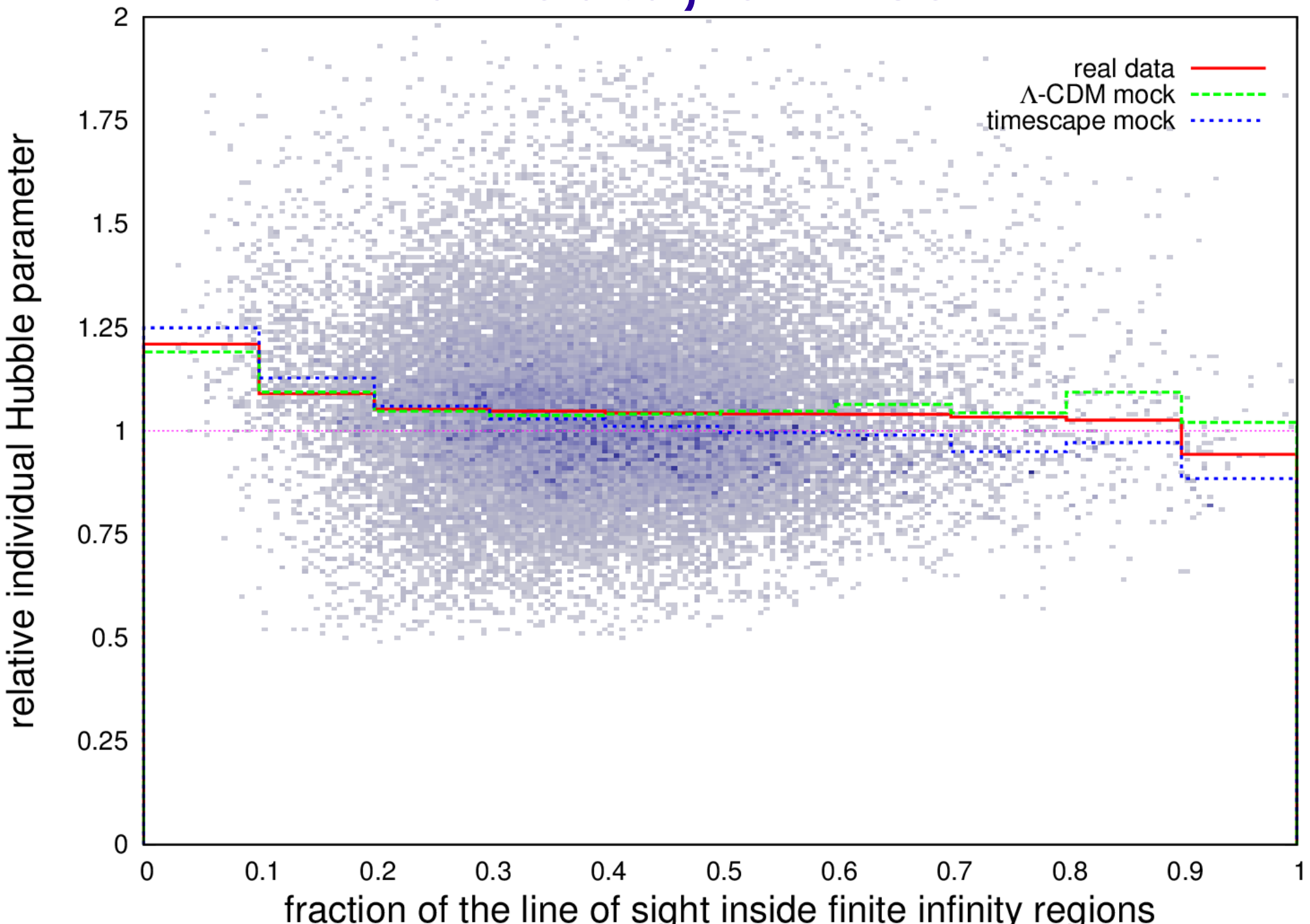
by Wiltshire 2007

- Approximated by (overlapping) spherical regions with an average density equal to the renormalized critical density in timescape cosmology.

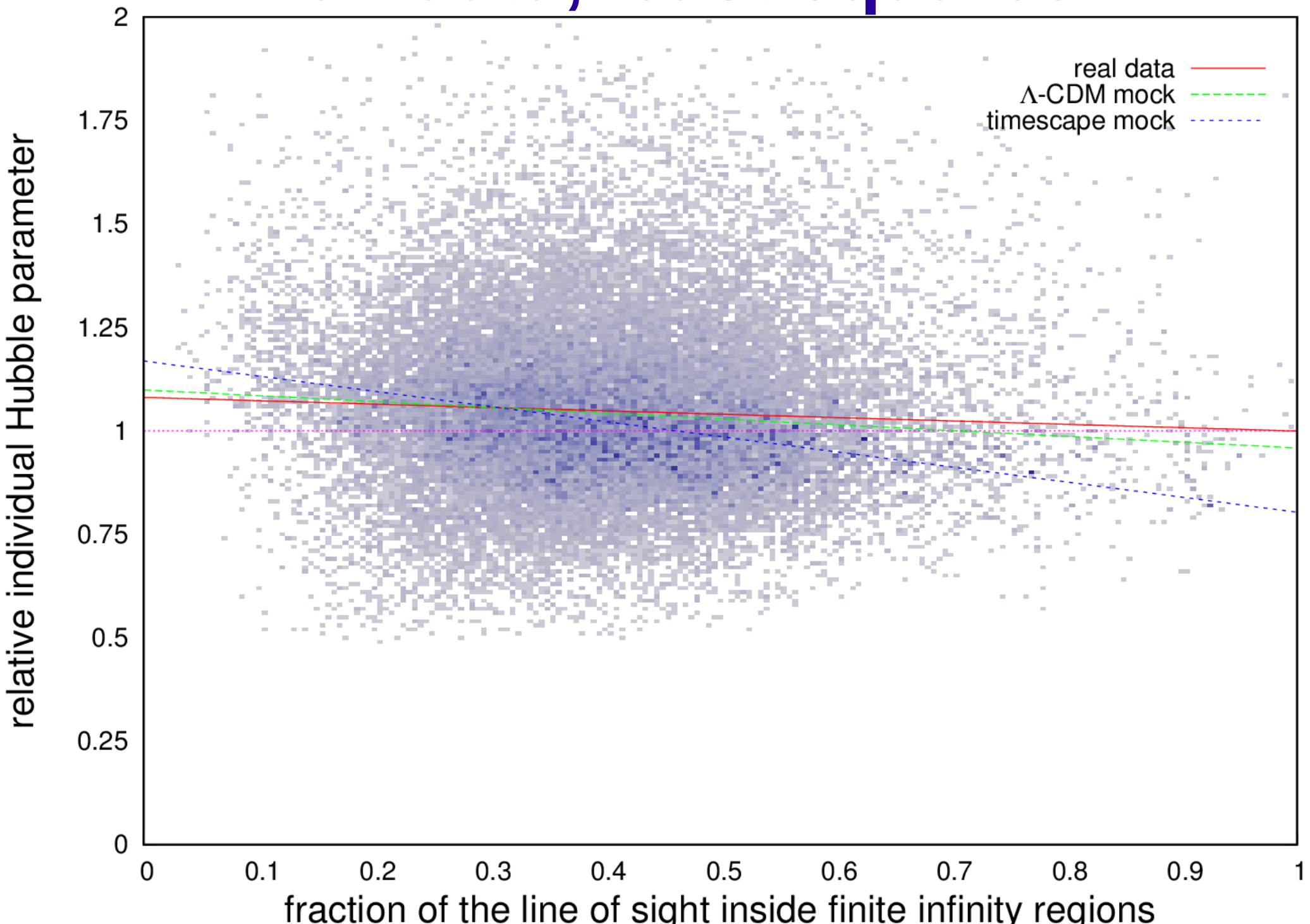
Variations between the different mock catalogues



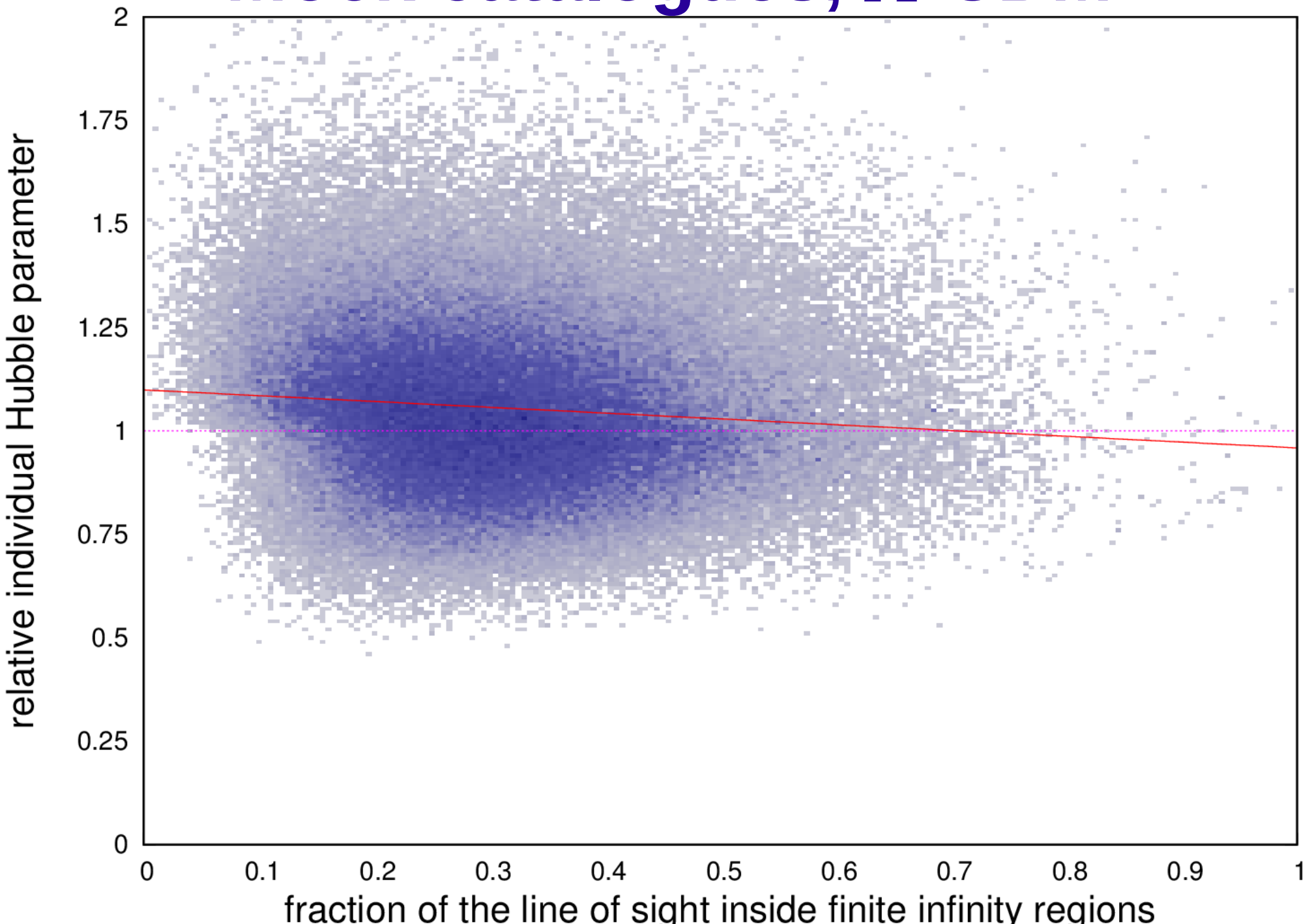
Full data, binned



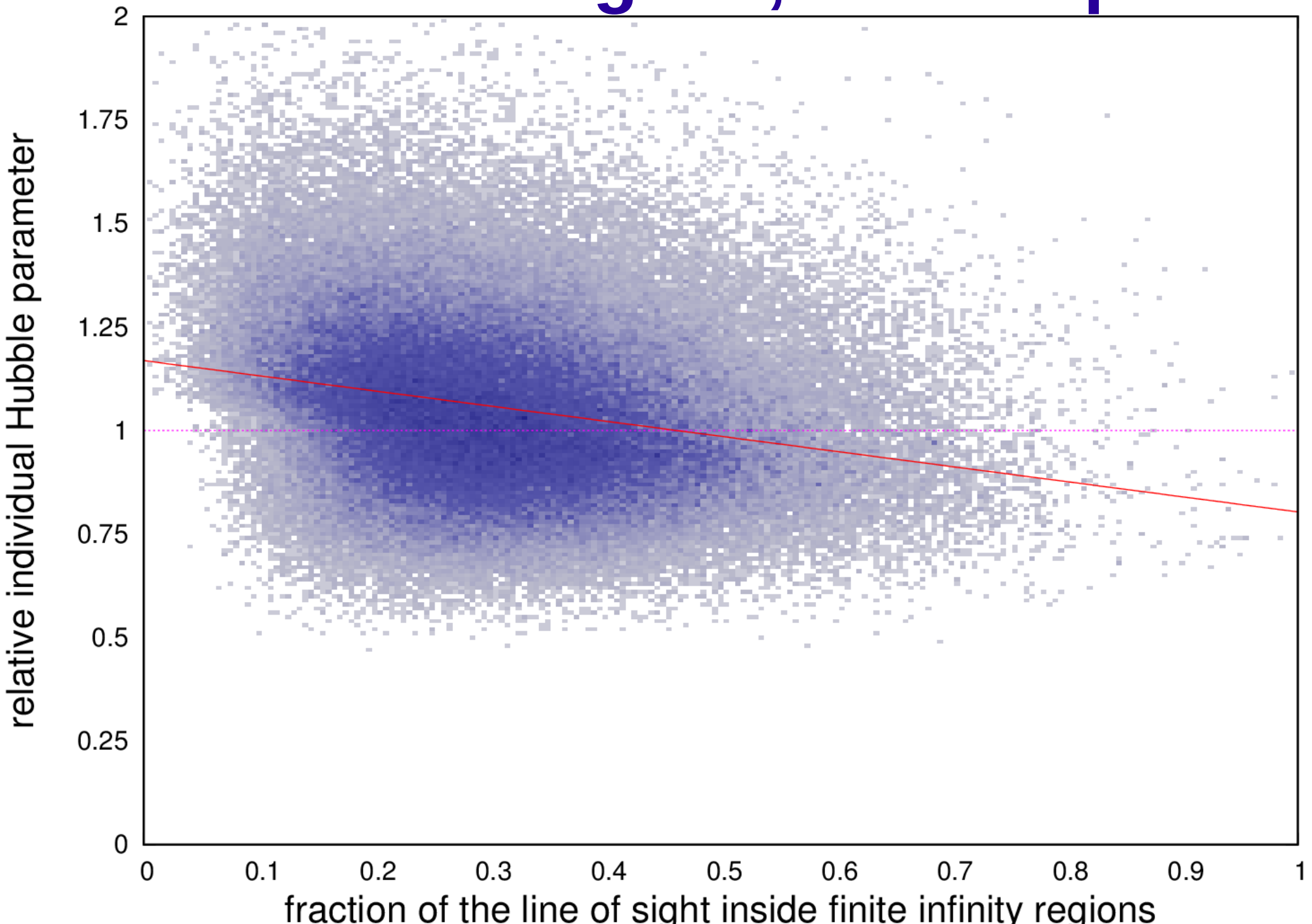
Full data, least squares



Mock catalogues, Λ -CDM



Mock catalogues, timescape



N/A

Sorry,

**but I haven't prepared a slide
for this question.**