



Cosmology group
at Swinburne

Our cosmology group!

me!



could we get pictures
of everyone else?

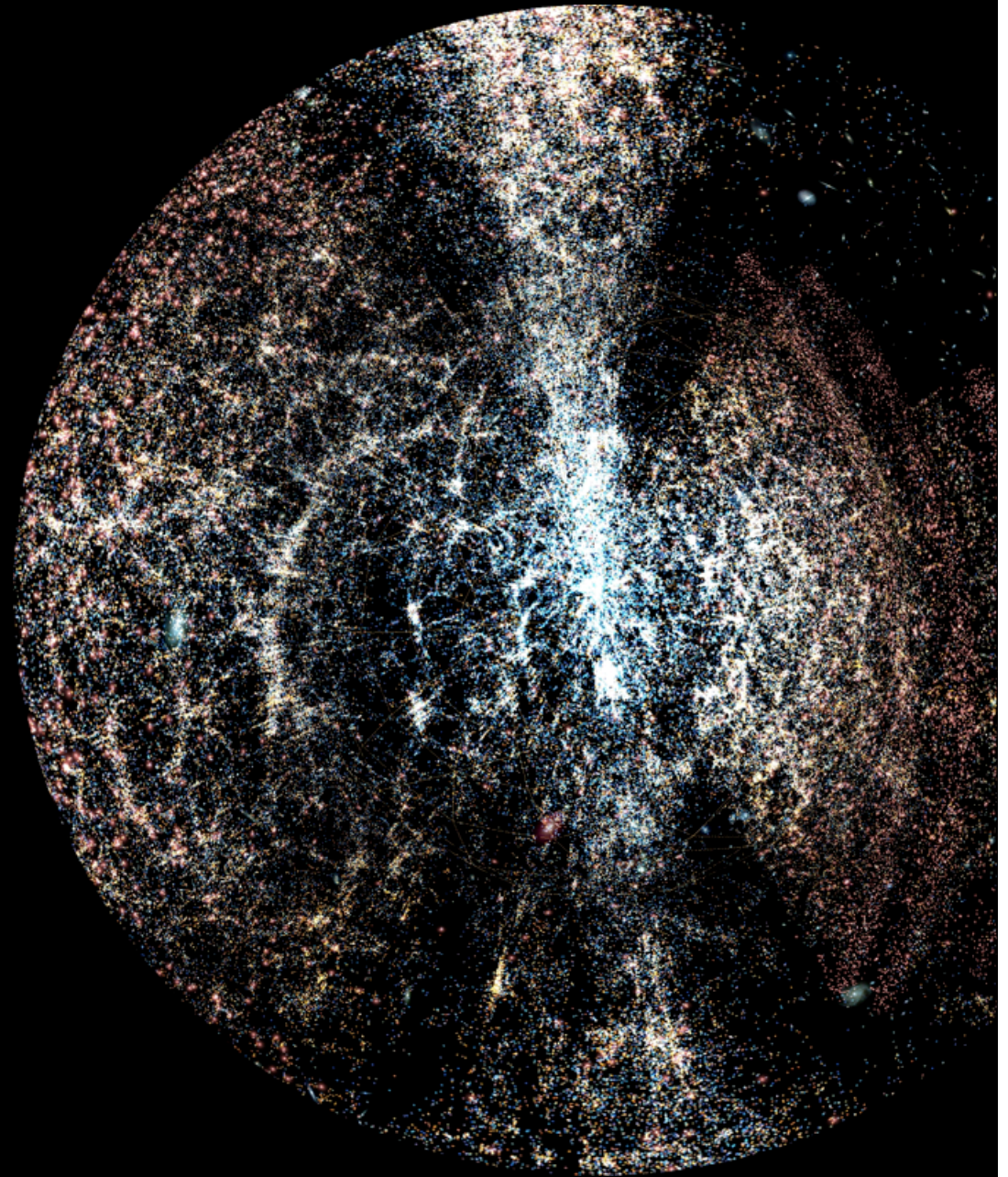
Cosmology : the key questions

- What is the physical model for dark energy, and laws of gravity across cosmic scales?
- What are the properties of the different components of the Universe (e.g. neutrinos, dark matter, curvature) ?
- Can we test theories such as inflation which establish the initial conditions?

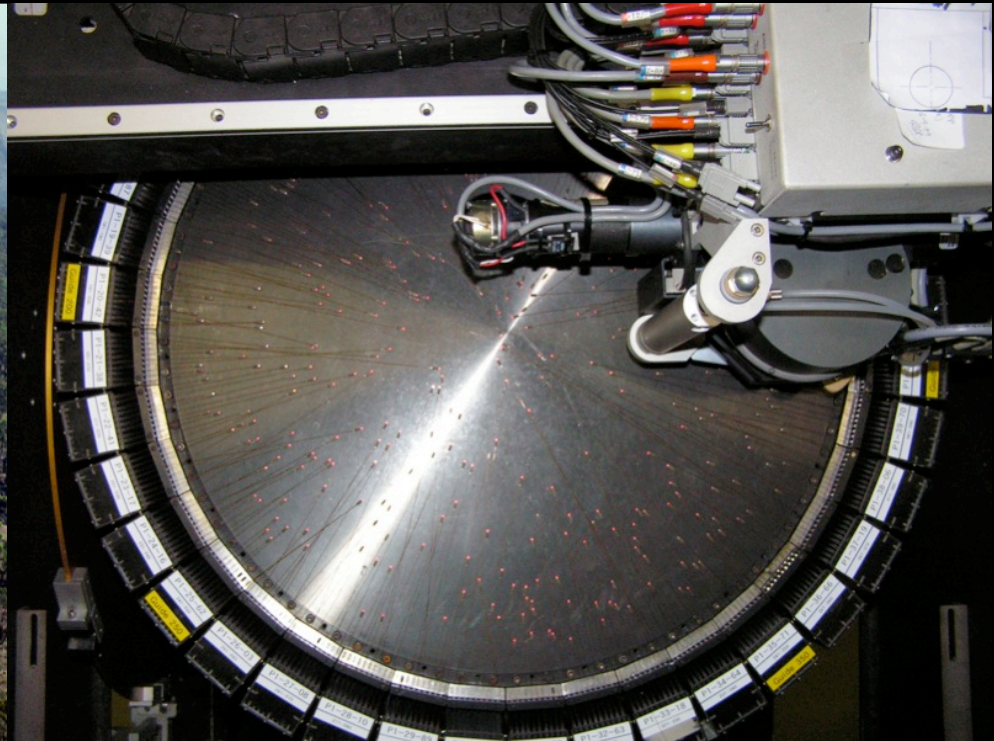


Our basic tool : large-scale structure

- **Geometrical information**
(e.g. baryon acoustic oscillations)
- **Gravitational information**
(e.g. redshift-space distortions)
- **Primordial information**
(e.g. shape of large-scale power spectrum)

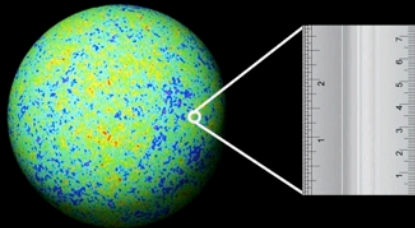
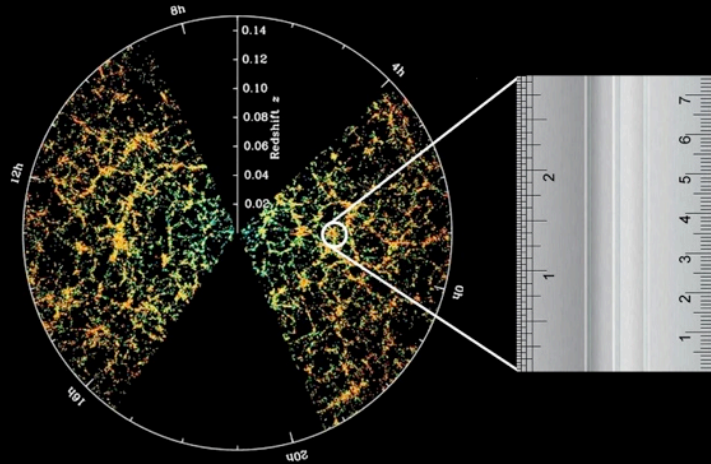


Redshift surveys (past, present and future)

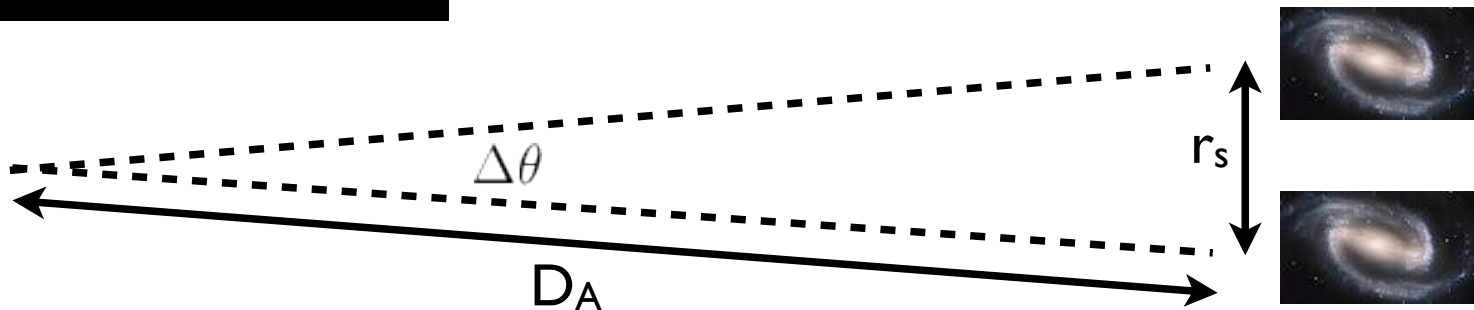


- WigglyZ Dark Energy Survey (completed 2011)
- 6-degree Field Galaxy Survey (completed 2006)
- 2-degree Field Lensing Survey (started 2014)
- Taipan Survey (starting in 2016)

Probe I : baryon acoustic oscillations



- Preferred co-moving separation of $105 h^{-1}$ Mpc between clumps imprinted at recombination
- We observe a preferred angular separation between galaxies at some redshift
- Allows **distance determination by simple geometry**



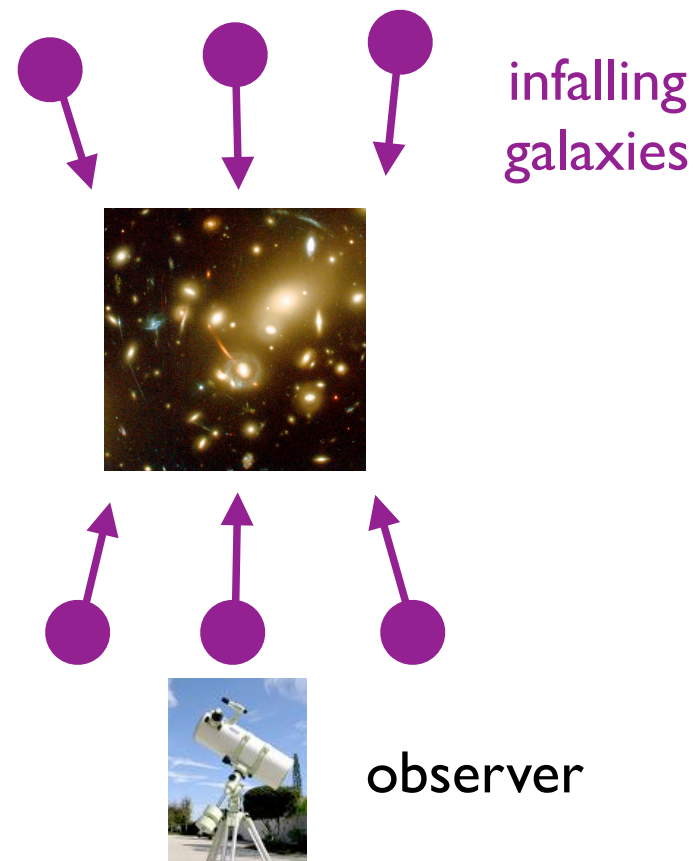
Probe 2 : galaxy velocities

Growth rate of structure is a key test of models

- Measure **individual velocities** (standard candles)
- Measure **correlated velocities** (redshift-space distortion)

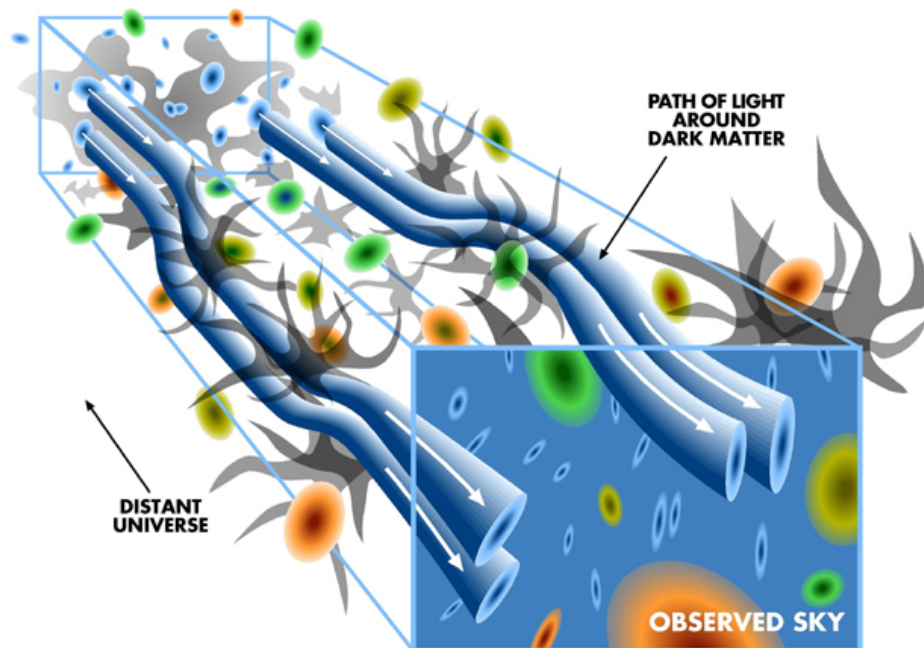


$$v_{\text{peculiar}} = cz - H_0 D$$

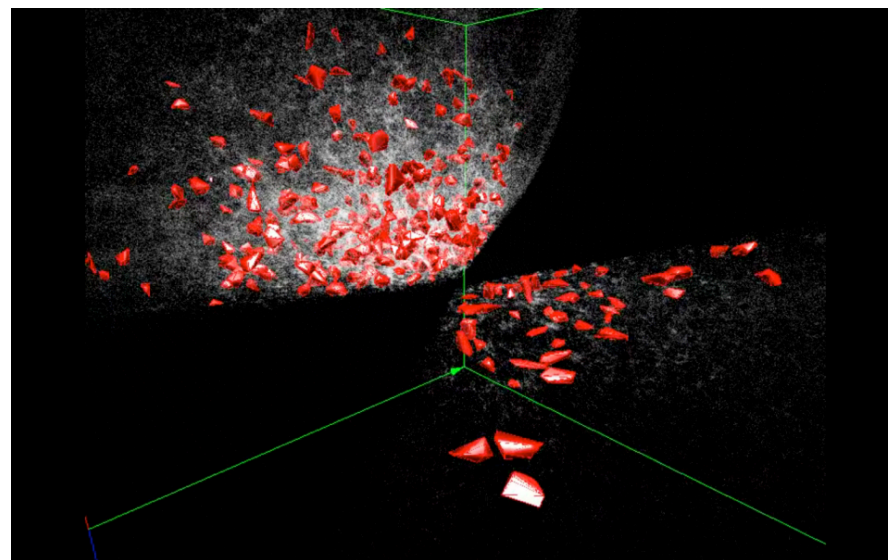


Probes 3 and 4 : lensing and voids

Weak gravitational lensing

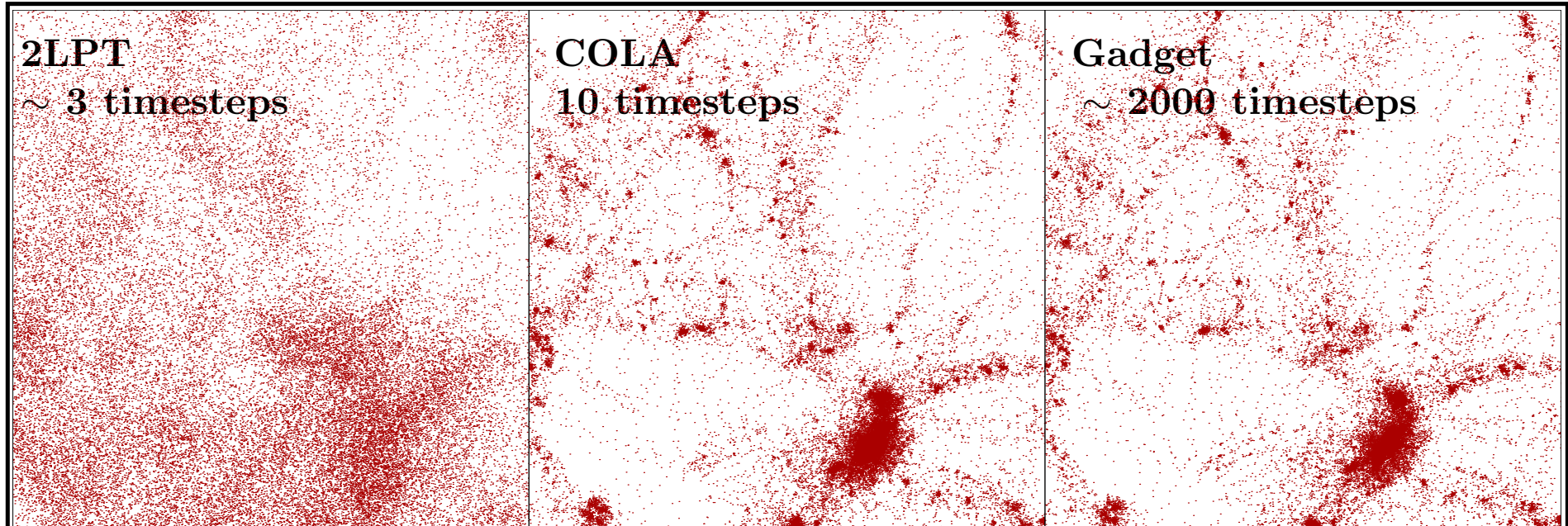


Voids in large-scale structure



- Testing cosmology with the **latest gravitational lensing surveys** (CFHTLenS, RCSLenS, KiDS)
- Testing gravitational physics around **cosmic voids**

Mock catalogues



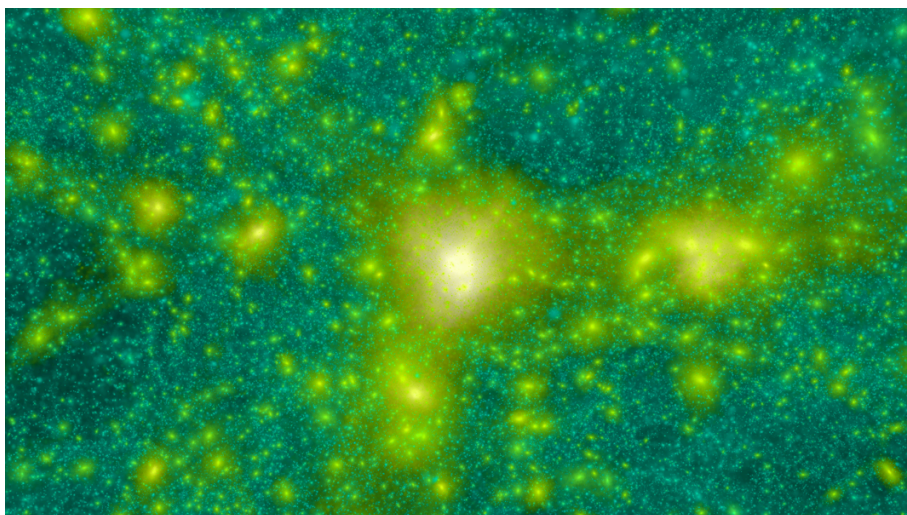
- **Mock catalogues** are needed to test our analysis pipelines and models, and obtain the statistical errors in our results
- **Full N-body mocks** using Gadget (e.g. GiggleZ)
- **Approximate mocks** (COLA method, 1000s simulations)

Tools our group uses

observations



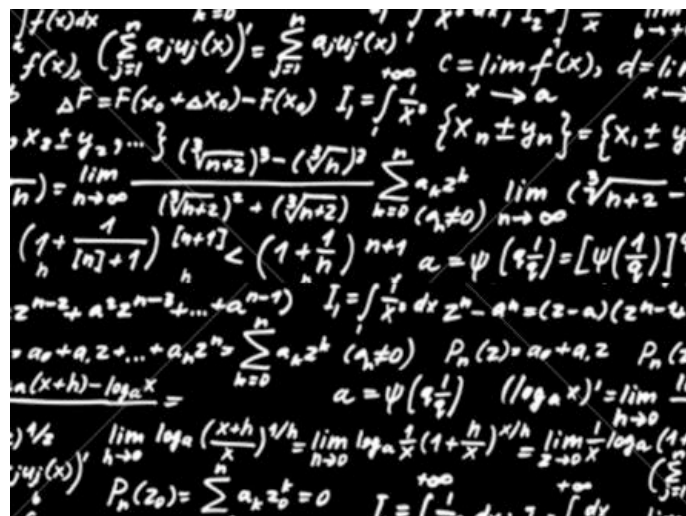
simulations



statistics

- Monte Carlo Markov Chain
- Bayesian / max likelihood methods
- Clustering statistics
- Machine learning

theory



Our collaborations

- Current **galaxy redshift surveys** (WiggleZ, 6dFGS, GAMA, 2dFLenS - especially with U. Queensland)
- **Future survey collaborations** (we are members of 4MOST and DESI)
- **Gravitational lensing surveys** (CFHTLenS, RCSLenS, KiDS - especially U. Edinburgh, U. Leiden and U. Bonn)
- **Radio surveys** (Square Kilometre Array and pathfinders)
- CAASTRO
- Our group has frequent visitors / vacation students

Our future needs

- Clear research budget!
- High-performance computing
- ... others?