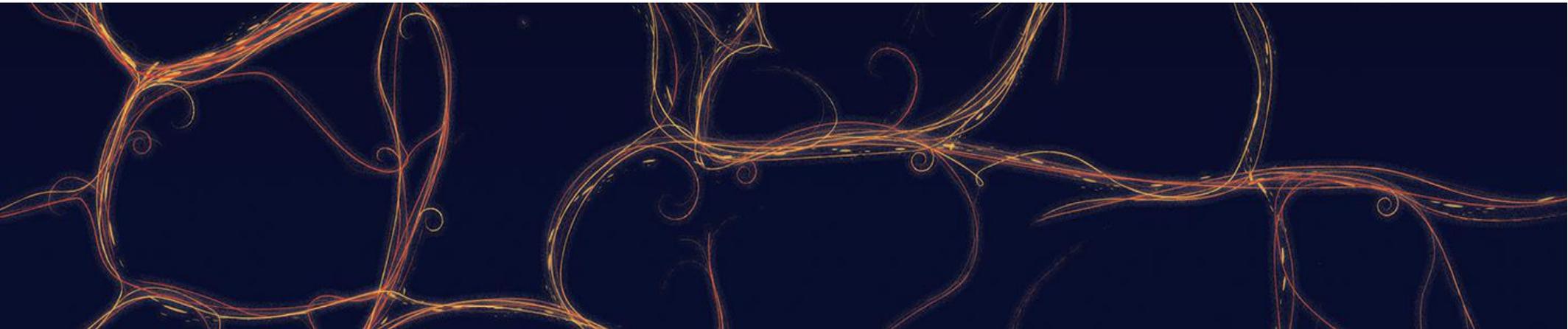


Neutrino mass and cosmic structure in the young universe

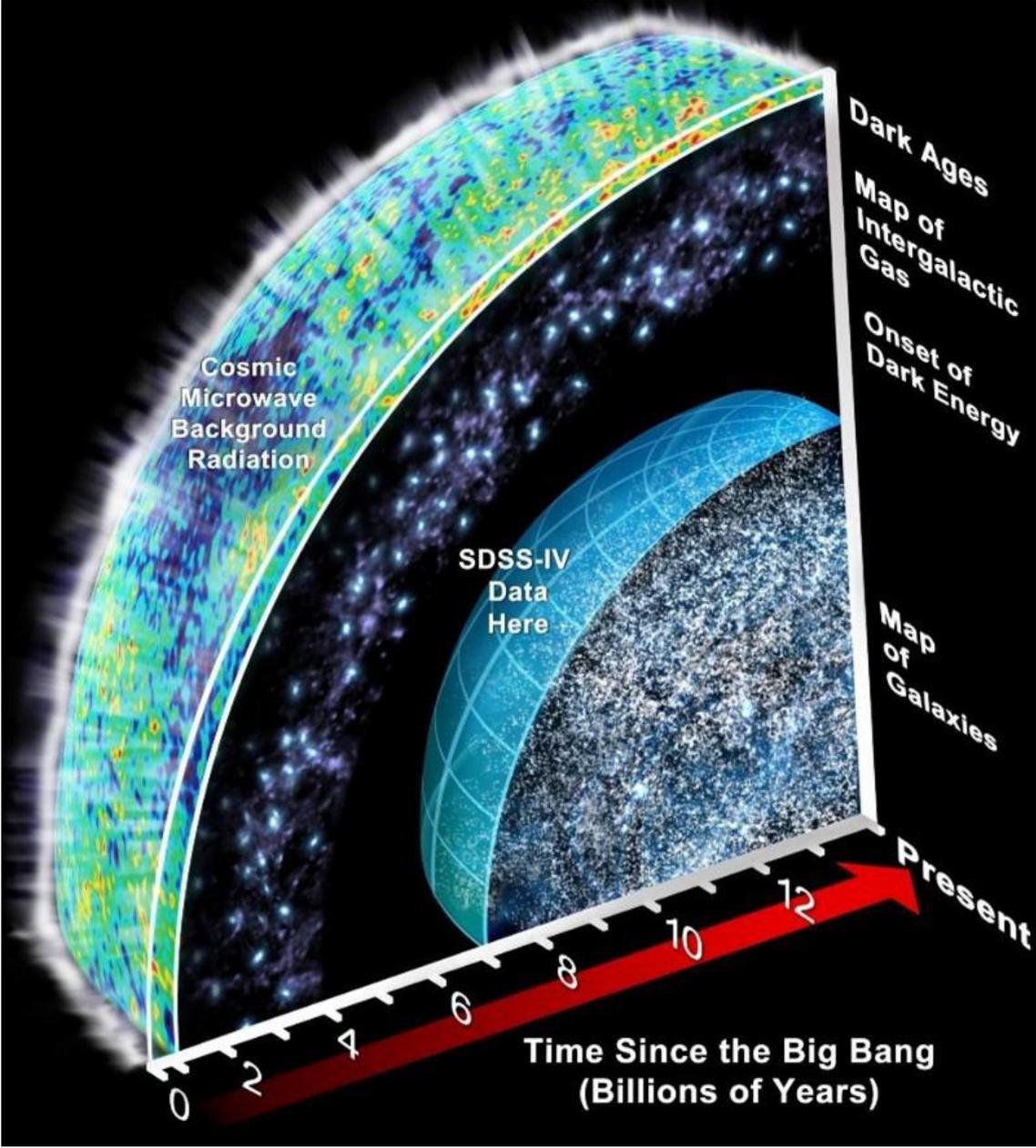


Chris Pedersen

PhD student supervised by Andreu Font-Ribera & Tom Kitching
Neutrinos@UCL (28/06/18)



Cosmological probes

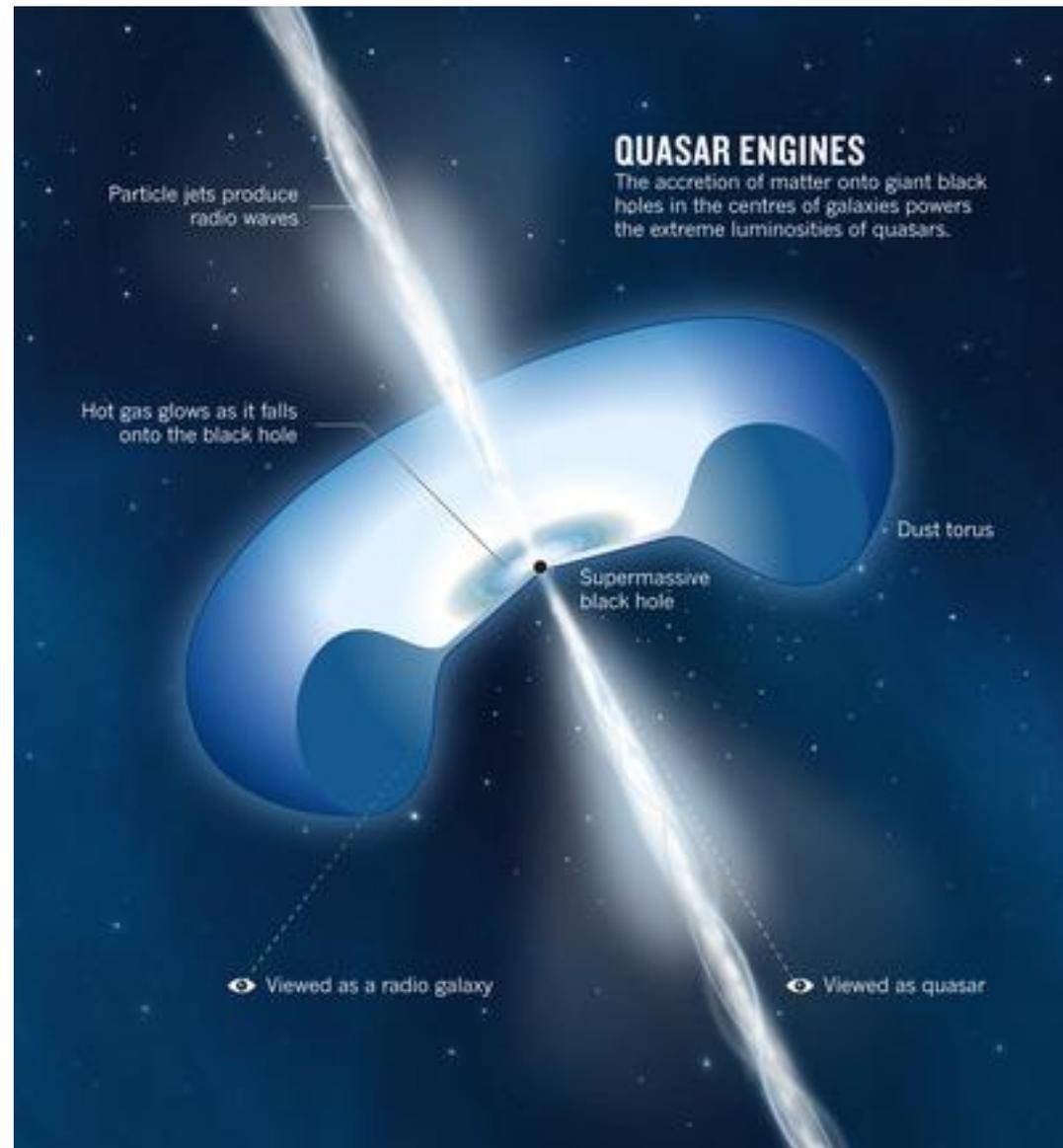


Quasars



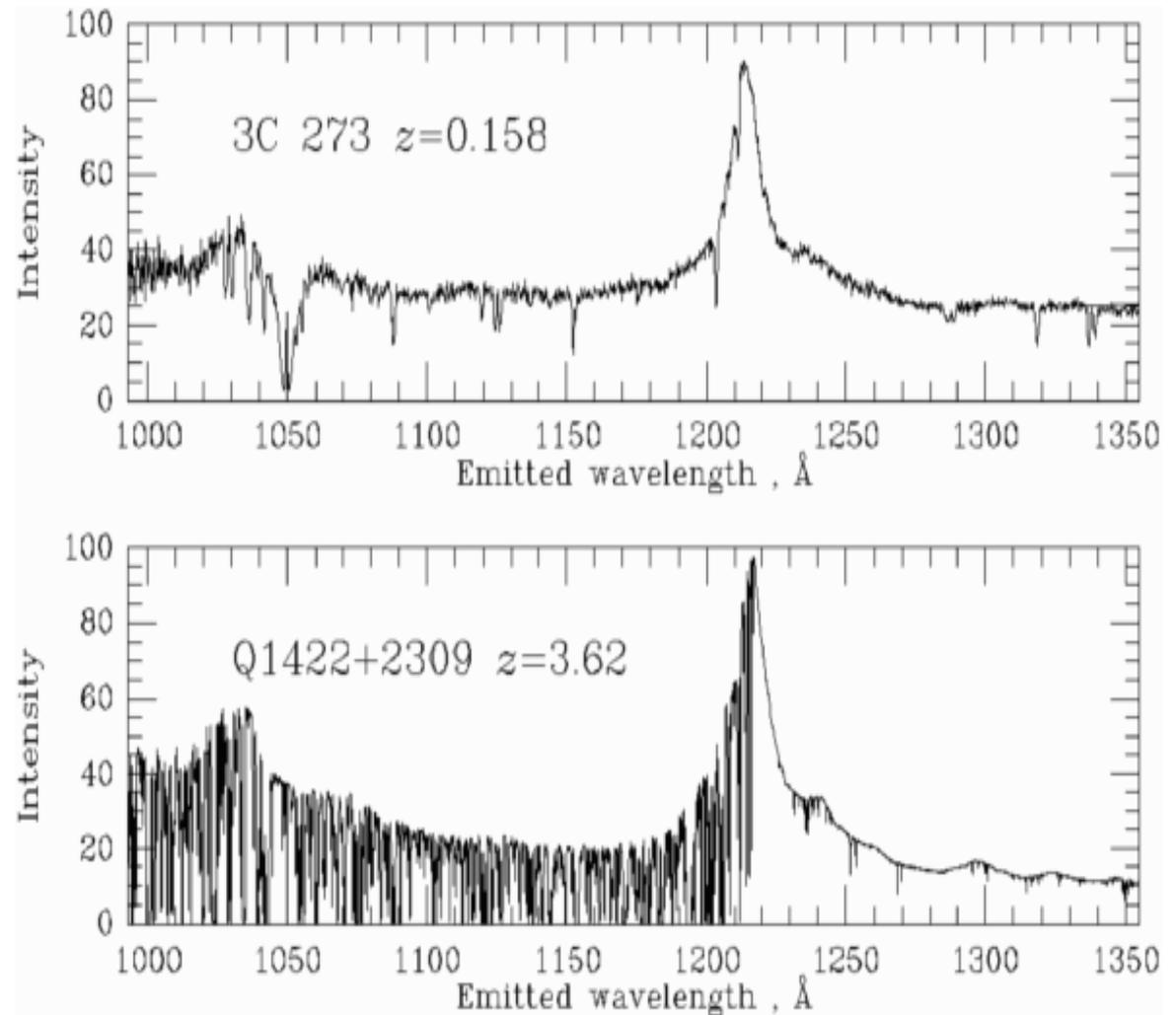
Extremely luminous, visible out to $z=7$.

Too sparse to gain good clustering statistics.

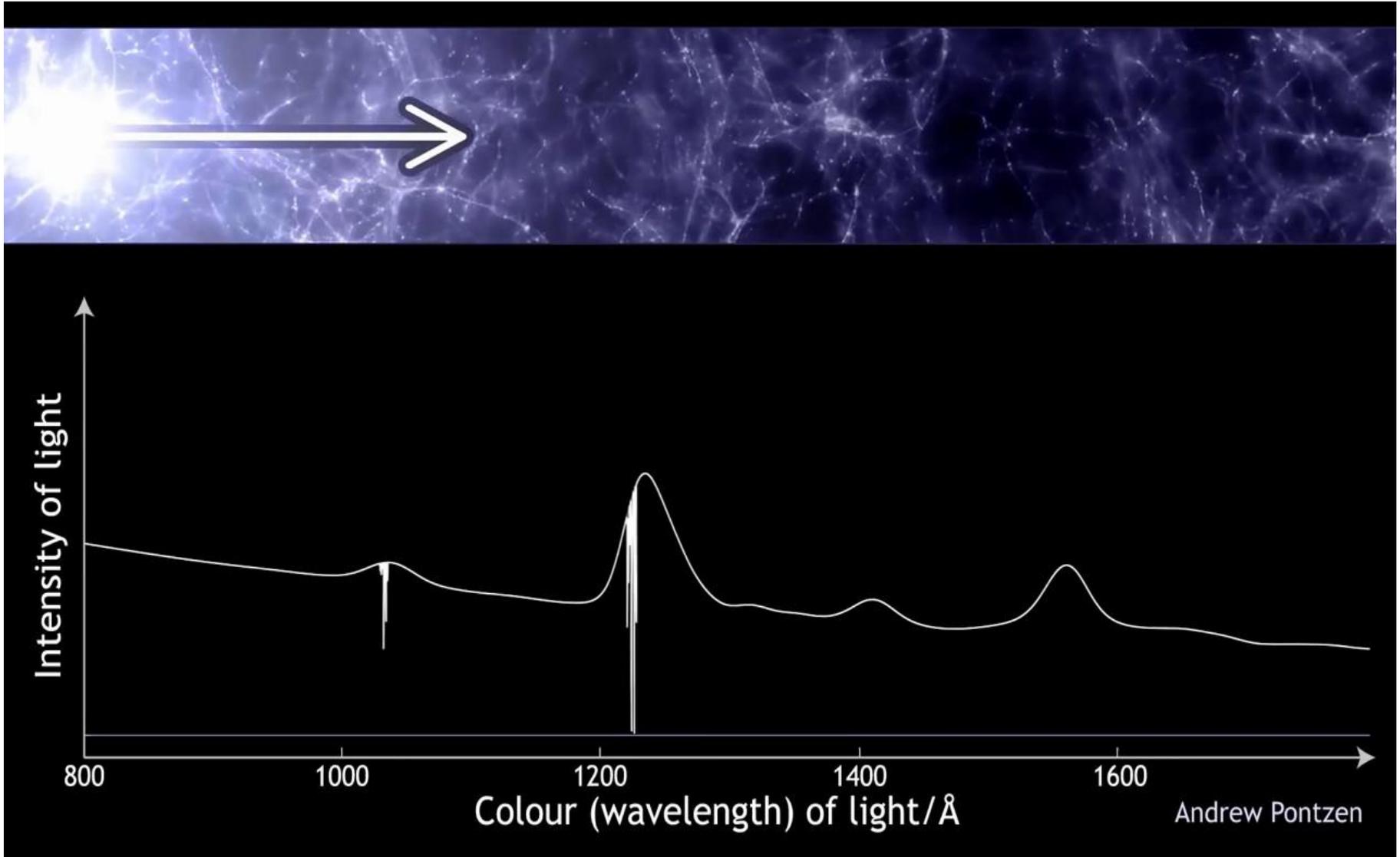


Lyman-alpha forest

- Absorption features in the (electromagnetic) spectra of distant ($2 < z < 5$) quasars.
- Caused by light passing through pockets of neutral hydrogen.
- Position of absorption feature depends on redshift of the hydrogen absorbers.

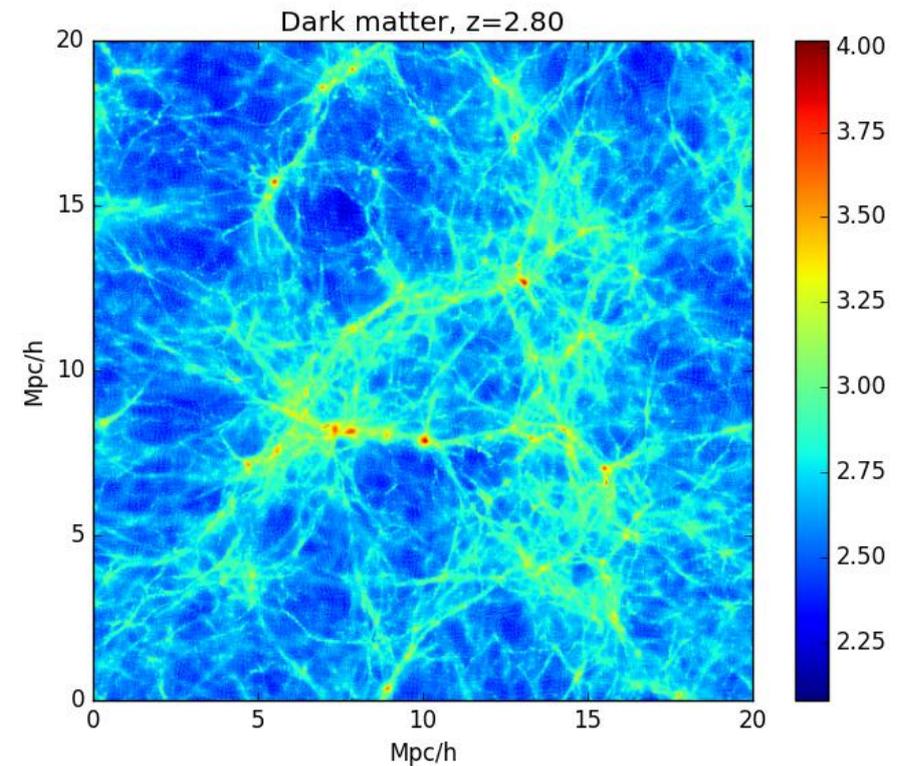
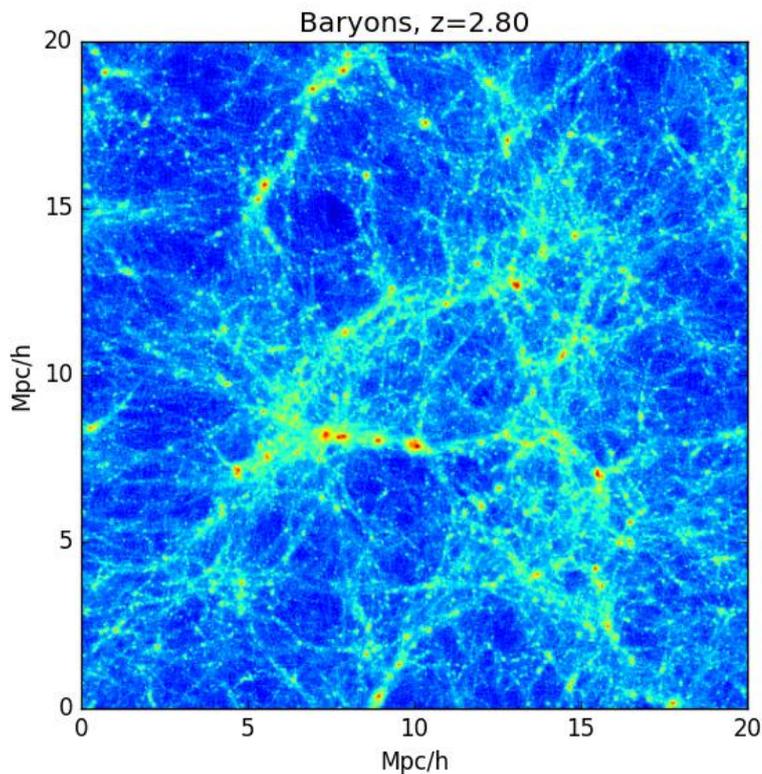


Lyman-alpha forest



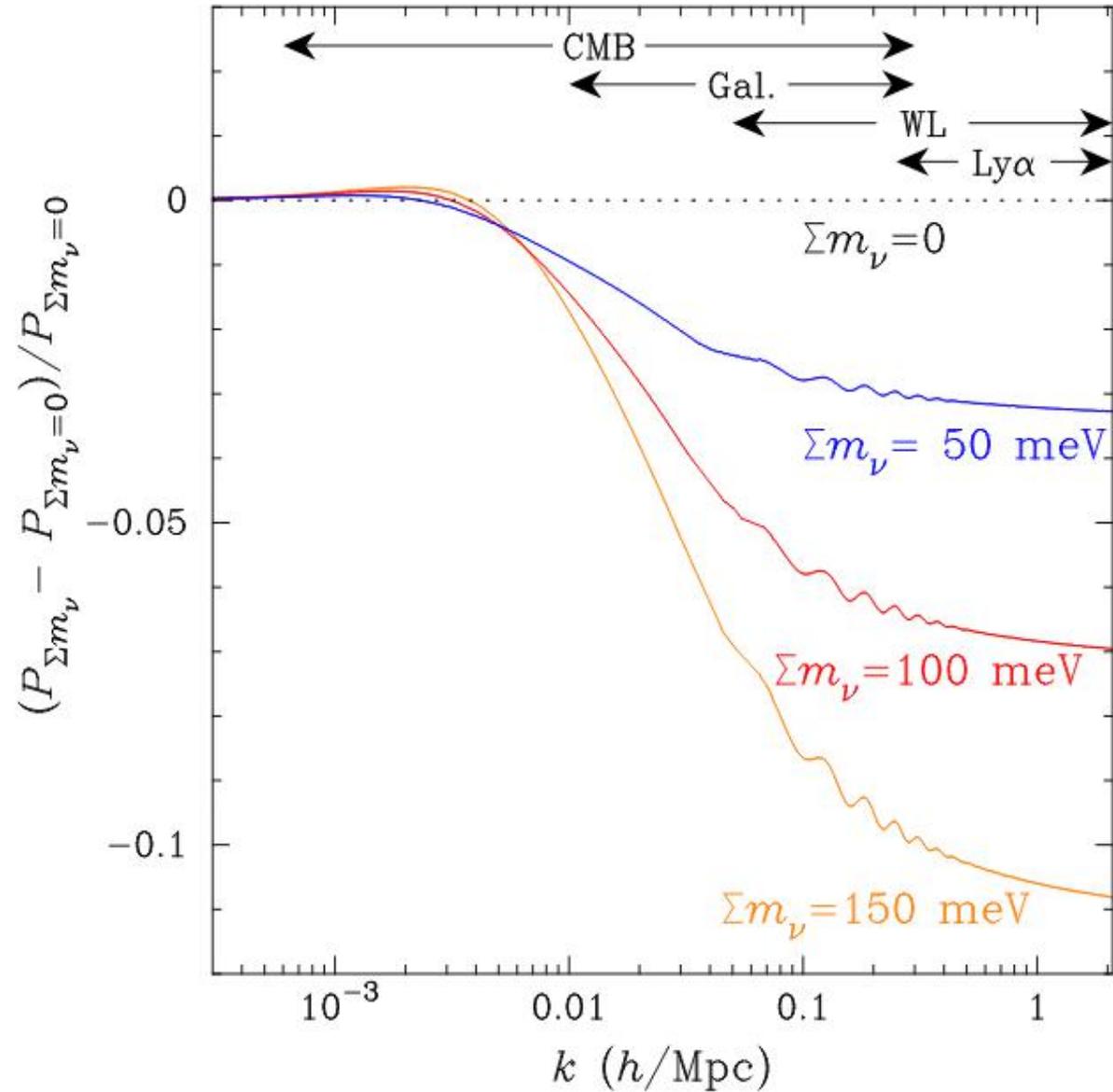
Analysing the Lyman-alpha forest

- Full hydrodynamical simulations are necessary to compare theoretical models to Lyman-alpha forest observations
- Extremely computationally intensive, requiring millions of CPU hours on supercomputers.
- Important to optimise parameter space dimensionality for the sake of computational efficiency.

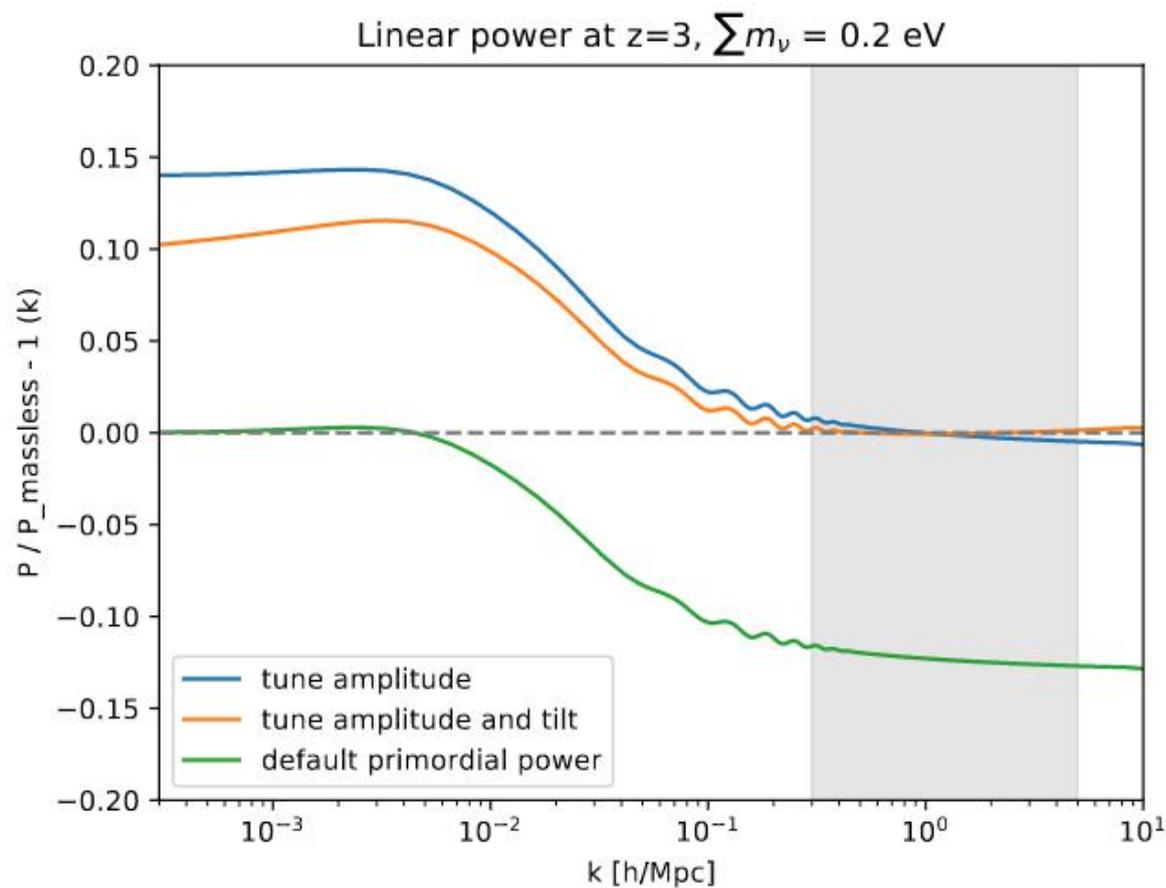


Effect of neutrino mass in linear theory

- Power suppressed on scales below neutrino free-streaming length
- Ly α forest is a strong probe of small scale structure.

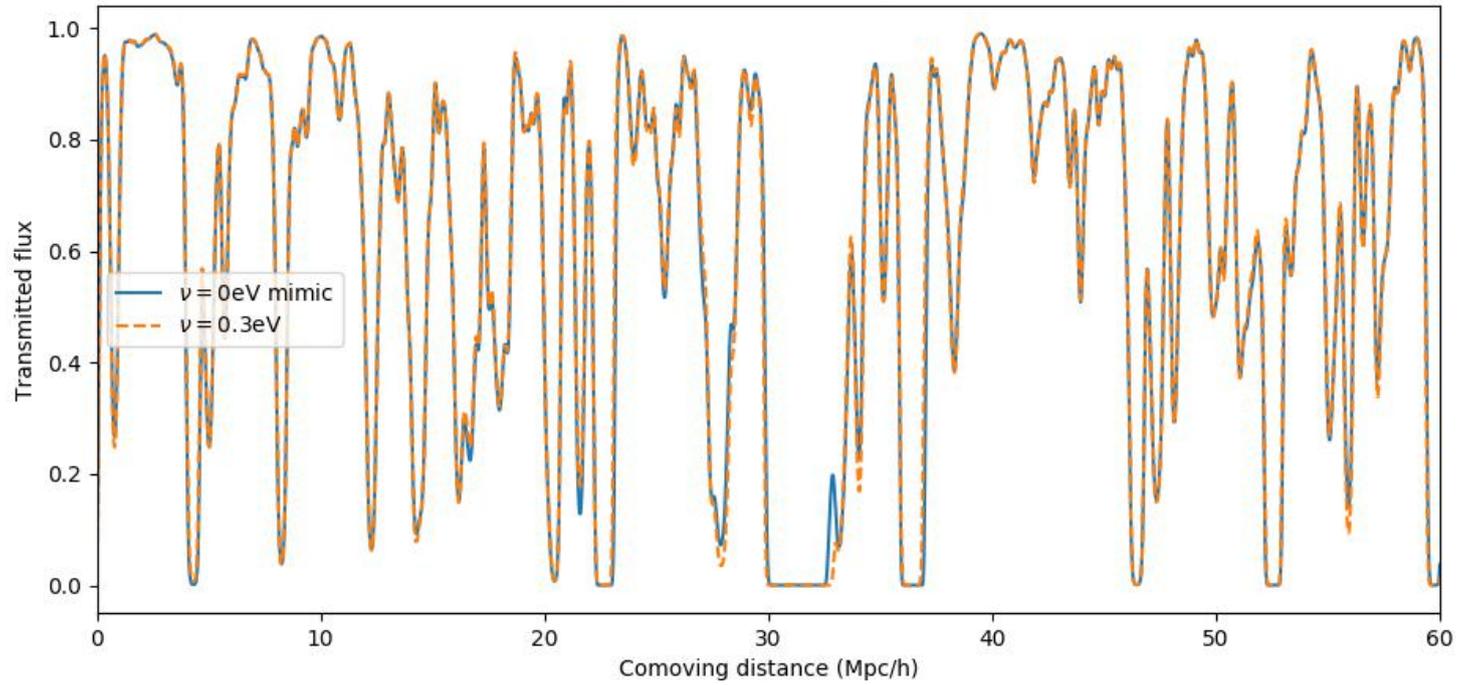


Degeneracies in the Ly α forest

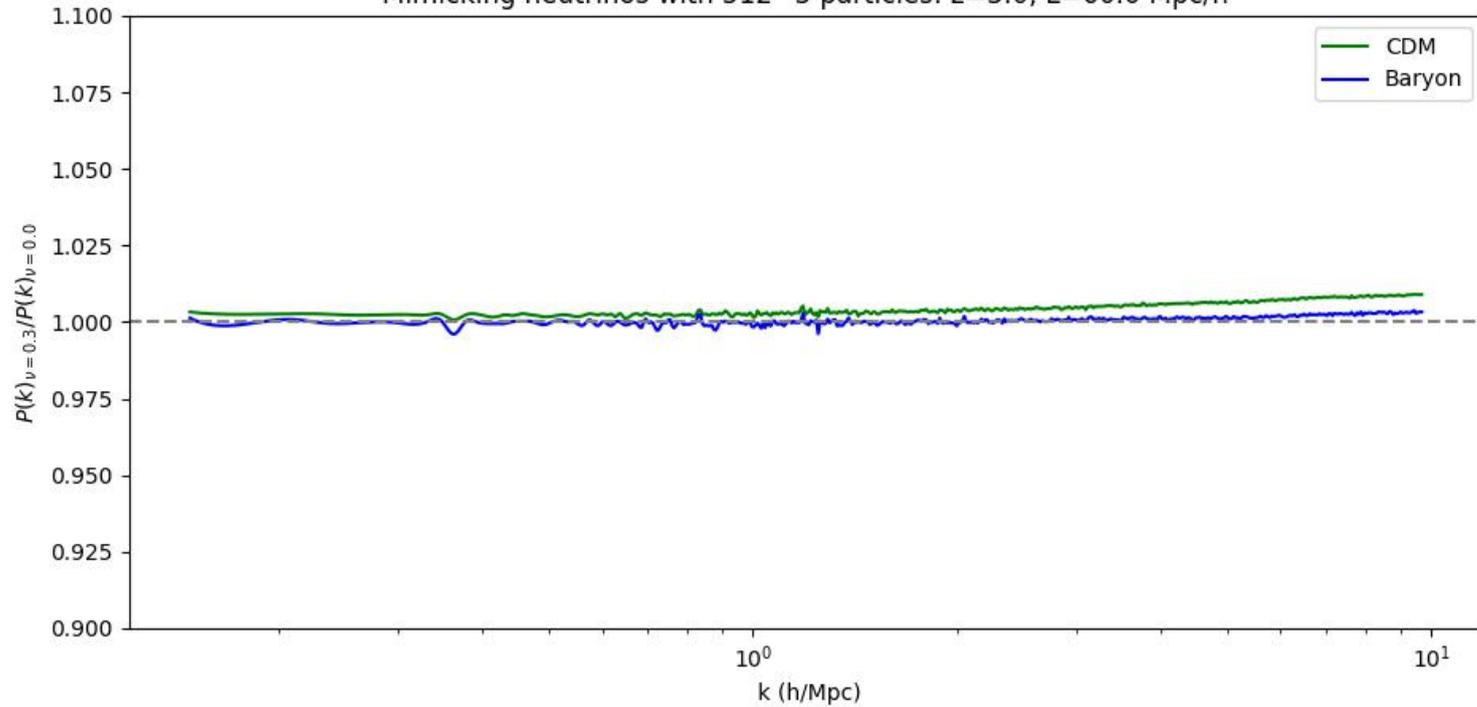


- Neutrino mass degenerate with other parameters on the scales Ly α probes.
- Important to determine best parametrisations for DESI simulations due to computational intensity of hydro sims.

Flux along a random line of sight at $z=3.0$

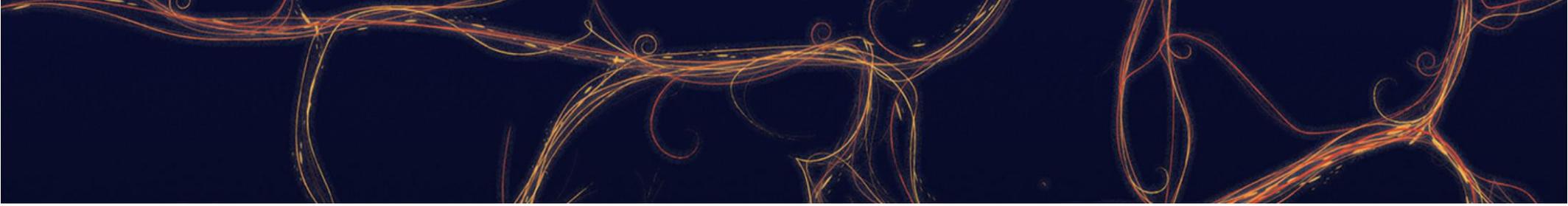


Mimicking neutrinos with 512^3 particles: $z=3.0$, $L=60.0$ Mpc/h



Next steps:

- Look at the flux power spectra (Ly α observable) for mimicked simulations to see how well the degeneracy carries over.
- Examine how robust the degeneracy is over the full range of redshifts that the Ly α forest probes ($5 > z > 2$), given that growth rate is different in massive neutrino cosmologies
- Experiment with modifying different parameters (i.e. keeping Ω_m fixed vs Ω_c when changing neutrino mass).



Take-home points:

1. Ly α forest is a strong cosmological probe of small scale structure in the high-redshift universe.
2. Neutrino mass is degenerate as a cosmological parameter on the scales that the Ly α forest probes.
3. Need to understand how robust this degeneracy is to optimise future simulation suites.

