

Computational Cosmology at the ARI

Alex Hill

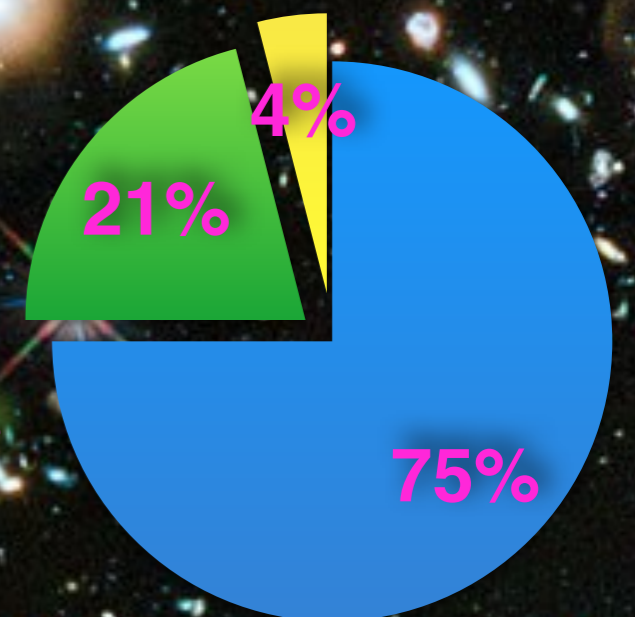
a.d.hill@2017.ljmu.ac.uk

Talk Structure

- Introduction to Observational and Computational Astronomy
- The HPC group
- The Work of PhD Students

The Universe

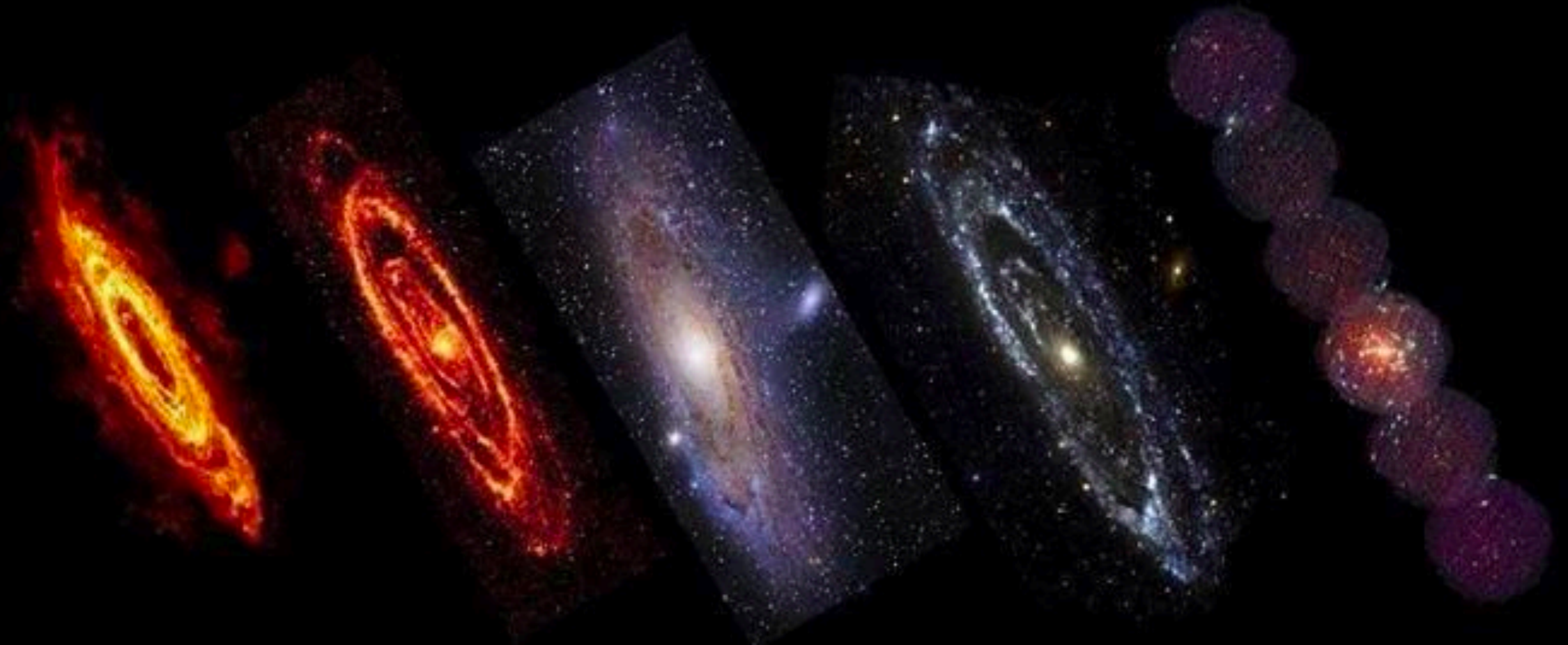
- Dark Energy
- Dark Matter
- Gas and Stars



Observational Astronomy



Observational Astronomy



Radio

Infrared

Visible

Ultra-violet

X-ray

Cool gas

Cold stars

Stars

Hot stars

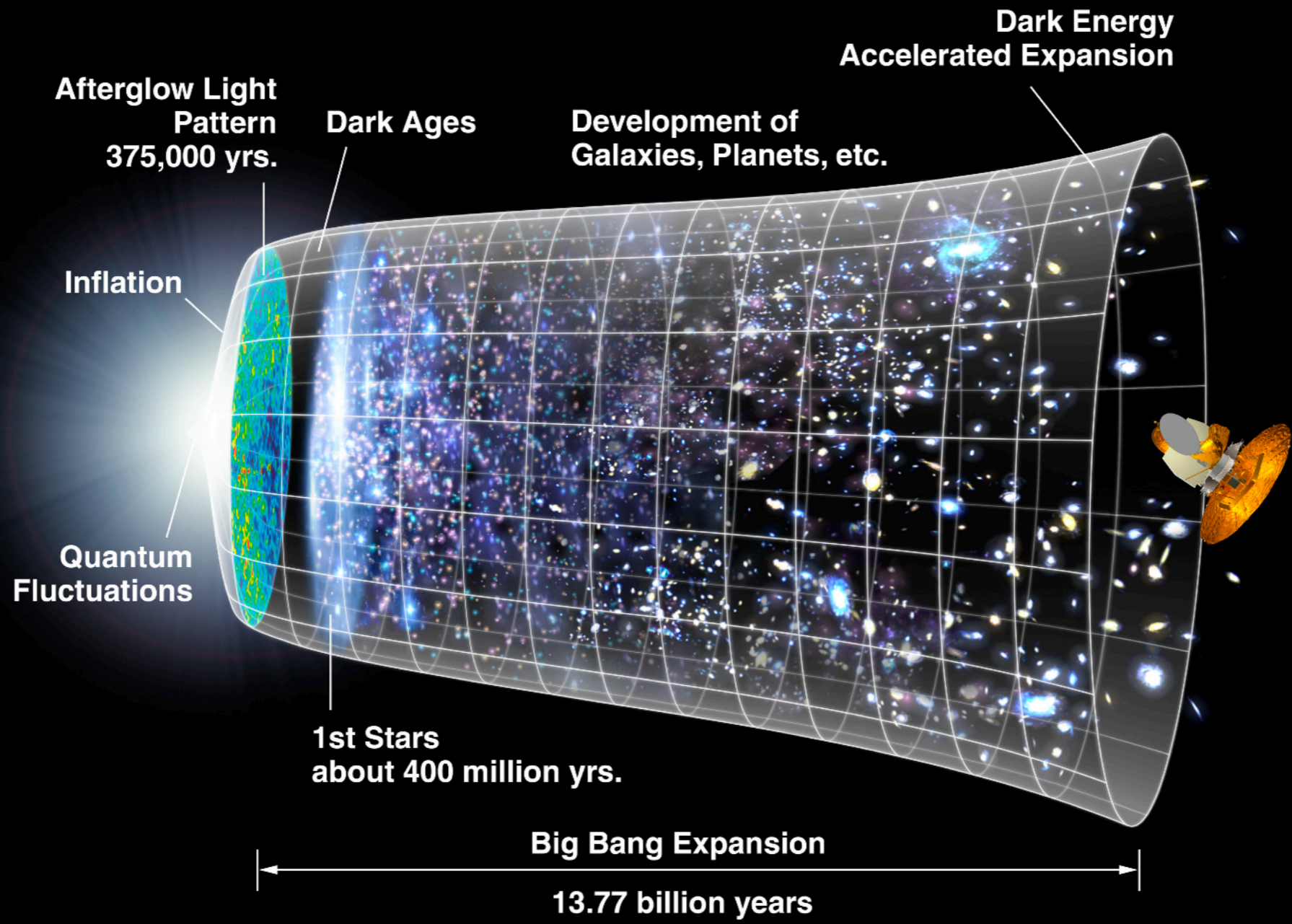
Hot gas

How did all this form and evolve?



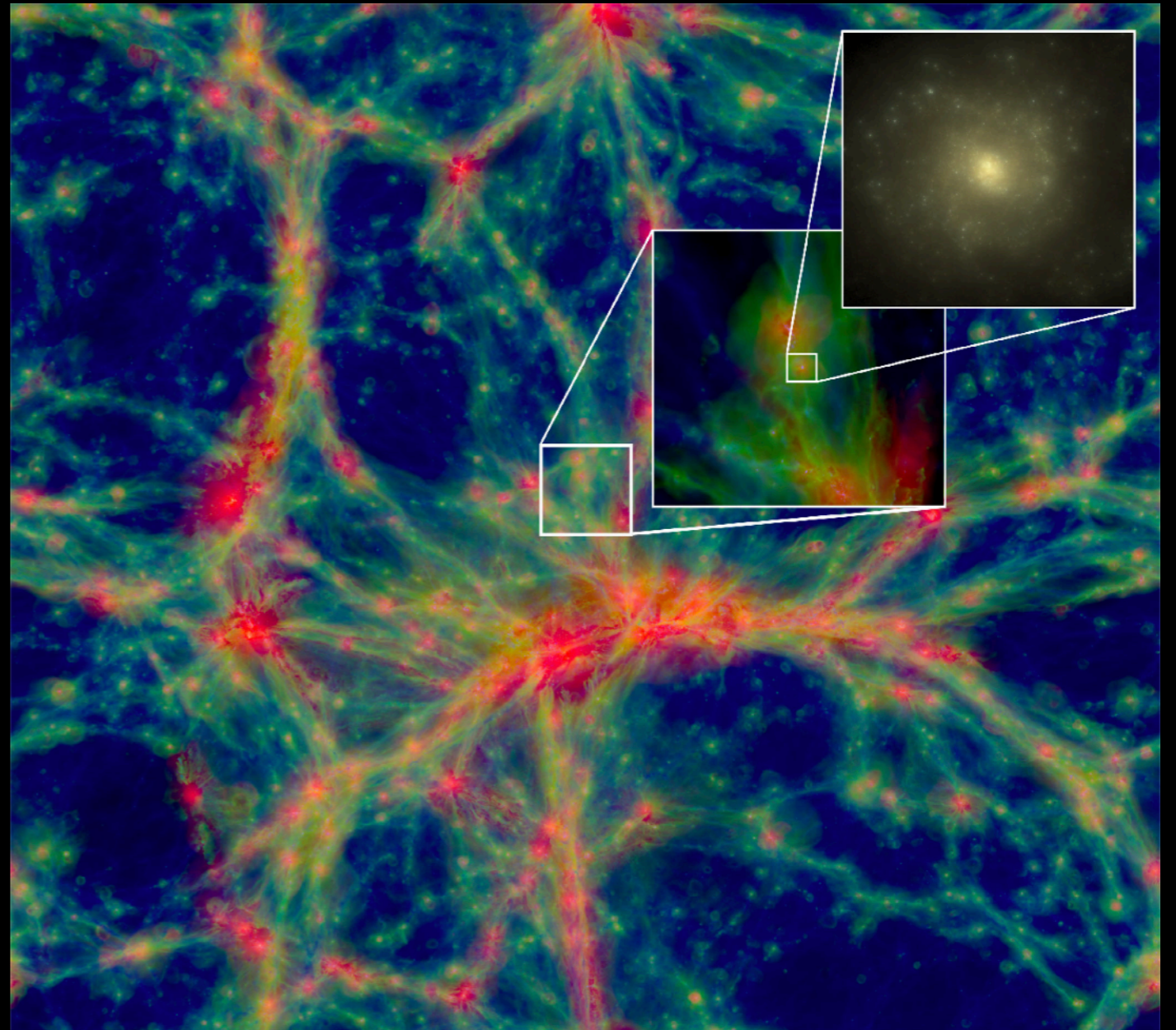
$t \sim 1$ month





Simulations

- Interpretation
- Prediction
- Experimentation



The EAGLE simulations

EVOLUTION AND ASSEMBLY OF GALAXIES AND THEIR ENVIRONMENTS

A project of the Virgo consortium

$z = 19.9$
 $L = 25.0 \text{ cMpc}$

Visible components:
CDM

HPC Group

 LIVERPOOL
SCIENCE PARK ic2



Research Staff



Dr Rob Crain

Dr Andreea Font

Dr Ian McCarthy

Galaxy Formation and Evolution

Milky Way and Dwarf Galaxies

Large-Scale Structure and Cosmology

Four PhD Students

Two PhD Students

Five PhD Students and Two Post-Docs

Simulations Study a Range of Scales

- BAHAMAS - Investigating Dark Energy and Dark Matter on Large Scales

BIGGEST

- EAGLE - Studying Galaxy Formation and Evolution

Bigger

- E-MOSAICS - High resolution zoomed Milky Way-like galaxies from EAGLE

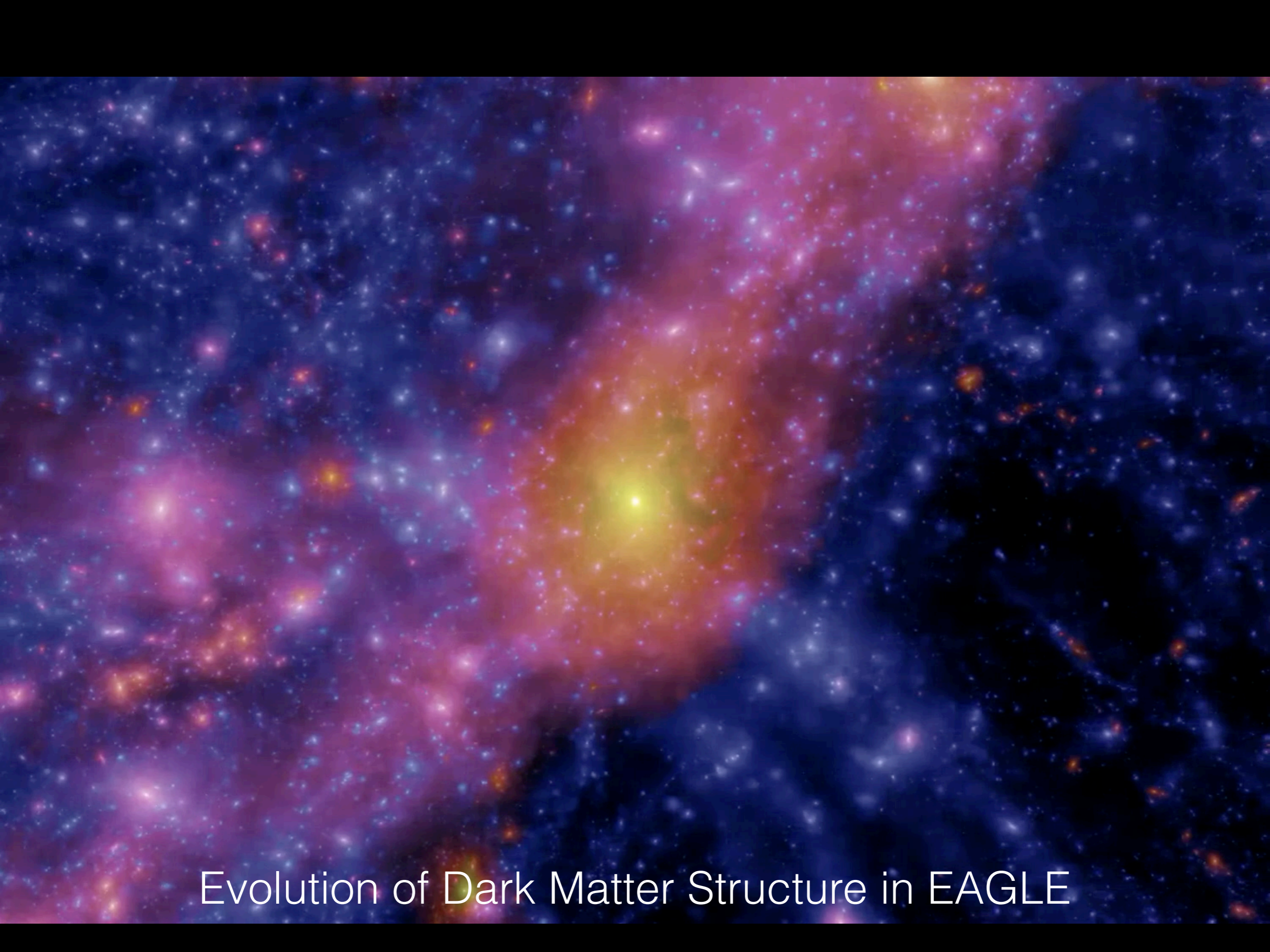
big

Computing Resources

- Local HPC Resources - Five **Dell PowerEdge r815** servers with 320 AMD opteron 2.5 GHz cores and 2.5 TB of RAM. 400 TB of storage
- National and International Supercomputing Facilities - **DiRAC** and **PRACE**





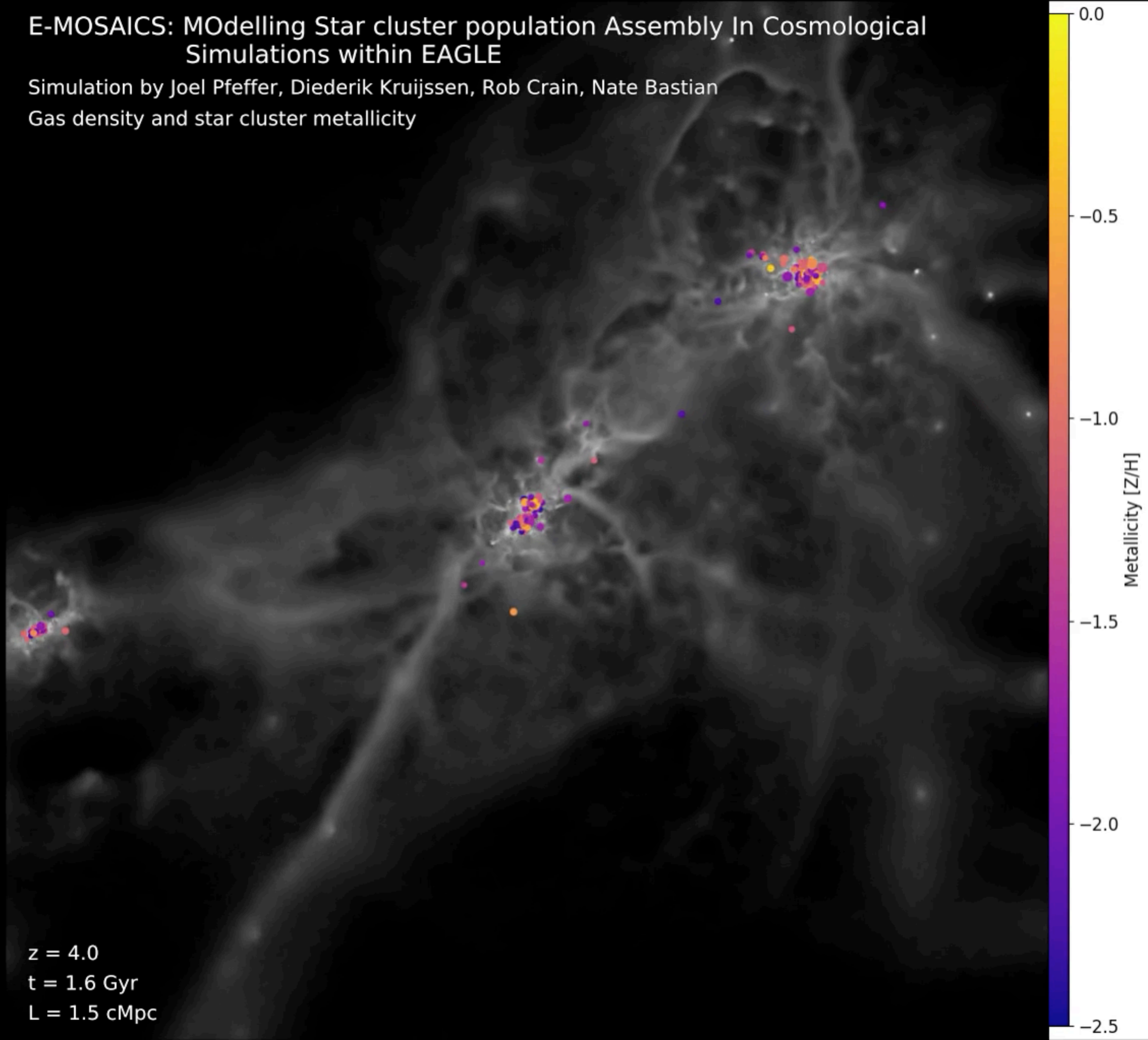


Evolution of Dark Matter Structure in EAGLE

E-MOSAICS: MOdelling Star cluster population Assembly In Cosmological Simulations within EAGLE

Simulation by Joel Pfeffer, Diederik Kruijssen, Rob Crain, Nate Bastian

Gas density and star cluster metallicity

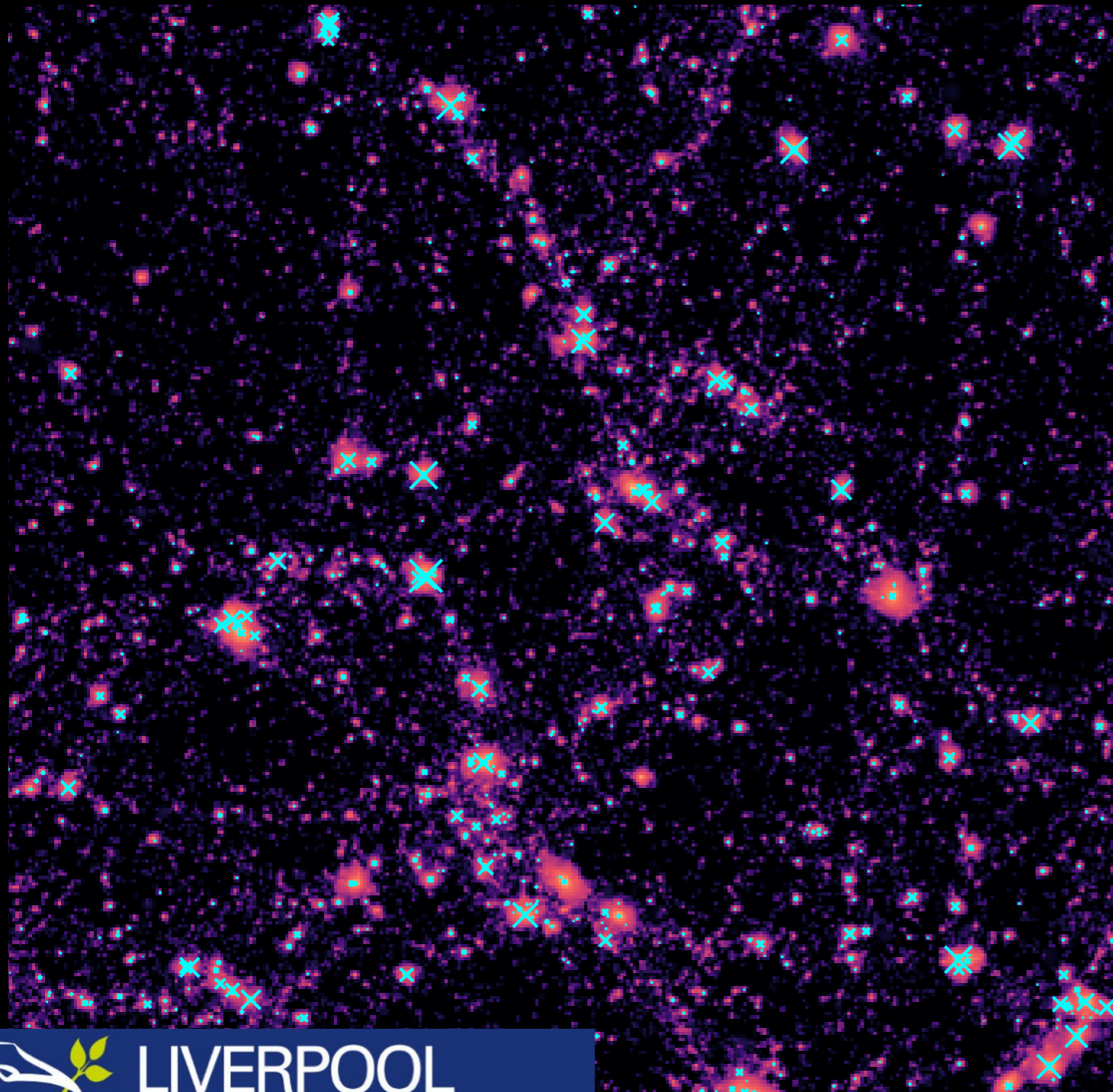


$z = 4.0$

$t = 1.6 \text{ Gyr}$

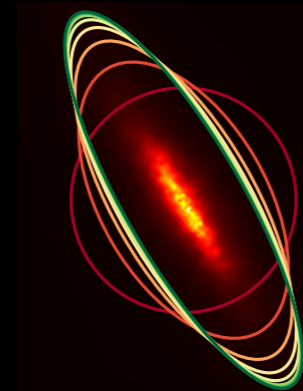
$L = 1.5 \text{ cMpc}$

PhD Students

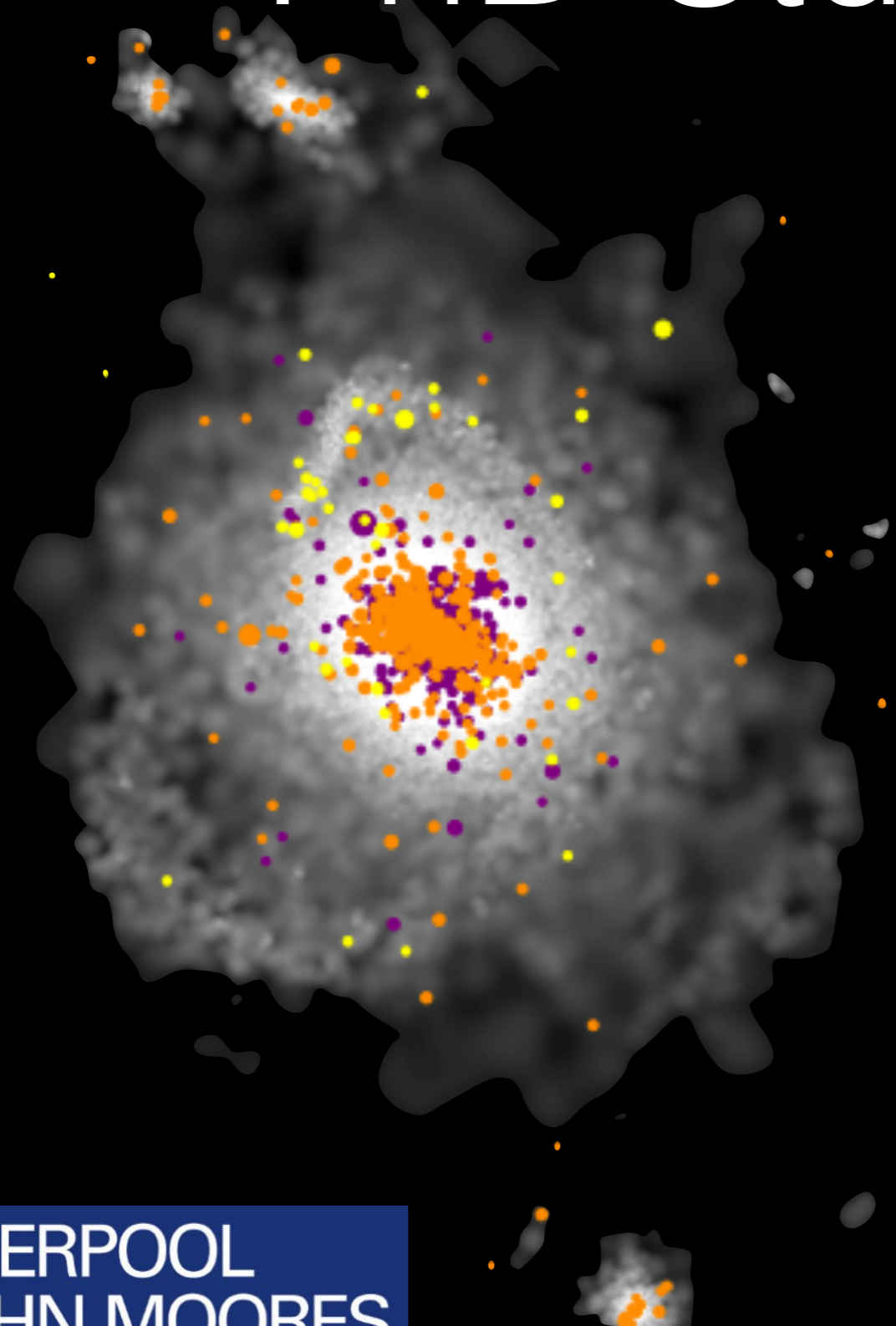


Alex Hill

Intrinsic alignment
of star-forming
galaxies in EAGLE



PhD Students



Meghan Hughes

Using E-MOSAICS to aid our understanding of how GCs can be used to infer the build up of the Galactic halo

PhD Students



Rob Poole-McKenzie

Searching for Dark Matter
Annihilation in EAGLE zooms

Reality Check

- The simulated universe isn't the real universe
- Resolution effects
- Finite resolution and computing time, so approximations and assumptions have to be made
- Calibrated to certain observed relationships, not derived from first principles

Questions