DYNAMICS OF CIRCUMGALACTIC GAS IN ASTROPHYSICAL SIMULATIONS

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PROBLEMS WITHIN GALACTIC EVOLUTION

- How do galaxies stop producing stars?

- Where are missing baryons & metals[†] in galaxies?
    - Surveys have uncovered a deficit

- Understanding composition of gas flow still unclear
    - Outflows & recycling
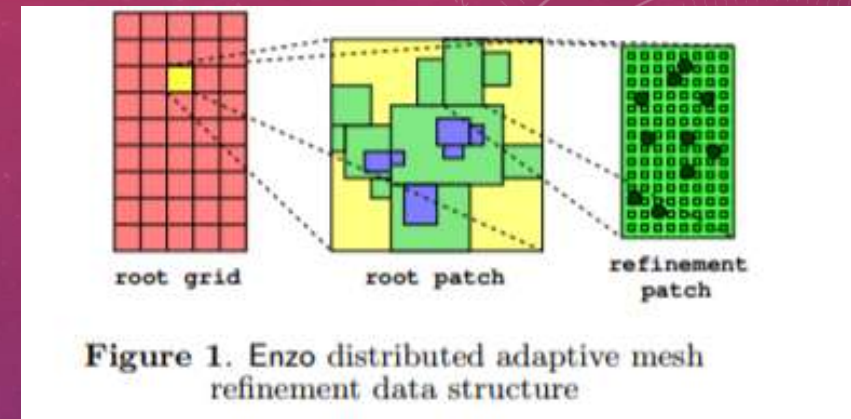
- Observational difficulties

How can we address these issues?

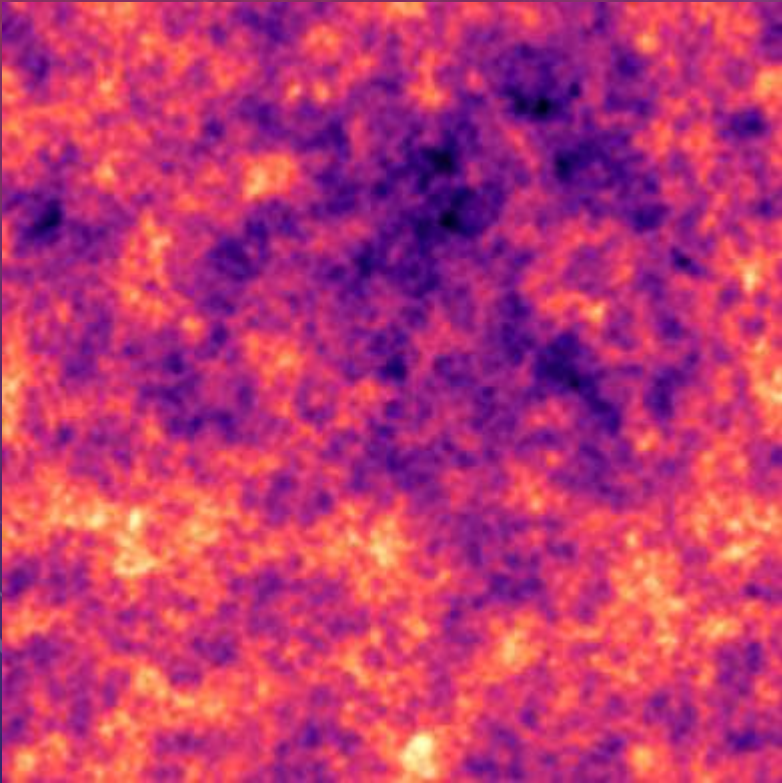*Composite image of M82 taken by Hubble Telescope*

ASTROPHYSICAL SIMULATIONS

- Produced using Enzo, an adaptive mesh-refinement hydrodynamic code
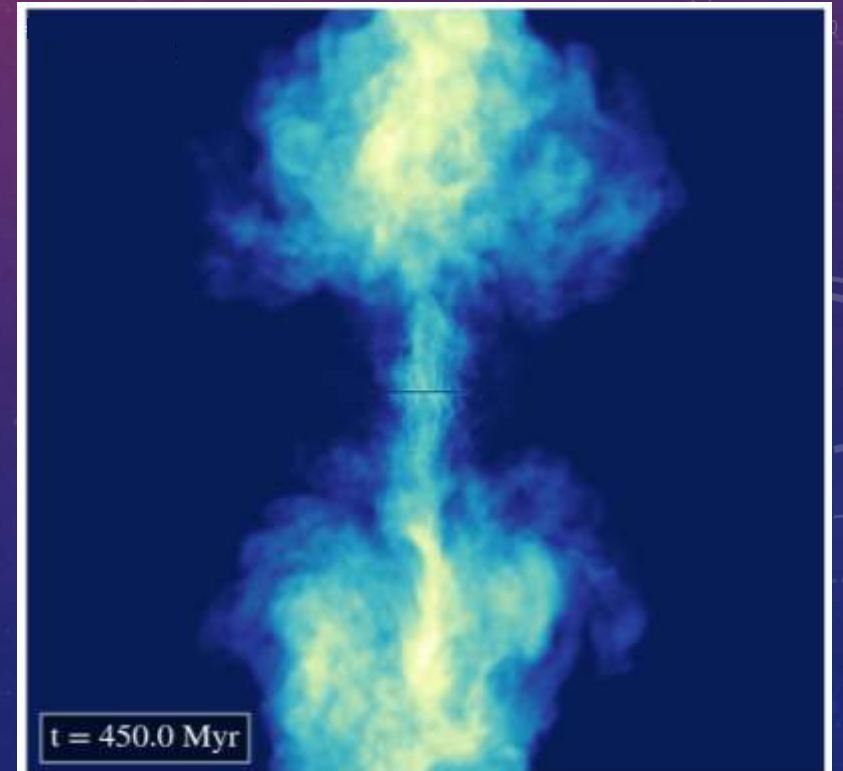
- Analyzed with yt, a python package

Figure 1. Enzo distributed adaptive mesh refinement data structure

Credit: J. Bordner & M. Norman

Cosmological: Entire universe

Idealized: Galaxy-in-a-box

t = 450.0 Myr

WHAT IS CIRCUMGALACTIC GAS & WHY WE CARE

- Bubble of diffuse gas surrounding a galaxy
    - Rich density, temperature, & velocity structure
- Arena through which outflows permeate
- Connected to star formation and believed to account for significant portion of baryon budget (50%)
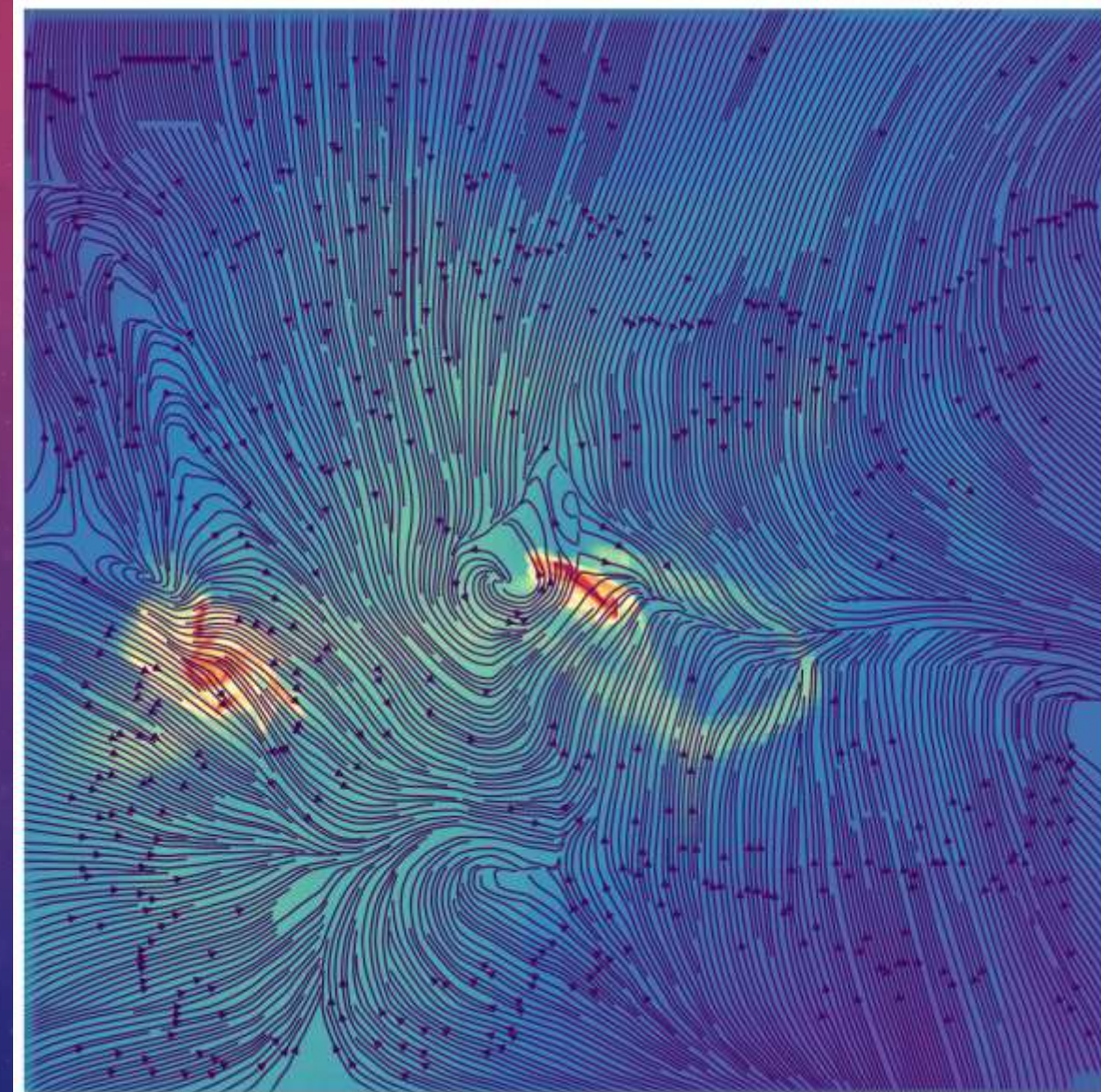- Considered a factor and indicator of galaxy "quenching"
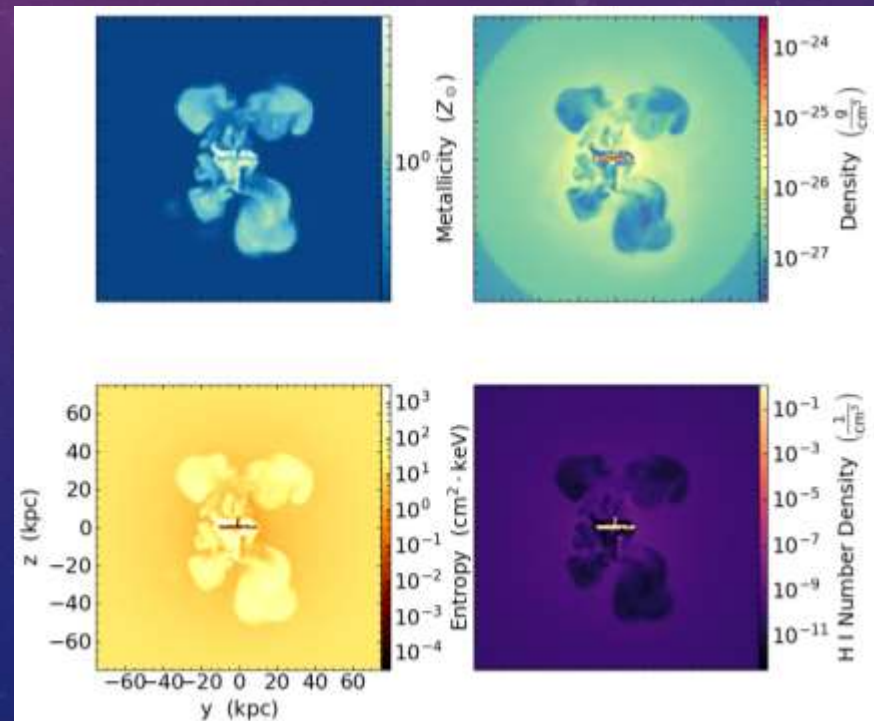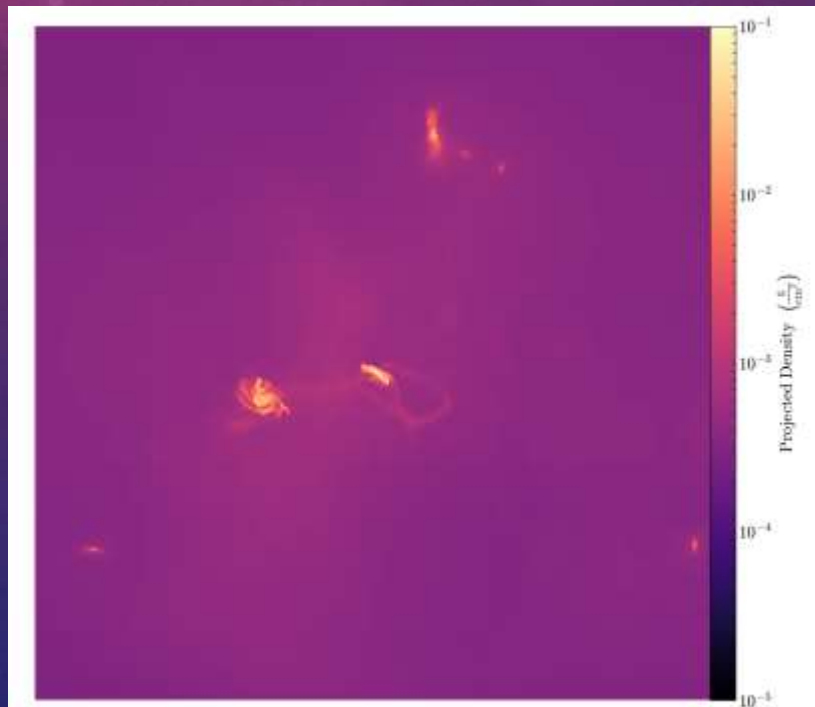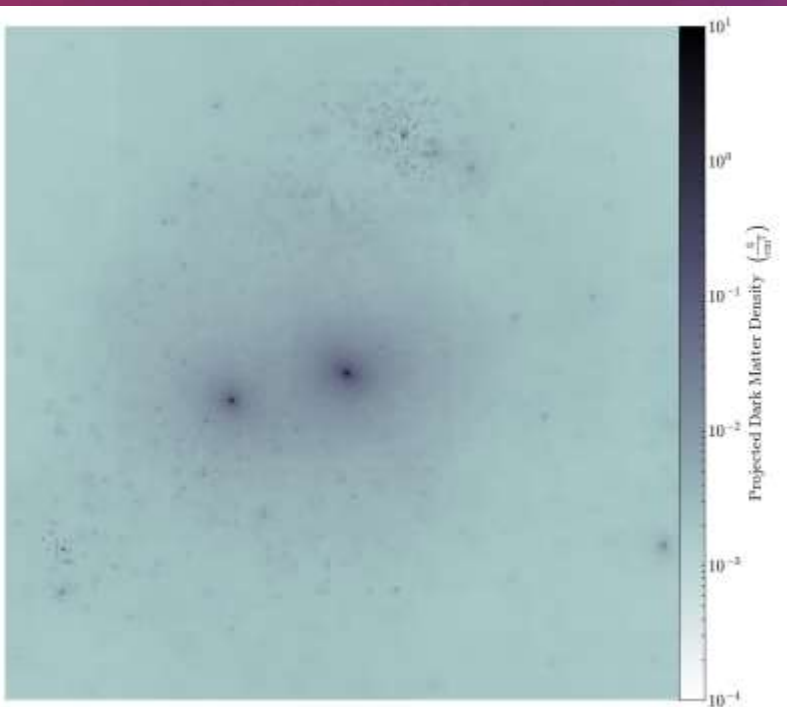
COSMOLOGICAL DYNAMICS

- Movement of gas between galaxies (IGM)

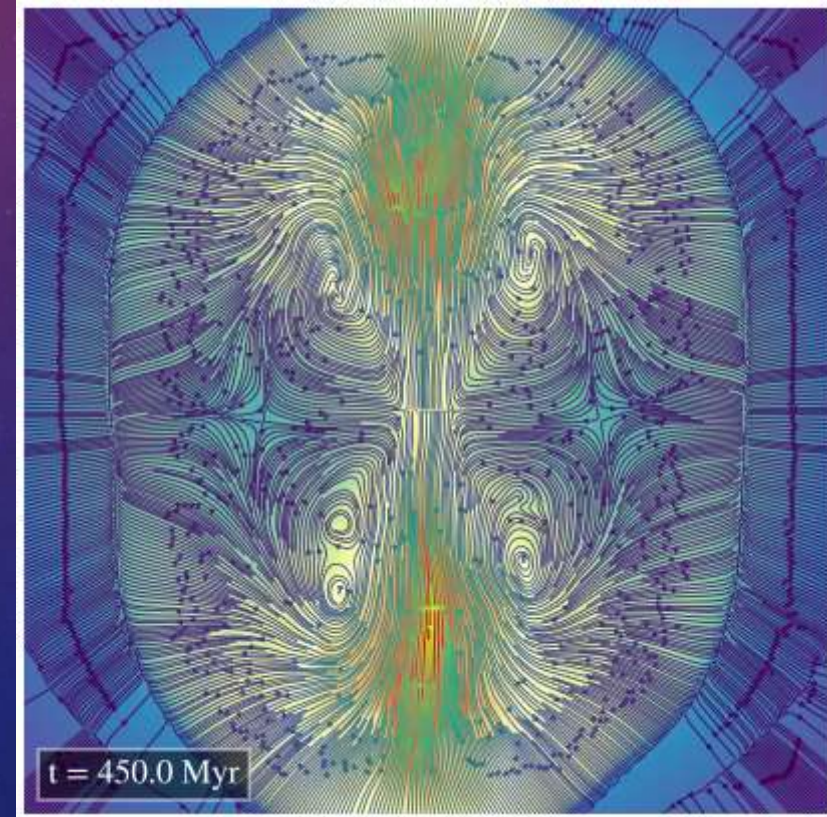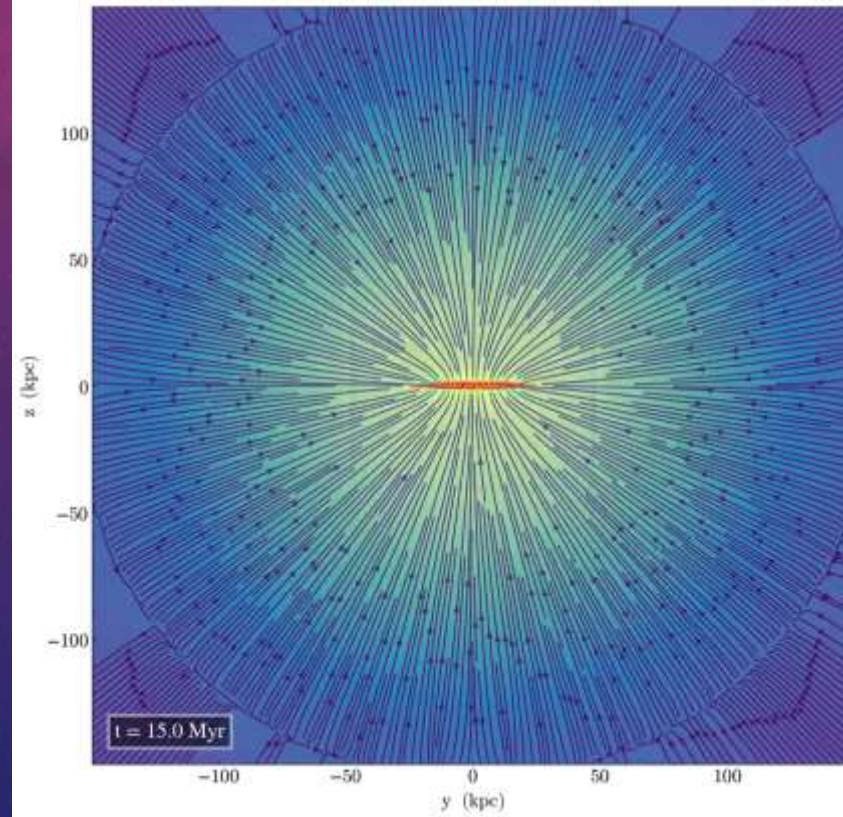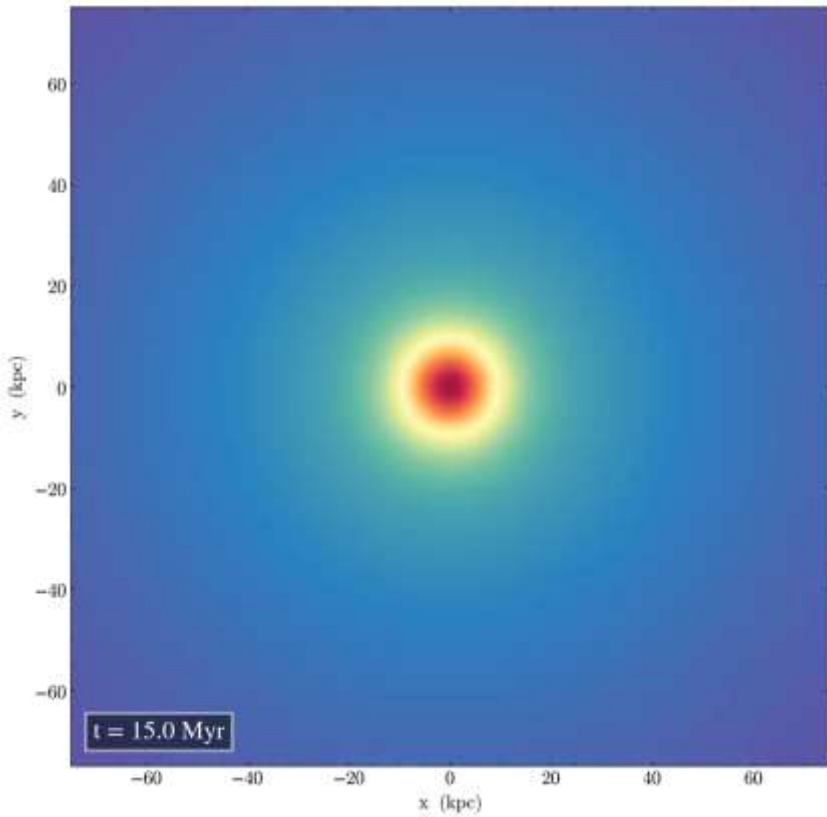- Interplay between galaxies
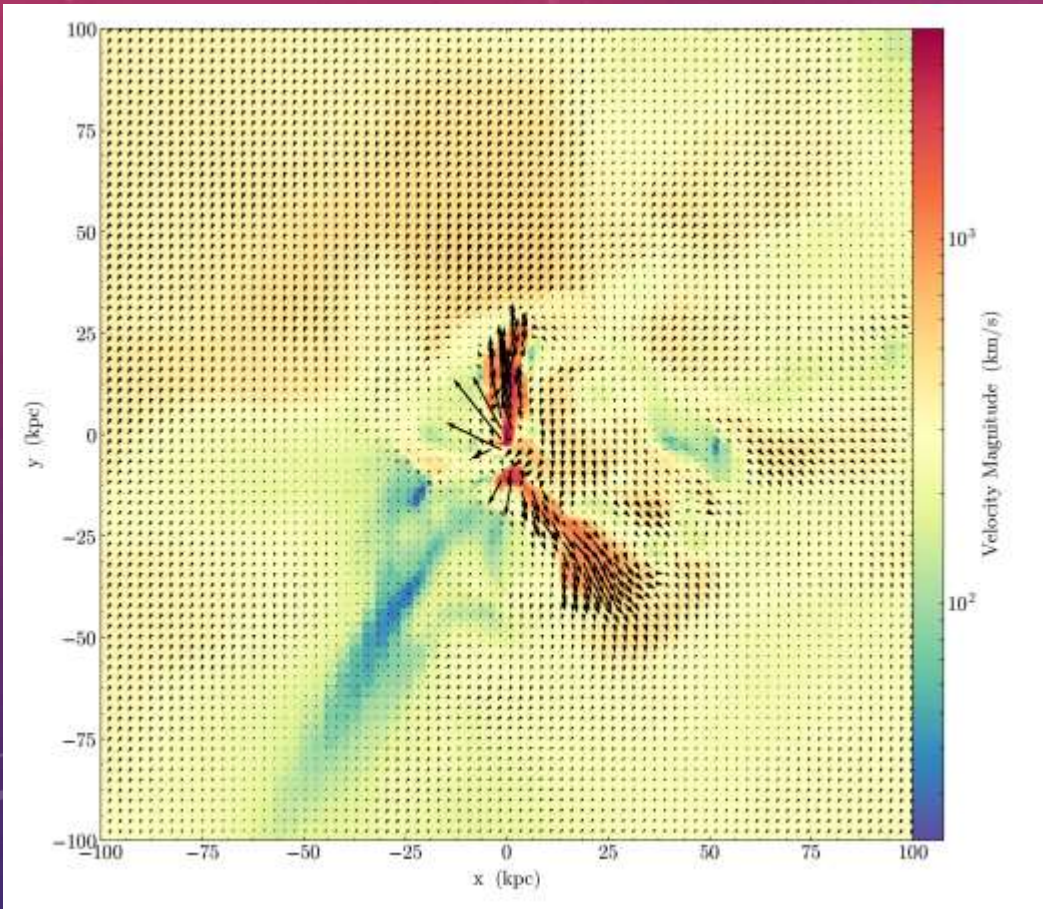
Slice plot of velocity magnitude

*Projection plot of density with annotated velocity streams*

DYNAMICS OF IDEALIZED SIMULATIONS

- Outward plumes & inflowing gas

- Convection
 - Multiphase nature of CGM

- Recycling

PROJECT LIMITATIONS & FUTURE WORK

- Confined primarily to low resolution analysis

- Expensive calculations made data analysis cumbersome
  - Many weeks to generate simulation data

- Use of single simulation code

- Future study to investigate simulations with varying parameters

- Usage of synthetic line spectroscopy as another probe of structure & dynamics

- Analysis of star formation rates
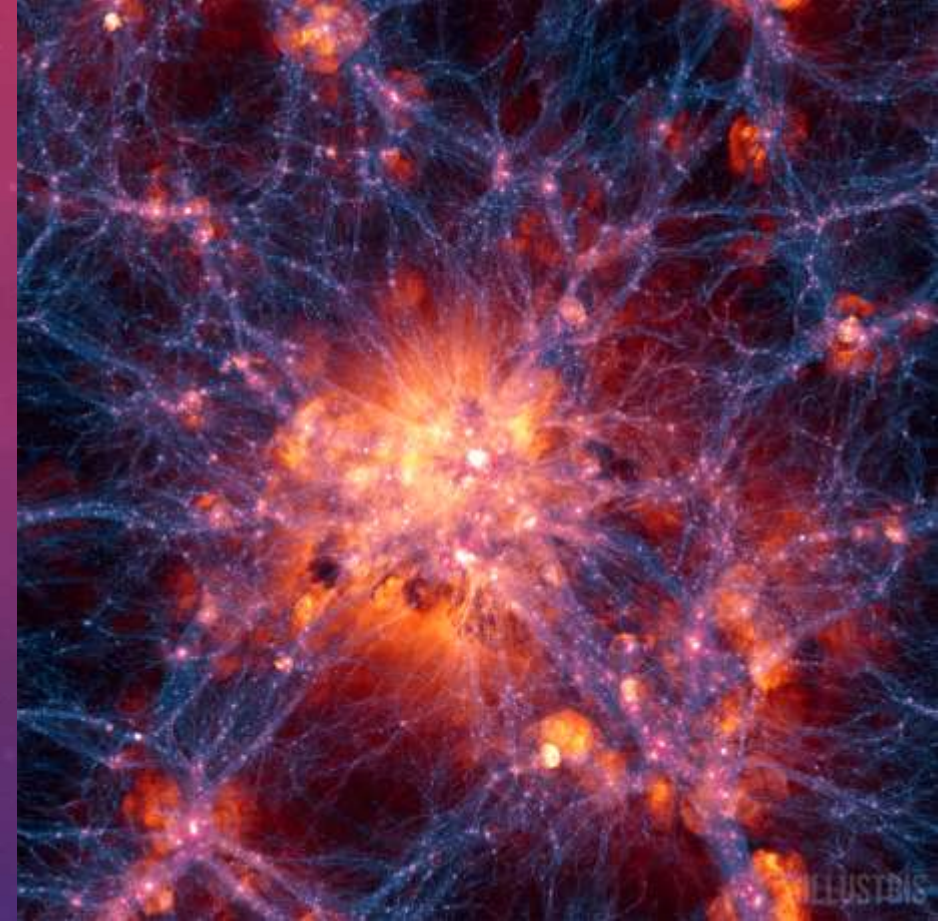
Credit: illustris-project.org
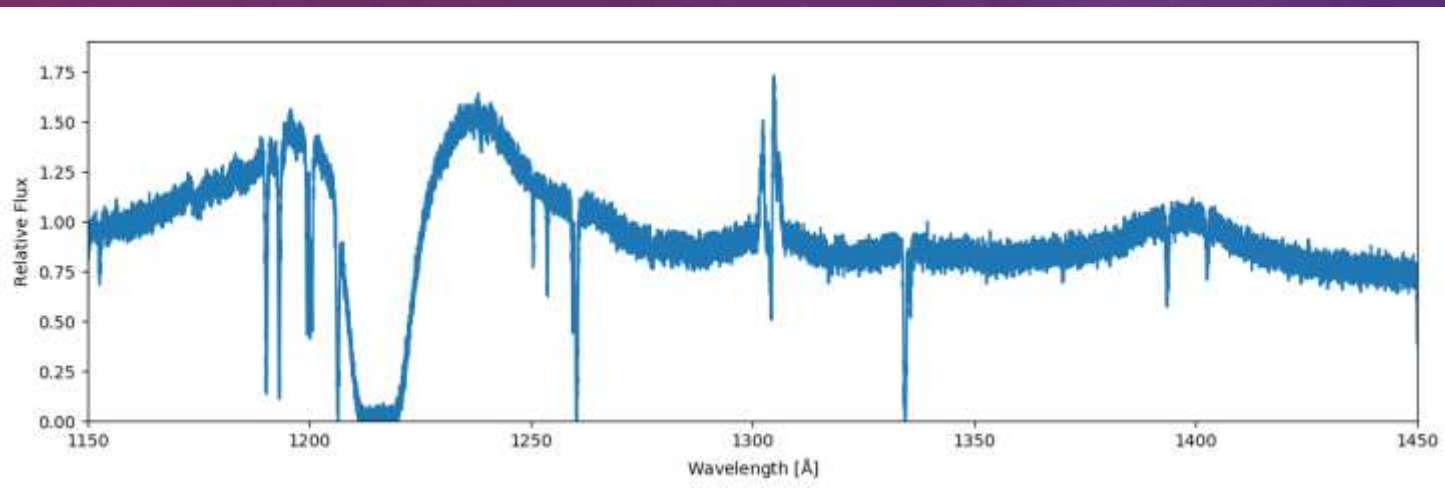
Sample absorption line spectrum generated by Trident

Trident

CONCLUDING REMARKS

- The circumgalactic medium is a complex system believed to greatly participate in galaxy evolvement

- Our models for galactic simulations are useful and reveal insight into galactic anatomy and evolution