Baryon Cycle WG

F2F Presentation

Current WG Status

- Joel Bregman & Juna Kollmeier (chairs)
- Piero M., Eliot Q., Alexey V. others? (internal STDT members)
- Andrey Kravtsov, Romeel Dave (external members contacted)
- Eugenio Ursino, Li Jingtao, Ralph Kraft, Akos Bogdan, Mehmet Alpaslan, Massimiliano Galeazzi, Scott Randall
- Invitations out to:
- Ben Oppenheimer, Mark Vogelsberger, Claude-Andre Faucher-Giguere (external support)

Missing Expertise?

- Need More Observers!! (Some suggestions: Todd Tripp, Crystal Martin, Jason Tumlinson, Mike Shull, Fabrizio Nicastro, Jelle Kaastra, Smita Mathur, Daniel Wang, Tim Heckman)
- More theorists: Daisuke Nagai

What Causes Hot WHIM Gas?

- Mainly gravitational collapse in overdense regions
  - Conversion of potential to thermal energy
  - Density wave shocks
    - Dark matter collapses and passes through itself but baryons shock
  - Accretion shocks
    - Continued accretion onto collapsed object
- Gas remains hot only if the cooling time is long (> 10 Gyr)
  - Cooling curve peaks around 1-3E5 K (and cooling time drops)
  - Don't expect hot halos around galaxies with virial T below 5E5 K
  - That's why OVI (peak at 3E5 K) is not an adequate tracer of hot halos
- Where does the gas remain hot for a Hubble time?
  - Galaxies with masses > 3E11 Msun (0.2 L*); formed from overdensities of 200
  - Galaxy groups & Clusters (but generally too hot for abs lines)
  - Non-virialized Cosmic Web filaments (but these are not great sites)

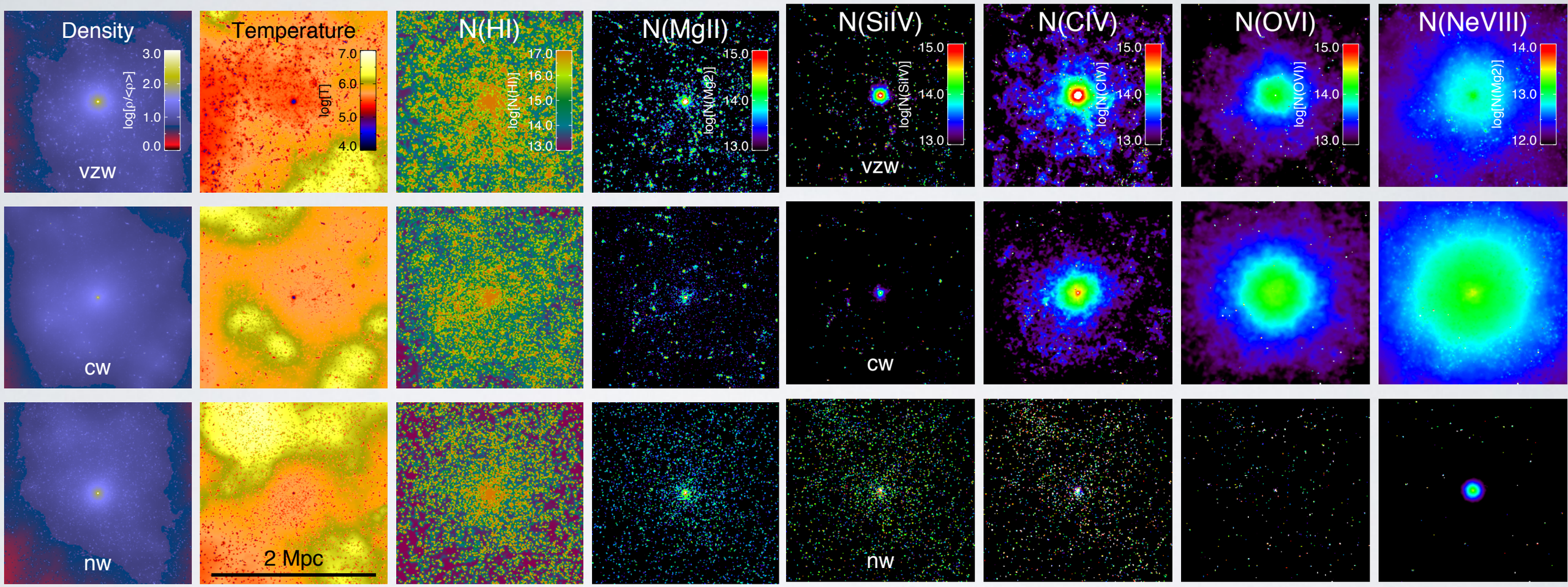
From J. Bregman

What About Feedback in Creating and Modifying Hot Galaxy Halos?

- Can add heat to halos (most are observed above T_{virial} by 50-100%)
  - Changes radial distribution of gas
  - Determines how much of the hot halo escapes beyond R_{200}
- Can extend the presence of hot halos to lower mass galaxies by balancing some of the radiative cooling with feedback
  - Highly model dependent, so observations will constrain models
- Feedback has a profound effect on the nature of hot halos
- Galaxy formation is the combination of dark matter collapse plus feedback into the baryons
- Feedback pollutes – this is responsible for the metals
  - Metal mass informs the amount and distribution of feedback

From J. Bregman

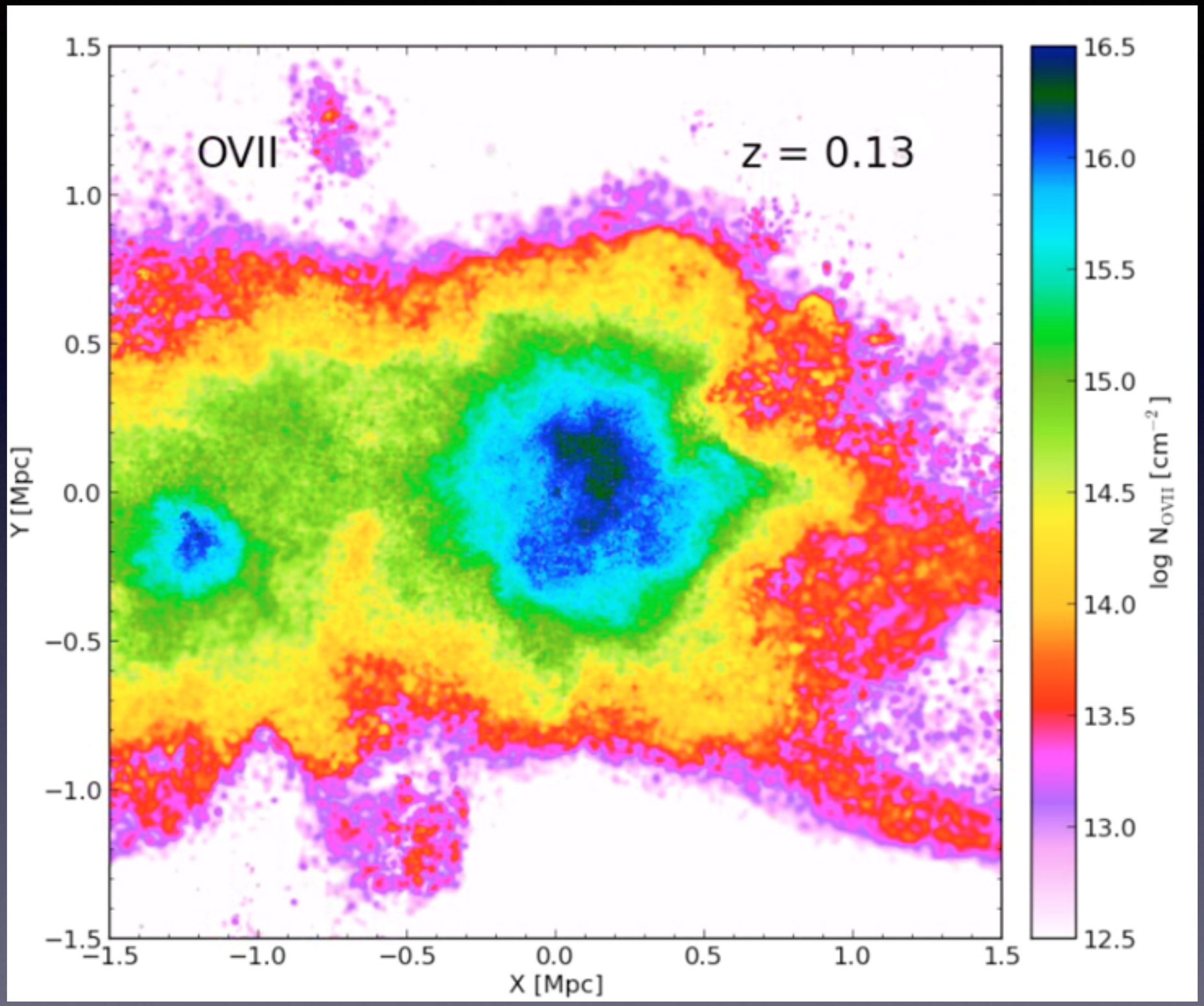
A METALLIC CGM



Can make predictions for all of these species (and lots more) to learn

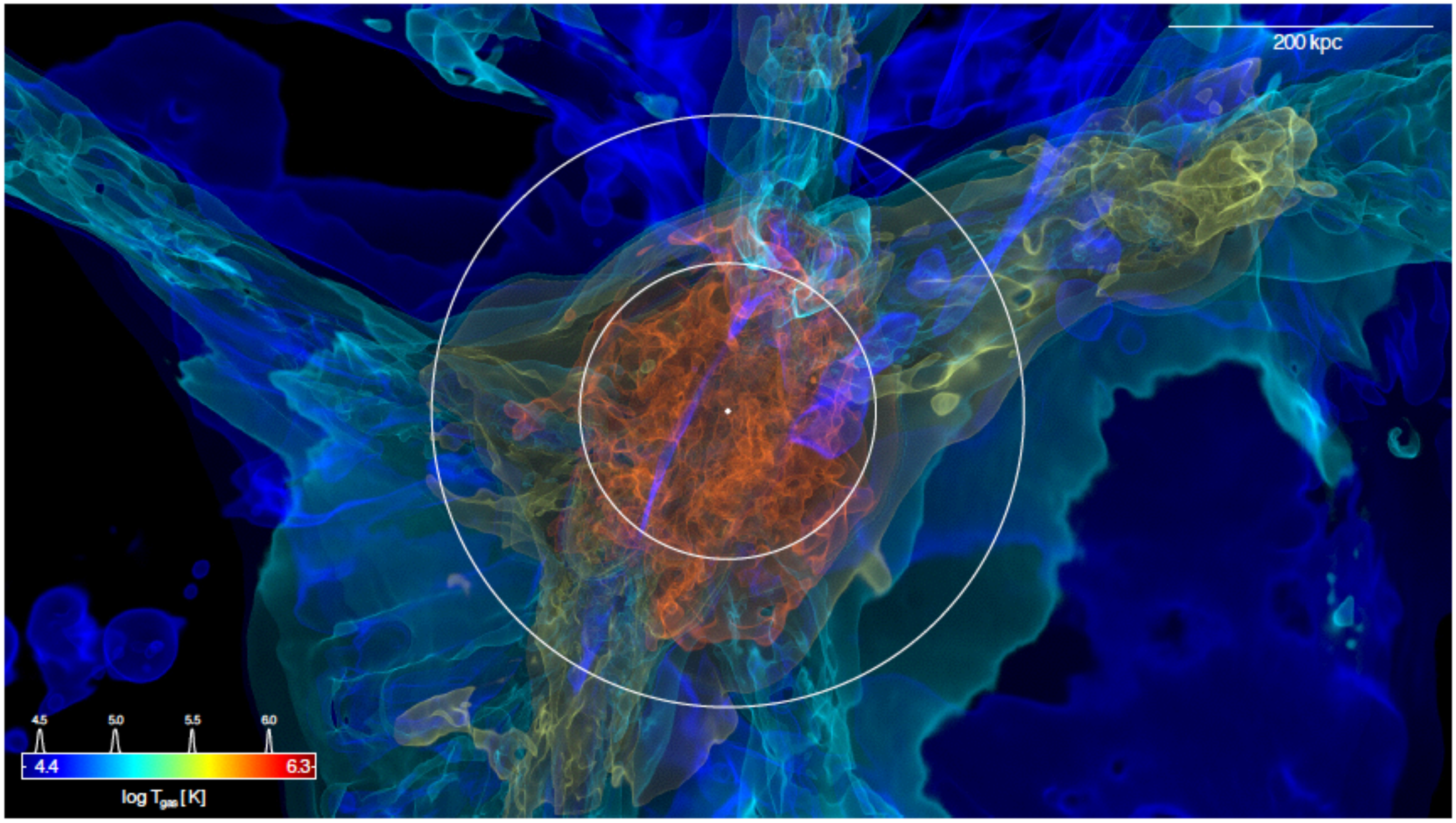
Ford et al. 2013

Qualitative features (spatial extent(ionization), multiphase structure)



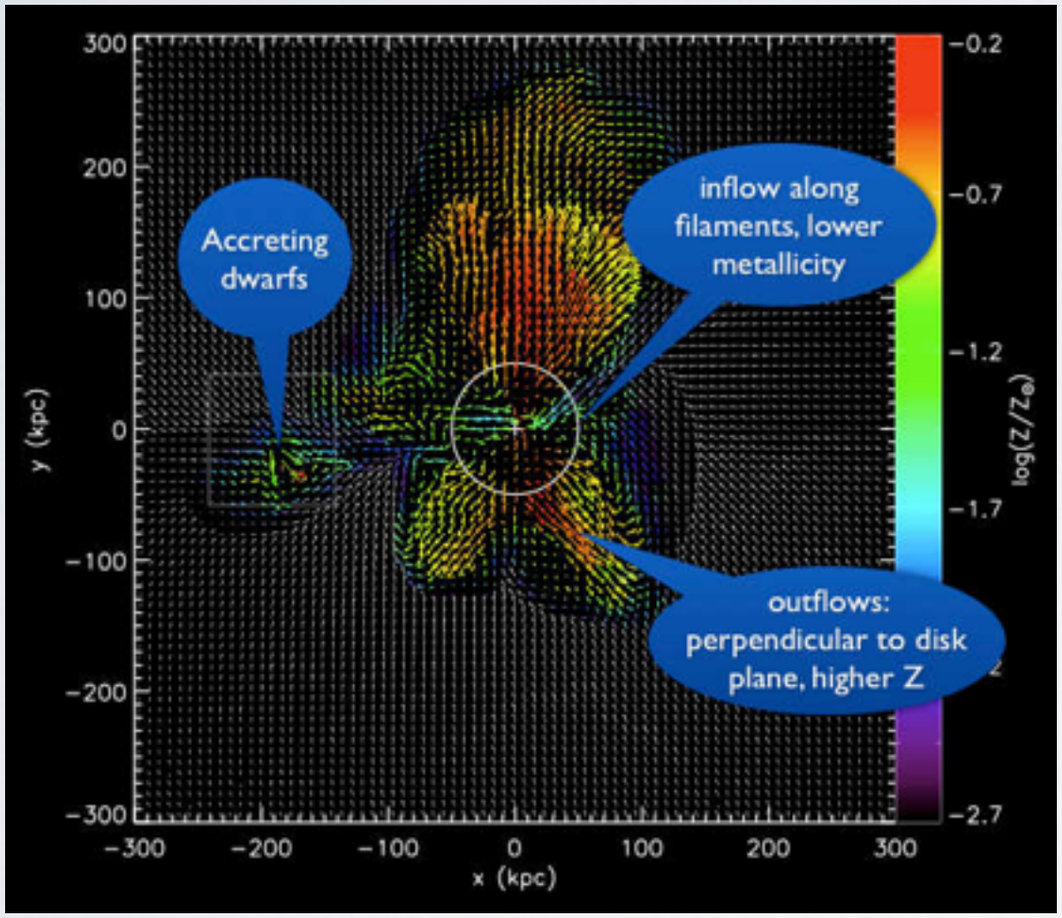
–Ben Oppenheimer

A HOT CGM



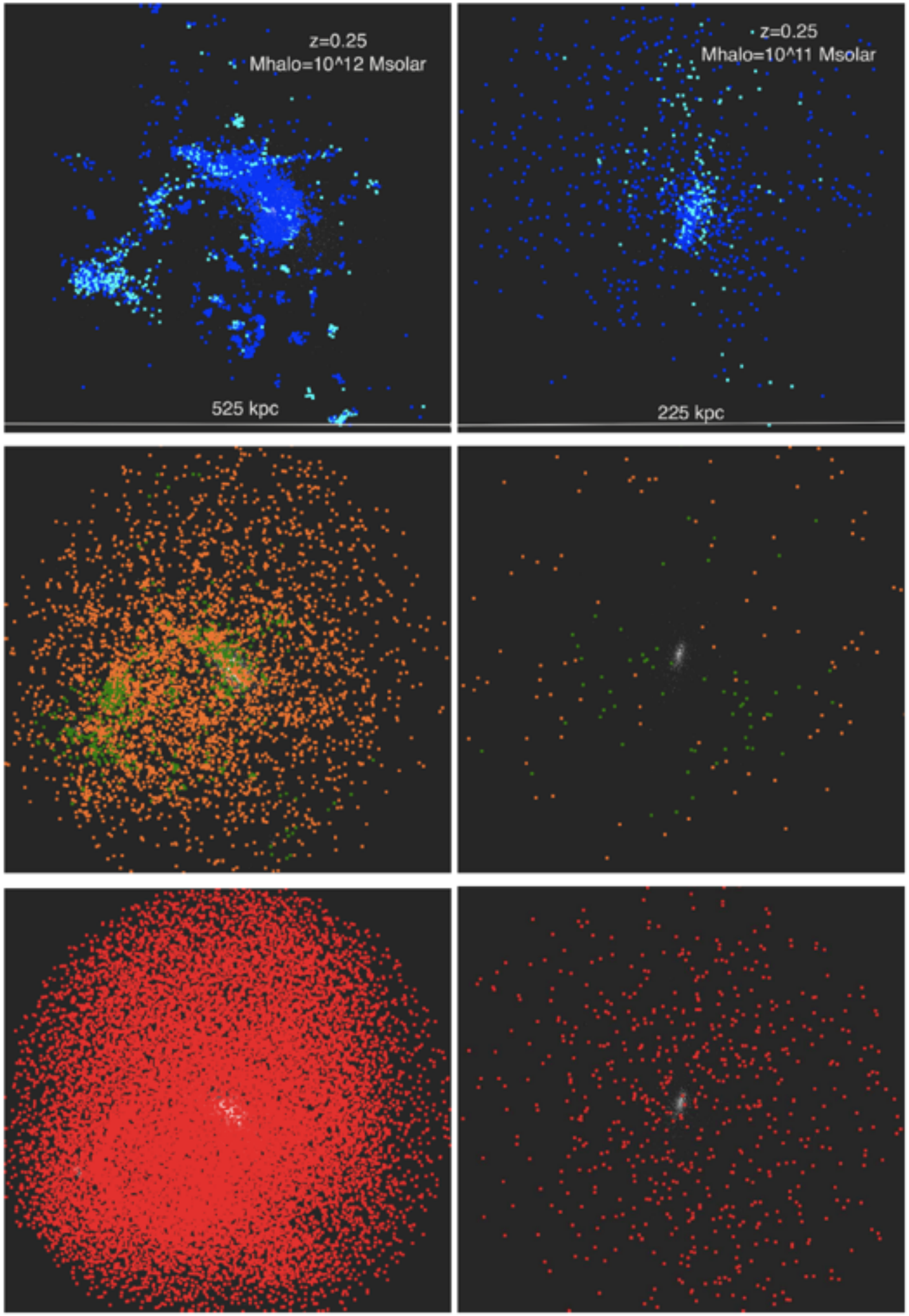
Nelson et al. 2015

DISSECTING ACCRETION

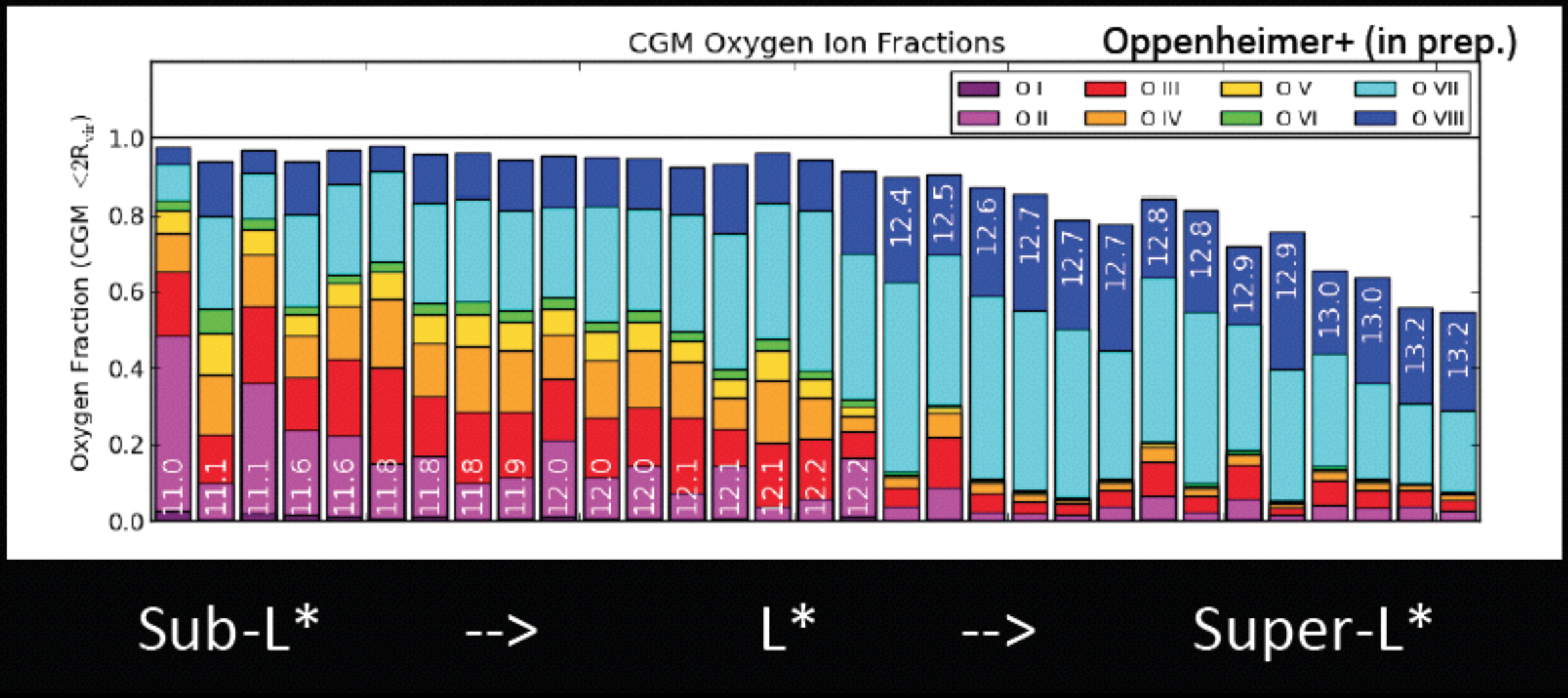


Shen et al. 2012, 2013

Ford et al. 2014



A cautionary tale about UV Absorption Lines…



Oppenheimer et al. 2015

Major Questions Arising?

- How to define baryon cycles vis a vis feedback WG for maximum synergy and minimum duplicate effort?
- What science cases really highlight the advantage over Athena?
- Sensitivity? Resolving out point sources!
- Spectral Resolution?
- Spatial Resolution?