FOGGIE: The (re-)distribution of metals in a simulated Milky Way Mass Galaxy

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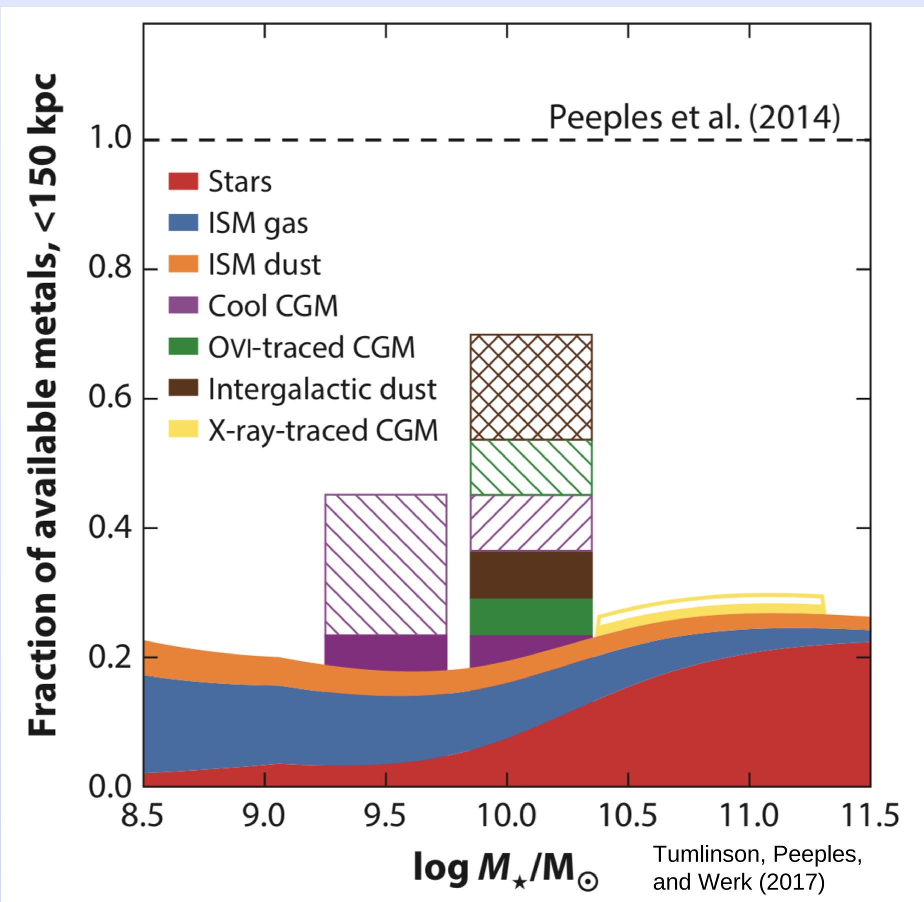
Abstract

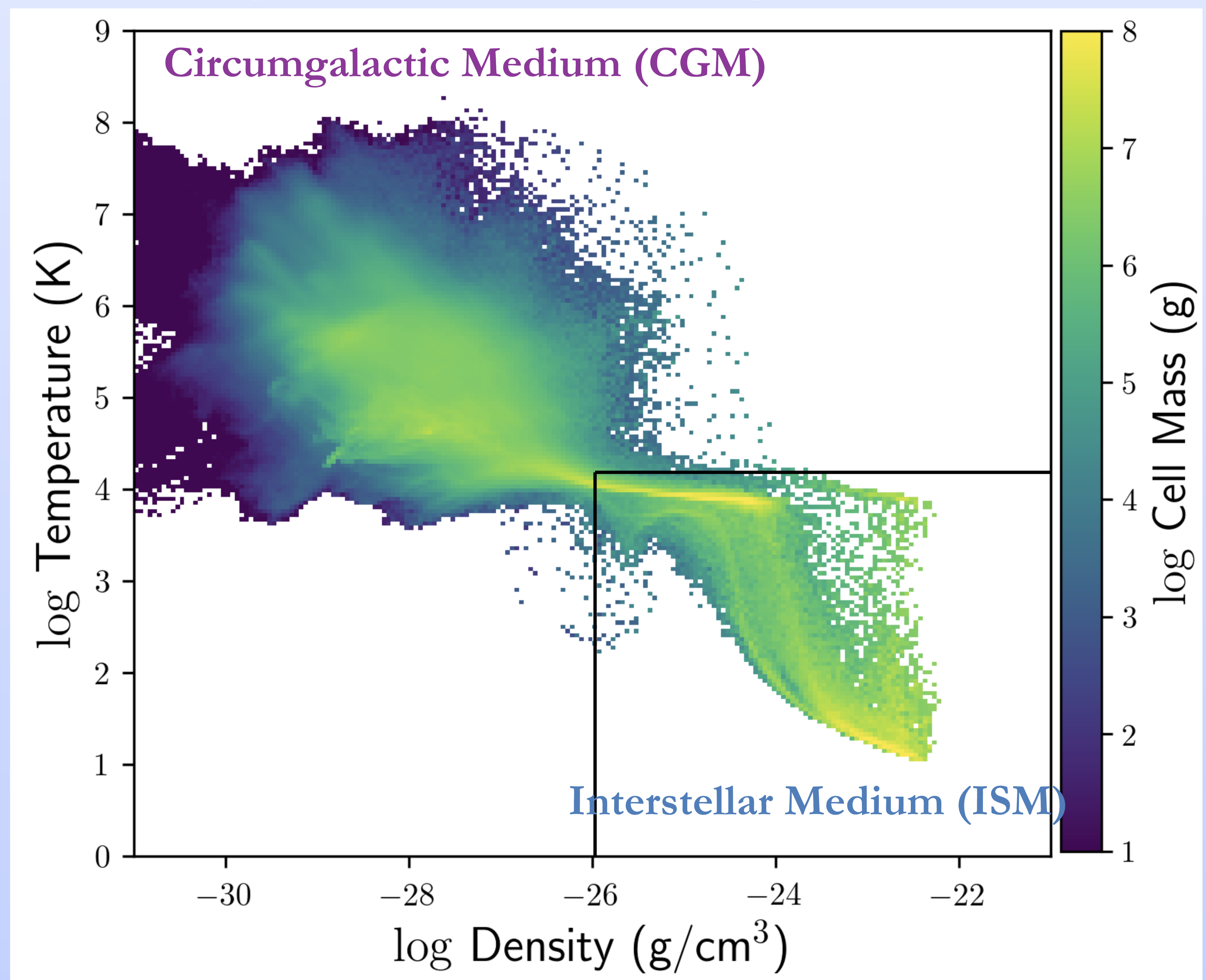
A complete picture of galaxy formation requires a complete census of metals in and around galaxies. The distribution of metals in galaxies is intimately linked to ongoing star formation and large-scale gas flows, as stars seed galaxies with metals that are then re-distributed through gas flows and feedback processes. We use a simulation with unprecedented resolution in the CGM to study the (re-)distribution of metals in a Milky Way mass galaxy. We measure evolution in the metal mass, total mass, and metallicity for the stars, ISM, and CGM. We are exploring how these results shed light on large-scale gas flows in and around the galaxy.

Metal Observations



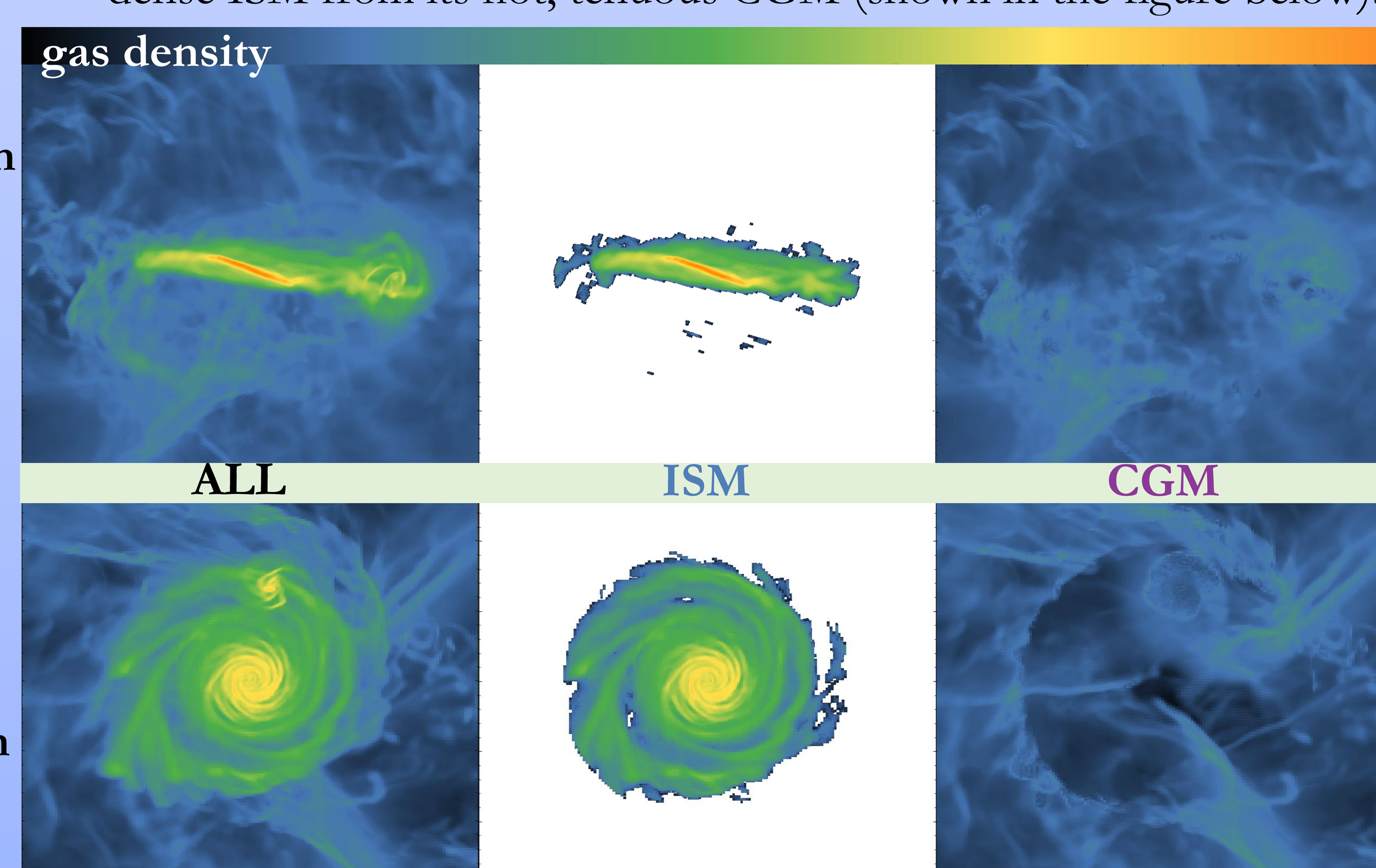
- Metals – elements heavier than helium – form in stars, presumably inside galaxies.
- However, as shown in the figure above, only a small fraction of the metals produced over a galaxy's lifetime (dashed line) are still found within their stars and interstellar medium (ISM).
- This suggests a significant fraction of metals are transported into and out of the circumgalactic medium (CGM) around galaxies.
- We are using a cosmological galaxy formation simulation, highly resolved in the CGM, to track the distribution of metals through time in a Milky Way analog (as seen below).

Tracking Metals through Simulations



- We use the temperature and density distribution of the gas in the simulated galaxy (shown in the figure above) to separate its cool, dense ISM from its hot, tenuous CGM (shown in the figure below).

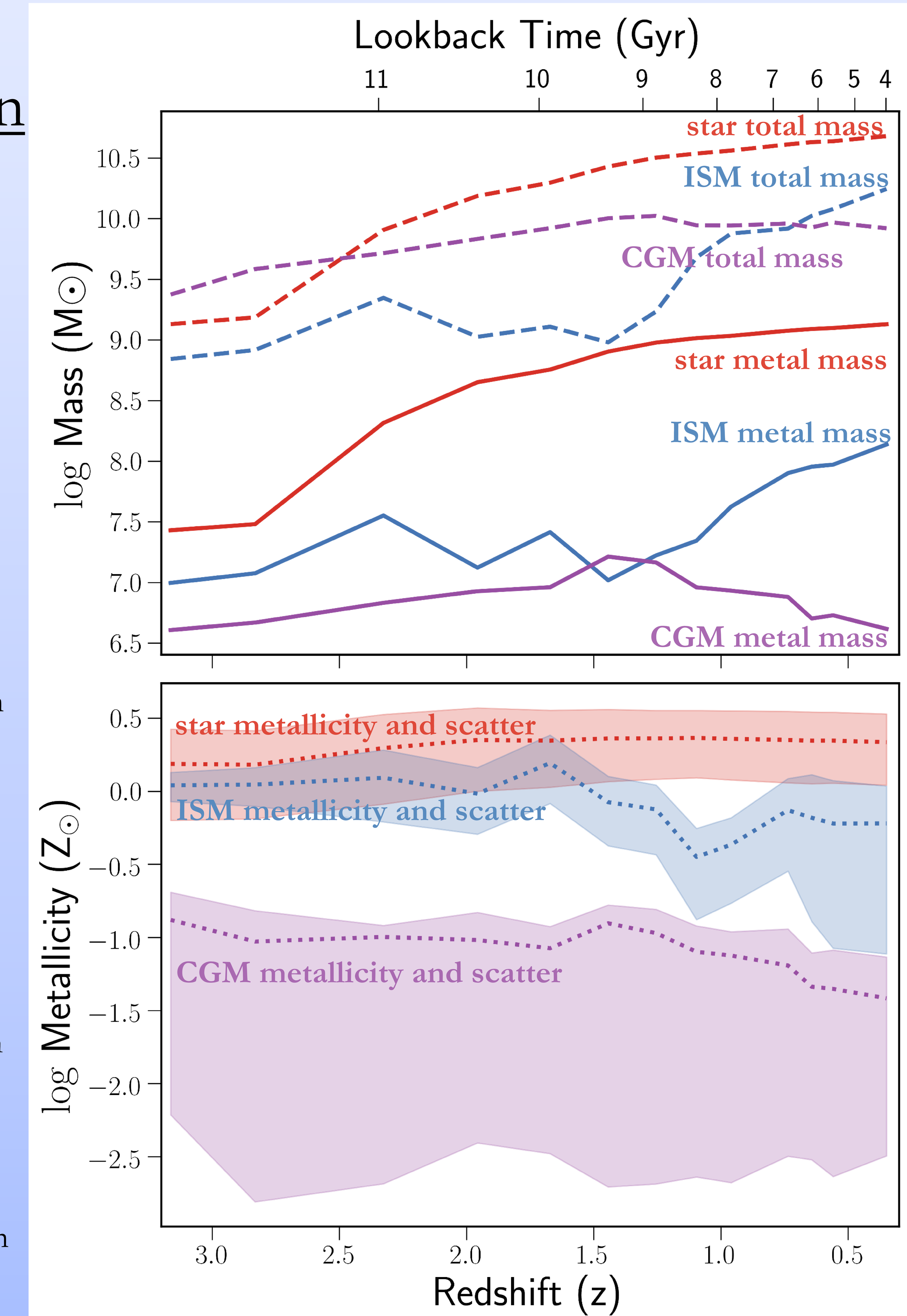
Edge-on View



Face-on View

Metal (re-)Distribution

- We find continuous evolution in the total mass and metal mass for all three components in and around the galaxy. This evolution is governed by metal production from star formation, metal-rich outflows, and metal-poor inflows.
- We find correlated evolution in the ISM and CGM metal mass: the ISM pollutes the CGM with metal-rich gas, and the CGM dilutes the ISM with metal-poor gas. These dominate at different times in our simulation, with the interplay most apparent at z ~ 1.5.
- These trends represent the results of a single halo within the FOGGIE simulation.



- Going further, we aim to generalize our results by looking at alternate feedback processes, as galaxies are complex ecosystems with an ebb and flow of both metal mass and metallicity in each component. We will also analyze different formation conditions and continue to refine our timescale.