Resolving Multiphase CGM by GAMER-2 Cosmological Simulation

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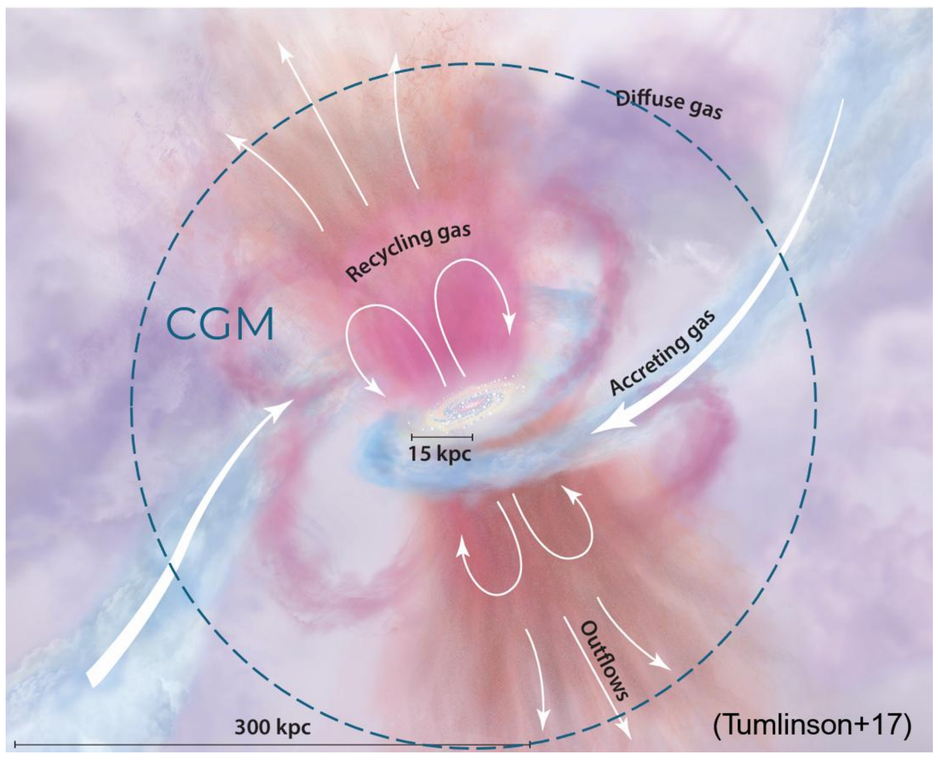
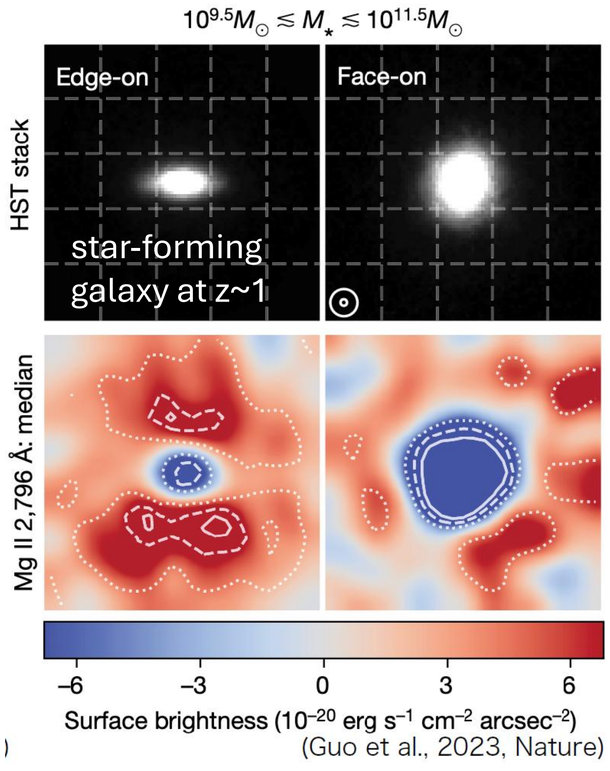
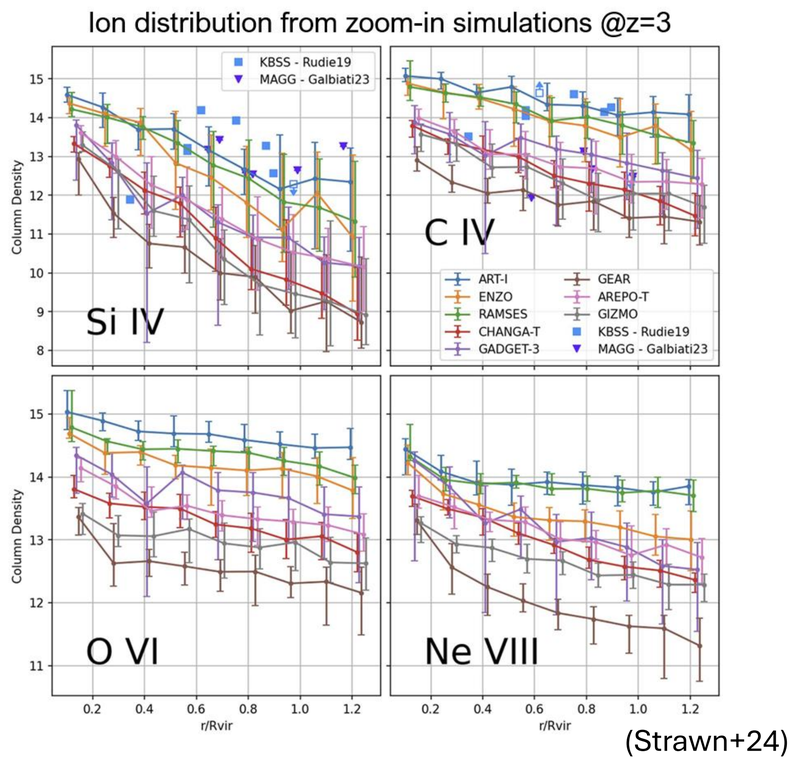
Background

The Circumgalactic Medium (CGM) is a gas reservoir that supplies star-forming gas to a galaxy. The structure of the CGM is influenced by astrophysical feedback mechanisms, which are the key ingredient in galaxy formation. Thus, CGM serves as a probe of feedback, and theoretical insight into the connection between CGM structure and feedback is required to reveal the feedback activity from recent CGM observations. Most cosmological simulations underpredict the spatial extent of CGM, possibly due to insufficient feedback strength, poor resolution in CGM, or cosmic environment of simulated galaxies.



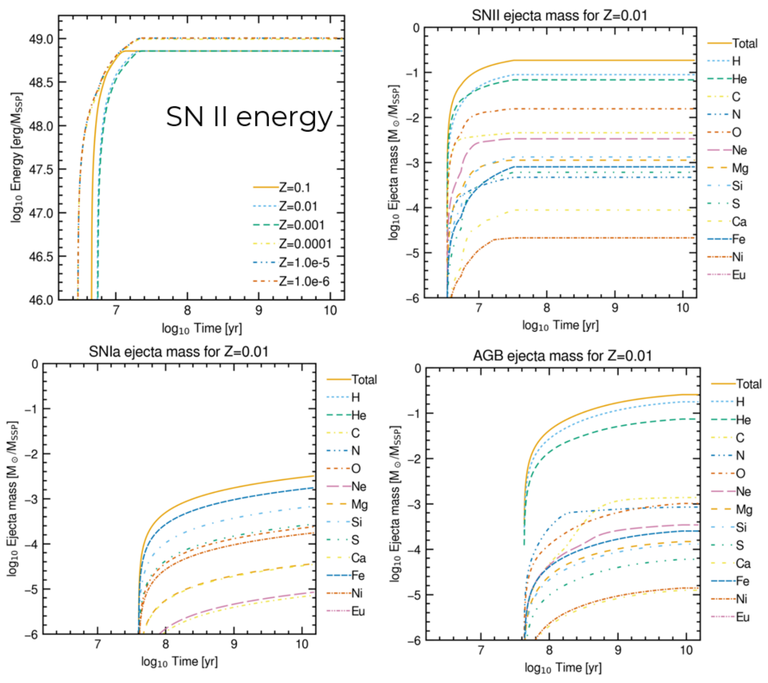




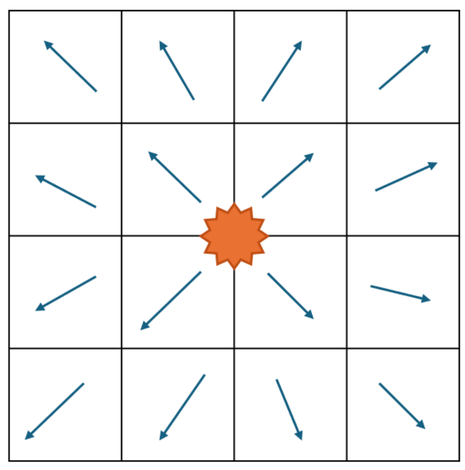
Code Development

The subgrid physics modules are implemented in the GPU-accelerated AMR cosmological simulation code GAMER-2 (Schive et al. 2018). The subgrid supernova feedback module is based on our previous work (Oku, Tomida, Nagamine, Shimizu, & Cen, 2022), which is based on high-resolution simulations and is physically motivated.

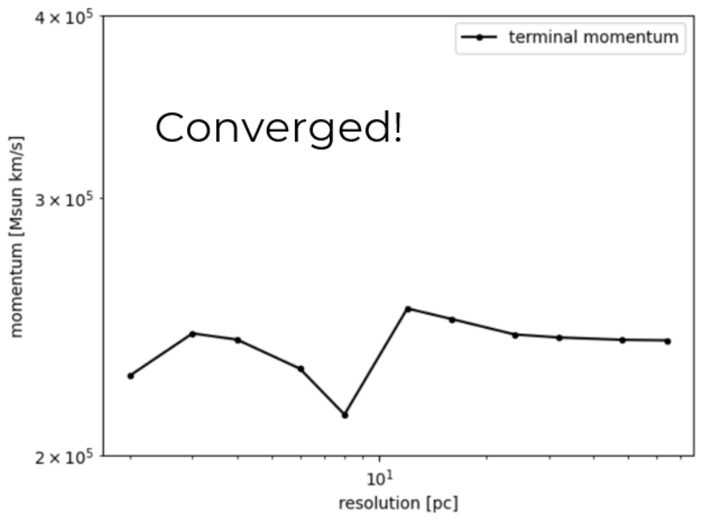
Chemical evolution model (IMF x Age x Yield model)



Distribute SN/AGB star mass/metal/momentum yield to the nearest 64 cells



Resolution dependence of momentum input by a single SN



Cosmological Simulation: Zoom-In Target Selection

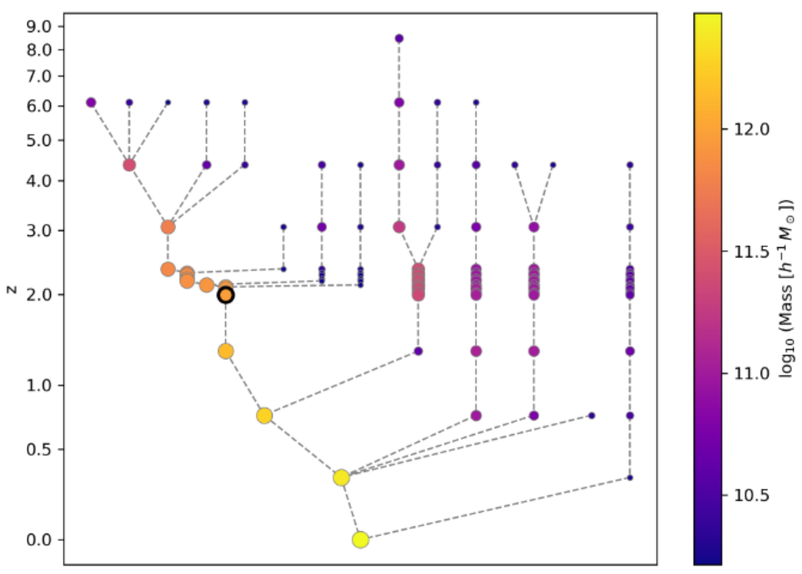
We perform a series of zoom-in simulations, which imposes a high resolution on a region of interest within the cosmological simulation box. The zoom-in targets are selected from a simulation box with a comoving volume of $(100\ \mathrm{Mpc}/h)^3$, considering the cosmic environment and the concentration parameter of the dark matter halo.

Selection Criteria:

1. M_{200}=$10^{11.8\text{-}12.2}$ M_{sun} at z=2
2. Primary subhalo consists >90% of the host halo mass
3. No major merger for 500 Myr before z=2
4. Concentration parameter c=r_{200}/r_s~4.0

1 halo in protocluster and 1 halo in field are selected as target halo

Merger tree of the selected field halo



Concentration parameter of M_{200}=$10^{11.8\text{-}12.2}$ M_{sun} halo at z=2