The Impact of Galactic Outflows on Super Solar MgII Clouds and High Column Density OVI Clouds in the CGM

藤田あき美（信州大学工学部）
利用カテゴリ XC−B

Observations reveal the presence in the circumgalactic medium (CGM) of galaxies of *numerous, compact* (1~100 pc), low-ionization gas clouds traced by weak MgII lines, often associated with larger ($\gtrsim$ 1 kpc) higher-ionization gas traced by CIV and OVI lines. Many of these weak MgII absorbers, with rest-frame equivalent widths of blue members of the doublet $W_r^{2796} <$ 0.3 Å, have *near-solar to super-solar metallicities*, and some of them are even *iron enhanced* in relation to α elements, even though luminous galaxies are rarely found within a ~50 kpc impact parameter. Analysis of low-redshift absorbers suggests that weak absorbers are created by transient processes that are less active in the modern universe, such as starburst-driven galactic outflows, as there are a fewer absorbers at present than in the past, and that the majority of absorbers seem to live in group environments The origin and nature of such weak MgII absorbers remains unclear, and in fact, such absorbers have never been studied in numerical simulations.

Thus we ran 3D numerical simulations of galactic outflows in a Milky Way-like halo and in a high-redshift dwarf halo with a highest resolution of 0.4 pc but confined in a 102.4 pc^2 region, using the adaptive mesh refinement (AMR) hydrodynamics code, Enzo. We modeled the effects of repeated SN explosions driving an outflow based on our superbubble model. Superbubbles are driven by hot, pressurized gas made of shocked stellar winds and SN ejecta from OB associations and clusters, and sweep the surrounding ISM into thin shells that accelerate and fragment due to Rayleigh-Taylor instability. Large-scale outflows result as the hot interior gas escapes between the fragments. We find that metal-enriched, hot, outflow gas drives a secondary shock into the CGM and mixes well with the swept-up gas and cools to form dense, near-solar to super-solar MgII clouds at ~100 kpc above galactic disks (Figure 1). The clouds are fragments of the mixed gas by Rayleigh-Taylor and Kelvin-Helmholtz instabilities, and are

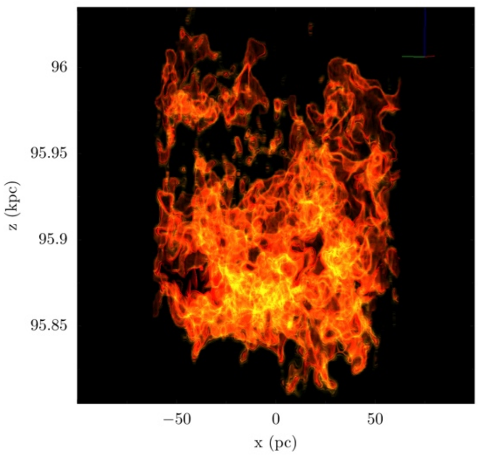

Figure 1: A 3D image of the density distribution of MgII absorbing clouds at ~100 kpc above a Milky Way-like disk at t =72 Myr. The outflow is driven by a mechanical luminosity of 10^{42} erg s^{-2} lasting for 40 Myr.

less than 10-100 pc in size. The cooling outflow gas behind these dense clouds produces larger CIV and OVI clouds, when it is placed in the metagalactic UV background radiation expected at $z \geq 1$. However, the structures are geometrically limited to only grow vertically in a rectangular grid, and therefore are likely to be much denser than expected in a more realistic fan-shaped outflow. We generate absorption profiles we generate using Trident, but the column densities are overestimated both for low and high ionization ions, and do not agree with the observed values.

As a next step, we began running 3D hydrodynamic simulations of galactic outflows in a dwarf halo at $z = 2$ with $M_{halo} = 5 \times 10^9 M_\odot$ and $R_{vir} = 17.5$ kpc in a grid that extends up to a few $\times R_{vir}$. We choose such a small halo because 1) it is small enough to enable us to resolve the interfaces between metal enriched hot gas and the CGM out to a few virial radii with a highest resolution of 1.6 pc using AMR, and 2) such small, invisible satellite dwarf galaxies expected in a group environment may be the parents of most weak MgII clouds associated with a larger, luminous galaxy, given the absence of post-starburst galaxies near the absorbers. Our preliminary results are show in Figure 2. We will continue to investigate the origin and nature of super solar, iron enriched, compact weak MgII clouds as well as larger higher-ionization gas with high column densities in our galactic outflow simulations.

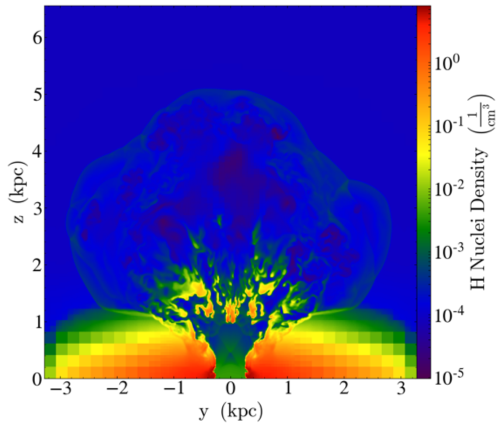

Figure 2: A slice of a density distribution in a high-redshift dwarf disk with a starburst-driven outflow at t =35 Myr. This is a test simulation.