Using Simulations to Uncover the Bias in Absorption Line Analysis of the Baryon Cycle

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The Simulations

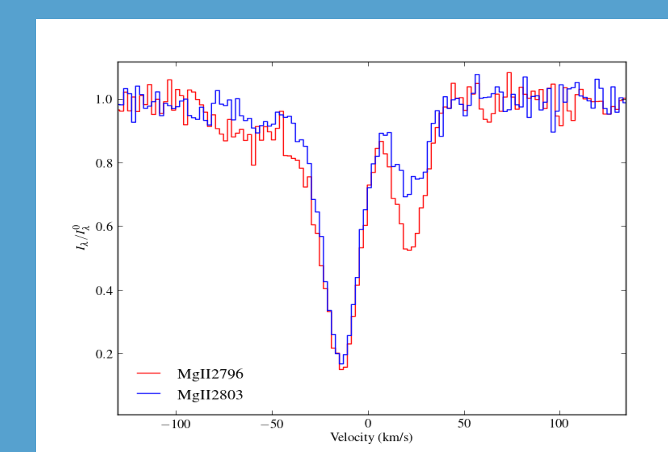
The simulations we used are from a cosmological zoom-in simulation suite were run by Sebastian Trujillo-Gomez as described in Trujillo-Gomez et al., 2013. These used a Eulerian Gasdynamics plus N-body Adaptive Refinement Tree (ART) code.We analyze a single dark matter halo for a present day dwarf galaxy (M_{vir} = 3x10^{10} M_{sun} , R_{vir} = 80 kpc). The halo was re-run to redshift zero using different description of physics to test the effects of radiation pressure as shown in **Table 1**.

Model	Feedback	P_{RP} / k_B
dwSN	*SNII+SW*	*0*
dwALL_1	*SNII+SW+RP+PH*	*1*
dwALL_8	*SNII+SW+RP+PH*	*8*

Table 1: Simulation Parameters
SNII+SW indicates supernova and stellar winds,
RP indicates radiation pressure,
and PH indicates photoheating

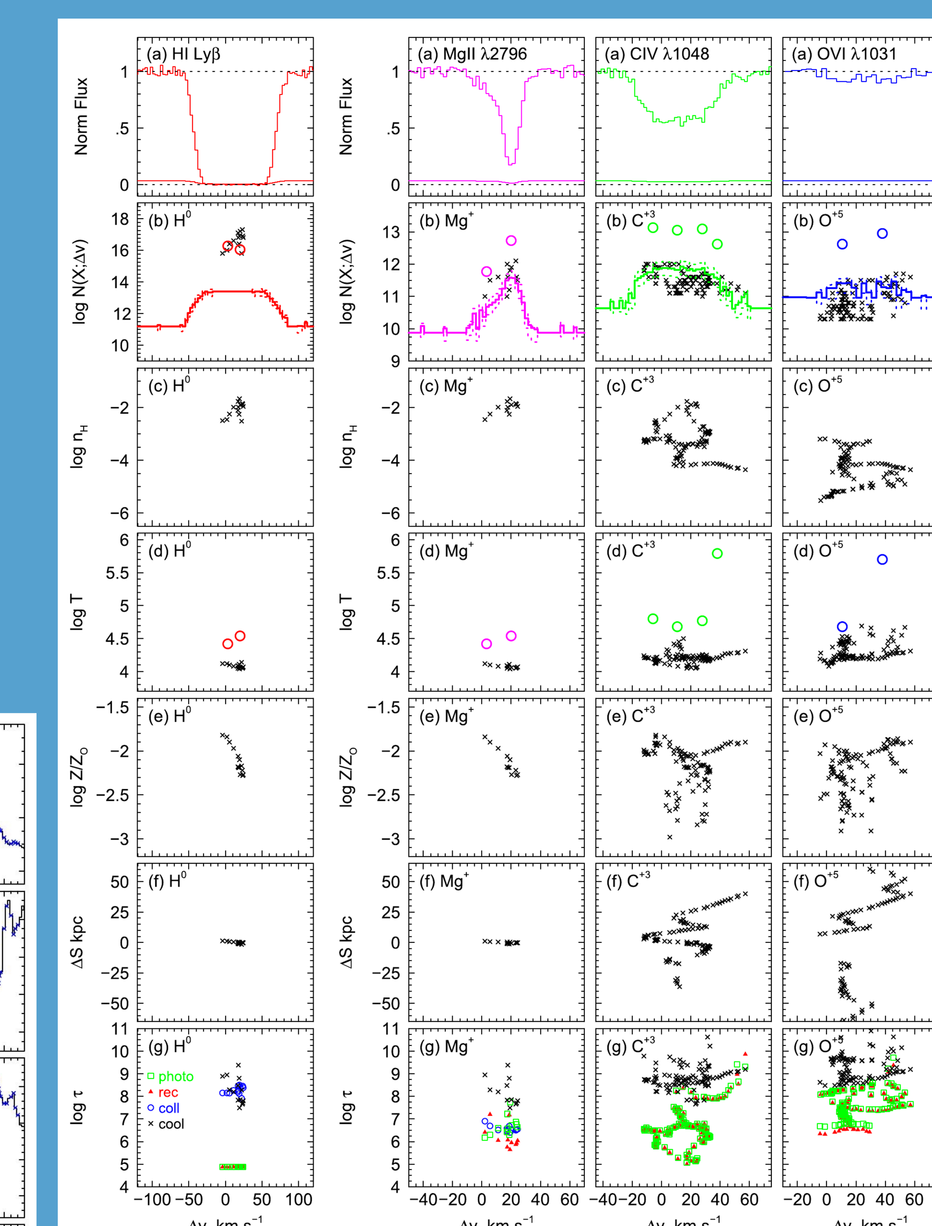
Generating Absorption Spectra

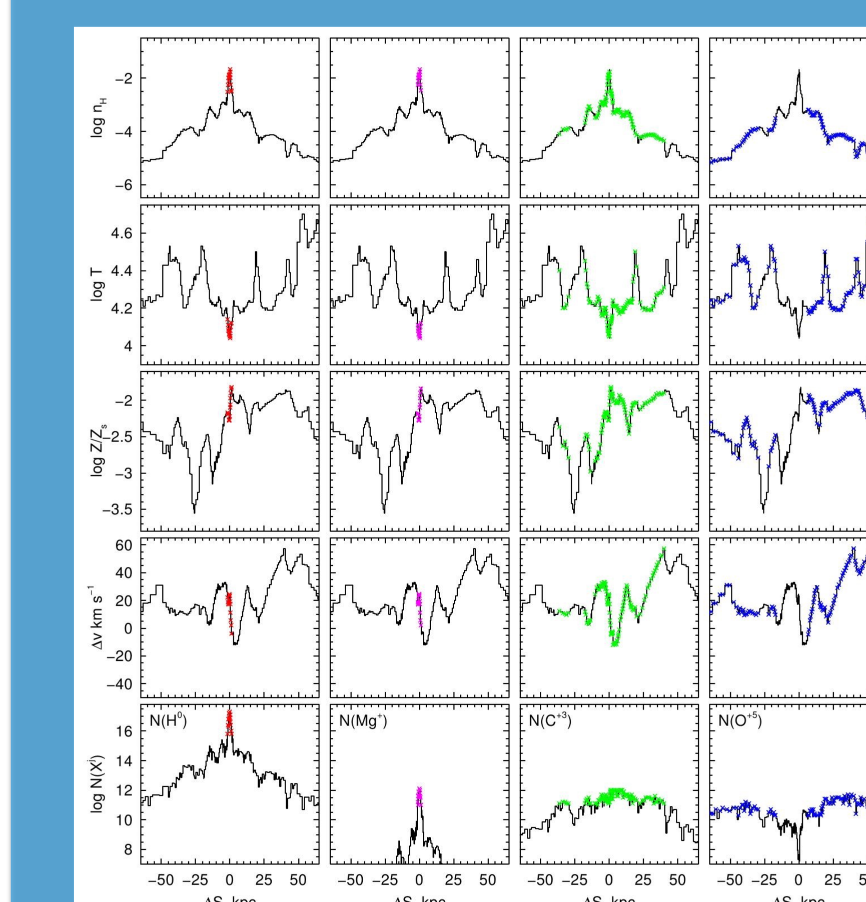
To generate the absorption profile, we ran 1000 lines of sight (LOS) through each simulated box, aligned so the galaxy is face on. The impact parameter and position angle of each line is randomly selected. The maximum impact parameter is 1.5 R_{vir} (~ 120 kpc at z=0). The optical depth of each cell that lies along the LOS is added to the absorption profile, depending on the velocity of the cell's gas. This spectrum is then convolved with the ISF of the appropriate instrument for that transition and redshift, generating realistic spectra as shown to the right. The equivalent width and AOD column density are then calculated.



Absorber Kinematics

To determine what is creating the absorption, we determine which cells are the most significant contributors to the absorption. We show the physical properties of these cells as they lie along the line of sight. We examine the density, temperature, metallicity, and spatial location of the gas along the LOS. This is used to evaluate the assumptions inherent in Voigt profile fitting, specifically the assumption that absorption arises from isothermal, is clouds of uniform density.

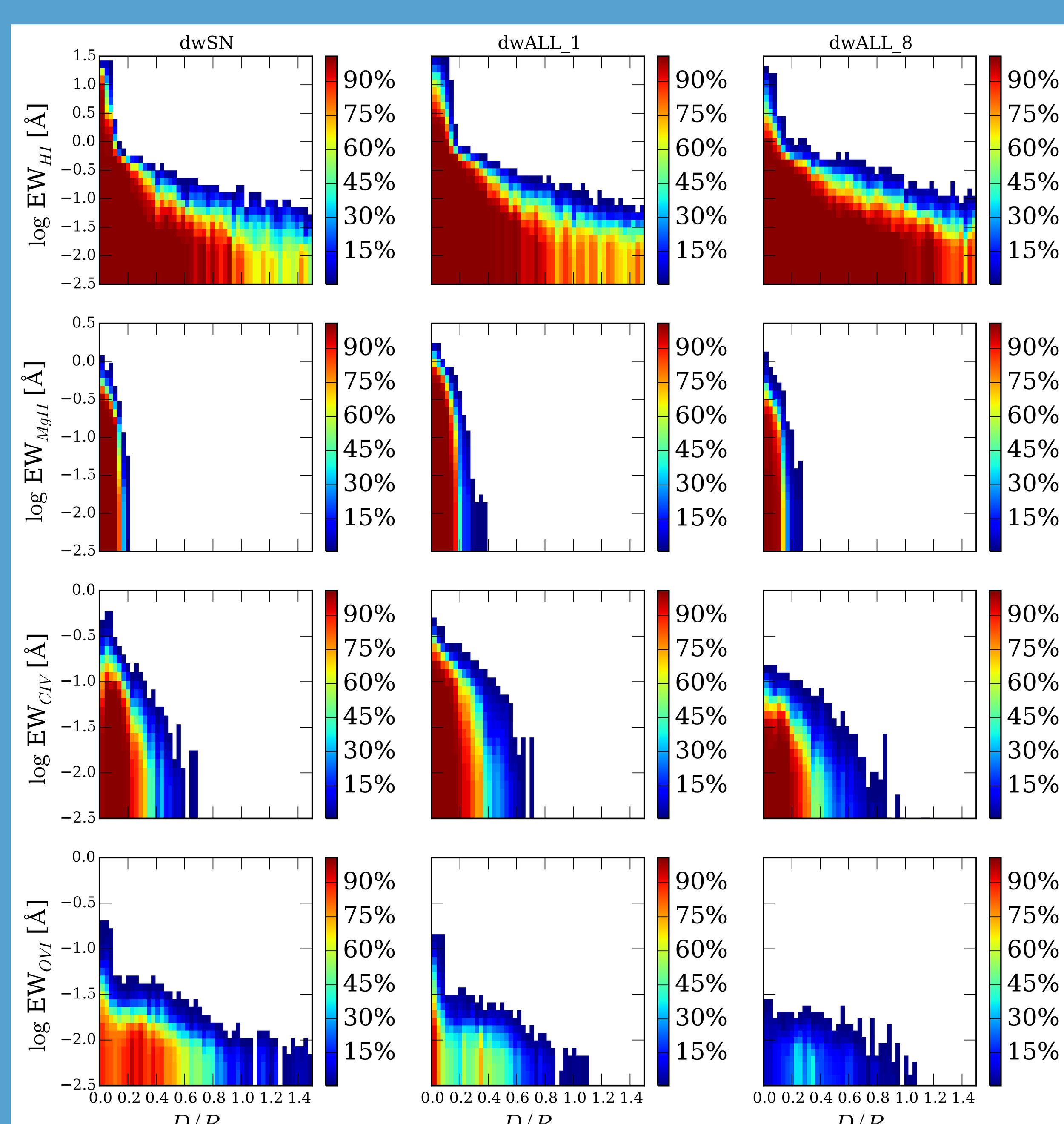




Low ionization species, such as HI and MgII, do form in isothermal clouds of uniform density. High ionization species, such as CIV and OVI, do not.

Covering Fraction

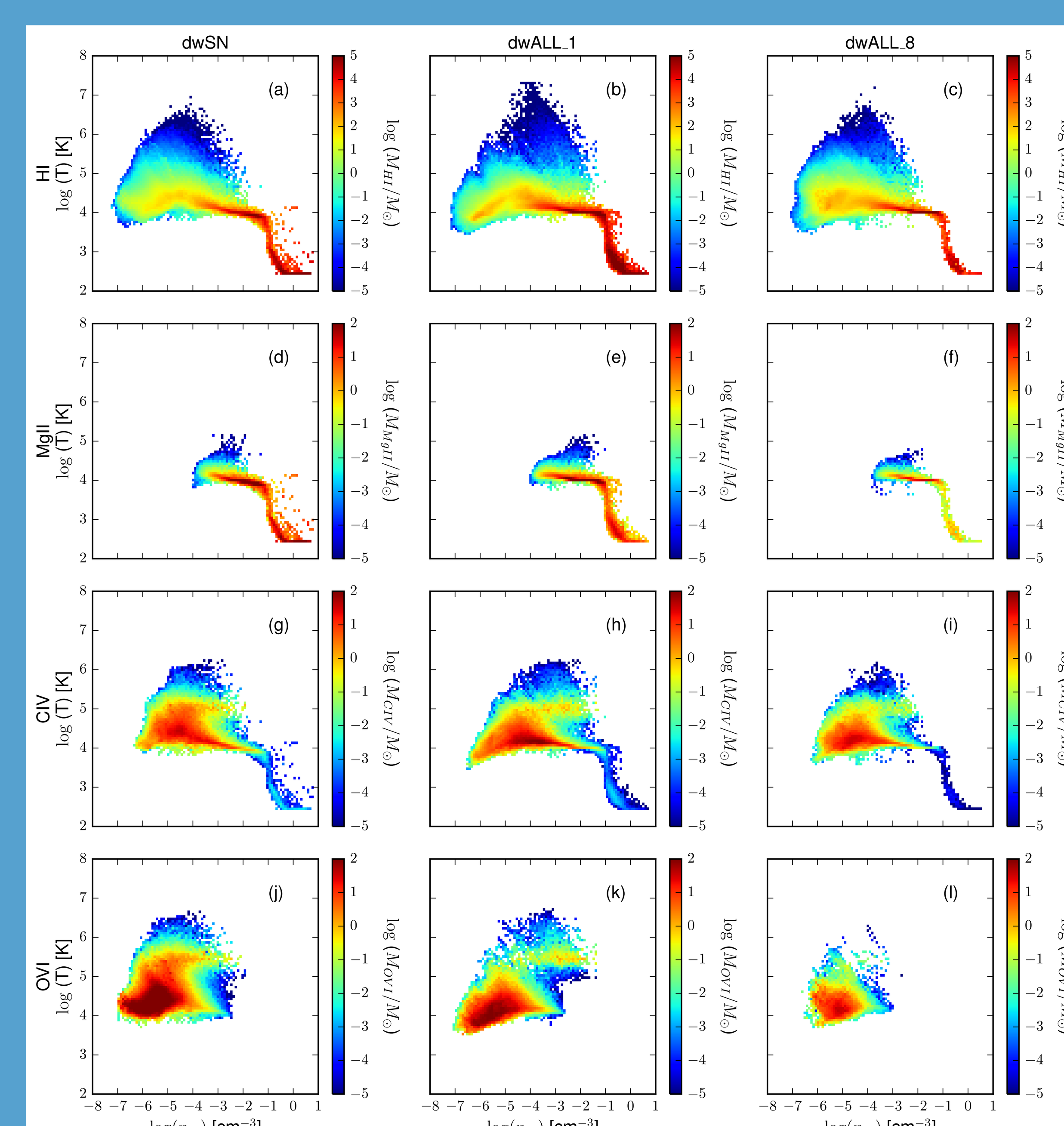
The spatial extend of various ions are quantified by calculating the ion's covering fraction, shown below. The color shows the covering fraction at that impact parameter and equivalent width cut.



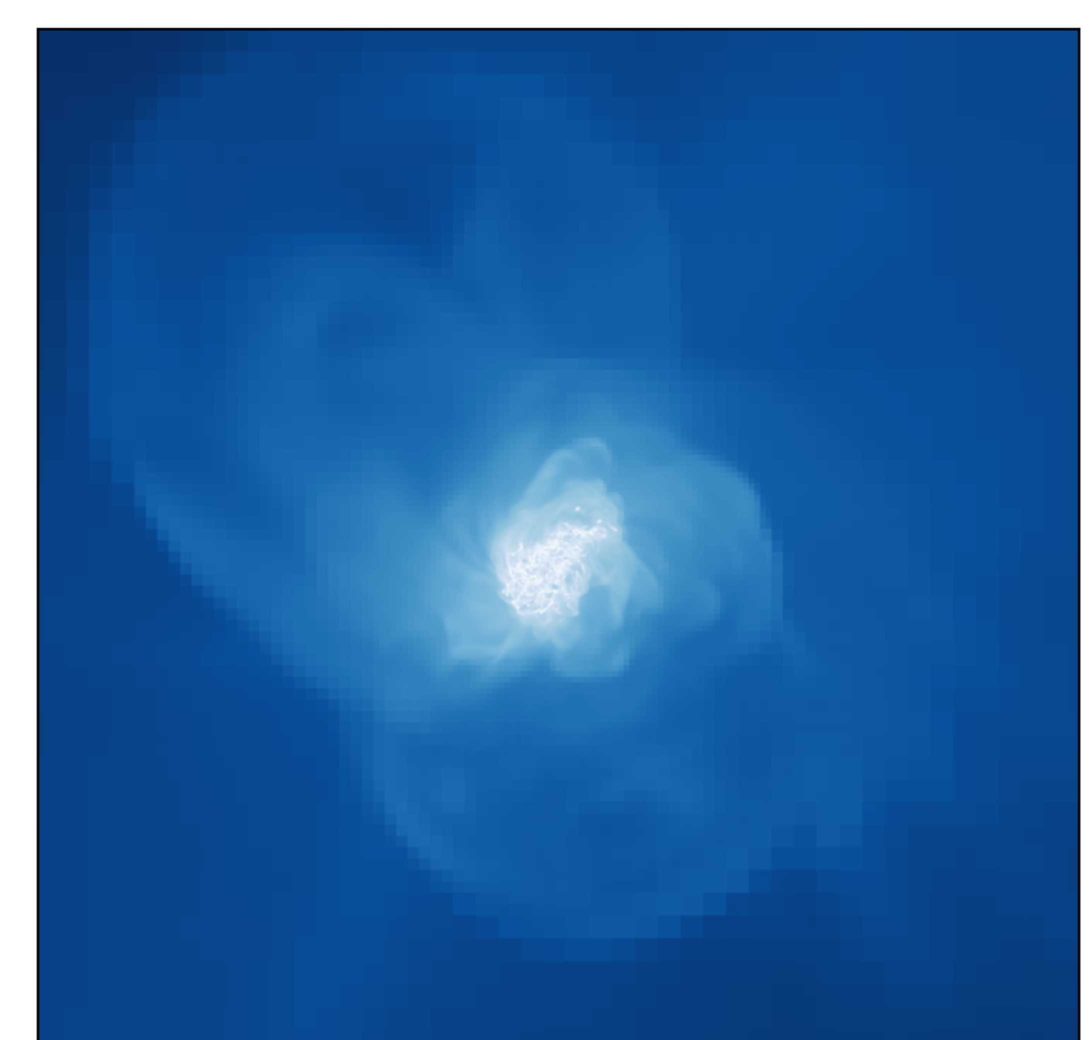
The spatial distributions of HI, MgII, and CIV are relatively unaffected by feedback prescription. OVI is significantly affected, but only appears with low equivalent widths, making it very hard to observe.

Absorber Phase

The physical conditions of the gas giving rise to absorption is characterized in the phase plot below, where the color indicates the mass in that particular ion.



The dominate phase by mass for HI and MgII is in the cool, dense ISM. CIV exists in a cool phase spanning a wide range of densities. OVI is dominated by photoionized, cool, diffuse gas.
The phase of the CGM as traced by QAL is not strongly affected by the feedback details used in the simulations.



Summary

- Low ion absorption arise from cloud-like structures
- High ions are distributed throughout the CGM
- Voigt profile fitting is appropriate for low ions, but may give misleading results for high ions.
- The CGM around dwarf galaxies is relatively insensitive to the feedback details.
- HI and OVI are found at all impact parameters
- MgII is not found beyond 0.3 Rvir
- CIV is not found beyond 0.5 Rvir
- OVI is the most sensitive ion to feedback details, but is too weak to be observed.