The Metal Enrichment and Star Formation of HI gas (DLAs) Over Cosmic Time
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The metallicity of HI gas evolves with redshift, with a sudden drop at z~4.7. The SFR efficiency of HI gas at z~3 is a factor of ~10 lower than predicted by the Kennicutt-Schmidt (KS) relation. To investigate the cause of this reduced efficiency, we measure the SFR efficiency as a function of redshift and thereby metallicity (since the metallicity evolves with redshift). The SFR efficiency is determined in the outskirts of star-forming galaxies, by combining the radial surface brightness (SB) profile of the galaxy outskirts, the column density distribution function of HI gas from absorbers, and the KS relation. Direct limits are not yet sensitive enough, but future HST imaging at high NHI would be.

1. Metallicity Evolution of Neutral HI gas over time

2. Column density distribution function of HI f(N_HI)

- Cosmic metallicity of HI gas evolves linearly with redshift out to z~4.7, and then drops suddenly. New X-Shooter data confirm drop.
- The normalization of f(N_HI) evolves with redshift. However, the value at z~1 is not well determined (need a large unbiased survey of QSOs).

3. No observed evolution in the SFR efficiency as a function of z

Combine galaxy outskirts SB profile, f(N_HI), and the KS relation with a model to determine efficiency.

There are two possibilities at z~1 due to uncertainty in normalization of f(N_HI). Regardless, no clear evolution of SFR with z.

4. SFR efficiency compared with models and other data

- Comparison of SFR efficiency of HI gas with models at different z. Models predict an evolution with metallicity (and therefore z) that is not observed.
- Comparison of SFR efficiency with atomic-dominated HI gas at high and low z. We need deeper direct data at high NHI.

Fumagalli+ 2015 2 kpc (HST)
Direct limits at z~2
SFG outskirts z=1 kpc
HI Column Density (N_HI)
12 kpc (ground)
HI Column Density (N_HI)
HI gas surface density
HI gas surface density
HI gas surface density
z~0 spiral outskirts and dwarfs
HI gas surface density
HI gas surface density
HI gas surface density
z=2
z=3
z=1 (kpc)
HI gas surface density
z=1 (kpc)
HI gas surface density
z=2
z=3