CHEMICAL EVOLUTION OF DAMPED LYMAN α SYSTEMS

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1. Chemical Evolution Model

I study chemical evolution of damped Lyman α systems (DLAs) as normal disk galaxies and compare the results with the observed redshift - metallicity relation and the relative abundance pattern, [Si/Fe] vs. [Fe/H] (Lu et al. 1996). A critical gas-mass fraction of star formation is

$$f_{\rm gas}^{\rm crit} = 2.5 \times 10^{-2} \left(\frac{R_{\rm DLA}}{20{\rm kpc}}\right)^2 \left(\frac{10^{11} M_\odot}{M_{\rm total}}\right) \left(\frac{\Sigma_{\rm H}^{\rm crit}}{2M_\odot {\rm pc}^{-2}}\right), \quad f_{\rm gas}^{\rm crit} = 0,\ 0.1,\ \&\ 0.3,$$

where $\Sigma_{\rm H}^{\rm crit}$ is the critical surface density of star formation (Kennicutt 1989). Here the dependence both on radius and $v_{\rm rot}$ is neglected, for simplicity. I then assume the formation epoch of DLAs and translate their age into the corresponding redshift in order to compare observations.

2. Results

A chemical evolution model suitable for normal disk galaxies can explain the observed large dispersion in metallicity of DLAs, if galaxy formation continues from $z \simeq 5$ to 3. The threshold of star formation also cases a similar scatter. However, a few DLAs do not follow such picture of evolution. Although relative abundances pattern of the DLA at $z = 1.78$ on the line of sight toward Q1331+17 are consistent with those of stars in our Galaxy and other DLAs, its metallicity is much lower. Such a DLA may be affected by dust depletion or belong to other class of DLAs.

References

Kennicutt, R.C. 1989, ApJ 344, 685
Lu, L., Sargent, W.L.W., Barlow, T.A., Churchill, C.W. & Vogt, S.S. 1996, ApJS 107, 475

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