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Gas accretion history of galaxies at $z \sim 0-2$: Comparison of the observational data of molecular gas with the mass evolution model of galaxies

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Abstract. We found stellar mass-dependent evolution of galactic molecular gas fractions ($f_{\rm mol} = \frac{M_{\rm mol}}{M_\star + M_{\rm mol}}$, $M_{\rm mol}$: molecular gas mass, $M_\star$: stellar mass) where less massive galaxies have decreased $f_{\rm mol}$ from $z = 1$ whereas massive galaxies have already had low $f_{\rm mol}$ until $z = 1$. Comparison of the observed quantities ($f_{\rm mol}$, optical and near infra-red [NIR] colors, specific star formation rate [sSFR = SFR/$M_\star$]) with mass evolution models suggests that less massive galaxies had high $f_{\rm mol}$ at $z = 1$ thanks to recent gas accretion.

Keywords. galaxies: evolution - galaxies: ISM - ISM: molecules

Measuring $f_{\rm mol}$ of galaxies at $0 < z < 1$ is essential for understanding the evolution of galactic disks. It is because $f_{\rm mol}$ is closely related to mass assembly history of galaxies (gas accretion and star formation). Additionally, optical and NIR surveys revealed that local disk galaxies have acquired their $M_\star$ and developed their disks at $z < 1$ (van Dokkum *et al.* 2013). We observed 12 disk galaxies at $z \sim$ 0.1-0.2 with the 45-m telescope at NRO and detected the CO emissions from 8 galaxies. Combined with literature CO data of different redshifts, we find that the CO detected galaxies follow $M_\star - f_{\rm mol}$ evolution suggested from the statistical study based on the indirect method (Popping *et al.* 2012). Comparison with theoretical predictions revealed a discrepancy from the observations, suggesting that the baryon processes (star formation, H_2 prescription, feedbacks) adopted in those studies bear improvements. Comparing the observed optical and NIR colors, sSFR and $f_{\rm mol}$ with mass evolution model, we find stellar mass dependence of gas accretion, mass loading factor and depletion time of gas. These suggest that less massive galaxies, possible progenitors of disk galaxies at $z = 0$, had high $f_{\rm mol}$ at $z = 1$ thanks to the gas accretion and have consumed gas to form galactic disks from $z = 1$ to $z = 0$.

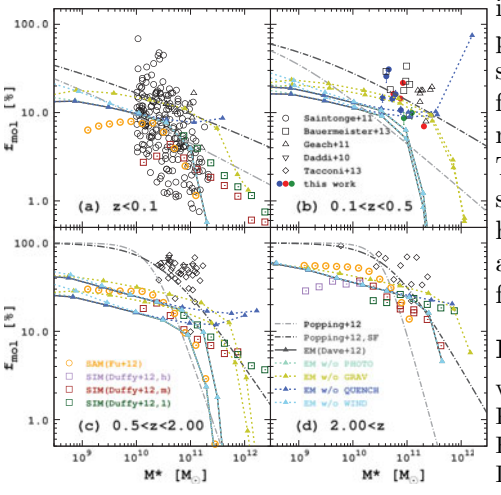

Figure 1. Comparison between observed and theoretically predicted $M_\star - f_{\rm mol}$.

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