

# Looking for molecular gas in a massive lyman break galaxy at $z = 4.05$

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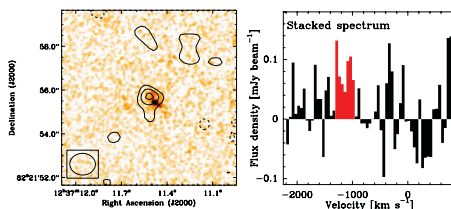
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**Abstract.** We present a search for CO emission in a massive lyman break galaxy at  $z \sim 4.05$ .

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We have observed the CO(4-3) and CO (6-5) lines with the Plateau de Bure Interferometer. The observations of each individual configuration show a tentative detection at the  $\sim 3\sigma$  level of CO emission at the position of the ACS/HST source. The signal is improved to  $S/N \sim 5$  when combining CO (4-3) and CO (6-5) observations (Fig. 1). We have run extensive simulations to estimate that the chance probability of such a signal in our combined datacubes is  $\sim 2 \times 10^{-4}$ . Assuming that both detections are real, we infer a molecular gas mass of  $\sim 1.4 \times 10^{11} M_{\odot}$  by adopting a conversion factor of  $\alpha_{CO} \sim 7.0$ , which is based on the  $\alpha_{CO}$  - metallicity relation (Magdis *et al.* 2011; Sargent *et al.* 2012b). The location of this galaxy in the  $L_{IR} - L'_{CO}$  plane suggests little variation from the trend defined by normal star-forming galaxies over  $0 < z < 2.2$ , possible evidence against a too strong evolution of the conversion factor to higher redshifts. The molecular gas ratio ( $\sim 68\%$ ) is found to be comparable to the ratios observed at  $z = 2$  (Magdis *et al.* 2012a), providing additional support for the existence of a plateau in the redshift evolution of the specific SFR of normal galaxies at  $z > 3$ . However, we need more CO observations to make a definitive detection and thus further confirm these conclusions.



**Figure 1.** **Left:** Countours of stacked CO (4-3) and CO (6-5) overlaid on HST+WFC3 F140W image. Countour levels start at  $\pm 2\sigma$  and are in steps of  $1\sigma$ , with positive(negative) countours shown as solid (dashed) lines. **Right:** Combined CO spectrum adopting average line ratio from GN20 and M82 total SLED models. The red color indicates the maximum emission region.

## References

- Magdis, G., Daddi, E., Elbaz, D., *et al.* 2011, *ApJ*, 740, 15  
Magdis, G., Daddi, E., Sargent, M., *et al.* 2012a, *ApJ*, 758, 9  
Sargent, M., *et al.* 2012b, in preparation