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New submillimeter diagnostics of physical properties of ISM in high redshift galaxies

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Abstract. We present a new diagnosis method for determining physical properties of star-forming gas in high-z galaxies. In this method, we employed three key observational quantities, [CI], CO, and FIR luminosities, including our new detections of CO $J = 4$–3 emission from the pure-starburst (non-AGN) submm galaxy SMM J14011+0252 ($z = 2.6$) and the type-2 AGN IRAS FSC 10214+4724 ($z = 2.3$) obtained with the Nobeyama Millimeter Array (NMA) at the Nobeyama Radio Observatory. These two sources have extremely high star formation rate, and exhibit strong emission of CO and [CI] 609 μm lines. We determined ISM physical conditions for the two objects and another three high-z quasars in order to investigate the relationship between their ISM and power sources (i.e., massive star formation or AGN). A new PDR analysis (Wolfire *et al.* 2005, private communication) using CO, [CI], and FIR on five high-z sources provides new evidence that AGN host galaxies harbor denser ($\log n_{\rm H} \sim 5$–6) ISM exposed to stronger far-UV fluxes of $\log G_0 \sim 3.5$–4 than the non-AGN submm galaxy. Volume filling factors of the star-forming dense gas in the AGN hosts are an order of magnitude smaller than that of the pure-starburst submm galaxy. This suggests that, in these AGN hosts, dense molecular clouds are dominating the central kpc around AGN, triggering extensive circumnuclear starbursts, and possibly feeding their central supermassive black hole simultaneously.

Keywords. galaxies: evolution, galaxies: high-redshift, galaxies: ISM, galaxies: individual (IRAS FSC10214+4724, SMM J14011+0252)

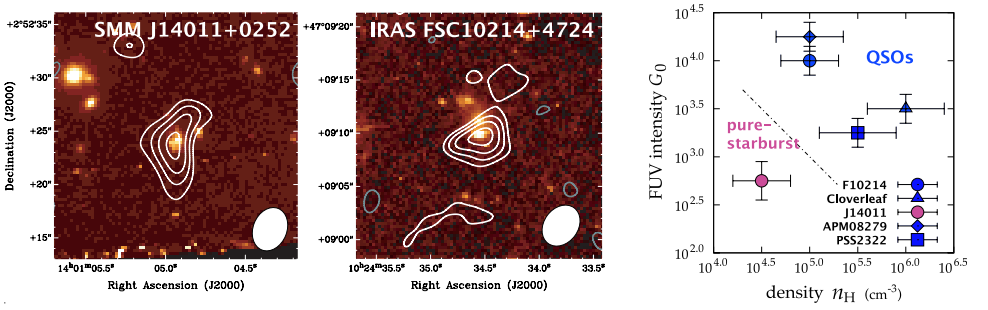

Figure 1. *left*: Integrated intensity maps of CO $J = 4$–3 in SMM J14011+0252 ($z = 2.6$) and IRAS FSC10214+4724 ($z = 2.3$) superimposed on *HST*/WFPC2 images. The contours are $-2, 2, 3, 4, 5\sigma$ ($1\sigma = 0.58, 1.17$ Jy km s^{-1} for SMM J14011, IRAS F10214, respectively). *right*: Results of submillimeter diagnosis of ISM physical conditions (hydrogen density and far-UV intensity) based on PDR model (Wolfire *et al.* 2005, private communication). AGN hosts (QSOs) have denser gas exposed to stronger far-UV fluxes than the pure-starburst SMM J14011.