

HCN Observations of Submillimeter Galaxies and QSOs at High Redshift

Yu Gao^{1,2}, C.L. Carilli², P.M. Solomon³ & P.A. Vanden Bout⁴

¹Purple Mountain Observatory, 2 West Beijing Road, Nanjing 210008; and National Astronomy Observatory, Chinese Academy of Sciences, Beijing, P.R. China
yugao@pmo.ac.cn, ygao@nrao.edu

²National Radio Astronomy Observatory, Socorro, NM 87801, USA

³Department of Physics & Astronomy, SUNY at Stony Brook, Stony Brook, NY 11794, USA

⁴National Radio Astronomy Observatory, Charlottesville, VA 22903, USA

We have conducted sensitive HCN(1-0) line observations of four high redshift submillimeter (sub-mm) galaxies and QSOs with the VLA. Although none is significantly detected in either line or continuum emission, thanks to the gravitational lens, sub-mm galaxy SMM J16359+6612 is marginally (at the $3-4\sigma$ level) detected once the three lensed components are stacked up. The HCN source appears to be double with a separation of $\sim 1.5''$, consistent with what has been implied from other observations. This first possible HCN detection of a submm galaxy, and three stringent HCN upper limits, combined with previous HCN detections and upper limits strongly constrain the HCN/CO ratios at high- z to be comparable to that of local ULIRGs.

A total of 16 hours VLA time were obtained for SMM J16359. The larger image shows HCN emission from SMM J16359, visible at the position of the CO component B (mid-cross). Note the position of CO component A also shows possible HCN ($\sim 3\sigma$) detection at exactly the position of the CO Component A centroid (upper-left cross). The inset image was constructed by overlaying the positions of the three CO components and taking a weighted average. The centroid of CO component B is at position J2000 RA: 16 35 54.1 DEC: 66 12 23.8, directly between the two possible HCN components. Although unresolved in CO, the elongation of CO morphology and the separation of the blueshifted and redshifted velocity components are all consistent with our observed HCN morphology.

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