

X10a ALMA observations of a submillimeter galaxy at  $z = 6$  I: Detection of nitrogen

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Nitrogen is one of the most important elements for understanding the chemical evolution of galaxies because it is mainly produced from carbon and oxygen already present in stars through the CNO cycle, referred to as secondary element. However, there are few detections of nitrogen emission lines in galaxies at  $z > 5$ . We present ALMA observations of [N II] 205  $\mu\text{m}$ , [O III] 88  $\mu\text{m}$  and dust emission in a strongly-lensed, submillimeter galaxy at  $z = 6.03$ , G09.83808. Both [N II] and [O III] line emission are detected at  $> 12\sigma$  in the 0.8''-resolution maps. Since these lines have different ionization potential, its ratio depends not only on metallicity but also on ionization parameter. We corrected for the dependence on ionization parameter by using the empirical relation among [N II]/[O III] luminosity ratio, [N III]/[O III], and the continuum flux density ratio between 63  $\mu\text{m}$  and 158  $\mu\text{m}$  in local galaxies. Then, we infer that the gas phase metallicity is relatively low compared to local LIRGs, but already nearly solar with  $Z = 0.5 - 0.7 Z_{\odot}$ . G09.83808 could be one of the earliest galaxies to have chemically evolved in the epoch of reionization.