

X54a NOEMA observations of GN-z11: Constraining Neutral Interstellar Medium and Dust Formation in the Heart of Cosmic Reionization at $z = 10.60$

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The first few hundred million years after the Big Bang at redshifts of $z > 10$ are the last major unexplored epoch in the history of the Universe. Recently, the arrival of the James Webb Space Telescope (*JWST*) has opened a completely new window to study the very high redshift Universe. During the first observation cycle, *JWST* confirmed a spectroscopic redshift of GN-z11 at $z = 10.603$, an extremely luminous $z > 10$ galaxy identified using *HST* and *Spitzer* (Oesch+16, Bunker+23). Due to the extreme luminosity of GN-z11 ($M_{UV} = -21.5$), GN-z11 is one of the prime interest in the *JWST* cycle-1, and detailed observations have been performed; Deep imaging (Tachella+23), spectroscopy (Maiolino+23a). Despite the detailed, large amount of observations, GN-z11 still remains one of the most puzzling galaxies (e.g., Maiolino+23b, Charbonnel+23).

In this talk, we present the results of our observations of GN-z11 using the Northern Extended Millimeter Array (NOEMA). The observations have been carried out over multiple cycles between the year 2014 and 2019. By combining all observations, we achieved a high sensitivity to deeply constrain the limit of the [CII] $158 \mu\text{m}$ emission luminosity and $\lambda \sim 160 \mu\text{m}$ dust continuum of GN-z11. The observations allow us to study the neutral gas and dust formation of GN-z11, to which *JWST* does not have access. We will further discuss the importance of future mm/submm observations of very high-redshift galaxies using NOEMA and ALMA.