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# High redshift spectral imaging of lensed sources using ALMA

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## Abstract

Very massive galaxies with a high SFR have been found in the early universe. The nature of the gas reservoir can be crucial to understand the evolution and nature of such galaxies. [CI](2-1) is an alternative cold gas tracer to CO(1-0). High-J CO transitions trace excited and dense gas. The CO(7-6) to [CI](2-1) lines can be observed simultaneously and the ratio can be a good proxy of the ratio of dense star forming gas to the total molecular gas. SPT0103-45 and SPT2357-51 were observed initially with APEX-SEPIA and were interesting. Both the sources have a high SFR at  $z \sim 3$ . SPT0103-45 was more [CI](2-1) bright than CO(7-6) and SPT2357-51 showed the presence of broad and blended [CI](2-1) and CO(7-6). Follow up observations of this pilot sample was done with ALMA band 5 at a resolution of 0.3 which observed CO(7-6), [CI](2-1) and the continuum for these sources. SPT0103-45 shows the presence of a strong asymmetry in both the lines, with a unidirectional tail-like feature. The continuum also shows the presence of a bright blob feature. We fitted a lensing model, directly in uv plane to constrain the intrinsic properties of our sources. The continuum shows the presence of two components, one compact and one extended, suggesting a minor merger. In the case of SPT2357-51 a strong double-peak feature was present in both the lines. The pixel wise gaussian decomposition of the source showed the presence of 2 components, with one component brighter in the continuum than the other, suggesting different ISM properties. The delensing has been done for both the lines as well as the continuum. These observations demonstrate the how powerful spatially and spectrally resolved multi-line interferometric observations are, to unveil the nature of high-z starbursts.

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