B14r Probing High Redshift Galaxies with ALMA

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There are significant progresses in our understandings of warm/cold gas and dust in high-z galaxies in the past two years of the ALMA operation. ALMA has already resolved $\sim$ 80% of cosmic infrared background light at a 1-mm band. Targeting high-z galaxies from optical, infrared, and (sub-)mm samples, ALMA detects starburst galaxies and QSOs at a redshift up to $6-7$ with emission of cold-dust continuum and an atomic [CII]158μm line from photo-dissociation regions (PDRs). ALMA reveals high-z starbursts with the significant metal enrichment and dust re-radiation near the epoch of cosmic reionization. Although these well-evolved high-z starbursts are important to understand massive galaxy formation, ALMA observations suggest that the contribution from dusty starbursts ($S_{870\mu\mathrm{m}} > 1$mJy) to cosmic star-formation rate (SFR) density is moderate, about 30-40% of total SFR density at $z \sim 2-3$, and that a dusty-starburst abundance decreases towards high-z. On the other hand, ALMA finds an interesting galaxy population at $z \sim 6-7$ with a high SFR of $100 M_{\odot}\mathrm{yr}^{-1}$ that shows neither reasonably strong dust-continuum nor [CII] emission whose luminosity-to-SFR ratio is less than 1/30 of local starbursts. Similarly, IRAM programs report weak CO line emission of $z \sim 2-3$ galaxies: their molecular hydrogen mass densities estimated from the CO fluxes depart from the local Kennicutt-Schmidt law. Such a weak metal and dust emission population would have PDRs and molecular regions of high-z galaxies with a density, radiation field, and/or metallicity of ISM different from those of local galaxies. Future ALMA programs will investigate evolution and physical origin of the weak dust/metal emission.