X33a Morphological Analysis of Nine Submillimeter Galaxies

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Submillimeter galaxies (SMGs) selected by their bright fluxes at submillimeter wavelengths are amongst the most massive and actively star-forming galaxies at cosmic noon (redshift $\sim 2-3$). We present multiwavelength analysis of nine SMGs at redshift ~ 2.1 detected at 1.1 mm by ALMA. We perform panchromatic spectral energy distribution modelling from ultraviolet to 1.1 mm to derive the stellar mass ($M_\star$) and star formation rate (SFR). The sample has median $M_\star = 13 \times 10^{10} M_\odot$ and median SFR $= 263\ M_\odot\ \mathrm{yr}^{-1}$. Eight of the nine SMGs are consistent with the $M_\star$-SFR relation of normal star-forming galaxies (the star-forming main sequence, MS). Then we examine their morphology using ALMA 1.1 mm and Hubble Space Telescope F160W imaging data. The eight MS SMGs include candidates of pre-coalescence galaxy pair and post-starburst galaxies with spheroid component co-spatial with 1.1 mm detection. The size of star-forming region in post-starburst candidates probed by the 1.1 mm data is ~ 1 kpc and more compact than other galaxies in our sample. On average MS SMGs are extreme objects with infrared surface density ($\sim 10^{11} L_\odot\ \mathrm{kpc}^{-2}$) two orders of magnitude higher than local normal star-forming galaxies, and are likely on the way from starburst to quiescence rather than secular star-forming galaxies. Our findings highlight the importance of combining multiple diagnostics in investigating the star formation mode of SMGs.