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Structural Evolution of Star-Forming Galaxies at Redshift $z = 0 - 3$ and its Implication on SED and SFR

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We use observations at 24 μm, Paα, and 1.4 GHz radio continuum to show that the galactic-wide star-forming regions in high-z LIRGs and ULIRGs are substantially more extended than those found in their local counterparts at the similar IR luminosities. High-z LIRGs and ULIRGs have similar physical diameters to those of local normal star-forming galaxies ($3-10$ kpc), but with the star formation rate (SFR) surface density scaled up by $100 - 1000\times$. We also find that the IR SEDs of galaxies are, to the first order, indicated solely by their IR luminosity surface density, allowing an accurate description of star-forming galaxy SEDs out to $z \sim 3$, and subsequently the appropriate bolometric corrections to extrapolate the total IR luminosities from single-band mid-IR observations. These findings afford a new single-band 24 μm indicator for the total IR luminosity and SFR at redshift $0 < z < 3$ that successfully takes into account the evolution of the spectral energy distribution of star-forming galaxies, and yields IR luminosities agreeing with the far-IR measurements (i.e., from *Herschel*) to within 0.1 dex on average, and with RMS scatter of < 0.2 dex. The success of the single-band 24 μm IR luminosity indicator suggests that a majority of IR-luminous star-forming galaxies in the Universe are not strongly nuclear concentrated as are the local merger-induced LIRGs and ULIRGs.