A Mid-Infrared Indicator for Total Infrared Luminosity and Star Formation Rate of Local and High-Redshift Galaxies

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We present a new method to use 24 micron observations to estimate the total infrared luminosity, LIR, and the star formation rate of star-forming galaxies across the redshift range $0 < z < 3$. This is accomplished by parameterizing the spectral energy distribution (SED) of a galaxy as a function of the LIR surface density, LIRSD, instead of the traditional LIR. Our reformulation allows an accurate description of star-forming galaxy SEDs, including the aromatic emissions, out to redshift $z \sim 3.0$. We test the new 24 micron LIR indicator against LIR measured from stacked far-IR photometry at redshift $0 < z < 3$. We show that a monochromatic 24 micron observation can be used to estimate LIR consistent with the values determined from the multi-band far-IR measurements such as those from Herschel, on average within 0.1-dex. This approach allows use of observed-frame 24 micron observation to determine the SFR of star-forming galaxies accurately across the currently expected peak of the star formation history of the universe. The success of this method indicates 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.

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