

X64a Clump-scale dust attenuation and re-emission in EoR galaxies from simulations

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Recent ALMA and JWST observations show that high-redshift galaxies ($z \gtrsim 6$) frequently exhibit clumpy structures. Even though dust properties such as UV slopes, dust temperature, attenuation, and re-emission IRX ($\equiv L_{\text{IR}}/L_{\text{UV}}$) should vary by location, most simulation studies focus on only the system-integrated values.

To examine dust property variations between galaxy-integrated scales and star-forming clumps, we conduct cosmological zoom-in simulations with post-processing dust radiative transfer. We identify clumps based on star formation rate surface densities ($R \gtrsim 100 \text{ pc}$, $\text{SFR} \gtrsim 1 M_{\odot} \text{ yr}^{-1}$), detecting 376 clumpy galaxies at $z = 6 - 9$ in total. For each snapshot, we investigate dust attenuation/re-emission properties for system, clumpy, and diffuse (surrounding) components. For attenuation, clumps have a gray attenuation curve with $\langle S \rangle = \langle A_{\text{UV}}/A_{\text{V}} \rangle = 1.7$, while system-integrated values have $\langle S \rangle = 1.9$. The diffuse component has a steep curve ($\langle S \rangle = 3.3$) due to scattering. For re-emission, the mean IRX of clumps is over 1 dex larger than diffuse and system values. To explain these results, we introduce a toy model for dust-star geometries on the IRX- β_{UV} plane using dust optical depth and dust-to-star scale-height ratio. Clumps have 3-10 times higher dust column density than system-integrated values with well-mixed or screen-like geometries, while system and diffuse components show well-mixed or sandwich geometries. These spatial variations suggest the importance of varying attenuation curves for pixel-by-pixel SED fitting and estimating spatially resolved dust obscuration.