First direct implications for the dust extinction and star formation of typical Lyα emitters at $z \sim 2$ from their faint infrared luminosities

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Abstract

Measuring the IR luminosity of galaxies is crucial for reliably deriving their dust extinction and stellar population. By stacking publicly available deep Spitzer/MIPS 24 μm (Magnelli+11) and Herschel PACS images (Lutz+11; Elbaz+11; Magnelli+13) for 213 $z \simeq 2.18$ Lyα Emitters (LAEs) in the GOODS-South, we obtain a strong upper limit to the IR luminosity of typical high-redshift LAEs and constrain the extinction law for the first time. The obtained very low 3σ upper limit $L_{\rm TIR}^{3\sigma} = 1.1 \times 10^{10} L_\odot$ implies that LAEs have little contribution to the faint (≥ 100 μJy) number counts of submm galaxies by ALMA (Hatsukade+13; Ono+14). This $L_{\rm TIR}^{3\sigma}$ gives $IRX \equiv L_{\rm TIR}/L_{\rm UV} \leq 2.2$, or $A_{1600} \leq 0.9$ mag, indicating that dust extinction is remarkably small. Indeed, the inferred escape fractions of Lyα, 16–37%, and of UV continuum, ≥ 44%, are both significantly higher than the cosmic averages at the same epoch (Hayes+11; Burgarella+13). We find that the SMC extinction law (Pettini+98) is consistent with the IRX and the UV slope $\beta = -1.4^{+0.2}_{-0.2}$ of our stacked LAE, while the Calzetti law predicts a 3.8 times higher IRX at this β. SED fitting using the Calzetti law (Meurer+99; Calzetti+00) also gives a ~ 10 times higher SFR than that calculated from the IR and UV luminosities, $SFR_{\rm tot,IR+UV} = 1.5$–$3.3$ M$_\odot$yr^{-1}. Thus, the SMC law is preferred. With the stellar mass $6.3^{+0.8}_{-2.0} \times 10^8M_\odot$, our LAEs lie on a lower-mass extrapolation of the star formation main sequence at $z \sim 2$ (Daddi+07; Rodighiero+11). It suggests that the majority of $z \sim 2$ LAEs are mildly forming stars with relatively old ages of ~ 200 Myr. Note that adopting the Calzetti law leads us to conclude that they are in the burst mode similar to brighter LAEs (Hagen+14; Vargas+14). Finally we will discuss the possibility of constraining the extinction law and star formation mode of luminous LAEs by ALMA. A preprint of this work is available at arXiv:1411.1615 [astro-ph.GA].