X06a ALMA reveals extended cool gas and hot ionized outflows in a typical star-forming galaxy at $z = 7.13$

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We present spatially-resolved morphological properties of [C II] 158μm, [O III] 88μm, dust, and rest-frame ultraviolet (UV) continuum emission for A1689-zD1, a strongly lensed, sub-$L^\star$ galaxy at $z = 7.13$, by utilizing deep Atacama Large Millimeter/submillimeter Array (ALMA) and *Hubble Space Telescope* (*HST*) observations. While the [O III] line and UV continuum are compact, the [C II] line is extended up to a radius of $r \sim 12$ kpc. Using multi-band rest-frame far-infrared (FIR) continuum data ranging from 52 – 400 μm, we find an average dust temperature and emissivity index of $T_{\rm dust} = 41^{+17}_{-14}$ K and $\beta = 1.7^{+1.1}_{-0.7}$, respectively, across the galaxy. We also measure the spatially-resolved $T_{\rm dust}$, which peaks at the galaxy center with ~ 50 K and cools to larger distance, reaching ~ 35 K at $r = 5$ kpc. We map the star-formation rate (SFR) via IR and UV luminosities and determine a total SFR of 37 ± 1 $M_\odot$ yr^{-1} with an obscured fraction of 87%. While the [O III] line is a good tracer of the SFR, the [C II] line shows deviation from the local $L_{\rm [C\,II]}$-SFR relations in the outskirts of the galaxy. Finally, we observe a clear difference in the line profile between [C II] and [O III], with significant residuals ($\sim 5\sigma$) in the [O III] line spectrum after subtracting a single Gaussian model. This suggests a possible origin of the [C II] halo from the cooling of hot ionized outflows. The extended [C II] and high-velocity [O III] emission may both contribute in part to the high $L_{\rm [O\,III]}/L_{\rm [C\,II]}$ ratios recently reported in $z > 6$ galaxies.