X31a Widely distributed cold gas and dust within a z=3 giant Lyman-α blob

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We present observations of a giant Ly α blob (LAB) in the SSA22 proto-cluster at $z = 3.1$, SSA22-LAB1, taken with the Atacama Large Millimeter/submillimeter Array (ALMA). Dust continuum, along with [C II] 158 μm, [N II] 205 μm, and CO(4–3) line emission have been detected in the prototypal LAB, showing complex morphology and kinematics across a $\sim$ 100 kpc central region. Seven galaxies at z =3.0987–3.1016 in the surroundings are identified in [C II] and dust continuum emission, with two of them potential companions or tidal structures associated with the most massive galaxies. Spatially resolved [C II] and infrared luminosity ratios for the widely distributed media ($L_{\rm [CII]}/L_{\rm IR} \approx 10^{-2} - 10^{-3}$) suggest that the observed extended interstellar media are likely to have originated from star-formation activity and the contribution from shocked gas is probably not dominant. LAB1 is found to harbour a total molecular gas mass $M_{\rm mol} = (8.7 \pm 2.0) \times 10^{10}\,{\rm M}_{\odot}$, concentrated in the core region of the Ly α-emitting area. While (primarily obscured) star-formation activity in the LAB1 core is the most plausible power sources for the Ly α emission, multiple major-mergers found in the core may also play a role in making LAB1 exceptionally bright and extended in Ly α as a result of cooling radiation induced by gravitational interactions.