

# The ALMA Frontier Fields Survey: II. Multiwavelength Photometric analysis of 1.1 mm continuum sources in Abell 2744, MACSJ0416.1-2403 and MACSJ1149.5+2223

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Context. The Hubble and Spitzer Space Telescope surveys of the Frontier Fields provide extremely deep images around six massive, strong-lensing clusters of galaxies. The ALMA Frontier Fields survey aims to cover the same fields at 1.1 mm, with maps reaching (unlensed) sensitivities of  $<70$   $\mu$ Jy, in order to explore the properties of background dusty star-forming galaxies. Aims. We report on the multi-wavelength photometric analysis of all 12 significantly detected ( $>5\sigma$ ) sources in the first three Frontier Fields clusters observed by ALMA, based on data from Hubble and Spitzer, the Very Large Telescope and the Herschel Space Observatory. Methods. We measure the total photometry in all available bands and determine the photometric redshifts and the physical properties of the counterparts via SED-fitting. In particular, we carefully estimate the far-infrared (FIR) photometry using 1.1mm priors to limit the misidentification of blended FIR counterparts, which strongly affect some flux estimates in previous FIR catalogs. Due to the extremely red nature of these objects, we used a large range of parameters (e.g.  $0.0 < A_V < 20.0$ ) and templates (including AGNs and ULIRGs models). Results. We identify robust near-infrared (NIR) counterparts for all 11 sources with Ks detection, the majority of which are quite red, with eight having F814W -

Ks  $\geq 4$  and five having F160W - [4.5]  $\geq 3$ . From the FIR point of view, all our objects have  $z_{\text{phot}} \geq 1.3$ , whereas based on the optical SED one object prefers a high-z solution ( $z \geq 7$ ). Five objects among our sample have spectroscopic redshifts from the GLASS survey for which we can reproduce their SEDs with existing templates. This verification confirms the validity of our photometric redshift methodology. The mean redshift of our sample is  $z_{\text{phot}} = 1.99 \pm 0.27$ . All 1.1mm selected objects are massive ( $10.0 < \log[M^*(M_{\odot})] < 11.5$ ), with high star formation rates ( $\log[\text{SFR}(M_{\odot}=\text{yr})] \geq 1.6$ ) and high dust contents ( $8.1 < \log[M_{\text{dust}}(M_{\odot})] < 8.8$ ), consistent with previous ALMA surveys.

Galaxies: distances and redshifts

Galaxies: high-redshift

Galaxies: photometry

Infrared: galaxies

Radio continuum: galaxies

Submillimeter: galaxies

FIR filters

Infrared devices

Photometry

Space telescopes

Stars

Surveys

Galaxies: distances and redshifts

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