ALMA 1.1 mm extragalactic survey in GOODS-South Field – First results

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The cosmic star formation history

- Peak of the star formation density: $z \sim 2$
- Then declined
- $z < \text{peak}$ constrained by MIR/FIR/radio observations
- $z > 3$ mostly based on solely UV-selected samples

Madau & Dickinson 2014
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Madau & Dickinson 2014
The GOODS-South Field
A multi-wavelength view

- Optical/near-infrared
  - WFC3/IR
  - ACS
  - HAWK-I Ks
  - ISAAC Ks
  - VIMOS U
  - FourStar
- Mid-Far IR
  - IRAC
  - MIPS
  - PACS
  - SPIRE
- Radio
  - JVLA (CO-I)
- X-Ray
  - Chandra 7Ms

Luo et al., 2016
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Our ALMA 1.1mm survey

Observation:
\( \sim 22 \) h

Size:
69 ' 

Comoving scale
15.1 x 10.5 Mpc at \( z = 2 \)

Depth:
Rms \( \sim 0.185 \) mJy

Resolution:
- Intrinsic \( \theta = 0.2'' \)
- Homogeneous \( \theta = 0.29'' \)
- Tapered \( \theta = 0.60'' \)

Franco et al., in prep
Selection criteria

Determination of the detection threshold

Below this threshold:
Higher proportion of sources without HST counterpart

Fidelity criterion = 80 %
HST counterparts = 80 %

Fidelity criterion : \( P_c = 1 - \frac{N_n}{N_p} \)

% optical counterpart \( p_{\text{HST}} = \frac{N_{\text{HST}}}{N_{\text{total}}} \)

Cumulative number of positive (red histogram) and negative (blue histogram) detections

Franco et al., in prep
ALMA detections

Franco et al., in prep
GOODS-South ALMA-HST offset

Systematic offset

Previously found:
\[ \Delta \alpha = 80 \pm 110 \text{ mas} \]
\[ \Delta \delta = -260 \pm 130 \text{ mas} \]
(Rujopakarn et al. (2016))

This work:
\[ \Delta \alpha = 94 \pm 42 \text{ mas} \]
\[ \Delta \delta = -262 \pm 50 \text{ mas} \]
(Franco et al., in prep)

After the subtraction of the systematic offset

Discovery of a local offset
ALMA unveils a new population of HST-dark galaxies (~ 15%)
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What is the nature of the ALMA detected galaxies?
ALMA detects distant massive SFGs
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\[ \sim 90\% \text{ of detected galaxies} \]

\[ M_* > 2 \times 10^{10} M_{\odot} \]

\[ \sim 50\% \text{ of detected galaxies} \]

\[ M_* > 10^{11} M_{\odot} \]
Redshift distribution

Opening of a new parameter space at $z > 3$

Partly or totally missed in smaller blind survey

Franco et al., in prep

Median redshift

1.99

1.67 2.13 2.94

Fractional error

Dunlop+16
Aravena+16
Laporte+17
This work

N
redshift
Redshift distribution

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Summary

• Largest ALMA blind survey
• Unbiased survey

• Median redshift $z \sim 2.9$
• Median stellar mass $\sim 10^{11.13} M_{\text{sun}}$

• Reveals a population of HST-dark galaxies