

THE ALMA VIEW ON HOT DUST OBSCURED GALAXIES AND THE MOST LUMINOUS GALAXY KNOWN

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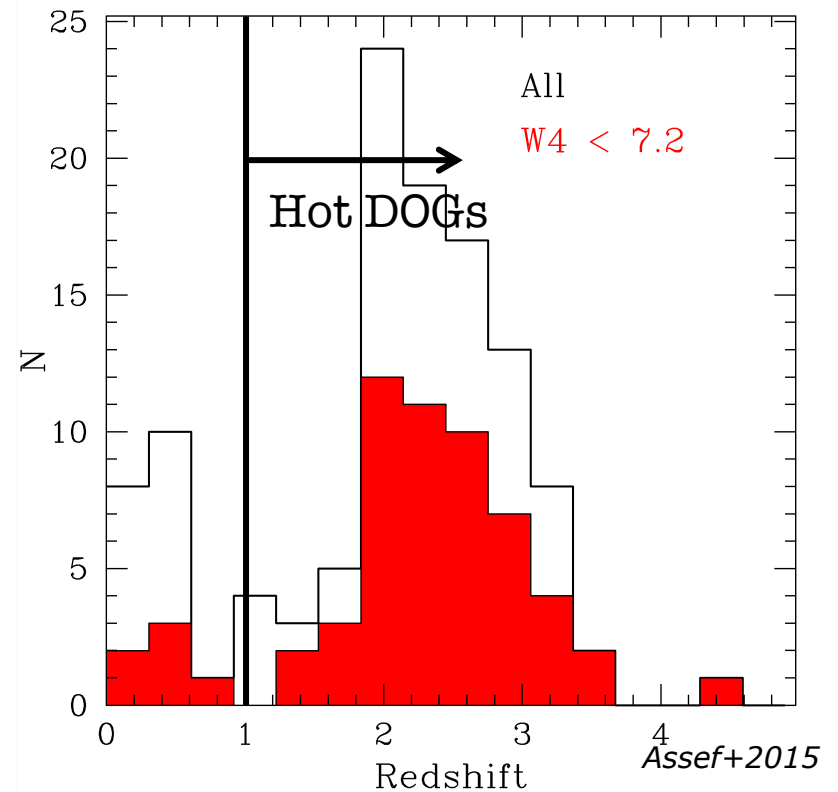
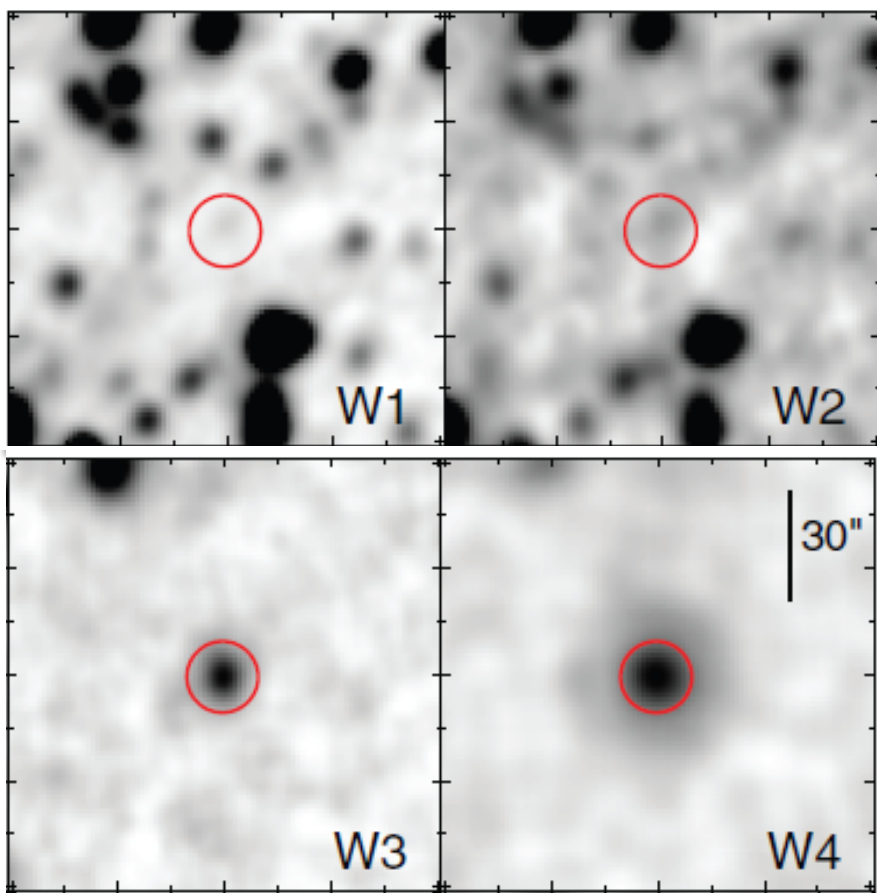
Atacama
Large
Millimeter/
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ALMA, March 27th 2018

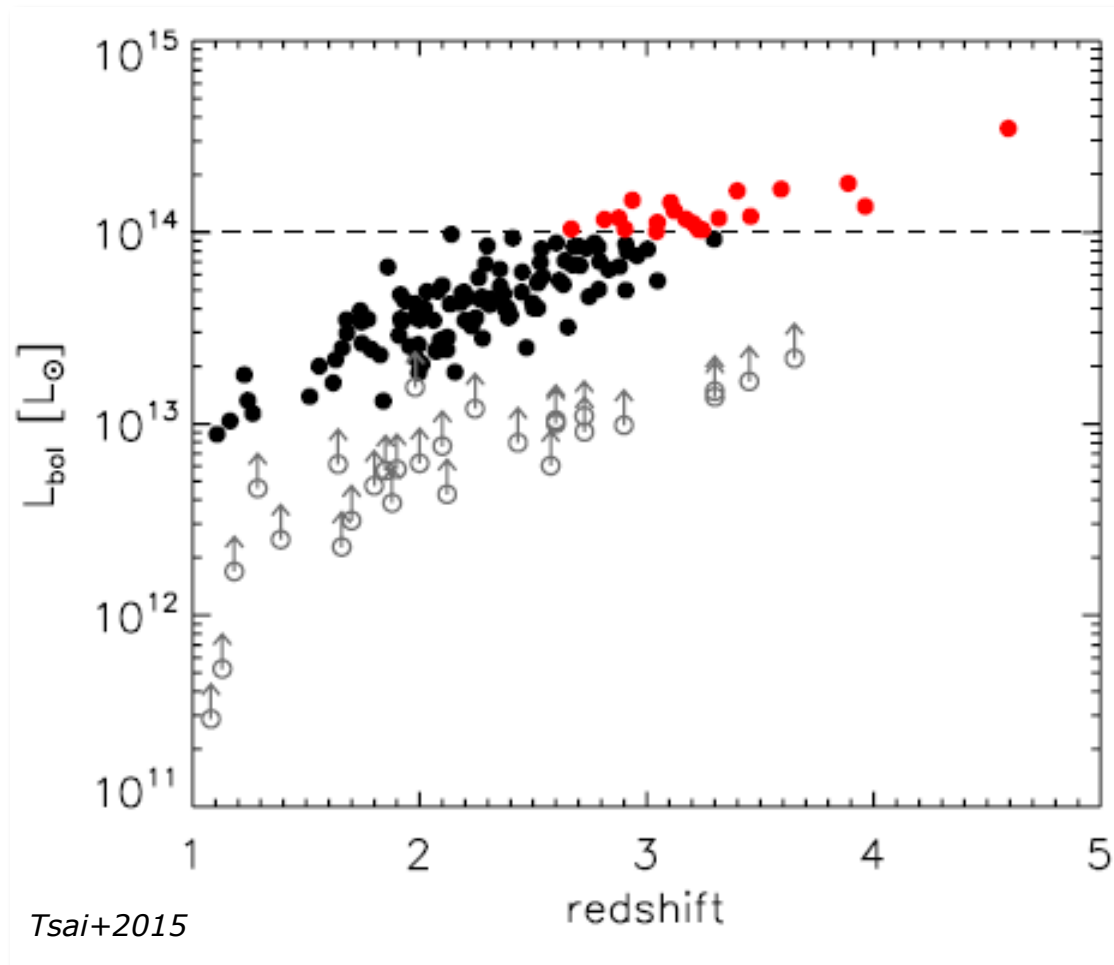
WHAT ARE HOT DUST OBSCURED GALAXIES?

- Hot DOGs are a newly discovered population of galaxies detected by WISE, selected to be strong W3 and W4 emitters, but undetected or very faint in W1 and W2.
- There are ~ 1000 such objects in the entire extragalactic sky, around $z \sim 1 - 3.5$



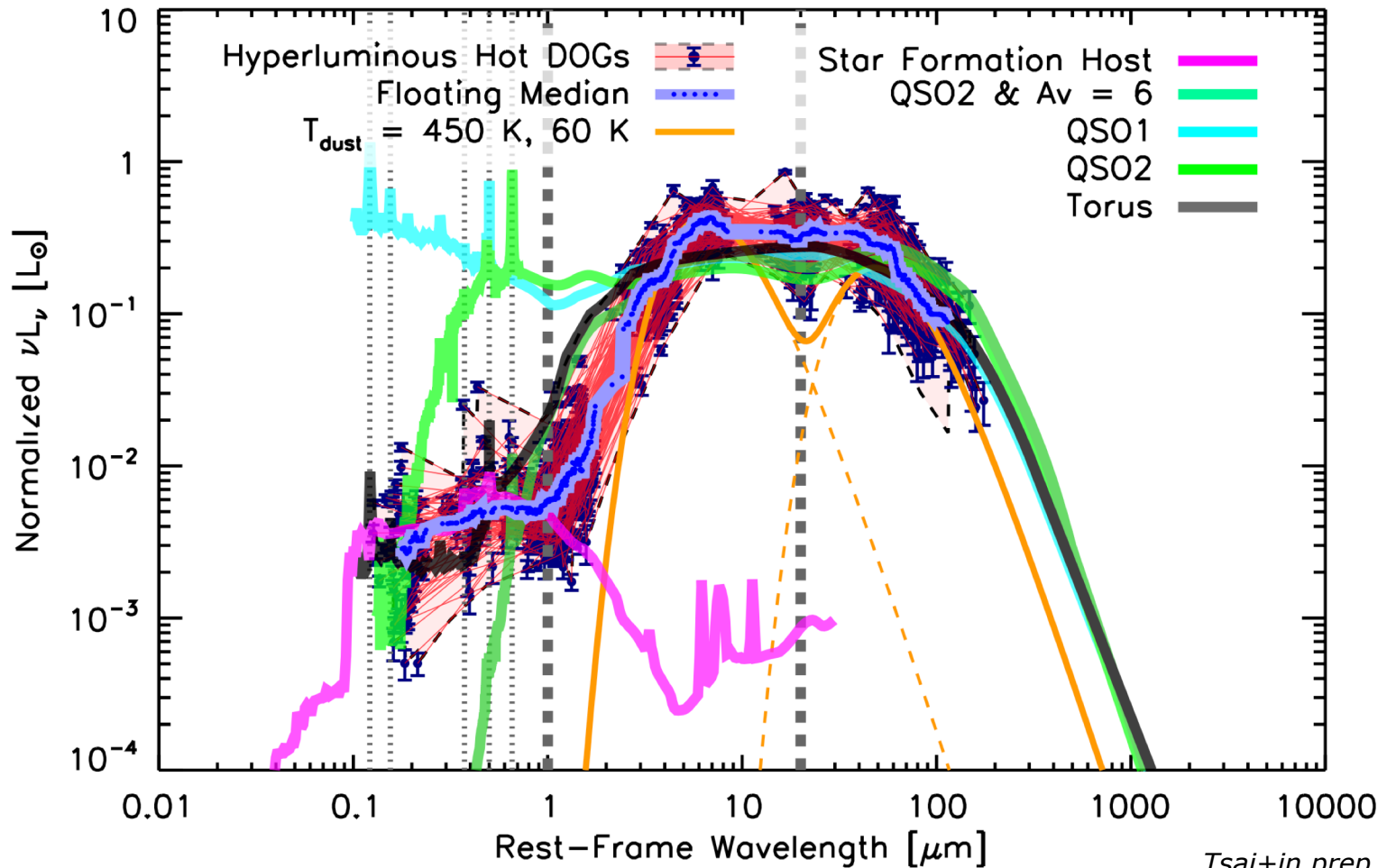
LUMINOSITY DISTRIBUTION

- Herschel photometry has been obtained for ~ 200 Hot DOGs (*Tsai+in prep.*). Almost all have $L_{\text{bol}} > 10^{13} L_{\odot}$, and since IR dominates the power, almost all qualify as HyLIRGs
- 10% have $L_{\text{bol}} > 10^{14} L_{\odot}$, mostly at $z > 2.5$



TYPICAL HOT DOG SED

- Dust temperatures as high as ~ 500 K
- All display a remarkably similar SED, dominated by AGN, even at $\lambda > 100\mu\text{m}$

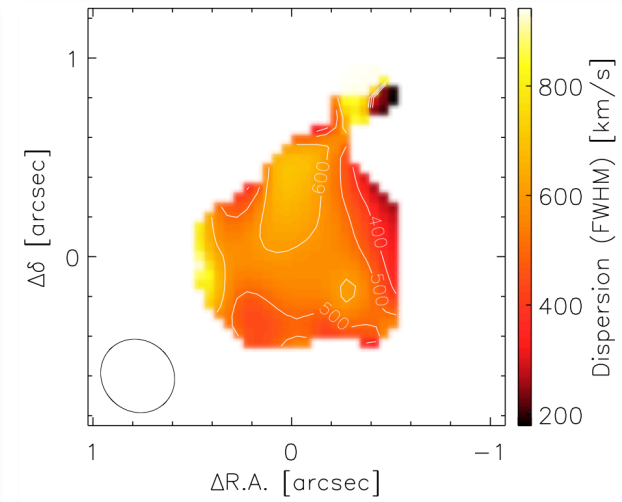
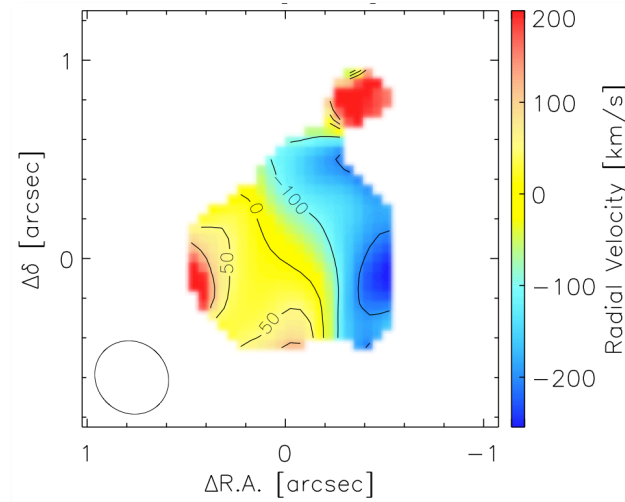
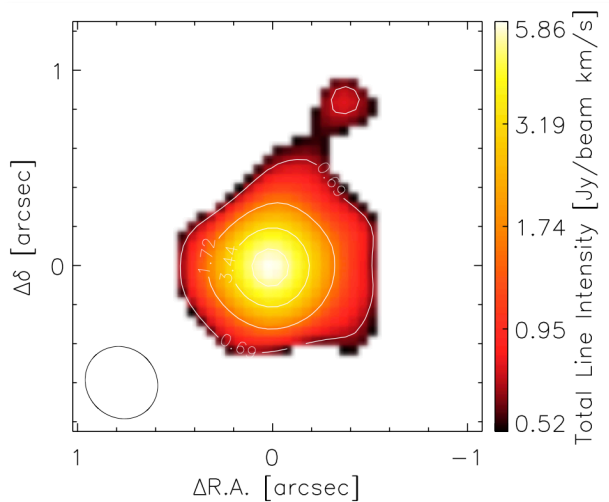


OBSERVATIONS

- ALMA cycle-2/3/4 campaign aimed at studying the ionized gas in the most luminous Hot DOGs at an angular resolution of $0.15'' - 0.35'' \sim 1 - 2.5$ kpc.
- Sample of 7 Hot DOGs at $z \sim 3 - 4.6$ and $L_{\text{bol}} \sim 1-3.5 \times 10^{14} L_{\odot}$, of which W2246-0526, the most luminous galaxy known, was the first to be observed.
- Awarded 8.1h in bands 7 and 8 to observe [CII] and the underlying dust continuum emission at $158\mu\text{m}$.



THE MOST LUMINOUS GALAXY KNOWN: W2246-0526 ($L_{\text{BOL}} = 3.5 \times 10^{14} L_{\odot}$; $z=4.6$)

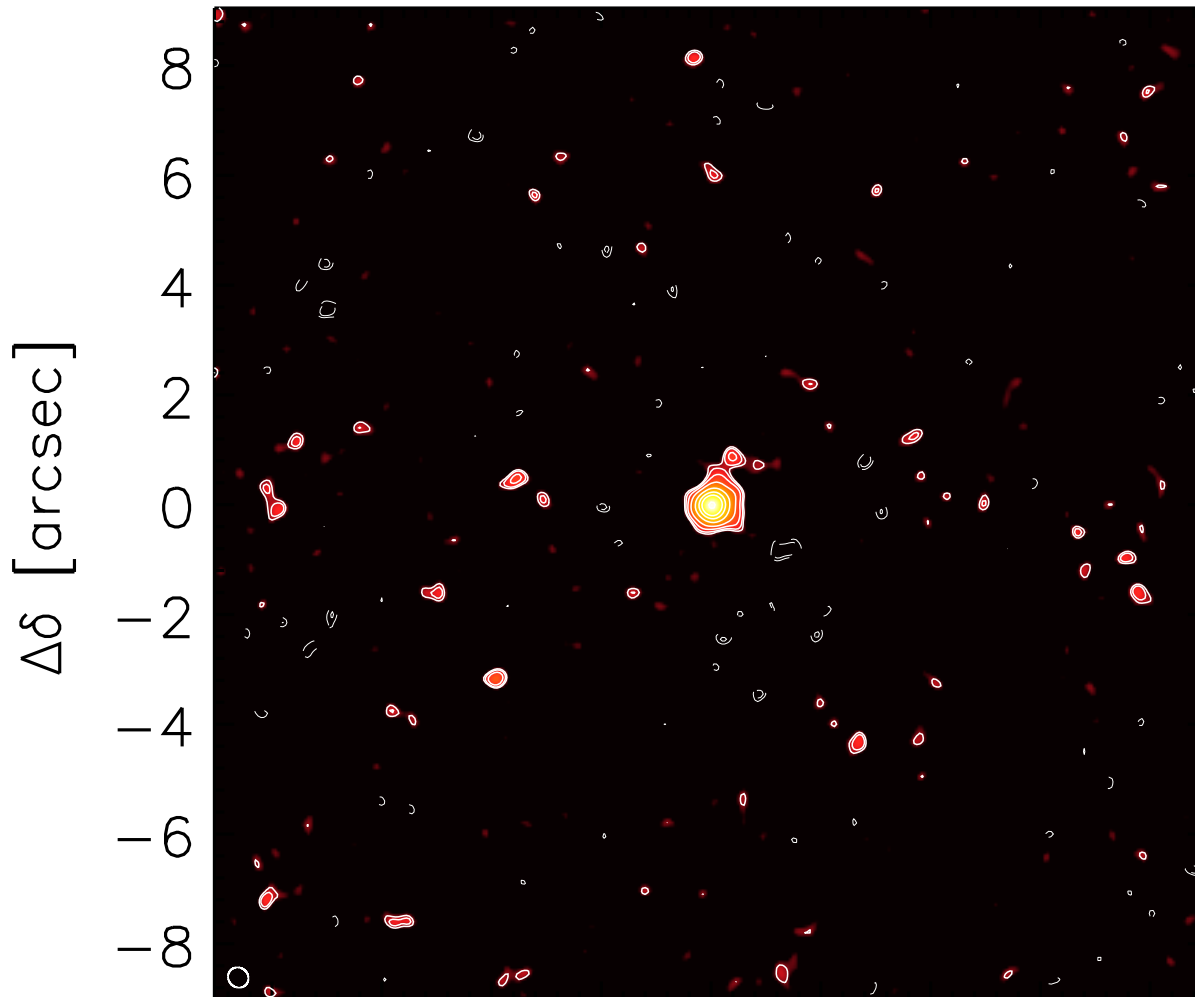


Diaz-Santos+2016

- $L_{\text{[CII]}} \sim 6 \times 10^9 L_{\odot}$. Dust continuum: 1.3 +/- 0.5 kpc. [CII] emission: 2.5 +/- 0.3 kpc. Small velocity shear. $\Delta v \approx 200$ km/s. Smooth rotation.
- Very uniform velocity dispersion. FWHM ~ 600 km/s. Highly turbulent ISM across the entire galaxy (see also *Falgarone+2017*).
- W2246 is beyond stability thresholds that limit the energy deposition and radiation pressure that the AGN can inject into the ISM before disrupting it. This requires an nearly **isotropic** blow out of the gas from the system.
- Feedback from the buried quasar likely causing uniform, several kpc-scale gas outflows. Critical evolutionary stage. Large-scale quenching of star formation in the host?

ENVIRONMENT: W2246-0526

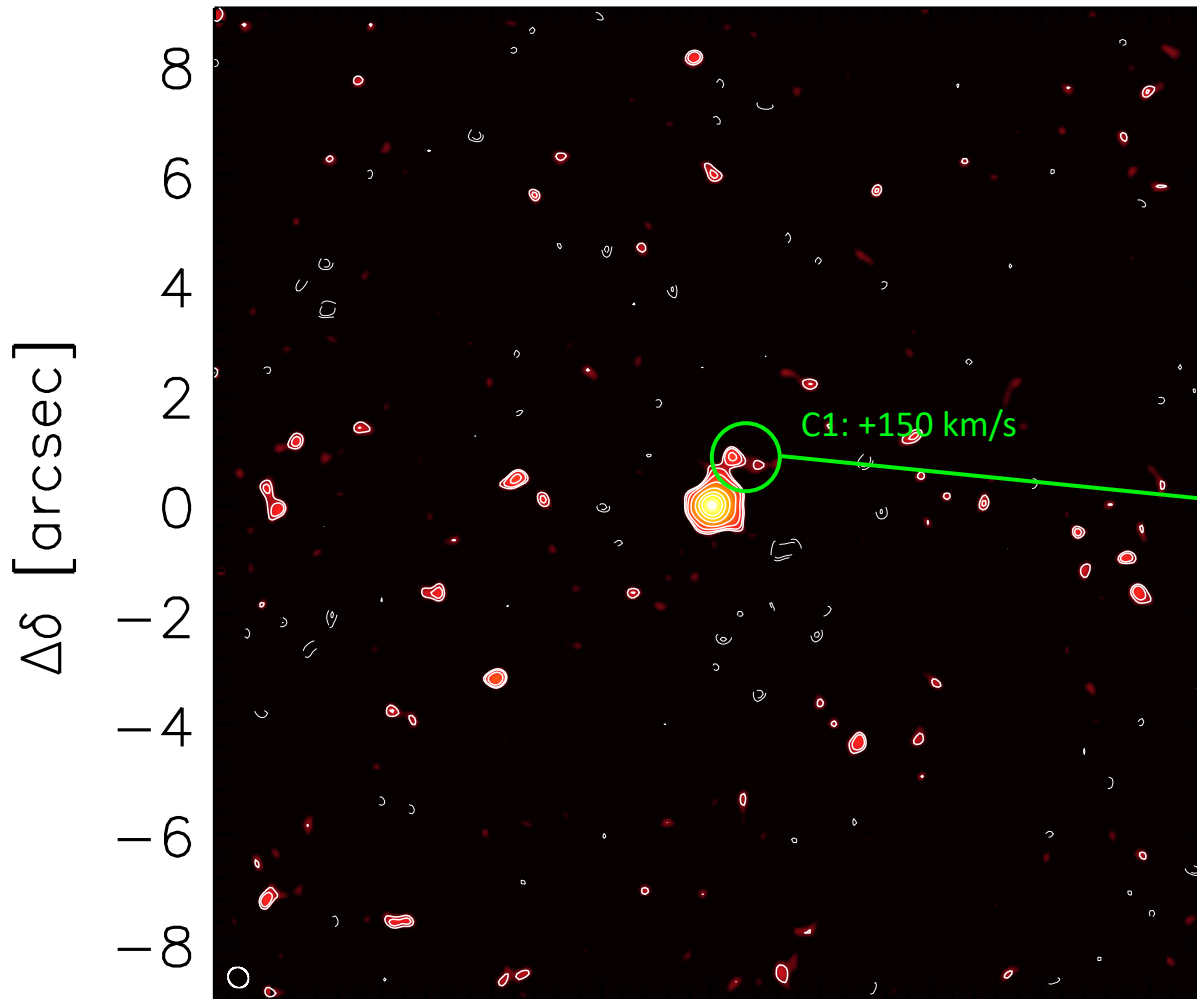
- There is statistical evidence that Hot DOGs live in large over-densities (*Jones et al. 2014, Assef et al. 2015, Fan et al. 2017*)
- ALMA allows to search for other [CII] emitting objects at the same redshifts, and for continuum detections in the FOV



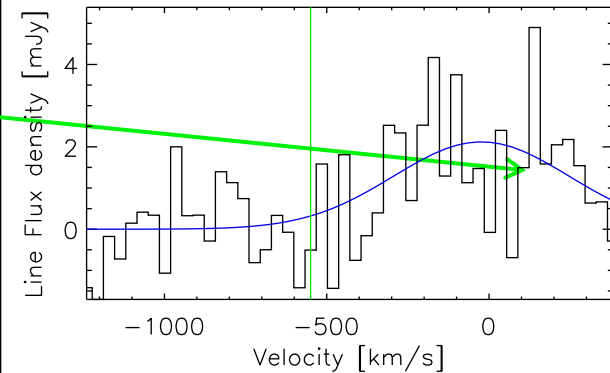
- W2246 has 3 galaxy companions detected in [CII] (1" to NW, 5" to SE, and 3" NE)

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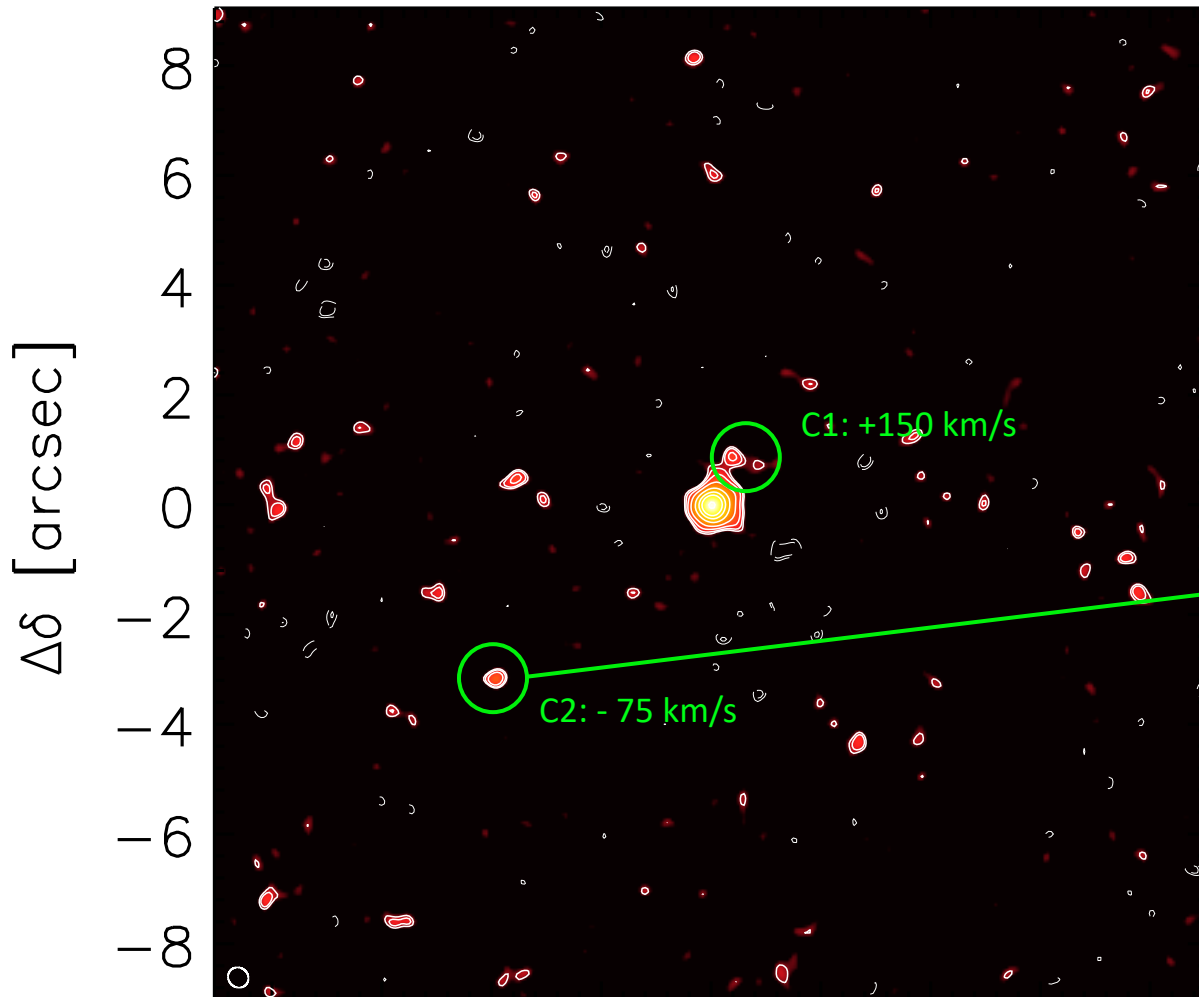


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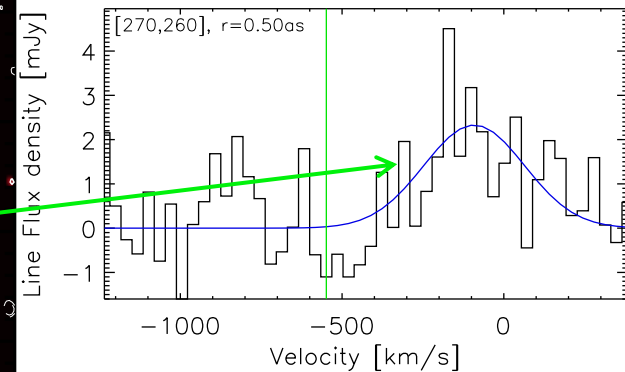


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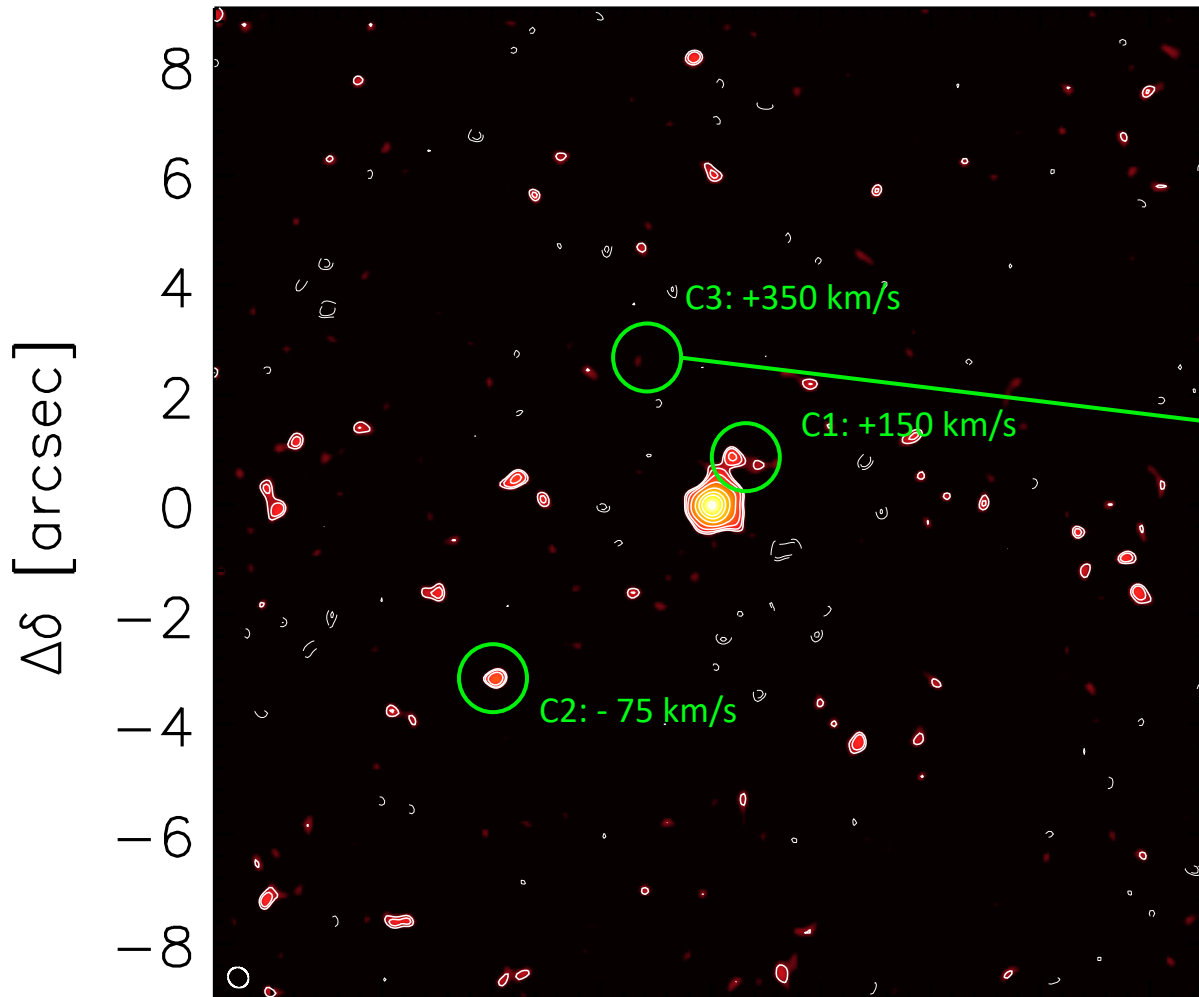


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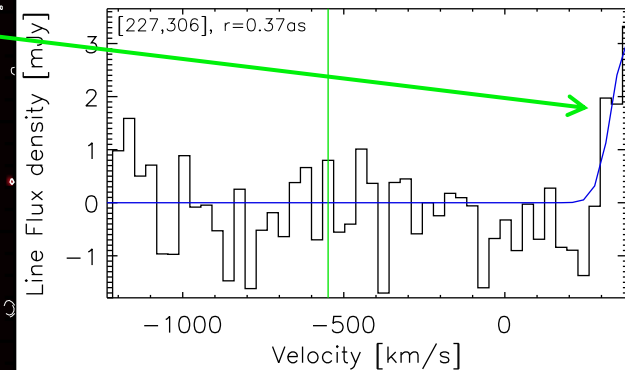


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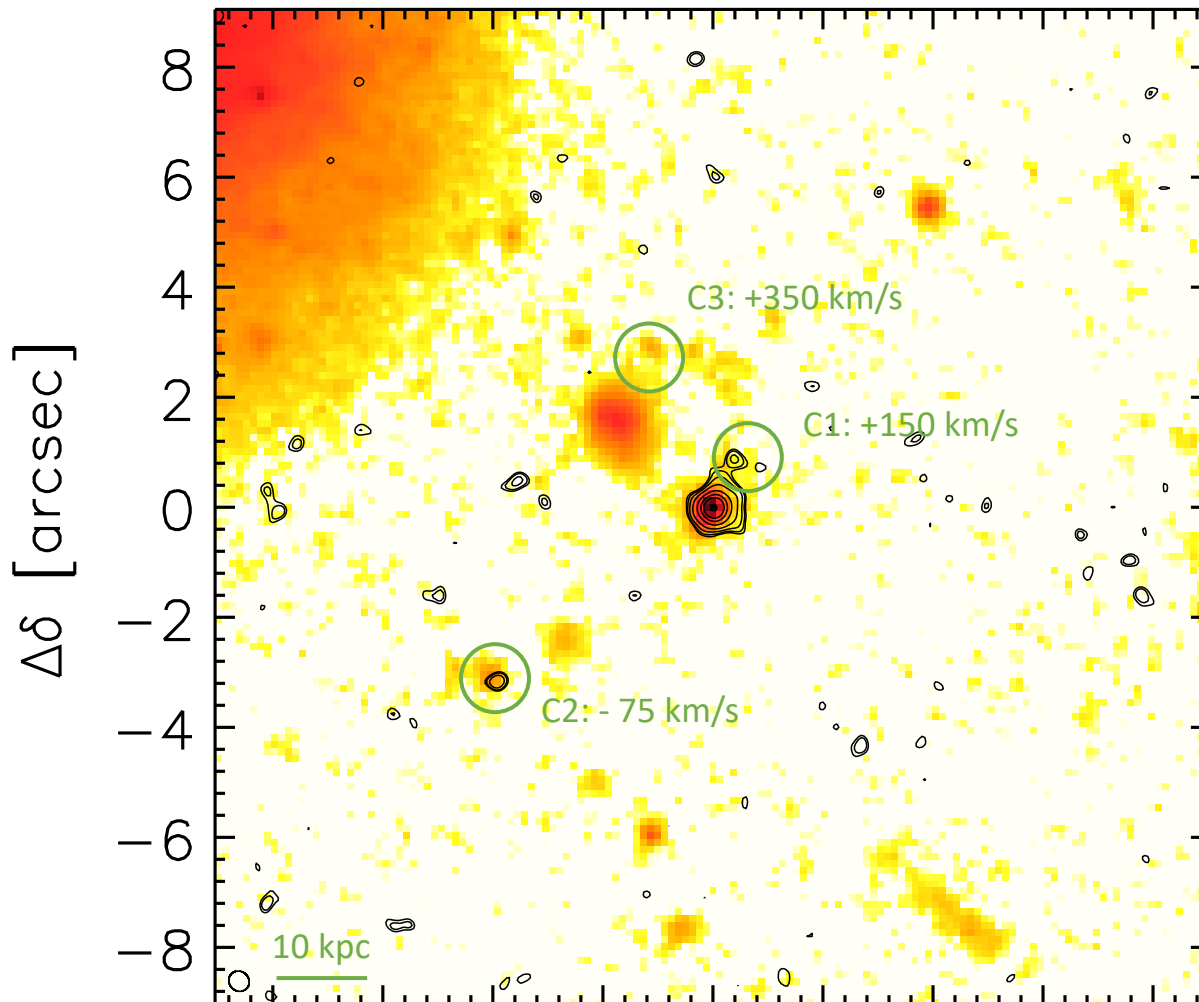


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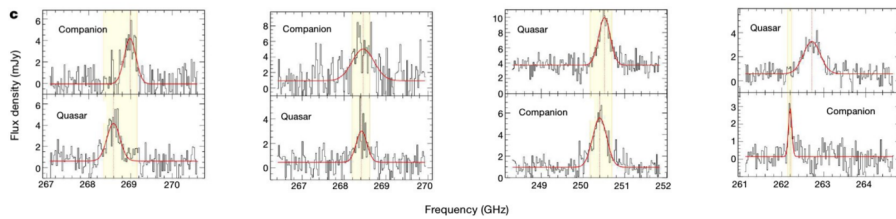
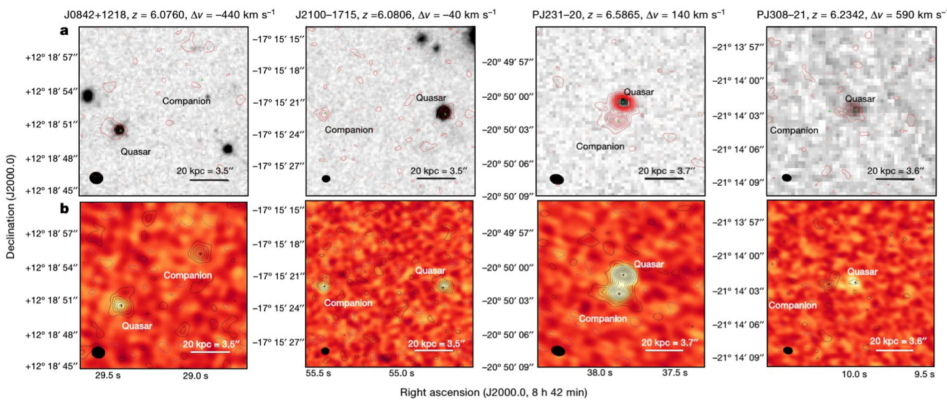
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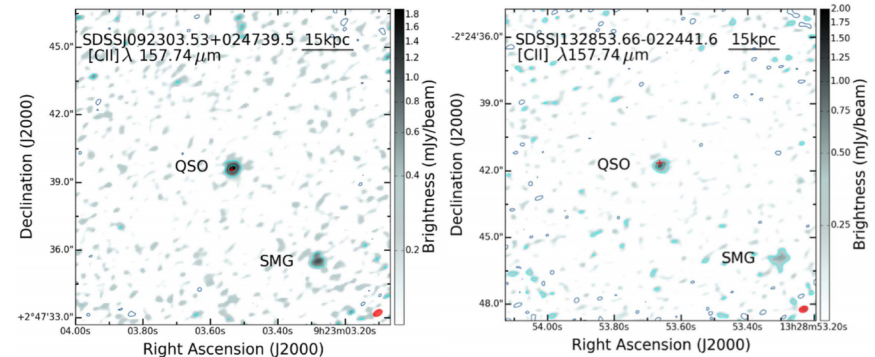
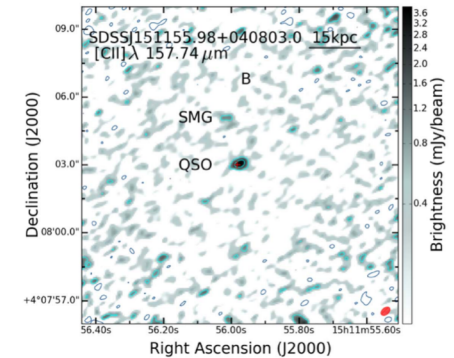
ENVIRONMENT IN HIGH-Z QSOs

- 20+ QSOs at $z \sim > 4$
- Companion galaxies detected in 4 sources, at distances < 600 kpc and velocity offsets < 600 km/s from the quasar.
- Six $z \sim 4.8$ luminous quasars powered by growing SMBHs
- Companion SMGs detected in 3 sources, separated 14-45 kpc from the quasar. SFR $\sim 1/2 - 1/10$ of the main host.



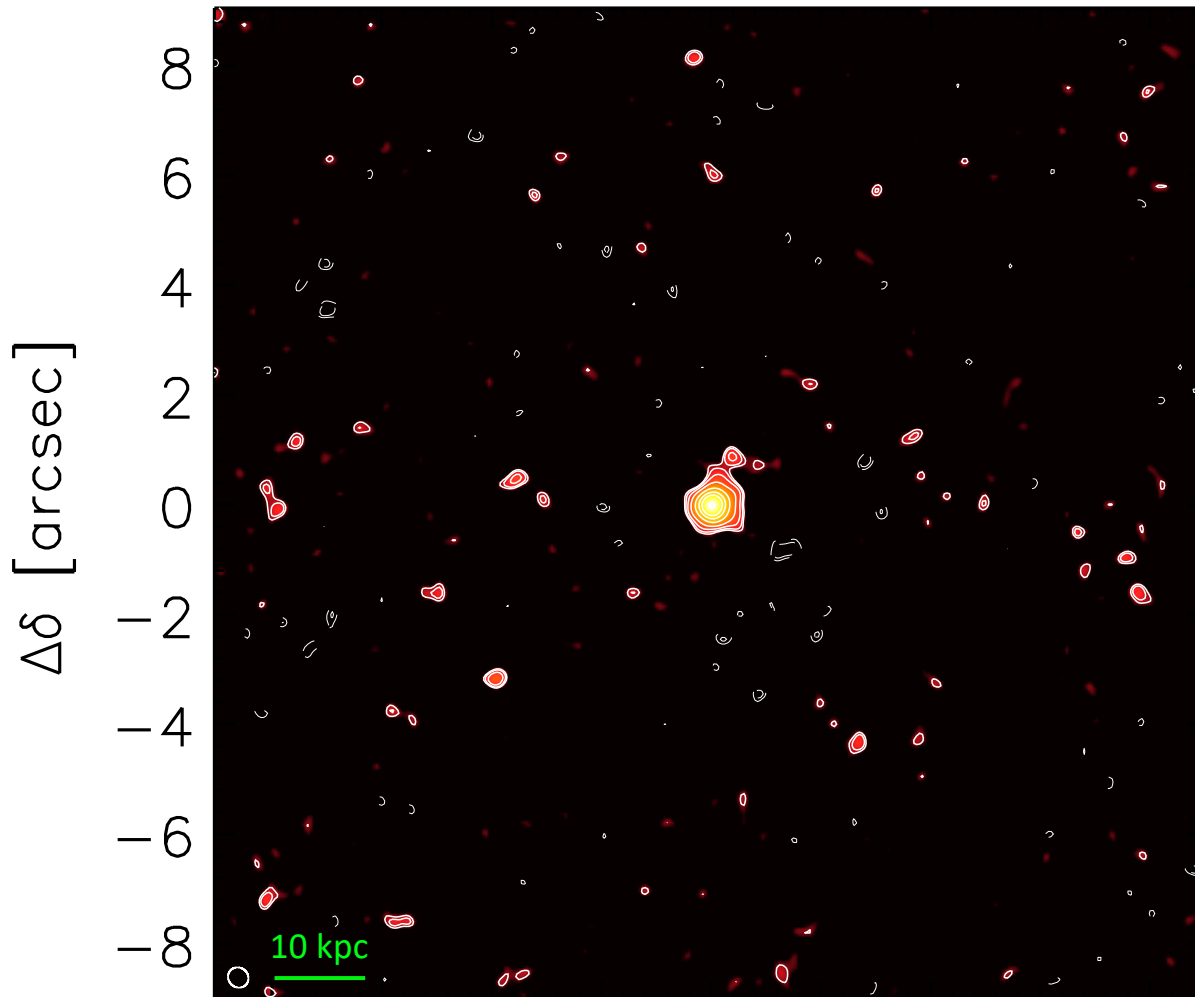
Decarli+2017,2018

Trakhtenbrot+2017



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- 2h on-source observations of the [NII] line and dust continuum at 205 μm .

CONCLUSIONS

- ALMA [CII] and 158 μ m continuum observations of a sample of 7 Hot DOGs, including W2246, the most luminous galaxy known, to study their gas content and kinematics.
- Dust continuum detected in all galaxies, which tends to be compact except for two sources. [CII] detected in 5 out of 7 Hot DOGs. Variety of kinematic properties, from slowly rotating galaxies to complex velocity fields, suggestive of mergers.
- High velocity dispersions of at least 500 km/s in some regions, if not over the entire galaxies. AGN feedback, but also merger driven?