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Characterizing the ISM of the most luminous quasar known and his host

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XIII Estallidos workshop

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Hot Dust Obscured Galaxies

D.M. Alexander+2012

- Identified with WISE as W12drops, Hot DOGs (Eisenhardt+12 & Wu+12) are high redshift galaxies (z>1) highly obscured.

- Very high luminosities ($L_{bol} > 10^{13} L_{\odot}$), high dust temperatures (peaks of >400K) & SFRs (>100 $M_{\odot}$/yr).

WISE 2246-0526

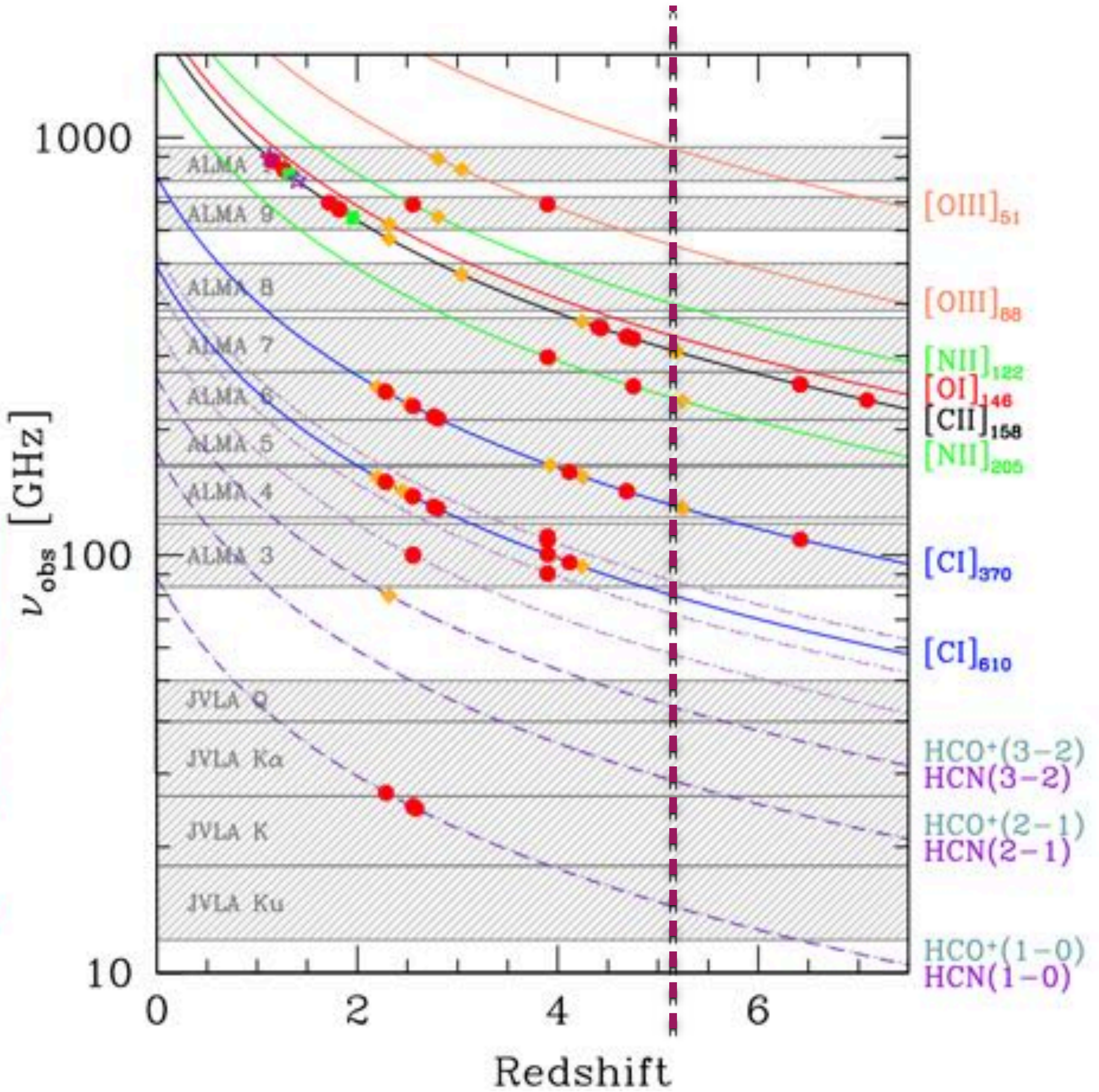
- Most luminous galaxy known.
- 3 galaxy companions detected connected to the host by dusty trails.

Artist rendering of W2246, credit: JPL

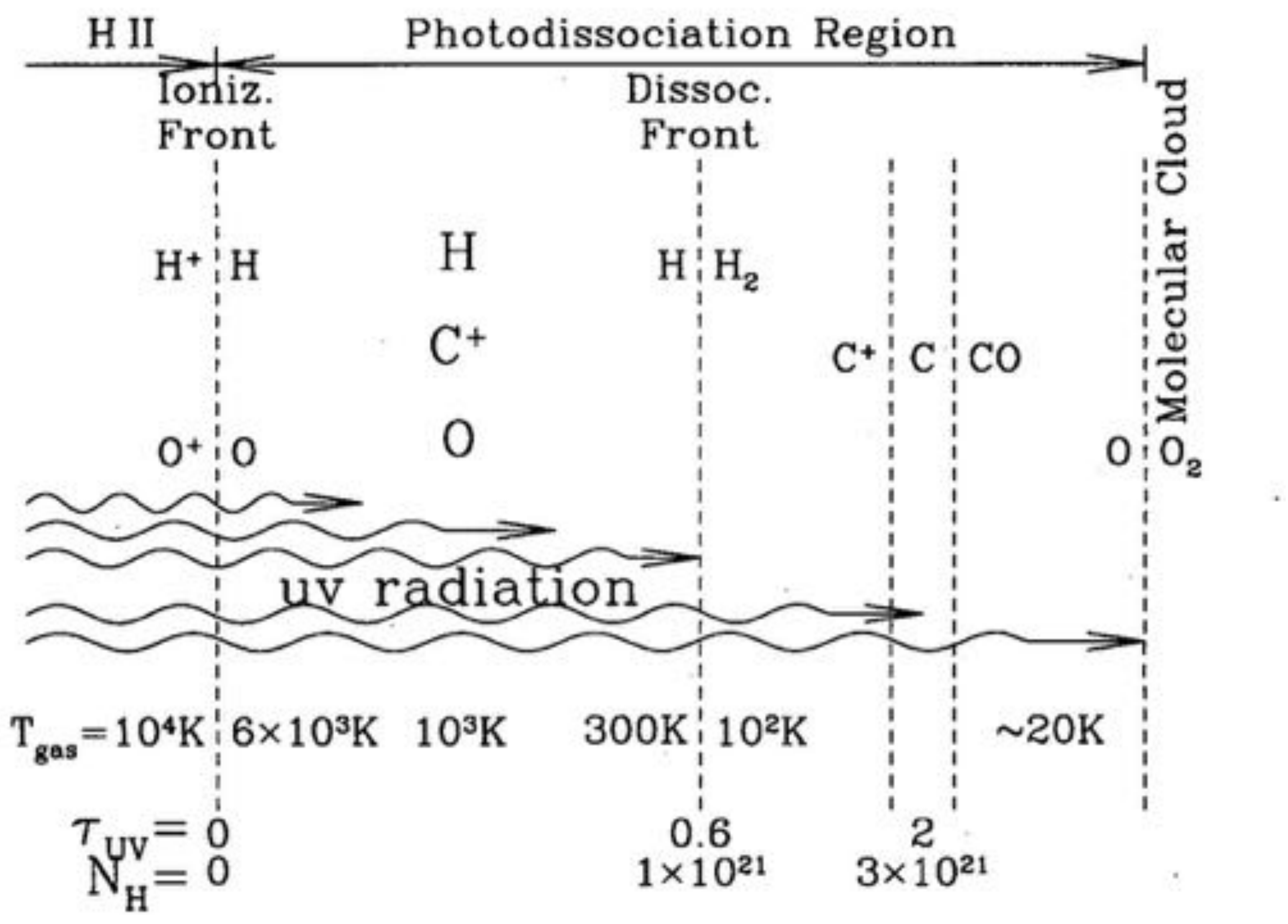
z	L_{IR} $10^{14}L_\odot$	L_{bol} $10^{14}L_\odot$	$M_\bullet$ $10^9 M_\odot$	λ_{Edd}	M_{mol} $10^{10}M_\odot$	$M_\star$ $10^{11}M_\odot$
4.601	2.21	3.6±0.3	$4.0^{+6.0}_{-2.4}$	2.8	1.5±0.8	$3.04^{+2.07}_{-1.34}$
Diaz-Santos+16	*Tsai+15*	*Tsai+18*	*Tsai+18*	*Tsai+18*	*Diaz-Santos+18*	*Diaz-Santos+21*

ALMA data

- Unique dataset of observations of 9 far-IR fine-structure and CO lines with ALMA, tracing the different phases of the ISM.



Carilli & Walter, 2013



https://ay201b.wordpress.com/2011/02/

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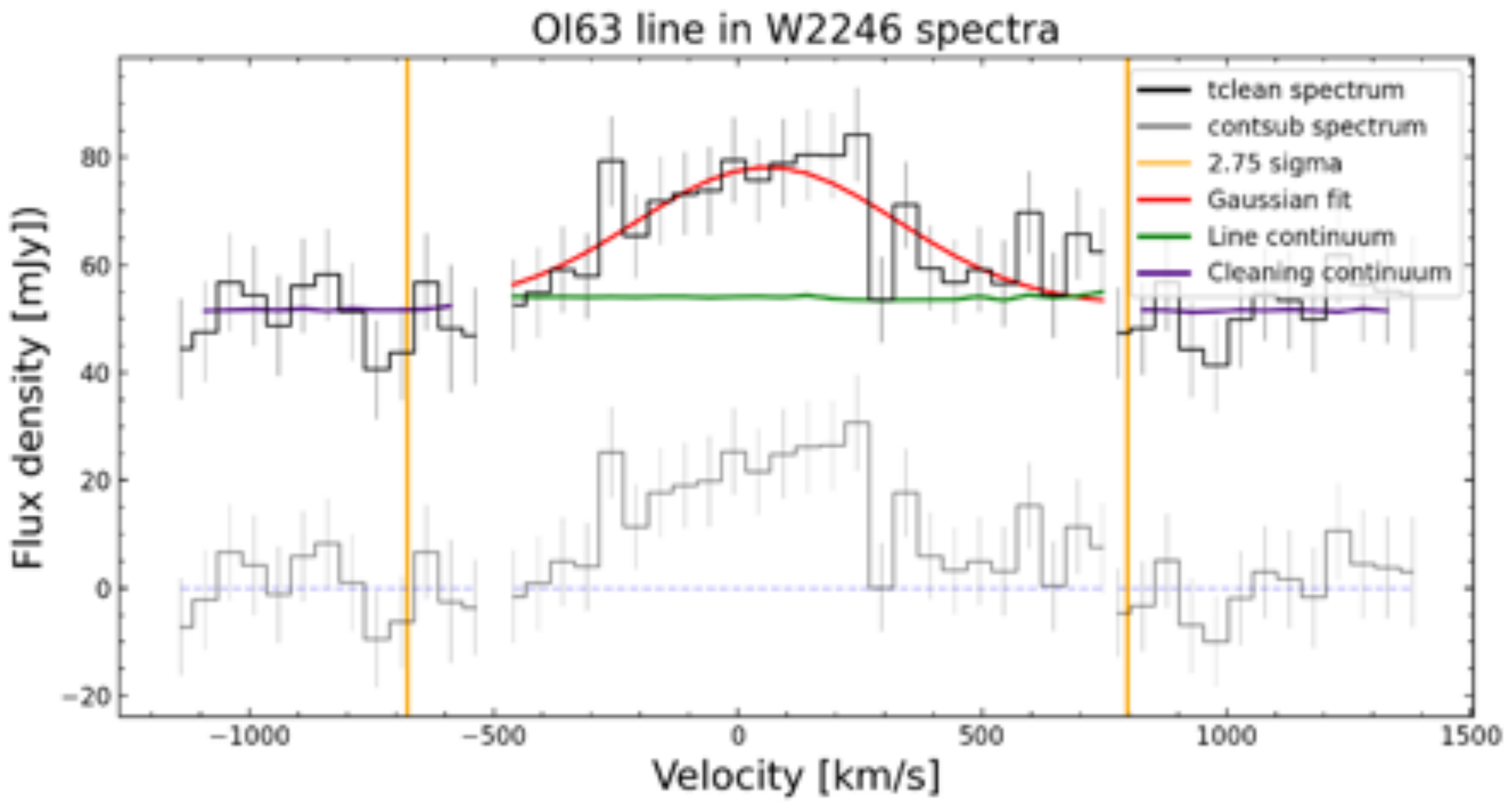
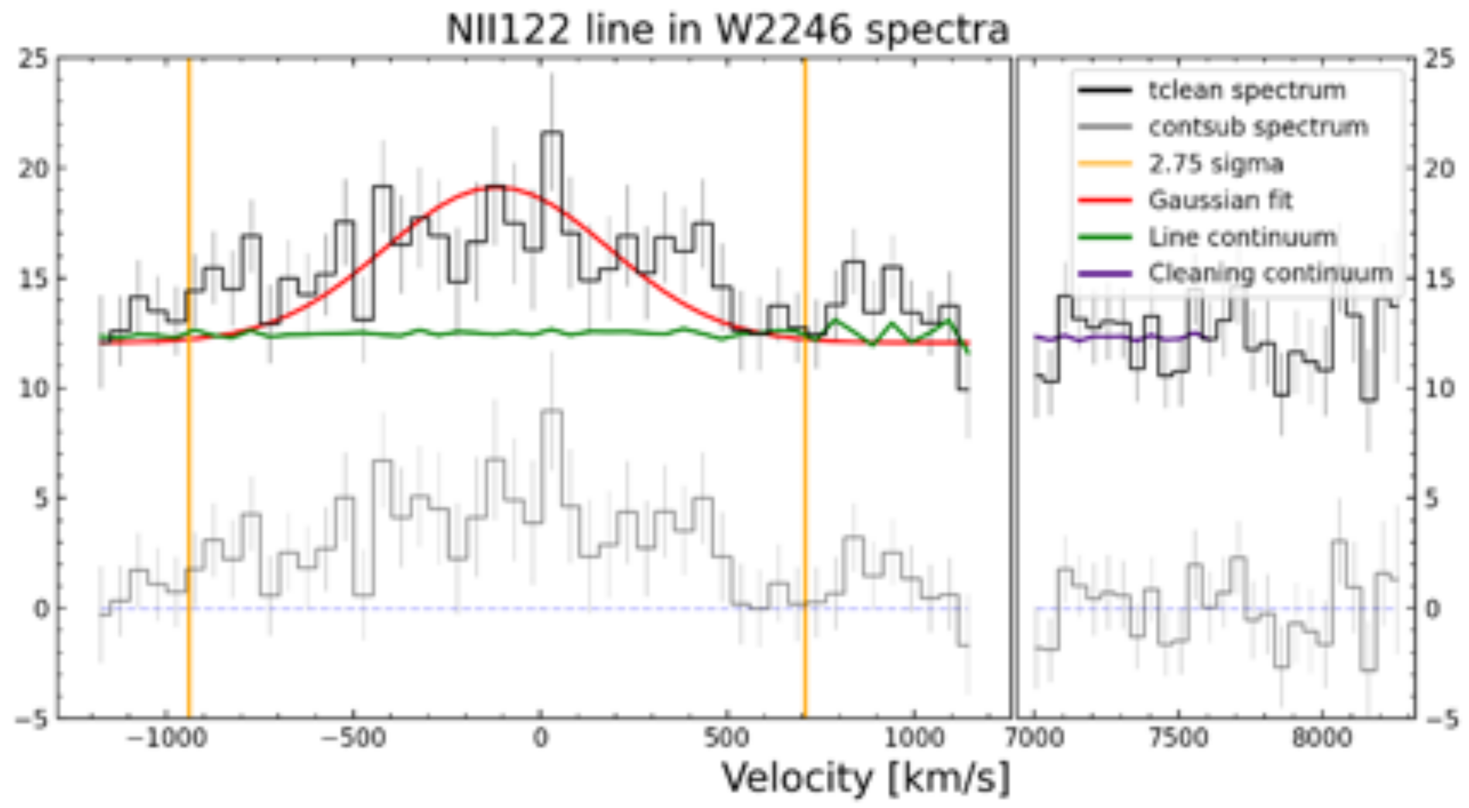
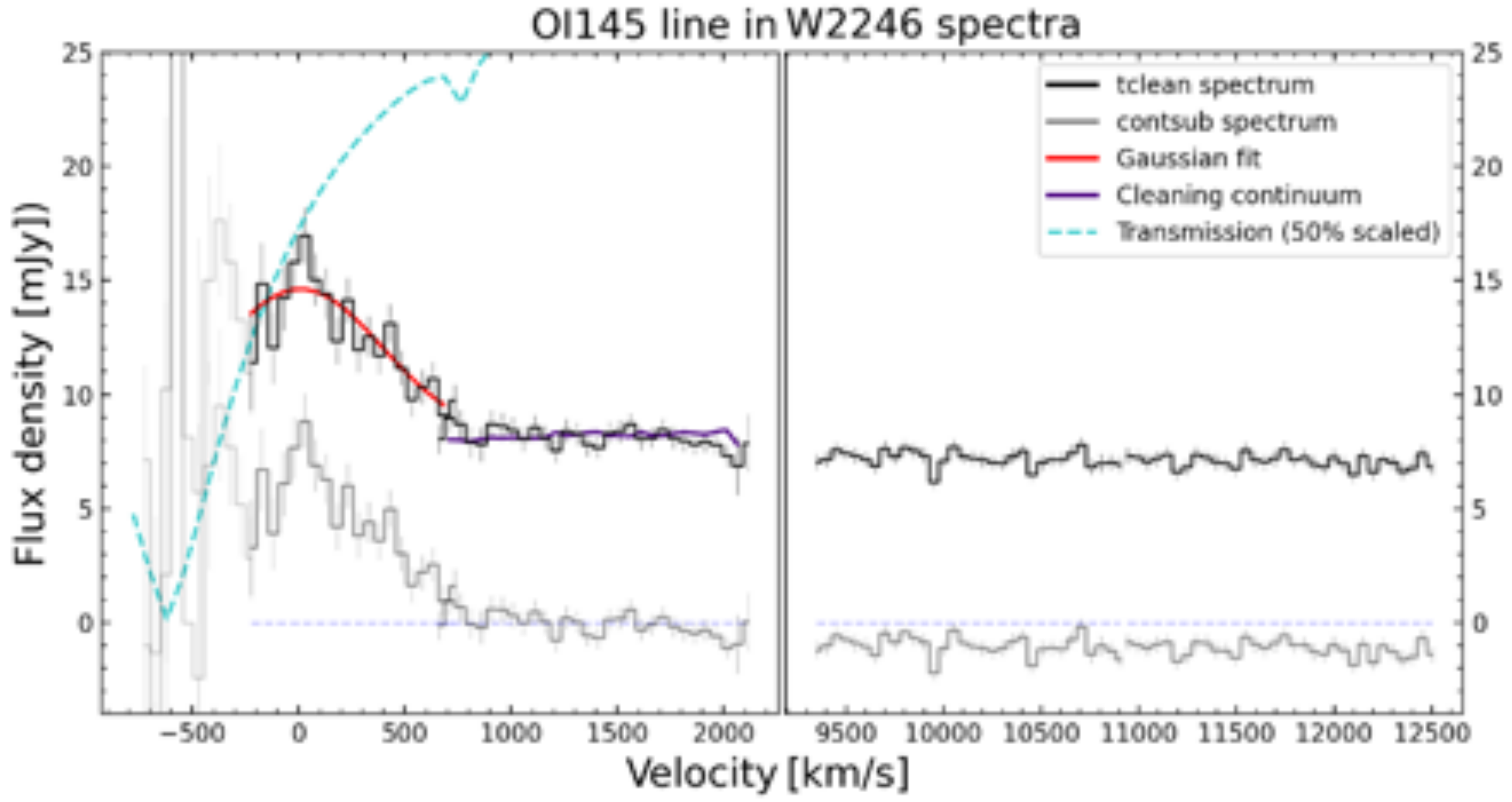
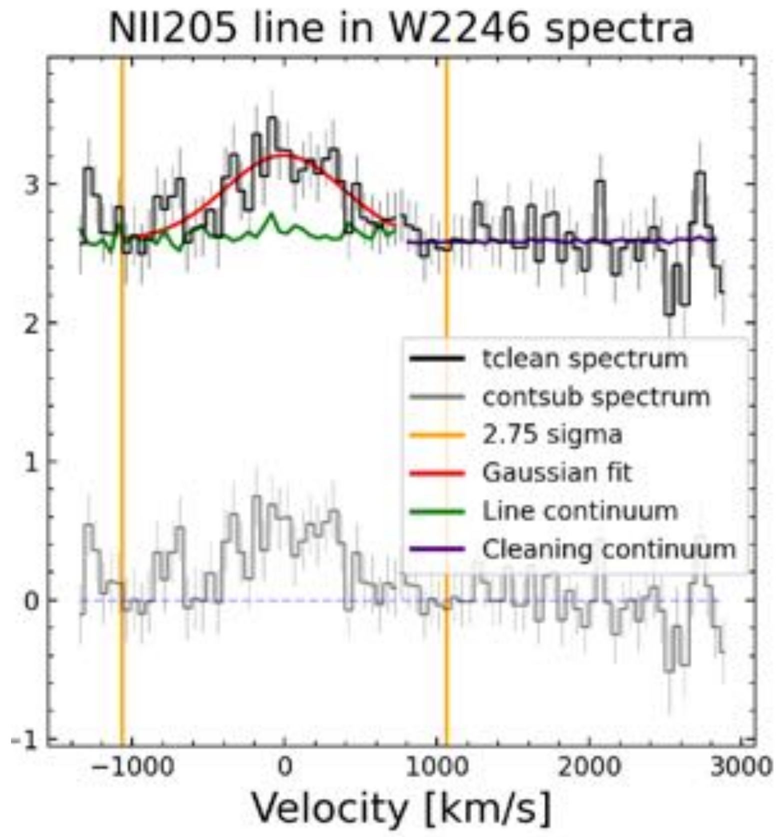
Spectra

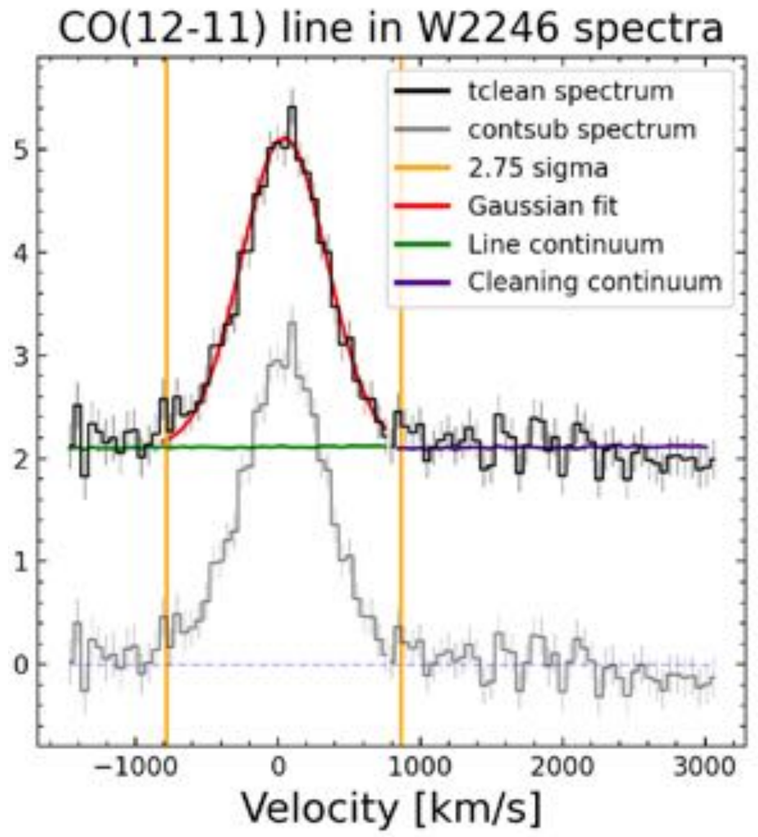




Species	trans.	λ µm	ν GHz	lum. $10^9 L_\odot$	FWHM km/s
[OI]	$^3P_1 \rightarrow ^3P_2$ $^3P_0 \rightarrow ^3P_1$	63.18 145.53	4744.8 2060.1	26.8±3.4 3.36±0.76	634 908
[NII]	$^3P_2 \rightarrow ^3P_1$ $^3P_1 \rightarrow ^3P_0$	121.90 205.18	2459.4 1461.1	4.15±0.50 0.27±0.03	706 909
CO	J=12-11	216.93	1382.0	1.10±0.03	707







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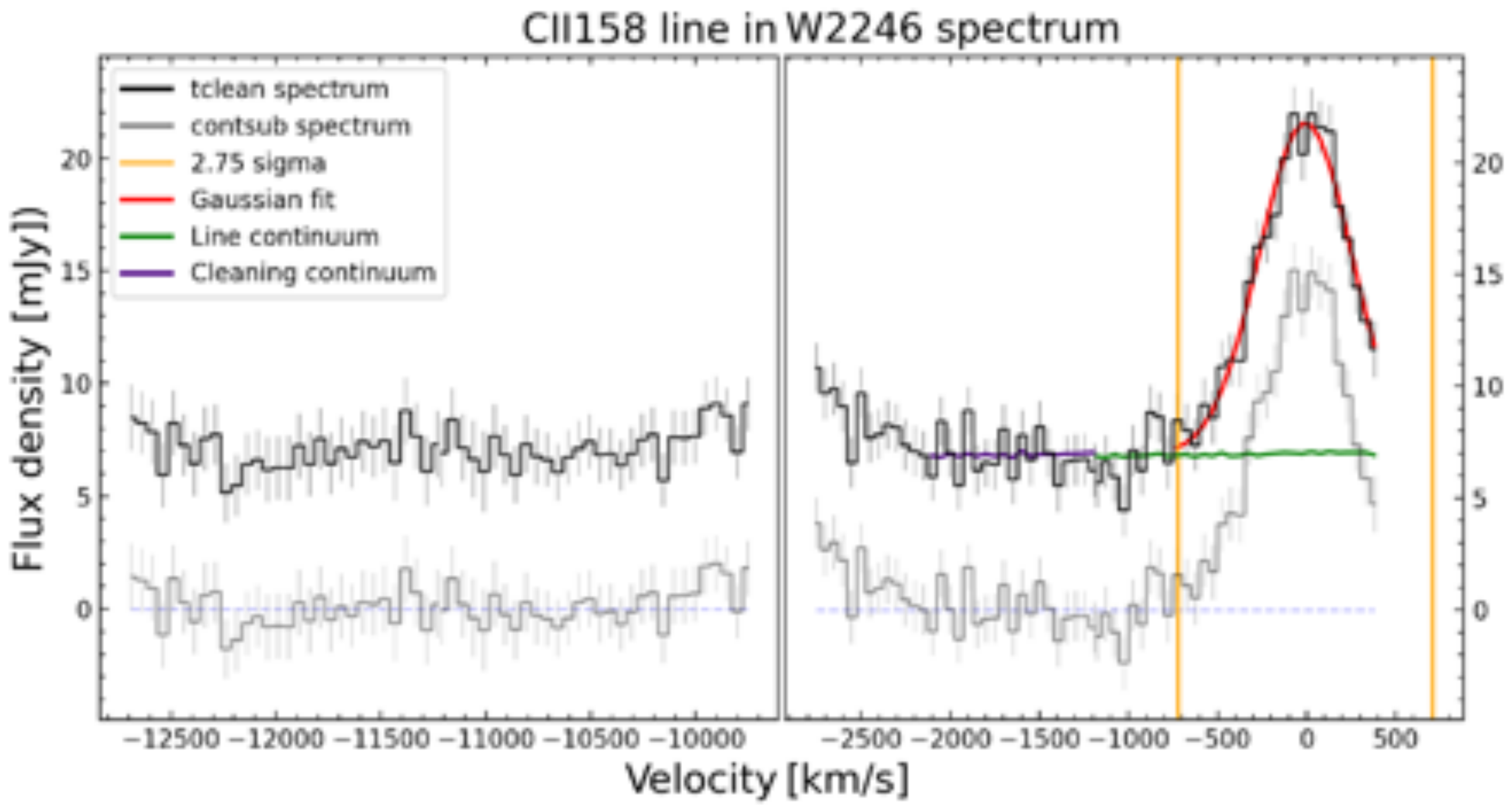
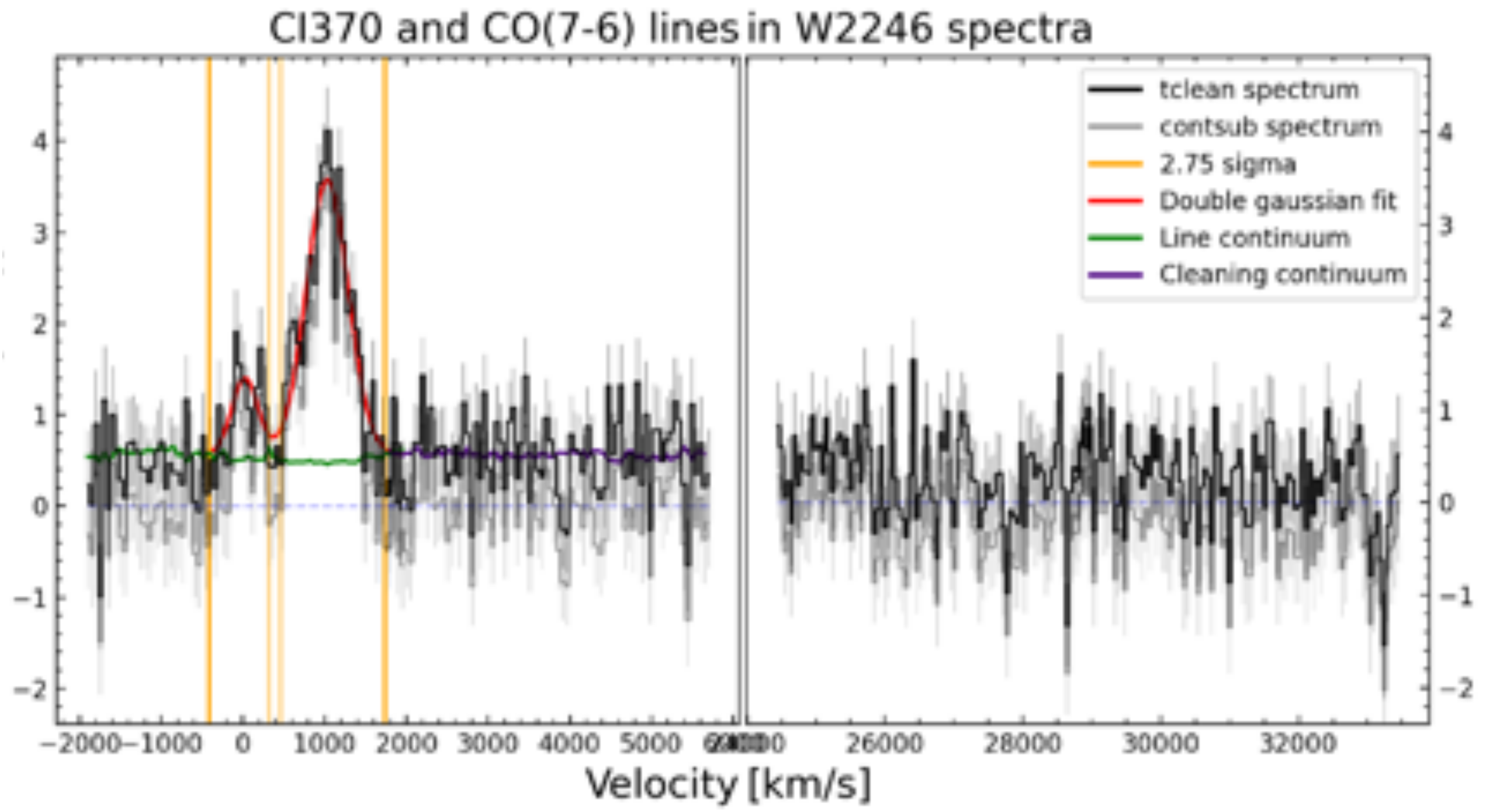
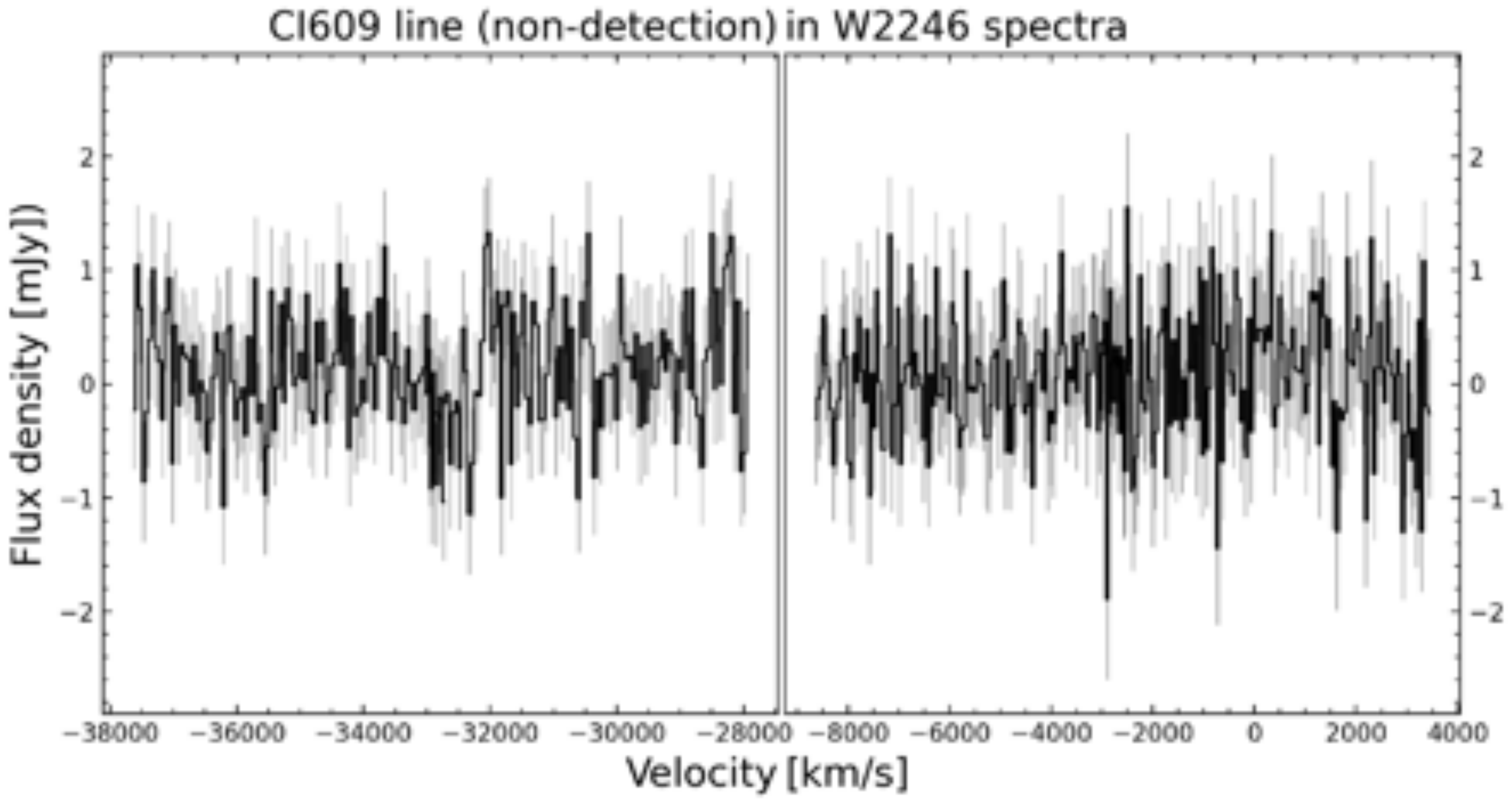
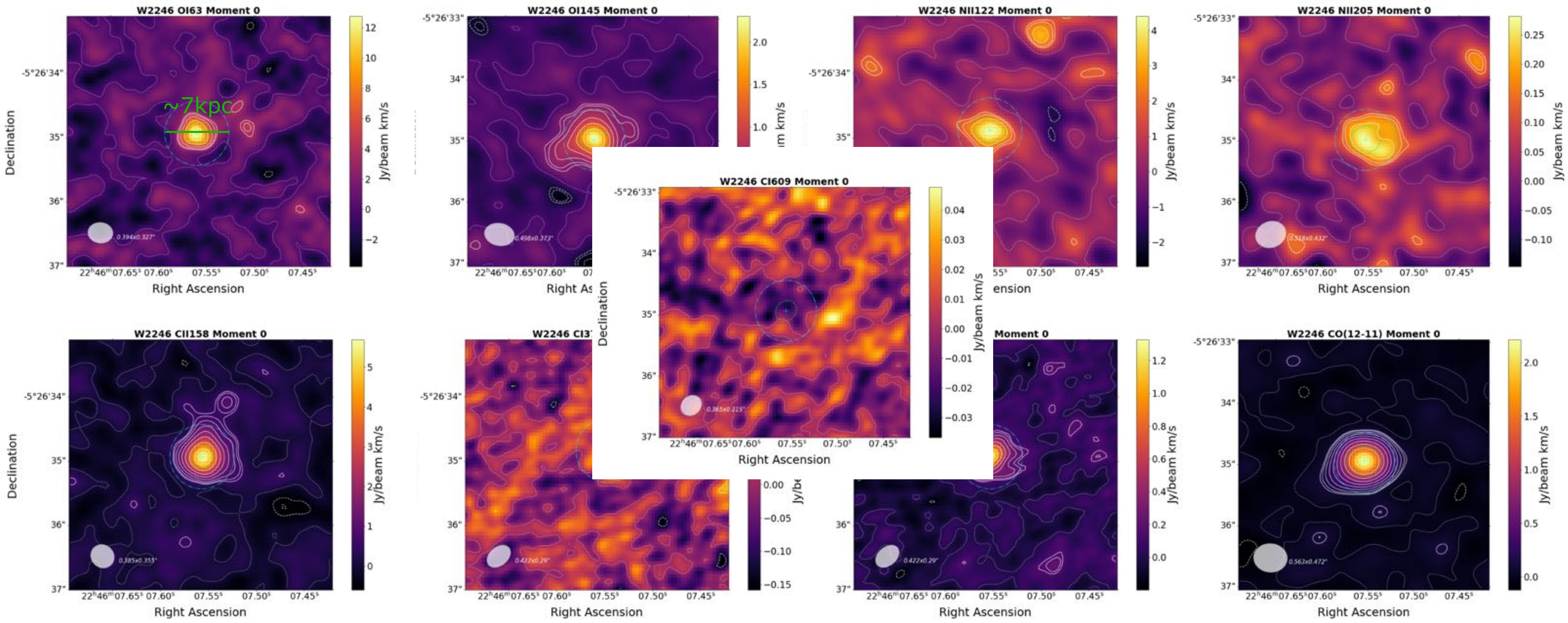




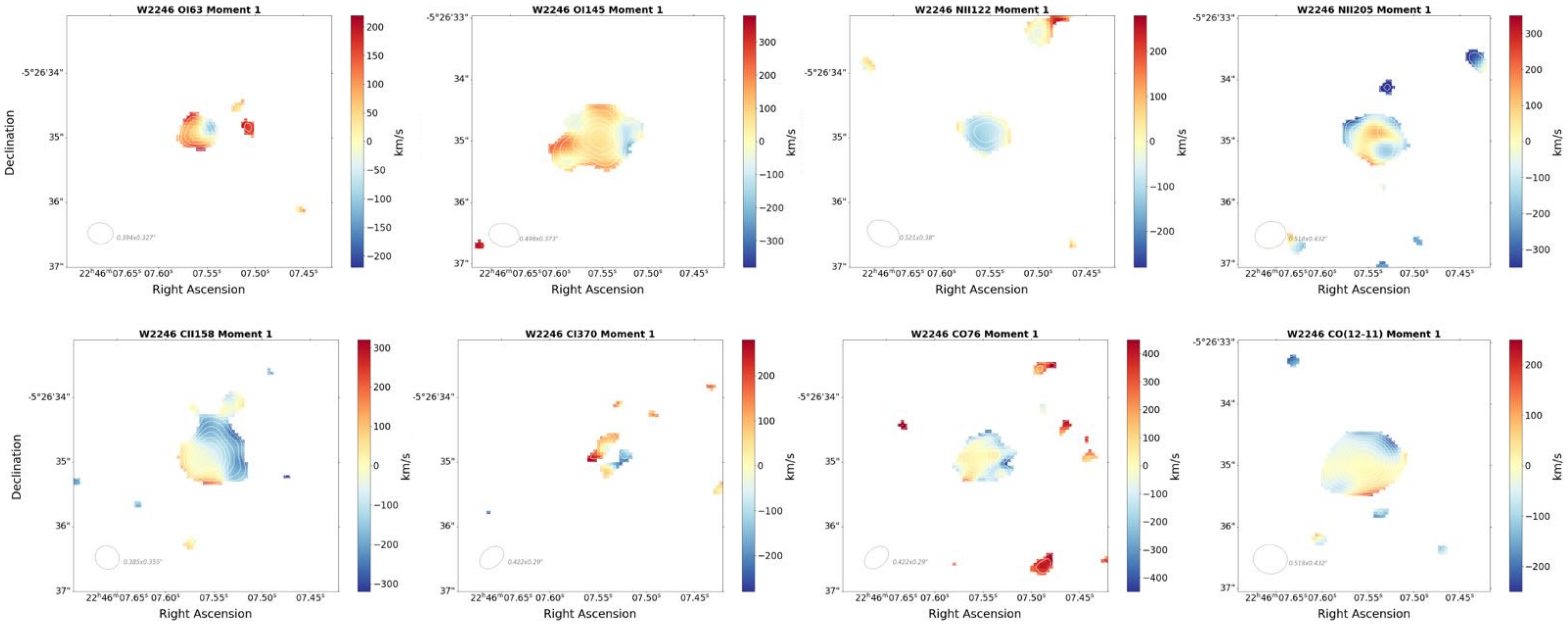


Species	trans.	λ µm	ν GHz	lum. $10^9 L_\odot$	FWHM km/s
[CII]	$^3P_{3/2} \rightarrow {}^3P_{1/2}$	157.74	1900.5	6.33±0.25	611
[CI]	$^3P_2 \rightarrow {}^3P_1$ $^3P_1 \rightarrow {}^3P_0$	370.42 609.14	809.34 492.16	0.09±0.03 <0.03	376 -
CO	**J=7-6**	371.7	806.65	0.53±0.03	605

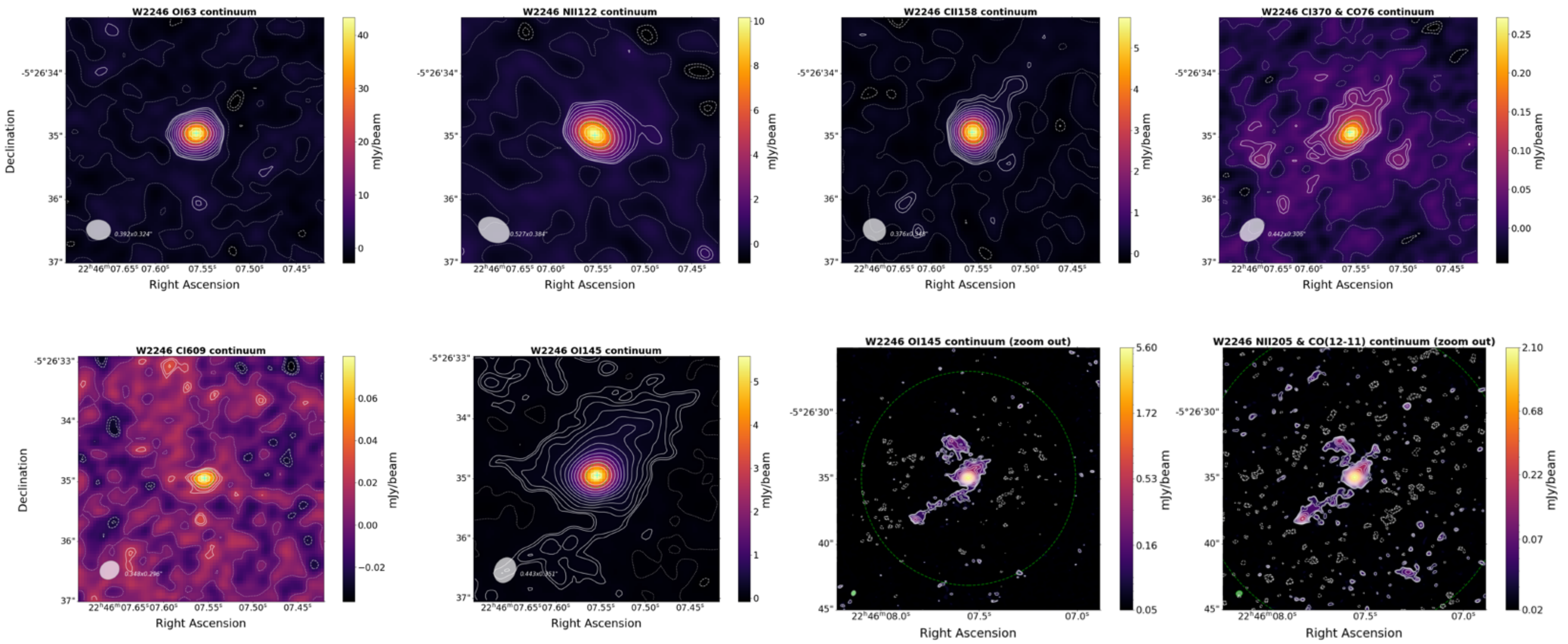
Intensity maps



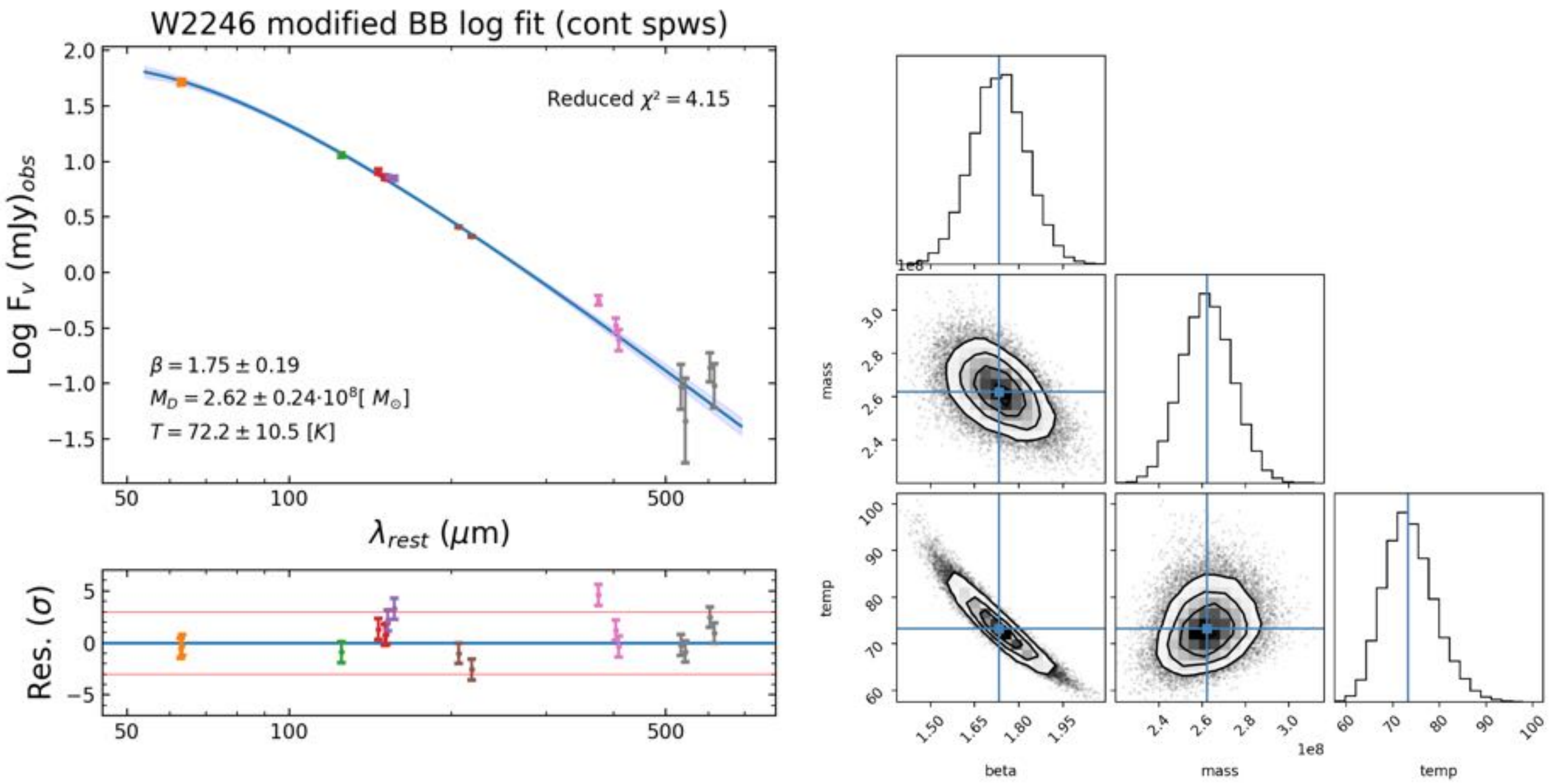
Velocity maps



Continuum maps



Dust (modified BB fitting)

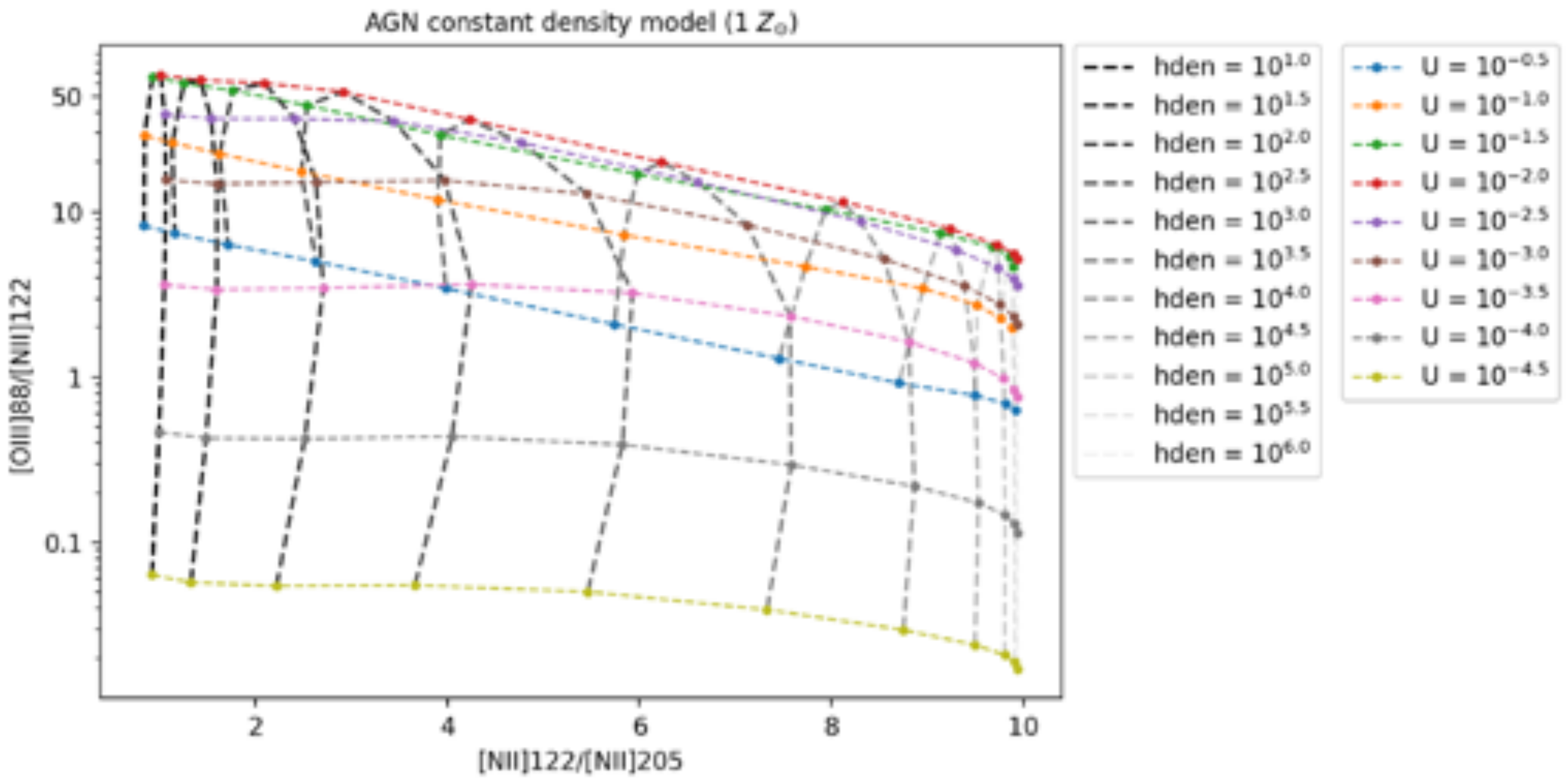


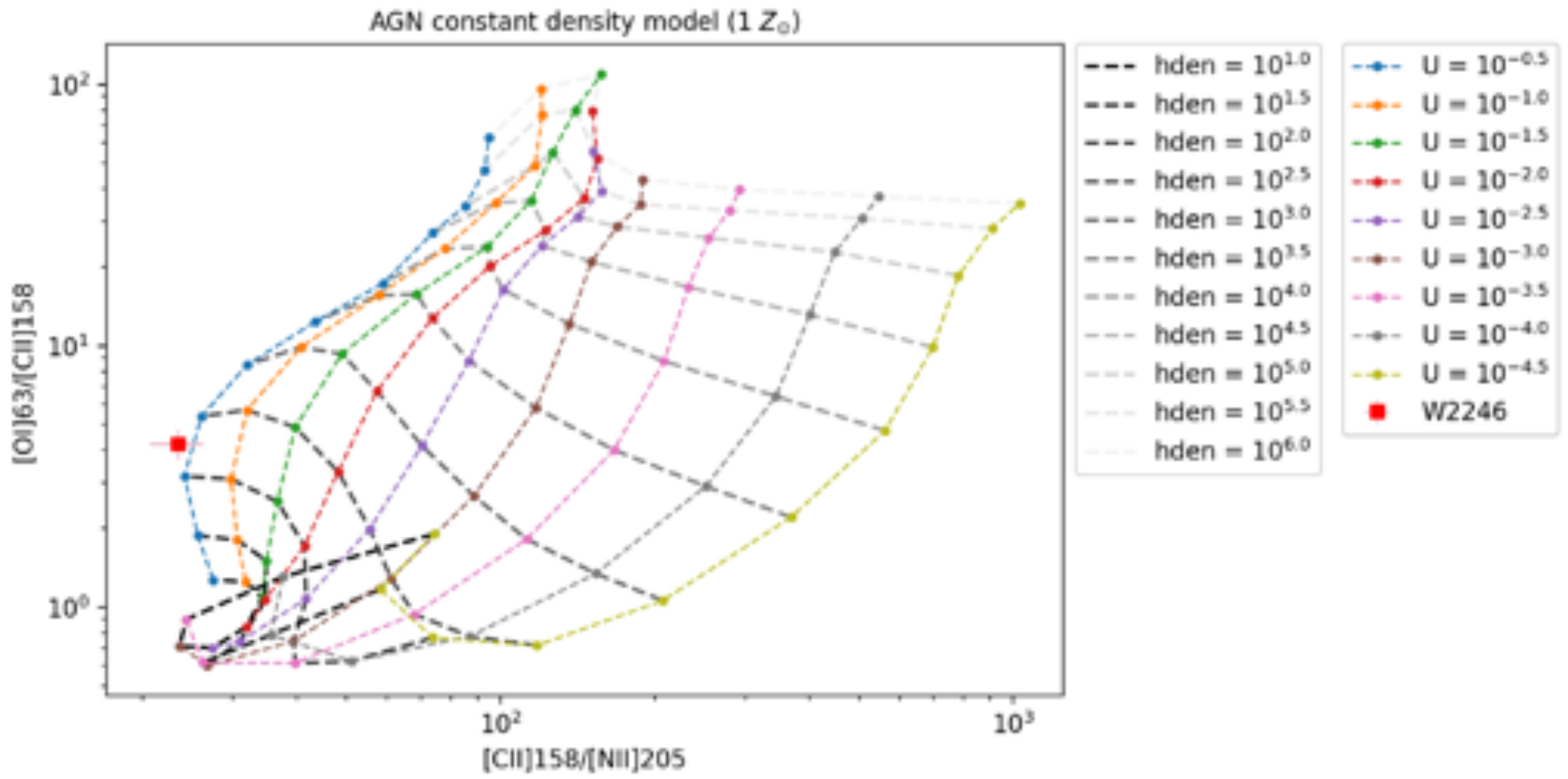
Line ratios

- $[CII]_{158}$ emission from PDRs: $f([CII]^{PDR}) = \frac{[CII]^{PDR}}{[CII]} = 1 - 3\frac{[NII]_{205}}{[CII]_{158}} = 0.86$
- $[NII]_{122/205}$ ratio (15.4±2.5) is extreme!
- $[OI]_{145/63}$ ratio (0.13±0.03) compatible with self-absorption of $[OI]_{63}$ (Ontiveros+16)
- $[CI]_{609/370}$ ratio (<0.3) indicates probable high X-Ray emission and existence of XDRs
- $[OIII]_{88}$ observations will help constraining the ionization and metallicity

Next: CLOUDY

- Model the different ISM phases and try to reproduce the observed line ratios.
- Constrain the gas and dust and the radiation source properties.





Conclusions & questions

- W2246 has a very turbulent ISM (high velocity dispersion). Extreme conditions in the ISM caused by the AGN (high dust temperature, extreme line ratios).
- Need of more observations to characterize the population of Hot DOGs.
- Are HyLIRGs lower counterparts of Hot DOGs?
- Is the Hot DOG phase recurrent or a single event?
- How to fit this Hot DOG phase in the galaxy evolution paradigm?

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