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Summary

To study the dynamical and physical structures of bright rimmed clouds (BRCs) in a nearby HII region, we observed IC1396, which is predominantly excited by an O6.5V star, with (up)GREAT. Our main findings (Okada et al., submitted) include

- Strong [CII] and [OI] emissions inside the BRC of the northern part of IC1396A suggest a clumpy structure to allow the UV radiation to reach the middle of the BRC, while the hot and dense gas traced by C¹⁸O(3-2) and optically thick [OI] 63μm likely shields the UV radiation in the southern part.
- The peak velocity of [CII] is blueshifted compared to ¹³CO(3-2) and C¹⁸O(3-2) in IC1396A, indicating gas blown off from the rim to the back side of the BRC. We do not find any sign of photoevaporating flows.
- The [¹³CII] analysis in IC1396A gives no evidence that the [CII] emission has significant optical depth.
- The optically thin [OI] 145μm emission line at selected positions in IC1396A confirms that the apparent shift in the peak velocity of [OI] 63μm relative to CO lines is due to self-absorption.

Observations

SOFIA/(up)GREAT (Heyminck et al. 2012, Risacher et al., 2018)

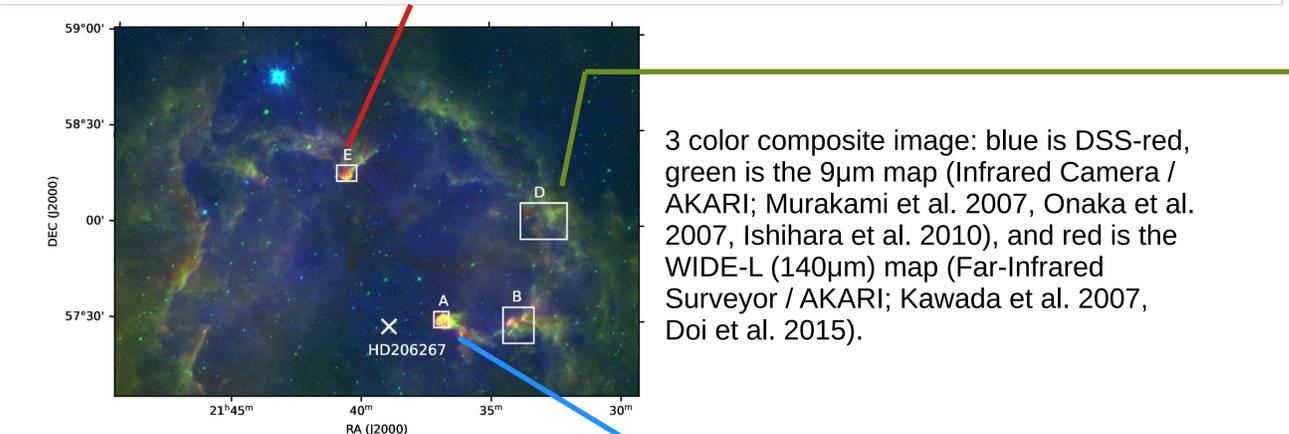
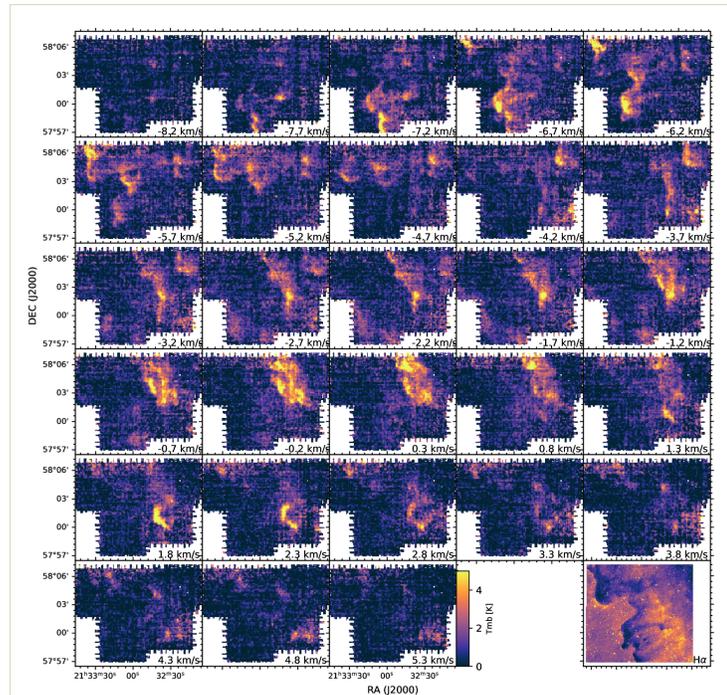
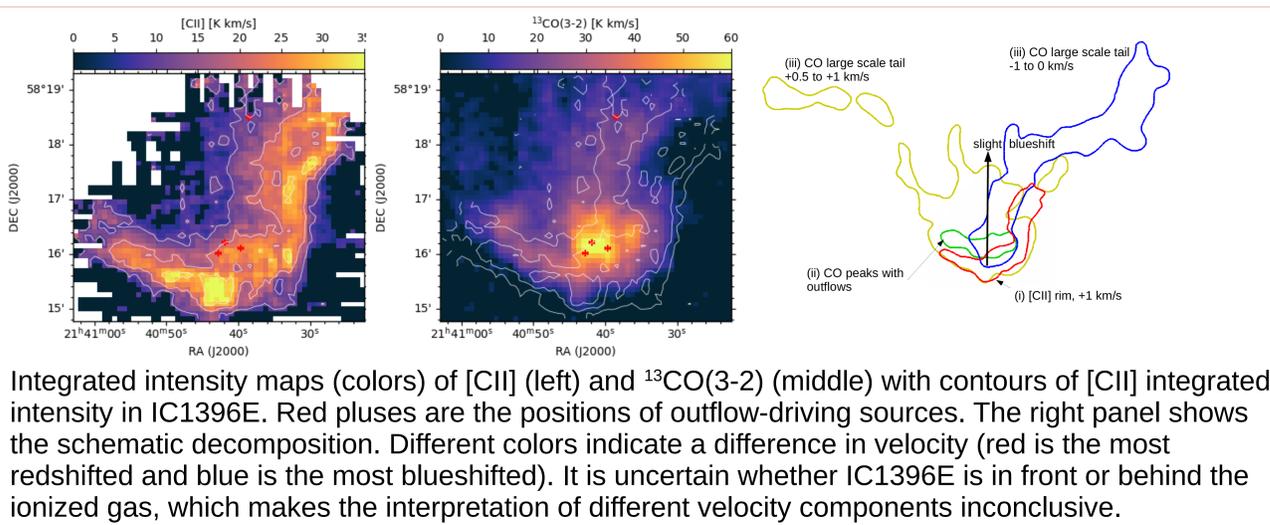
- A long term guaranteed time key program
- [CII]: IC1396A, B, D, E
- [OI] 63μm: IC1396A
- [OI] 145μm: IC1396A

JCMT HARP (data archive)

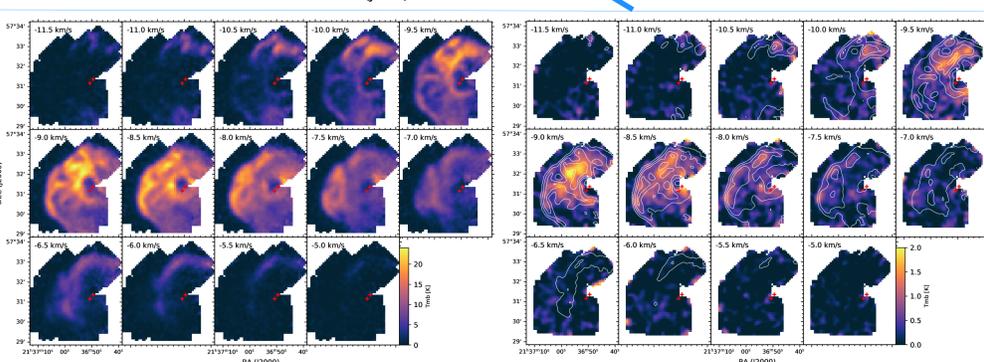
- CO(3-2): IC1396A, B, D, E
- ¹³CO(3-2): IC1396A, D, E
- C¹⁸O(3-2): IC1396A, E

All spectra are convolved to the 16'' resolution.

Selected results

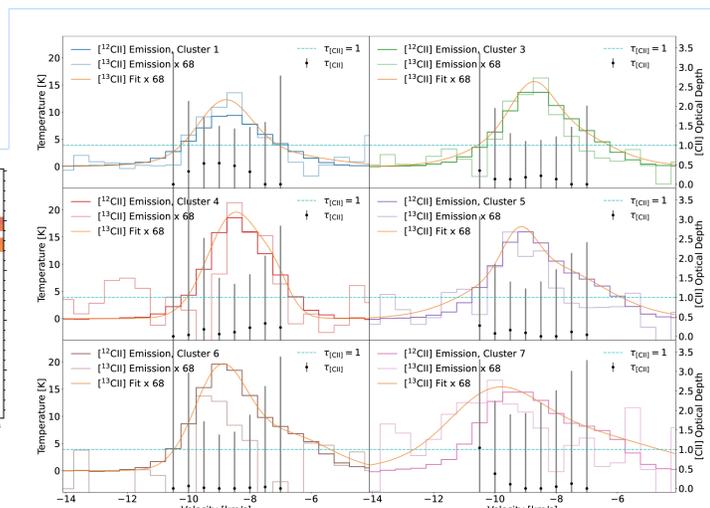
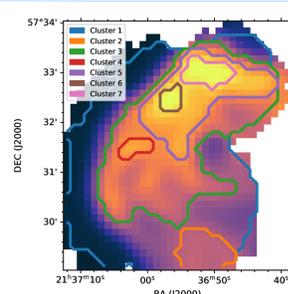


Channel maps of [CII] in IC1396D. The right bottom panel shows the H α image (2.5-m Isaac Newton Telescope; Barentsen et al. 2014). It shows a complex structure with multiple velocity components, likely located separately along the line of sight.



(Left) The schematic decomposition of IC1396A. Different colors indicate a difference in velocity (red is the most redshifted and blue is the most blueshifted).

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(Left) 2D dendrogram clusters on the [CII] integrated intensity map in IC1396A. (Right) Averaged spectra in each dendrogram cluster. Colored stepped data are the [CII] spectra (thick) and the combined and scaled [¹³CII] spectra (thin). Orange curve is the fit to the [¹³CII], and derived optical depths of [CII] are shown as black data points with errorbars. The optical depth does not significantly affect the interpretation of the observed [CII] emission in IC1396A.

Outlook

We are working on applying the kosmatau3d PDR model (Andree-Labsch et al. 2017, Yanitski 2023) to the line and continuum emissions in IC1396A in order to derive the physical properties. kosmatau3d, based on the clumpy KOSMA- τ PDR model, treats the radiative transfer between clumps properly and allows us to compare the observed velocity profile of individual lines.

References

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