Hot Gas in the Nuclear Region of IC 342

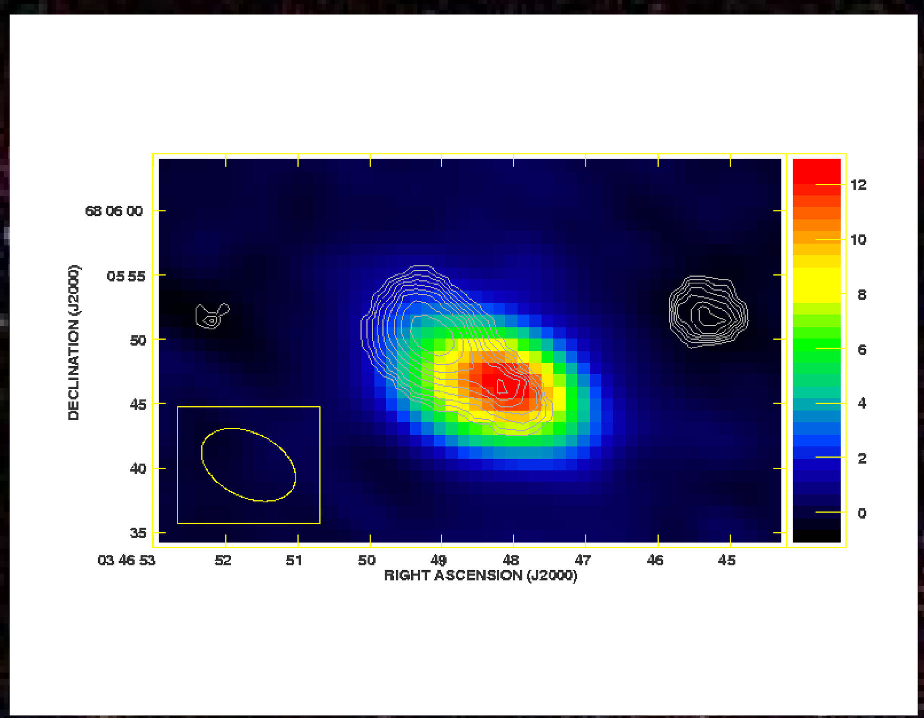
María Montero-Castaño[1,2], Paul T.P. Ho[1], Chao-Wei Tsai[3], David S. Meier[4] and Jean L. Turner[3]

[1] Harvard – Smithsonian Center for Astrophysics, 60 Garden St, Cambridge, MA 02138, USA.
[2] Departamento de Astrofísica, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040-Madrid, Spain.
[3] Department of Physics and Astronomy, UCLA, Los Angeles, CA 90095-1562, USA.
[4] Department of Astronomy, University of Illinois, Urbana-Champaign, 1002 Green St., Urbana, IL 61801, USA.

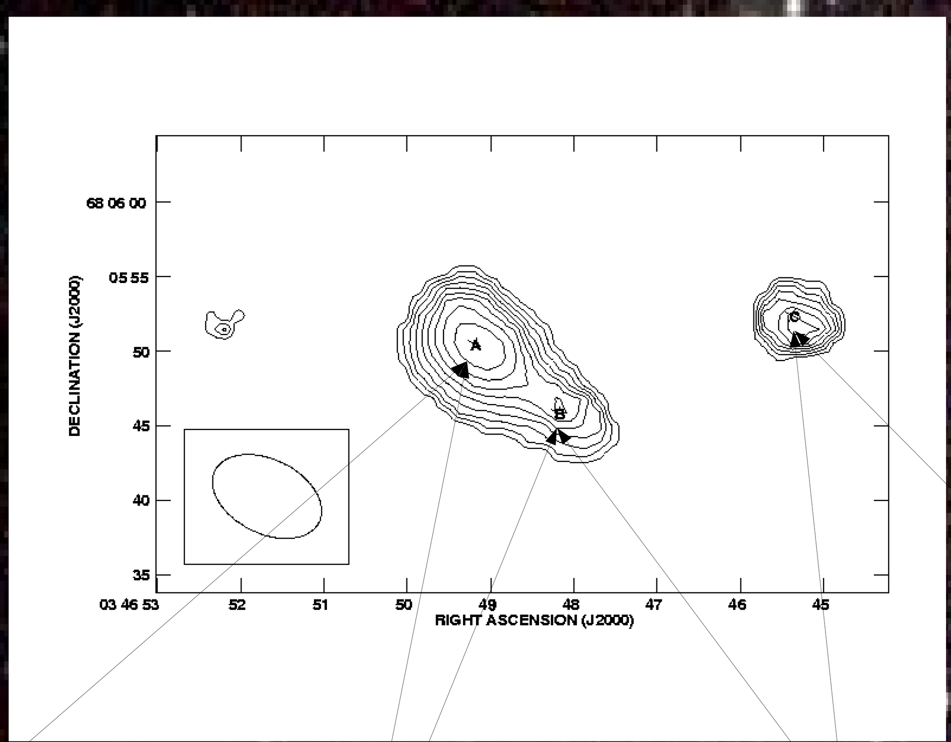
IC 342 is one of the closest galaxies to the Milky Way and, at the same time, the most similar to it, as it is a late-type galaxy with a nuclear cluster formed 60 Myr ago. The properties of the molecular clouds found in IC 342 and the infrared luminosity are very similar to those in the Milky Way. IC 342 is a very rich source of molecular emission due to its face-on position. Also, as many galaxies studied lately, it shows a high concentration of molecular gas within the inner 1kpc. The largest quantity of gas is within 250pc from the nucleus, with a small starburst in the center. Previous studies have shown that the morphology of the nucleus of IC 342 is dominated by the presence of a S-shaped bar (known as mini-spiral) that ends in a central ring composed by dense gas. Giant molecular clouds, GMCs, (composed by several smaller clouds) are concentrated along the axis of the bar. Gaseous material moves along the bar towards the center, accumulating where the bar meets the ring and triggering star formation at that position.

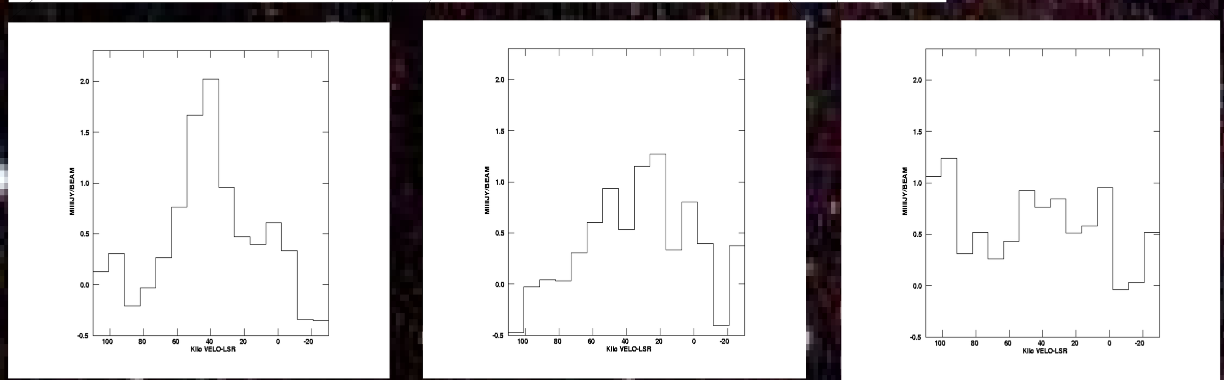
We present the first Very Large Array (VLA) and SubMillimeter Array (SMA) molecular observations of I C342 in the high-temperature gas tracers NH_3(6,6) and CO(3-2), respectively. The maps show two different peaks, one of which coincides with the continuum emission peak. We have compared these results with studies in different molecular lines. The two peaks are located in the same positions of what have been called GMC B and GMC C.

We present the first VLA observations ever taken of IC 342 in NH_3(6,6). The source was observed in February 2003, using the D configuration. The contours represent the line emission, and the colour scale the continuum emission. We observe two different peaks in the central condensation, and when comparing the line emission with the continuum emission, we find that the weakest peak in the emission line coincides with the continuum emission peak.

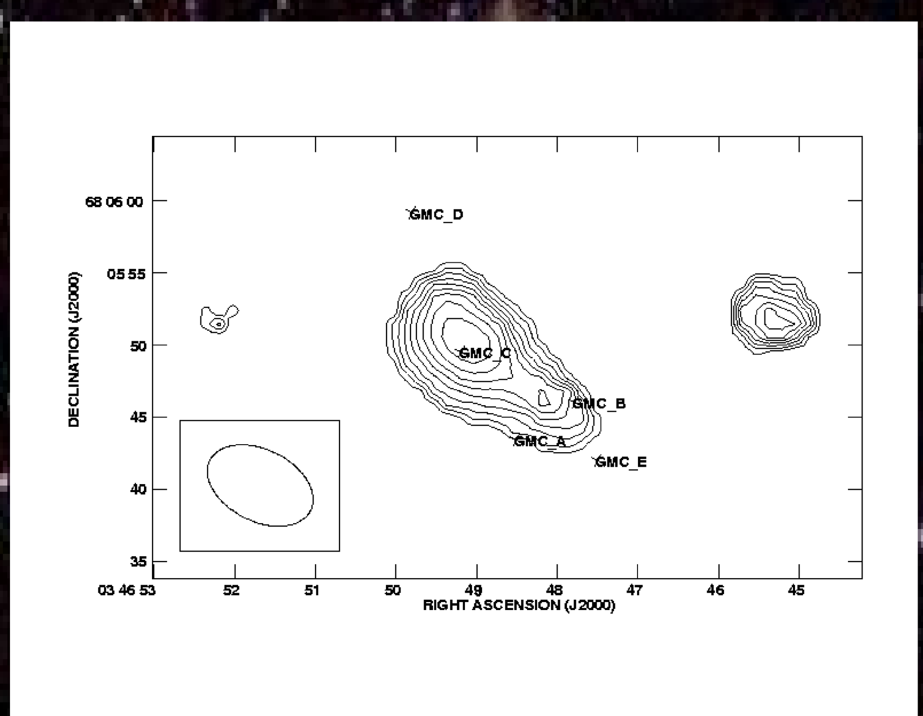


The spectra that we extract from the two central peaks, together with the other feature found on the west side, are plotted below. The third structure has a very broad emission. It is very extended along the velocity axis. We have not detected a counterpart in any of the other molecular lines we have used for comparison.

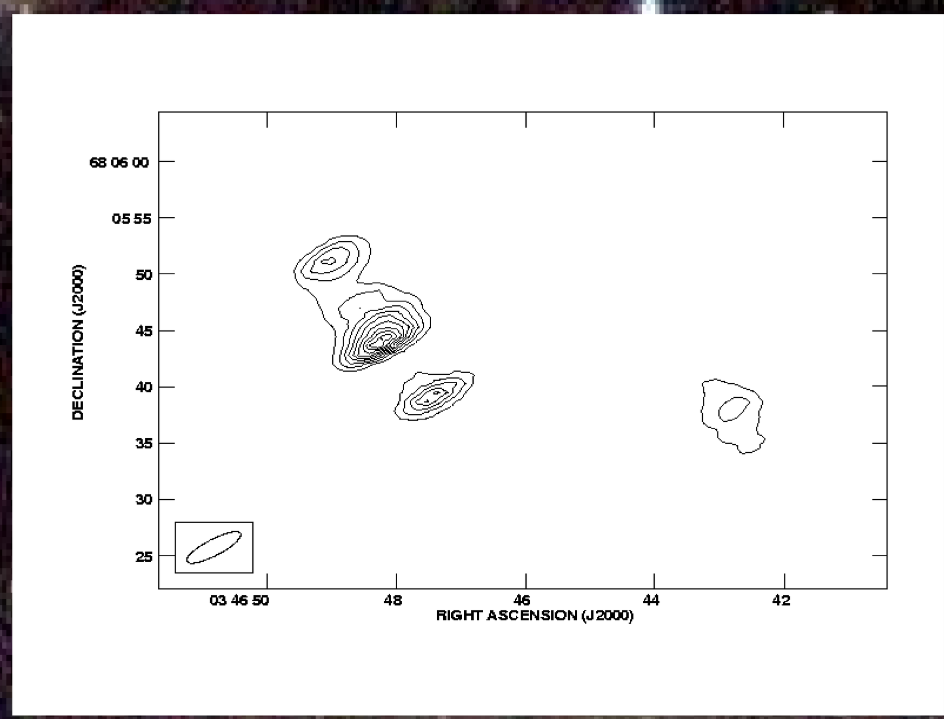




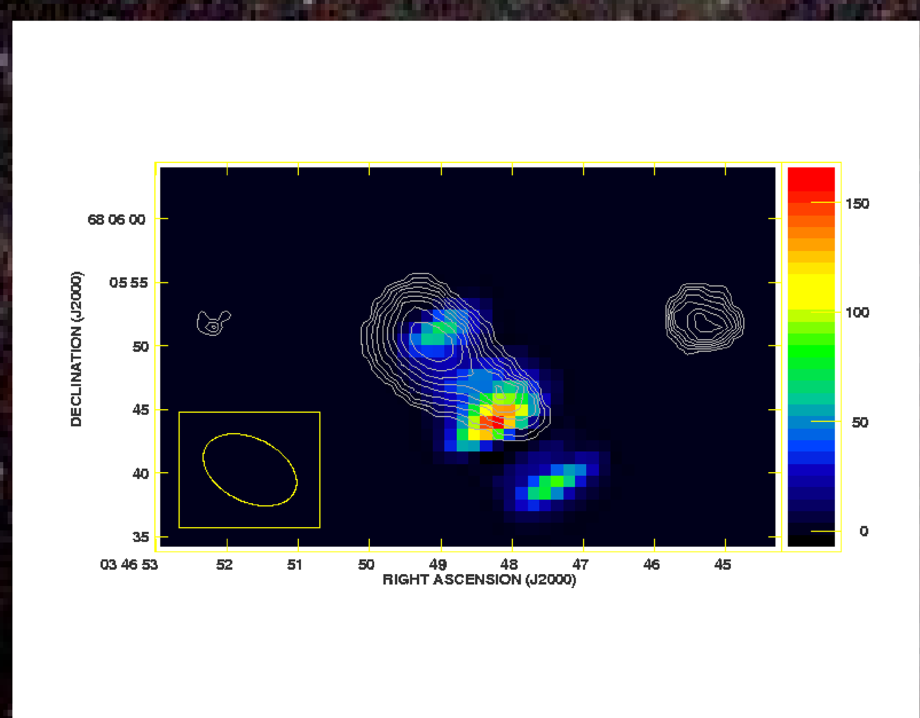
We plot the positions of the 5 giant molecular clouds as described by Downes et al. (1992). We observe that the line emission peak coincides with GMC C, whereas the continuum emission peak is quite close to GMC B, and not too far from GMC A. Both GMC B and C have been described as regions with strong star formation, much stronger than the other three GMCs. Therefore, we can conclude that NH_3(6,6) is a good star formation tracer.



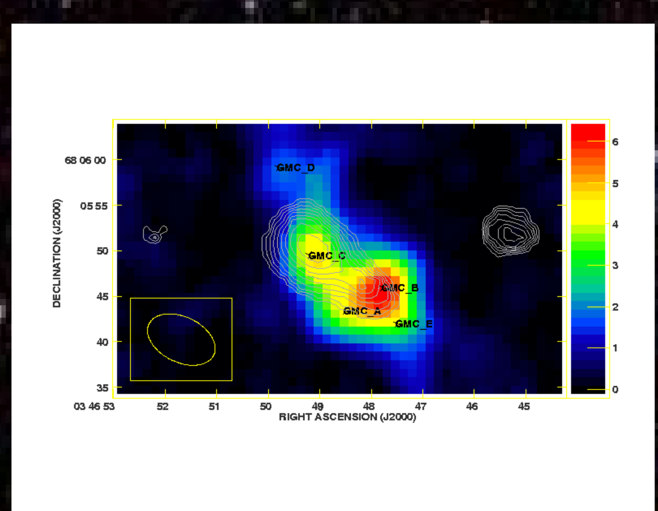
We have also detected CO(3-2) emission from IC 342 using the SMA. We observe several peaks as well in this line.

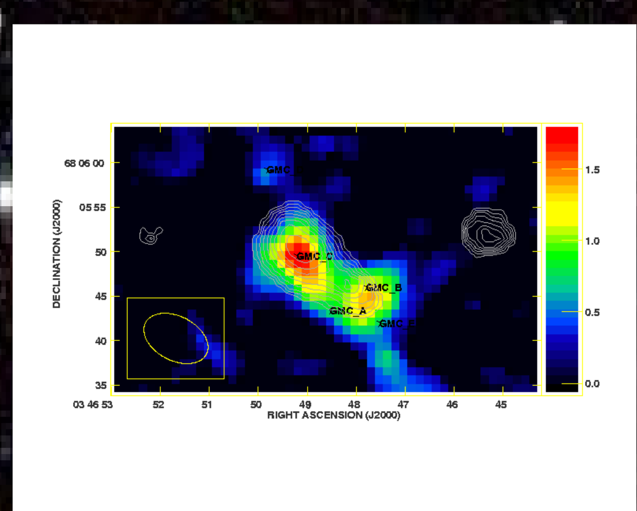


Comparing the CO(3-2) data with the NH_3(6,6) ones, we observe that two of the emission peaks do coincide. The strongest peak in CO(3-2) coincides with the continuum, whereas it is exactly the opposite for NH_3(6,6).

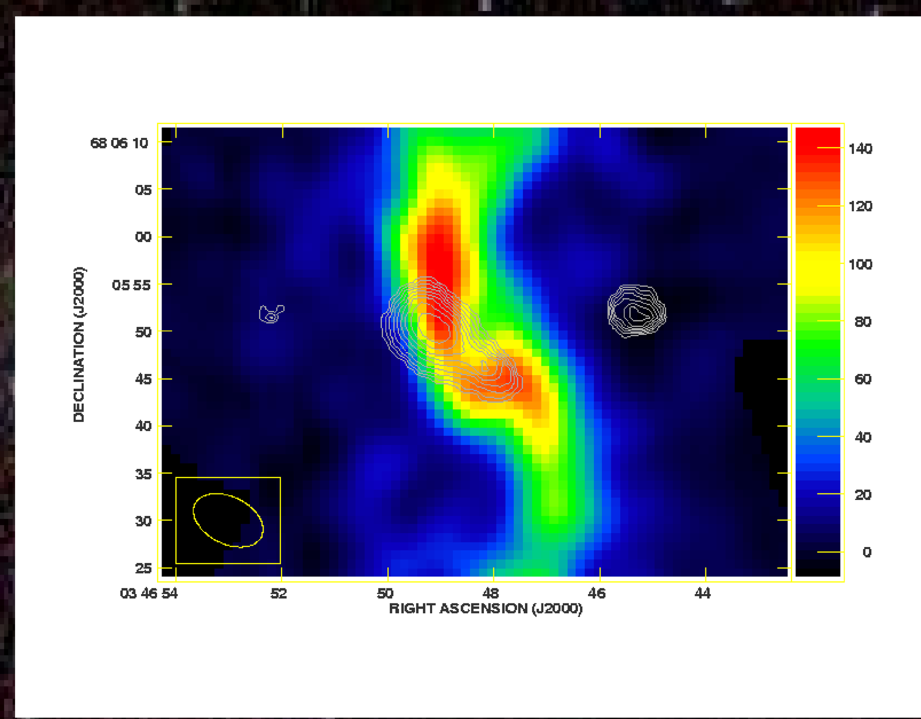


We compare the NH_3(6,6) (contours) with other interferometric results. We start with recent maps by Meier & Turner (2004) in HNC(1-0) (left) and HC_3N(10-9) (right) (both in colours). We have also plotted the GMCs positions. We observe that the HNC(1-0) map has a similar behaviour to the CO(3-2) map, whereas the HC_3N(10-9) behaves like the NH_3(6,6), showing a stronger emission where GMC C is located.

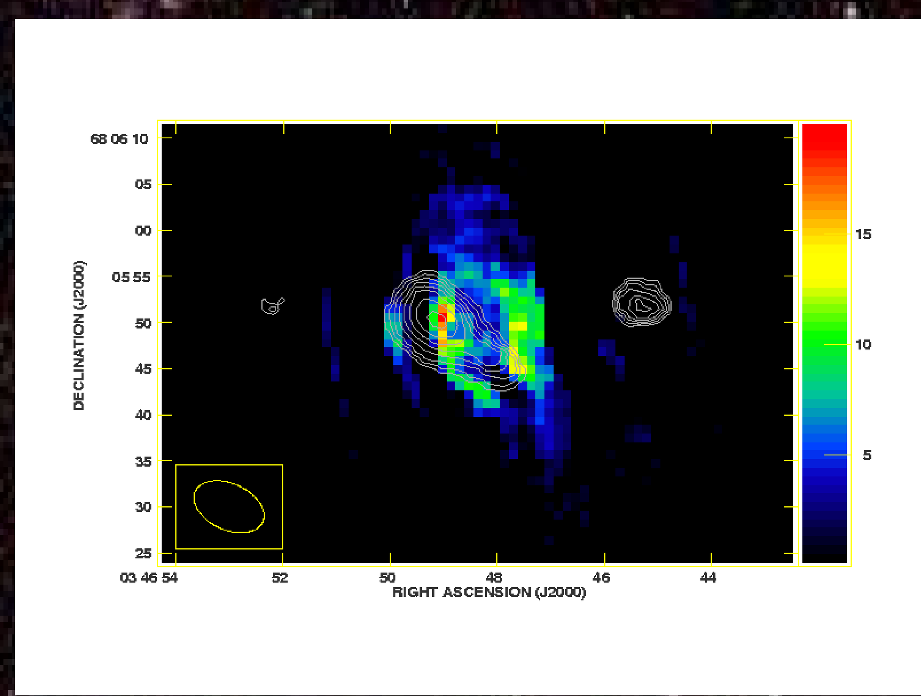




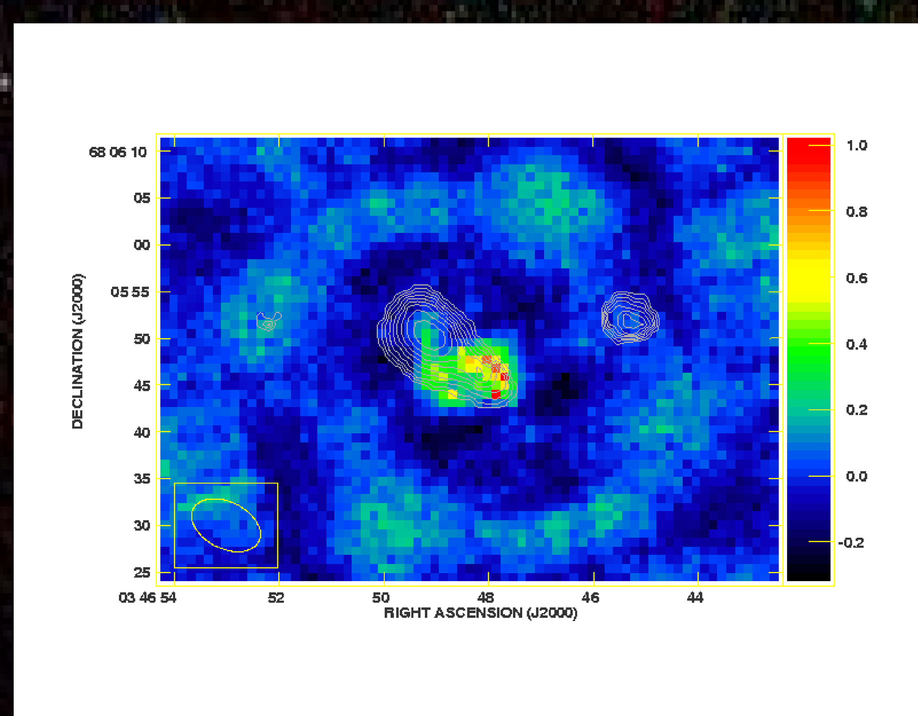
We compare CO(2-1) observations taken with the Owens Valley Millimeter Array (Schinnerer et al. 2003). The NH_3(6,6) emission appears in contours, and the CO(2-1) in colours. The OVRO resolution is better than the VLA one (1.2" opposed to 7.8"), thus we have to adapt the maps to the same resolution. The CO(2-1) traces the two molecular spiral arms that terminate in the inner ring. The NH_3(6,6) peaks at the outer edge of the eastern arm. As shown before, the line peak coincides with GMC C. Therefore, this suggests that the gaseous material flowing inwards from the "mini-spiral" is interacting there with the inner ring, possibly triggering in that same spot a burst of star formation.



We also compare the NH_3(6,6) integrated emission map (contours) with the CO(1-0) emission observed with the BIMA interferometer combined with the NRAO 12m antenna (Helfer et al. 2003). The NH_3 emission peak is offset with respect to the CO(1-0) peak. This suggests that the CO(1-0) is tracing the more extended and colder gas that forms the S-shaped bar, while the NH_3(6,6) detects the warmer material accumulated in the regions where the inflow from the bar meets the inner ring.



Finally, we compare the NH_3(6,6) integrated intensity map with a 6cm VLA continuum map. As expected, the continuum emission peak in NH_3(6,6) is in the same position as the 6cm continuum peak. The line emission peak appears at the edge of the ionized complex traced by the continuum emission.



References
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