ALMA's view of photoionized gas and star formation in nearby dust-obscured starbursts

George J. Bendo
UK ALMA Regional Centre Node
Jodrell Bank Centre for Astrophysics
MANCHESTER 1824
The University of Manchester

We present a summary of ALMA observations of both free-free continuum emission and millimetre hydrogen recombination line emission from star forming regions in the closest dust-obscured starburst nuclei. Unlike infrared or radio continuum star formation metrics, the millimetre emission directly traces the young, photoionizing stellar population, but unlike ultraviolet, optical, or near-infrared star formation metrics, the millimetre emission is unaffected by dust attenuation.

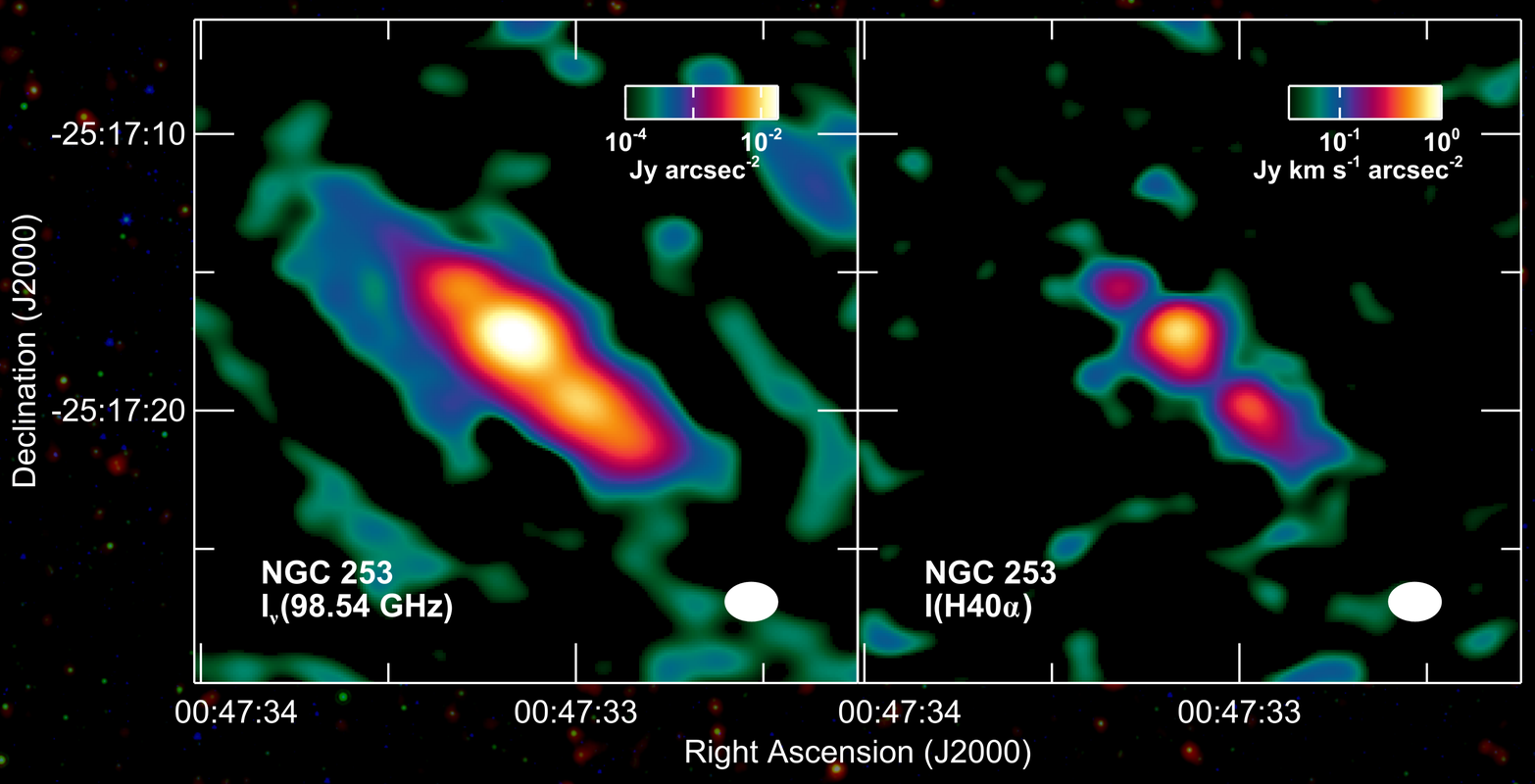
Our comparison of the star formation rates (SFRs) from ALMA data to SFRs from optical, infrared, and radio metrics shows that the other metrics could yield highly inaccurate results for nearby starbursts. The most surprising result that SFRs from mid-infrared data may differ from the ALMA-based SFRs by 10× because of dust extinction and extreme heating effects. Additionally, near-infrared recombination line emission may be more heavily affected by dust extinction than previously expected, and lower frequency radio recombination lines are potentially affected by masing and gas opacity issues.

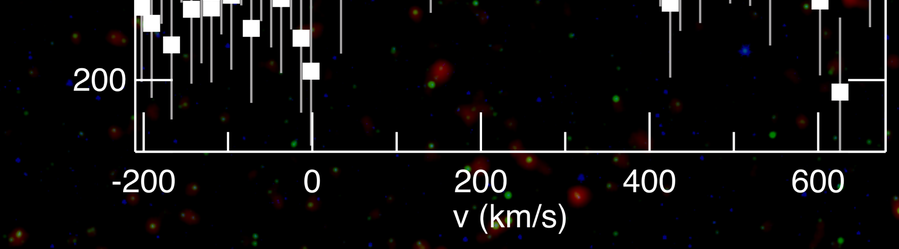
These comparisons ultimately provide new insights into the phenomenology of the most obscured starbursts in the local universe and will lead to improvements in the measurement of star formation in both nearby and high-redshift galaxies.

NGC 253

Bendo et al. 2015
MNRAS 450, L80

- The SFRs from free-free continuum and H40α line (1.73 ± 0.12 $M_\odot$/yr) fall within the broad range of SFR measurements based on radio data.
- Many lower frequency free-free continuum and recombination line measurements produce lower SFR measurements, possibly because of gas opacity issues.
- The near-infrared dust extinction is ~1.5 magnitudes higher than previously thought.

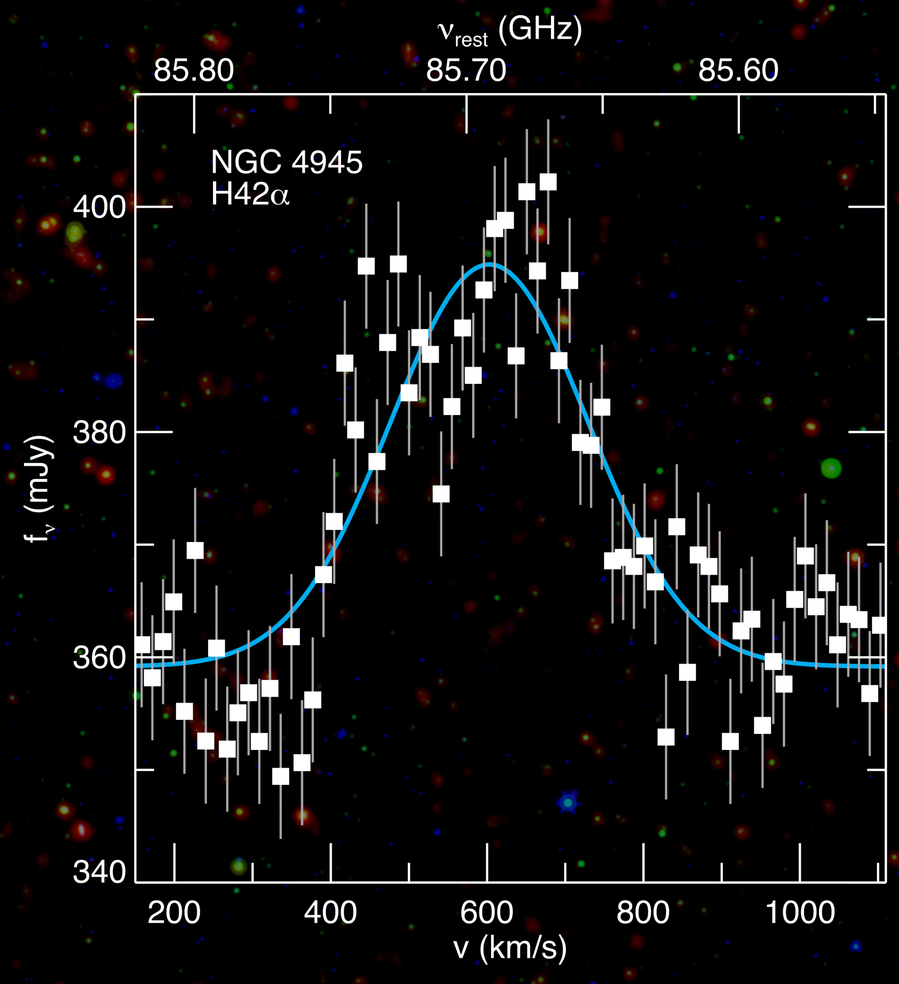




NGC 4945

Bendo et al. 2016
MNRAS 463, 252

- The SFRs from free-free continuum and H42α line (4.35 ± 0.25 $M_\odot$/yr) are comparable to the SFRs from total infrared and lower frequency radio data.
- The SFR from mid-infrared (22 and 24 μm) data is 10× lower than the ALMA measurements.
- Extreme dust densities in the center of the galaxy may make it optically thick to mid-infrared emission, which is why the SFR from the mid-infrared data is so low.



NGC 5253

Bendo et al. 2017
MNRAS, 472, 1239

- The SFR from H30α line (0.087 ± 0.013 $M_\odot$/yr) is similar to SFRs from 70 μm and total-infrared data.
- The SFRs from 22 μm data are ~3× higher.
- The SFRs from 160 μm data are ~2× lower.
- The low metallicity in NGC 5253 leads to low dust densities and lower attenuation of ultraviolet light. The dust that is present is very hot, which is why individual infrared bands do not yield reliable SFRs.