Extragalactic Science in the Low-z Universe with the Submillimeter Array

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Resolving Giant Molecular Clouds in NGC 300

(Faesi, C., Lada, C., Forbrich, J., 2016, ApJ, 821, 125)

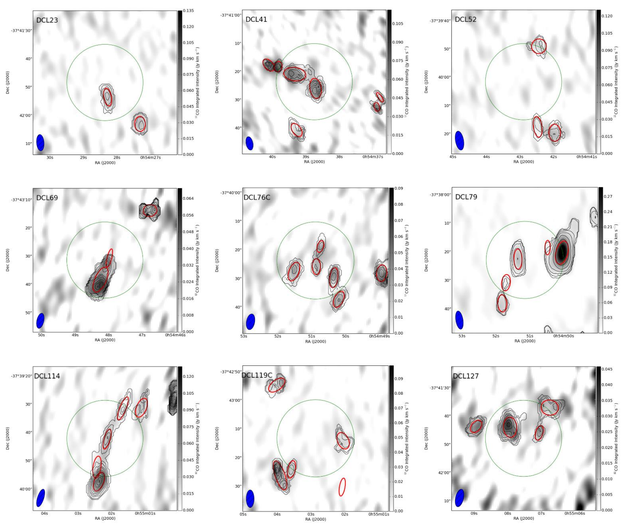


Figure 1: CO J=2-1 integrated intensity maps for nine regions of NGC 300. Contours are in integer multiples of the noise starting at 1 sigma. The red ellipses show the cloud sizes as derived by the CPROPS routine. The synthesized beam is shown in the lower left corner and the green circle represents the 27" FWHM of previous APEX observations.

Goal: use the SMA to image 45 individual GMCs in the galaxy NGC 300 in CO J=2-1.

Results: - physical properties are similar to those in the disk of the Milky Way

- derive a mass spectrum with a slope of 1.8
- cloud properties are consistent with Larson's fundamental relations between size, linewidth, and mass.

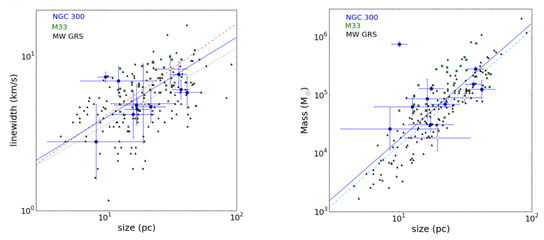


Figure 2: Size-Linewidth (left) and Size-Mass (right) relations for individual clouds in NGC 300 (blue) compared to clouds from M33 (green) and the Milky Way.

Wide Mosaic of the "Fireworks Galaxy" NGC 6946

(Wu, Y.-L., Sakamoto, K., & Pan, H.-A., 2017, ApJ, 839, 6)

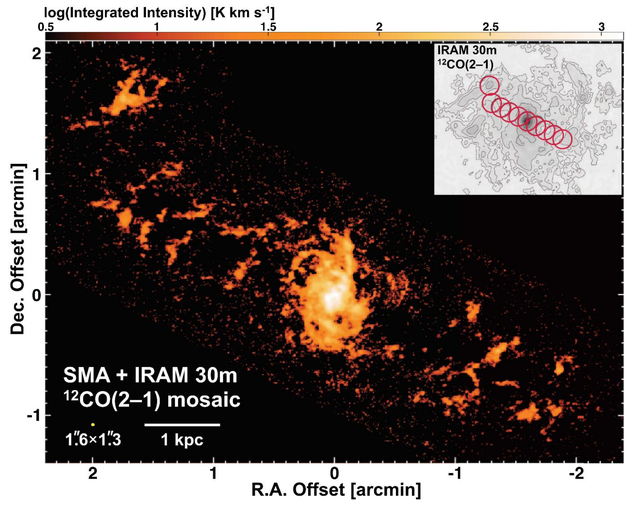


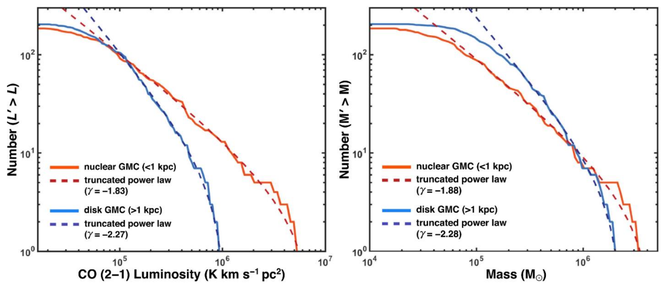
Figure 3 (above): CO J=2-1 mosaic of NGC 6946 showing a strong gas concentration in the nuclear regions, with chains of GMCs in the outer disk. This map is single dish corrected using data from the IRAM 30-m.

Goal: mosaic a strip through the center of the "Fireworks Galaxy" and measured the gas properties of 390 GMCs.

Results: - the clouds in the inner 1 kpc tend to be more luminous and turbulent.

- is likely bar-driven dynamics regulate GMC properties in this region.
- mass function has a shallower slope in the inner region, and steepens at larger radii (see below). This may reflect different cloud formation pathways: gravitational instabilities in the nucleus, and gas coalescence further out.

Figure 4 (right): Luminousity and Mass functions (left and right resp.) for nuclear (red) and disk (blue) populations of clouds.



Molecular Gas Properties in Late-Stage Mergers

(Sliwa, K., et al., 2017, ApJ, 840, 8)

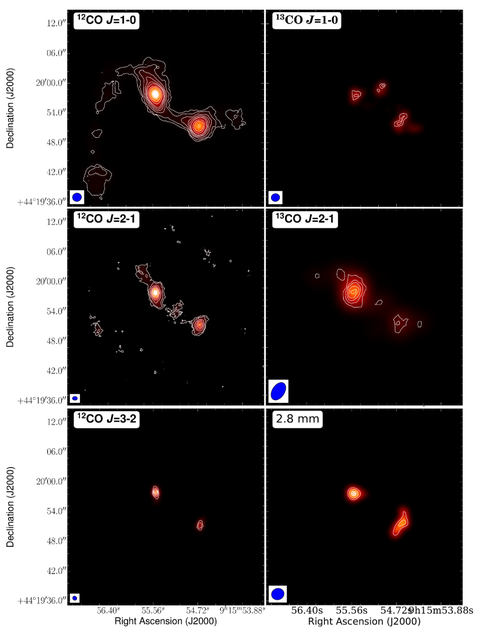


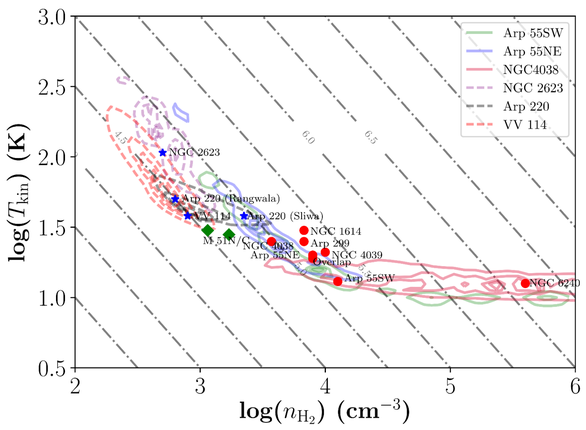
Figure 5 (above): CARMA (J=1-0, 2.8 mm) and SMA (J=3-2, J=2-1) observations of Arp 55. Spatially resolved observations of a variety of transitions allows detailed modeling of gas properties.

Figure 6 (right): Gas properties for a sample of mergers. Later stages of merging are on the left and show warmer less dense gas overall.

Goal: combine new and archival SMA data with ALMA and CARMA observations for a variety of luminous infrared galaxies (LIRGs) to create a catalog of gas properties across a variety of merger environments.

Results: - gas properties are generally cooler and denser in early stages of mergers, and warmer and less dense in later stages.

- the [12CO]/[13CO] abundance ratio is higher in later stages, suggesting the higher star formation rates in mergers enriches the interstellar medium.



Complete Warm Gas Inventory in NGC 2903

(Xu, Z., et al., 2018, in prep.)

Goal: map the entire disk of the Hot Spot Galaxy NGC 2903 simultaneously in 12CO, 13CO, and C18O J=2-1 to provide a complete inventory of warm gas properies.

Results: - strong 12CO J=2-1 emission is seen primarily along the bar with a clear "twin peak" morphology seen in the nucleus suggesting the presence of strong Inner Lindblad Resonances.

- The CO J=2-1/1-0 ratio shows the highest values in the nucleus, with enhancements at the spiral arm ends.
- 13CO/12CO ratios suggest regions of high optical depth occur preferentially where CO J=2-1 emission is strongest.
- The C18O/13CO ratio suggest the presence of young and vigorous star formation in the nuclear regions.

Figure 7 (left): CO J=2-1 map of NGC 2903. Strong emission is seen along the bar and gas dynamics show signs of bar streaming and resonances. **(right)** CO J=2-1/1-0 line ratio map. "Hot spots" are seen along the bar and in the spiral arms, but LVG analysis shows only the nucleus is actually hotter and denser. The rest are artifacts of line-width variations.