Galaxy Ecosystems

The matter cycle in and around galaxies

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On behalf of Working Group 2: *A. Leroy, E. Murphy, et al.*

Atacama Large Millimeter/submillimeter Array

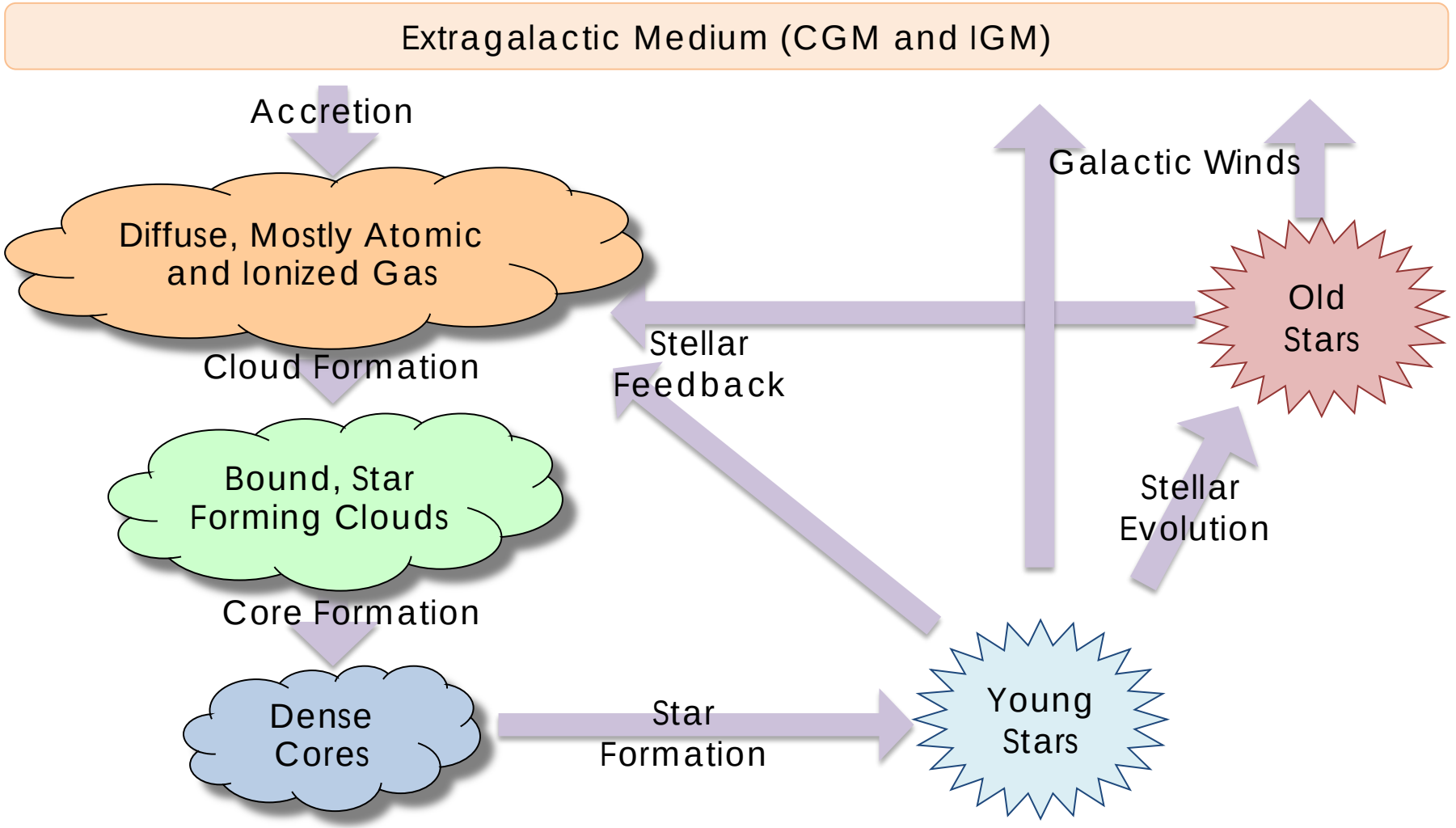
Karl G. Jansky Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array

Gastrophysics

Multi-process & multi-scale

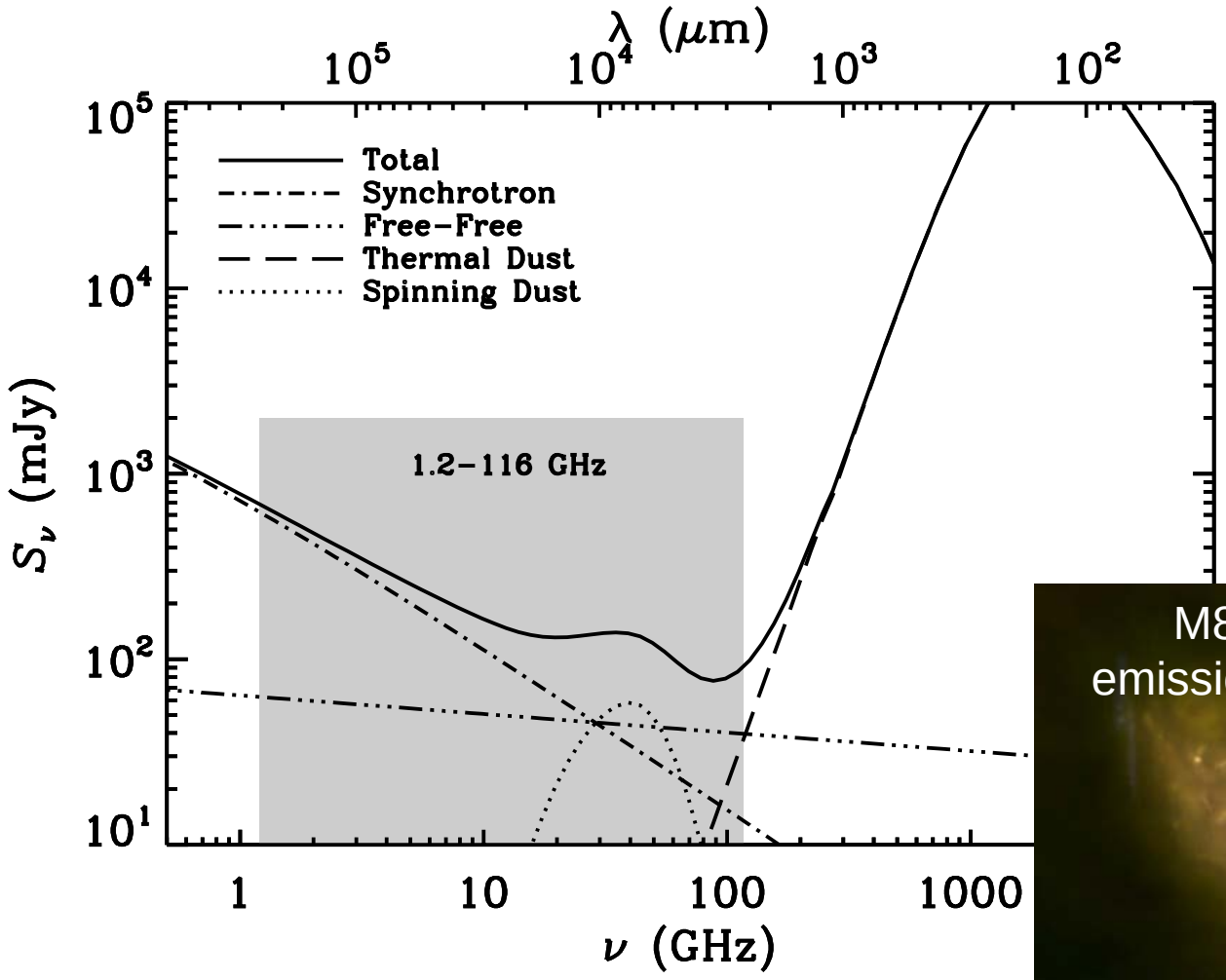


Key Science

1. Broad-band continuum imaging
2. Spectral line mapping
3. Thermal imaging at high spatial resolution
4. VLBI micro-arcsecond astrometry

Broad-Band Continuum Imaging

Unleash diagnostic power of the full spectral energy distribution



Gas Tracers:

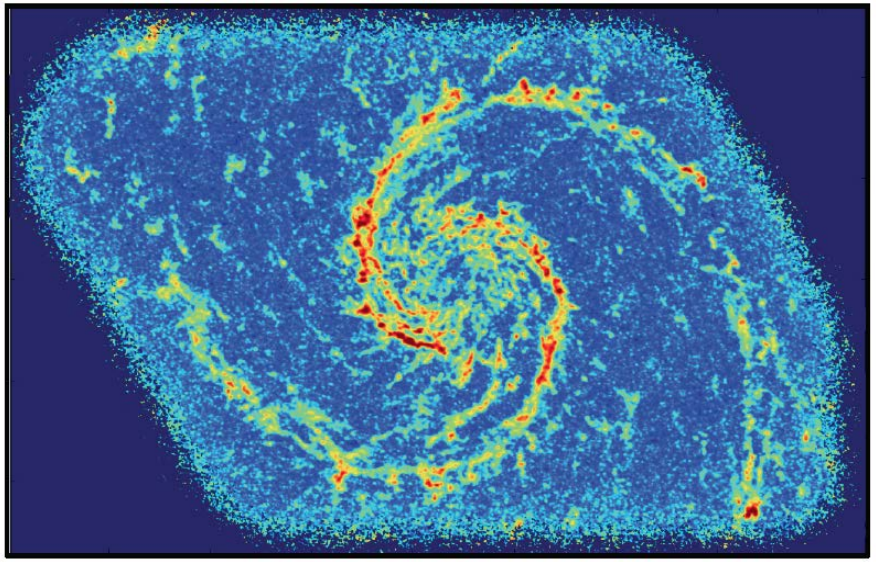
Cool: spectral lines

Ionized: free-free, recomb.

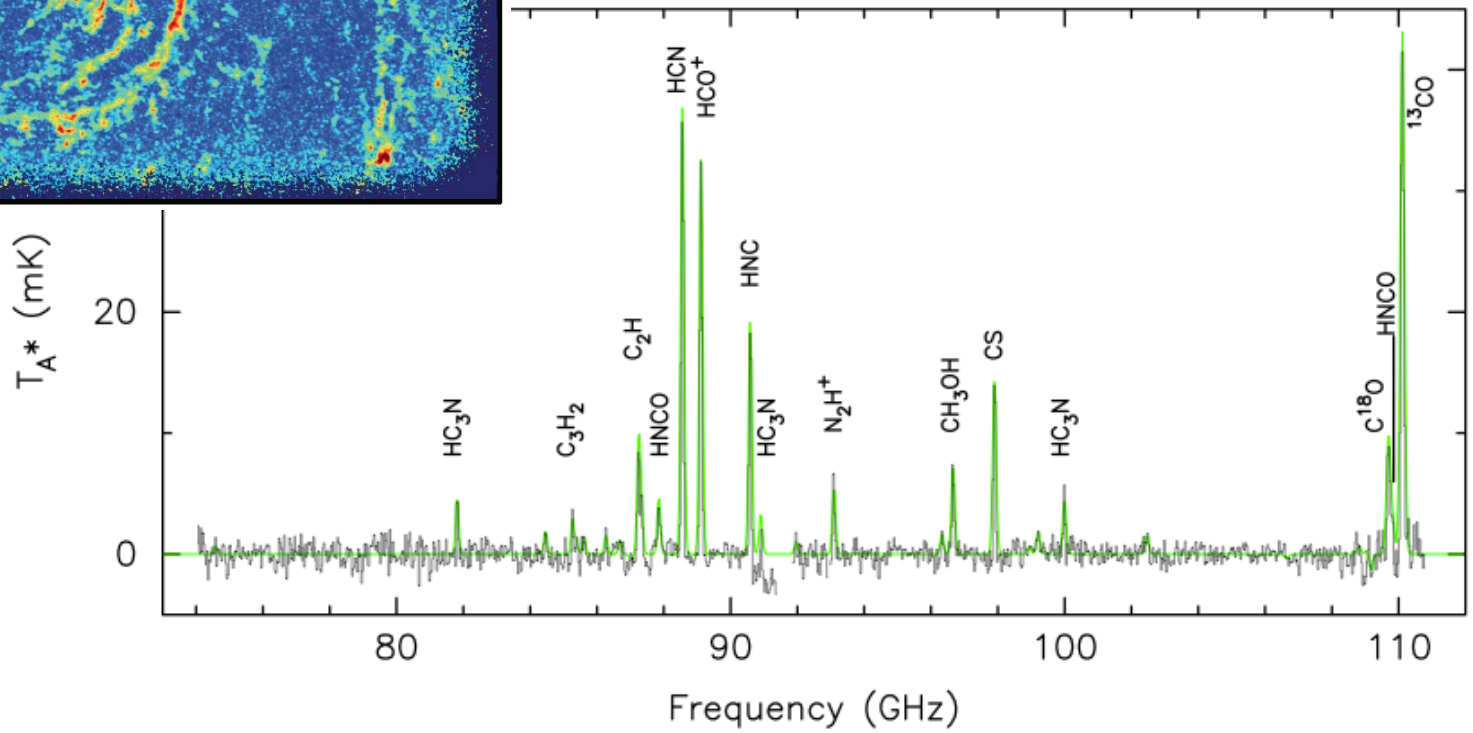
Hot: synchrotron, SZ

Spectral Line Mapping

Map cool ISM 50x faster than ALMA

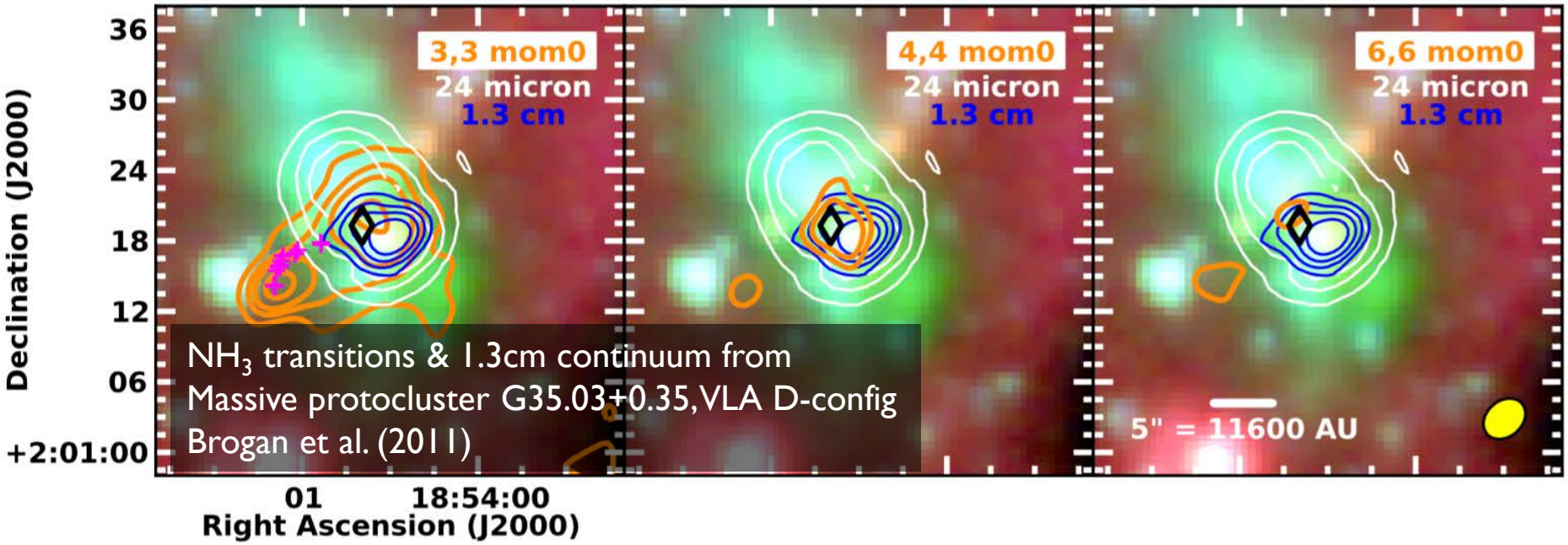


State of the Art: M51 in CO (*J*=1-0) at 1" and ~1 K per km s^{-1} - Schinnerer et al. (2013) **-- 200 hr with PdBI ~ 15 hr w/ ALMA ~** ***12min with ngVLA***



Thermal Imaging At High Resolution

Finding hidden power sources



Resolve binary out to 10 kpc

→ ~0.1 arcsec @ 1cm

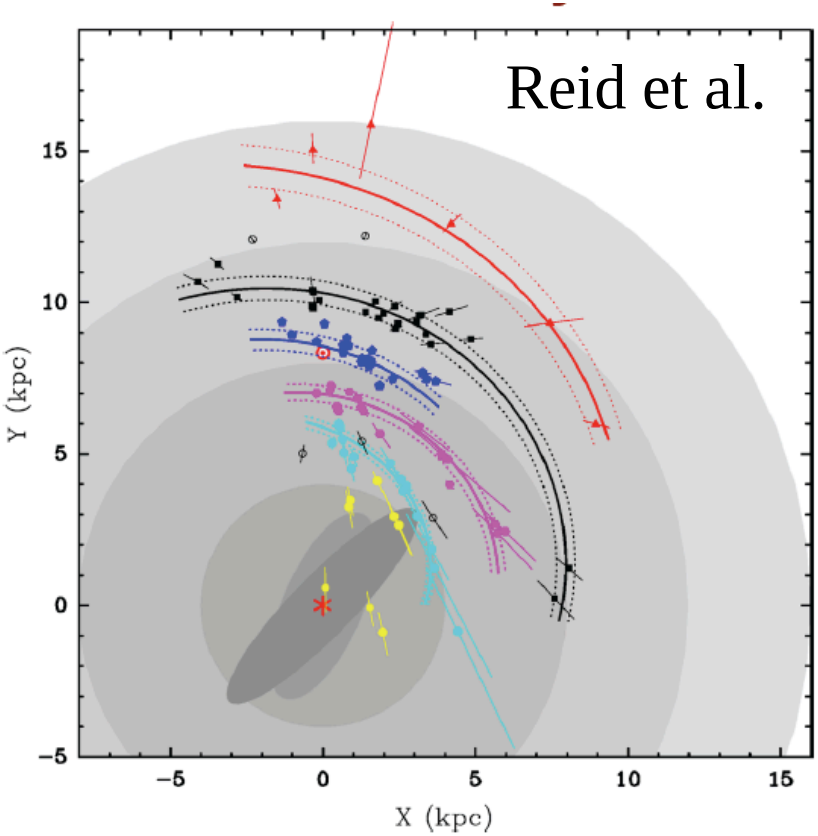
→ surface brightness on 20km baselines

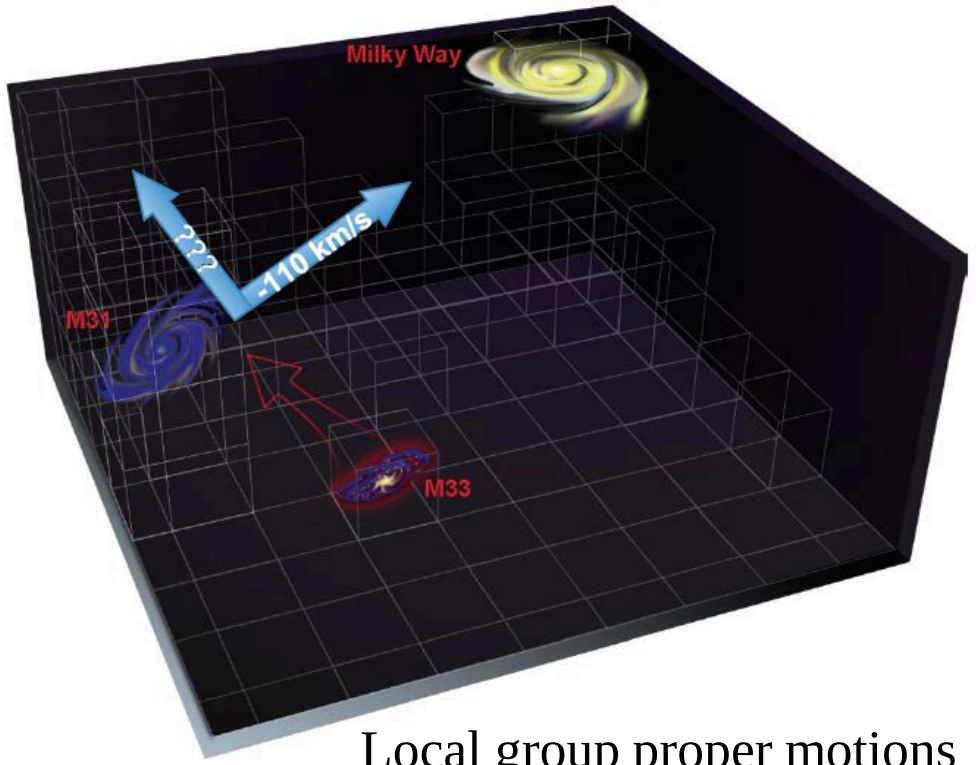
Accretion around Sgr A*

- Dense ionized gas in high extinction
- mm HI recombination lines

VLBI Micro-Arcsecond Astrometry

Mapping and weighing the Milky Way Galaxy





Local group proper motions
0.1 μas/year = 400 m/s !
(Darling)

Much of the science requires ~20% of collecting area at long baselines

Considerations to optimize a ngVLA for "Galaxy Ecosystem" work

Unprecedented collecting area on the ~km baselines key to 0.1-1 arcsecond mm-wave imaging.

Integration with very long baseline capabilities built in to the array design.

Capability for high fidelity mapping and full flux recover (short and zero spacing observations)

Coverage from 1-115 GHz with wide instantaneous bandwidth.

Small dish size.

Benchmarks to ensure a revolutionary ngVLA in this field

Map lines 30 times fainter than ^{12}CO 1-0 with ~ 1" resolution, high fidelity and full flux recovery quickly enough to allow surveys of many normal nearby galaxies and a large part of the Milky Way.

Measure the radio spectral energy distribution at ~1" resolution with high fidelity and full flux recovery over the area of active star formation quickly enough to allow mapping surveys of many normal galaxies.

Achieve sensitivity to thermal lines and continuum processes at ~0.1" resolution quickly enough to allow surveys of forming protoclusters and galactic nuclei.

Measure the proper motion of galaxies at the level of ~ 0.1 μas yr^{-1} and measure distances to weak masers with ~ 10% accuracy at a distance of 20 kpc.