PASEO Meeting

July 15-16, 2010 – Socorro, NM

First science with the EVLA

Chris Carilli

Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

NRAO

Realizing EVLA science themes

I. Evolving Universe: High z molecular gas = 'fuel for galaxy formation'

- Low order molecular transitions: total and dense gas mass
- High spatial/spectral resolution => sizes and dynamics
- Wide bands => large cosmic volume searches

II. Obscured Universe: Broad band spectroscopic imaging of star formation

- Multiple, key diagnostic lines
- Sub-arcsecond imaging

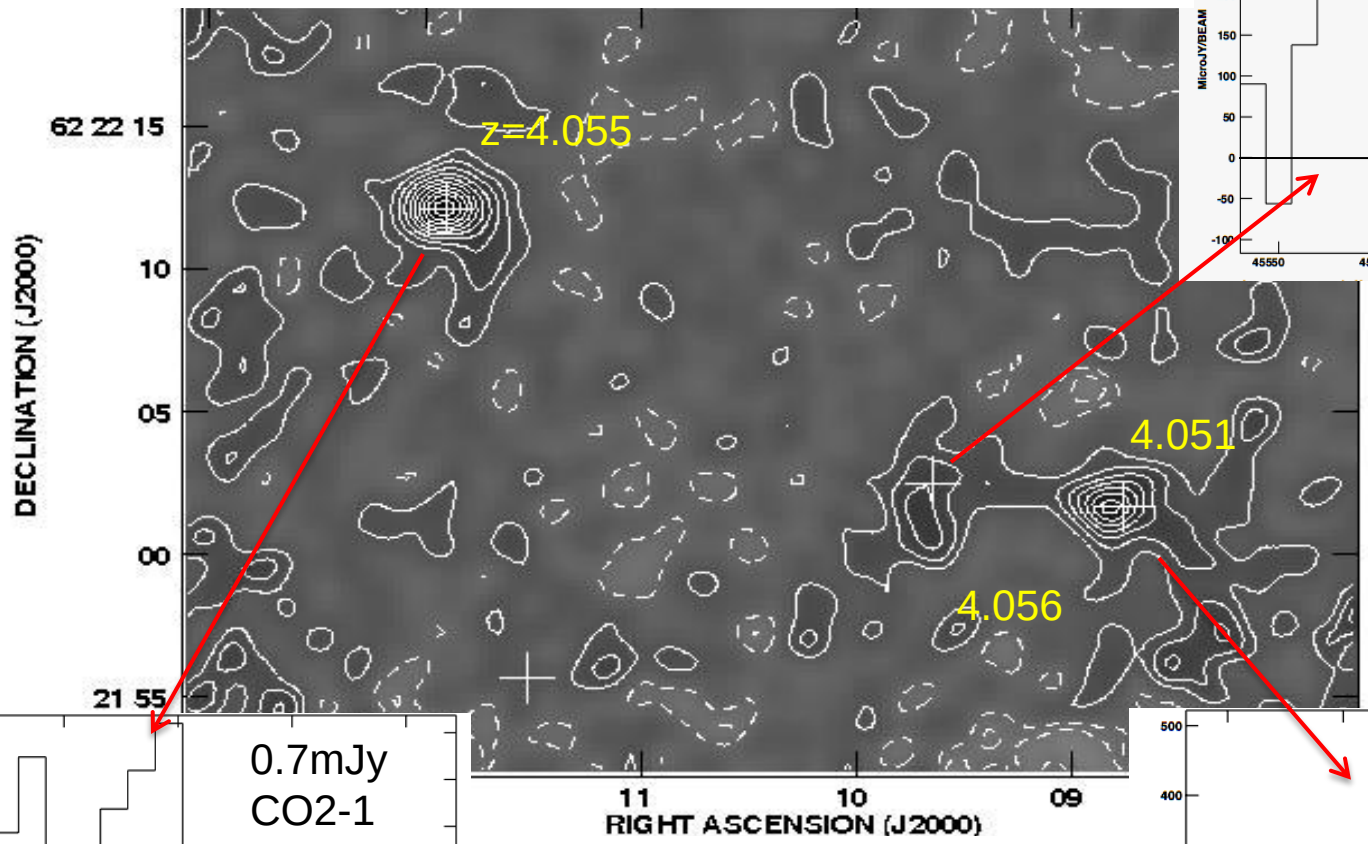
III. Transient Universe

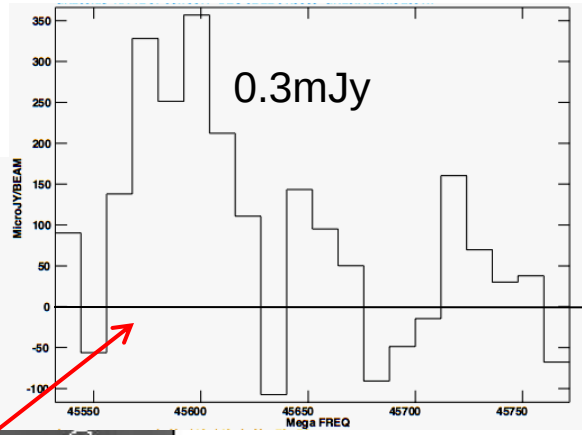
- Progenitors of Ia SNe

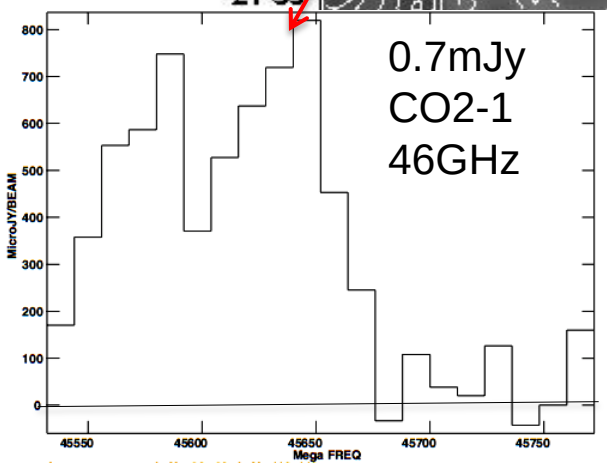
IV. Magnetic Universe: Pending Observations

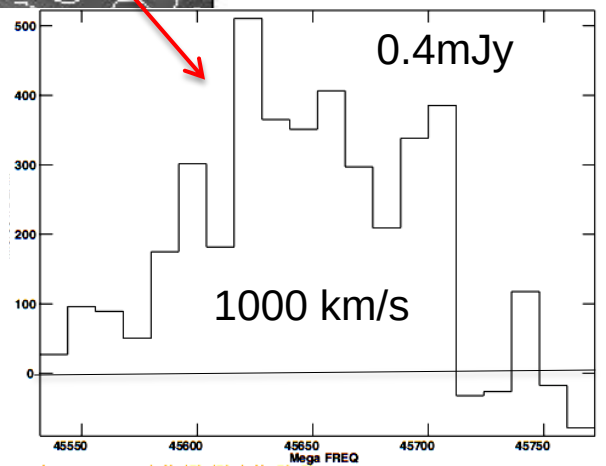
Evolving Universe

GN20 molecule-rich proto-cluster at z=4 (Daddi)
CO 2-1 in 3 submm galaxies, all in 256 MHz band





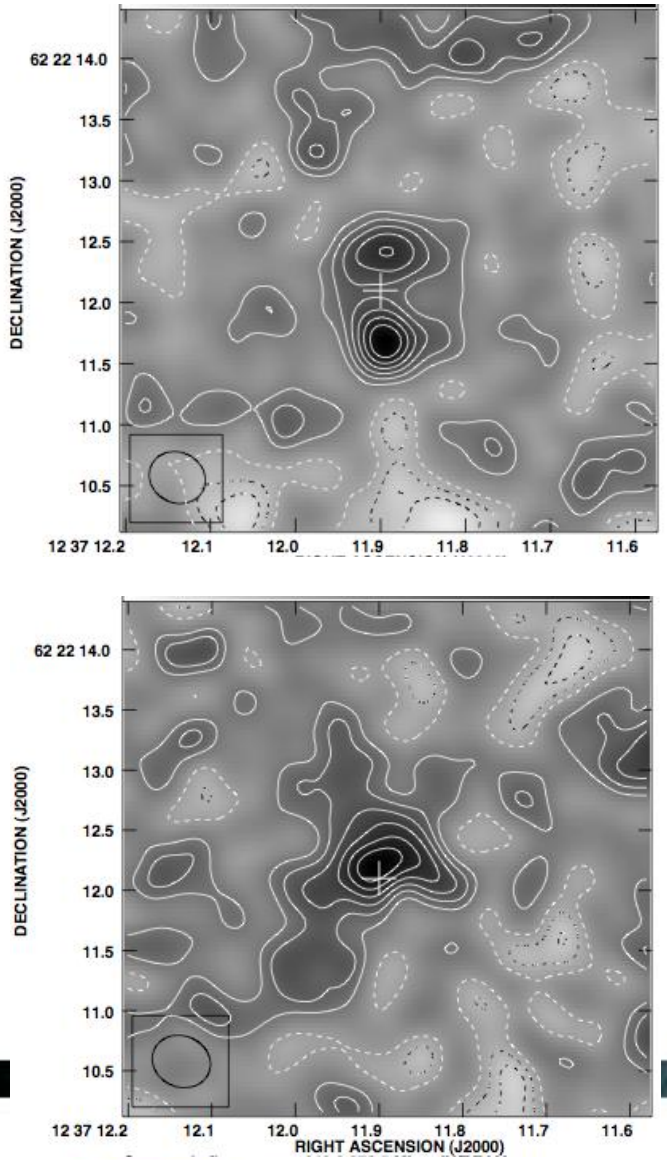




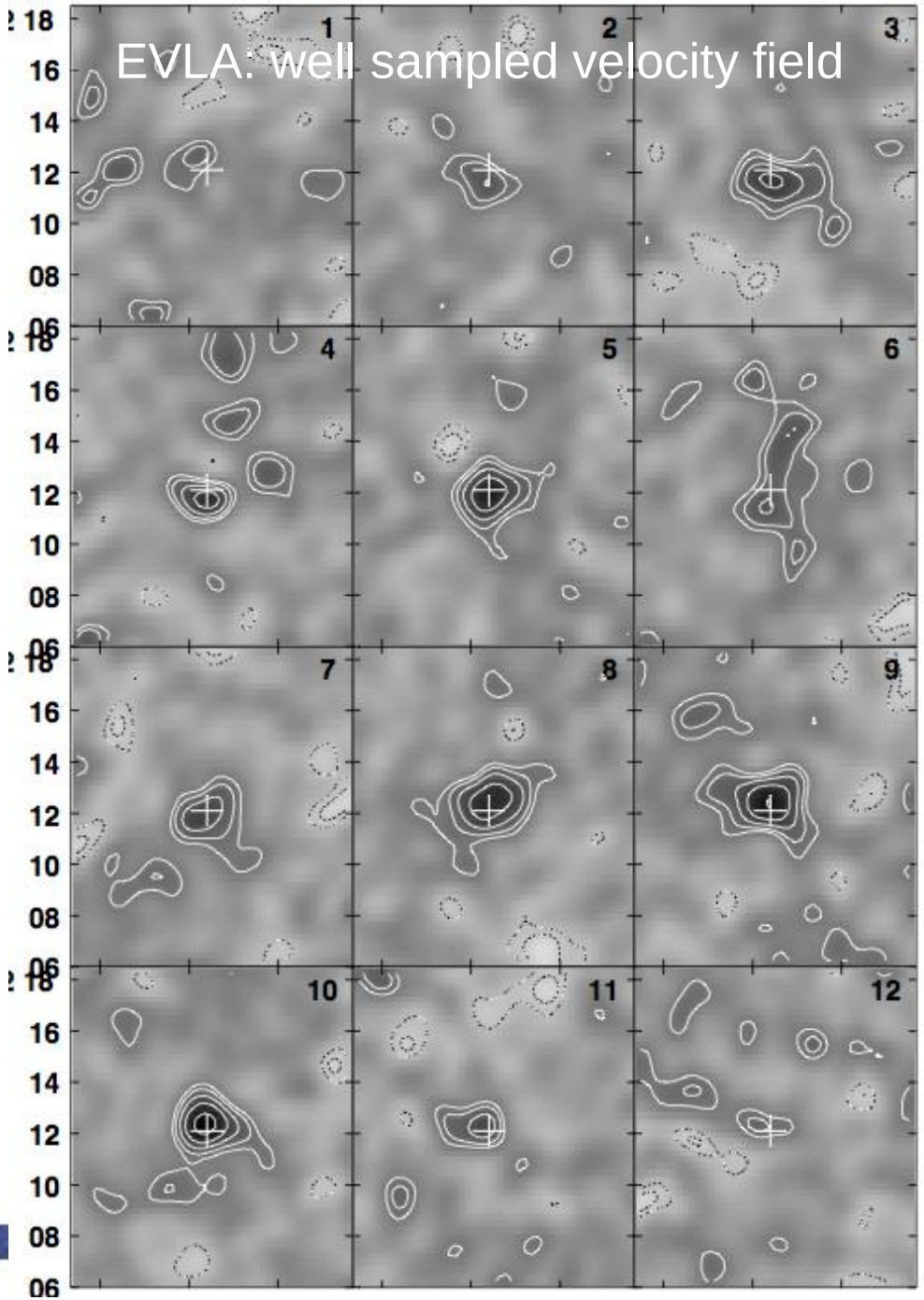
- SFR ~ 10^3 M_o/year
- $M_{gas} > 10^{10}$ M_o
- Early, clustered massive galaxy formation

GN20 z=4.0

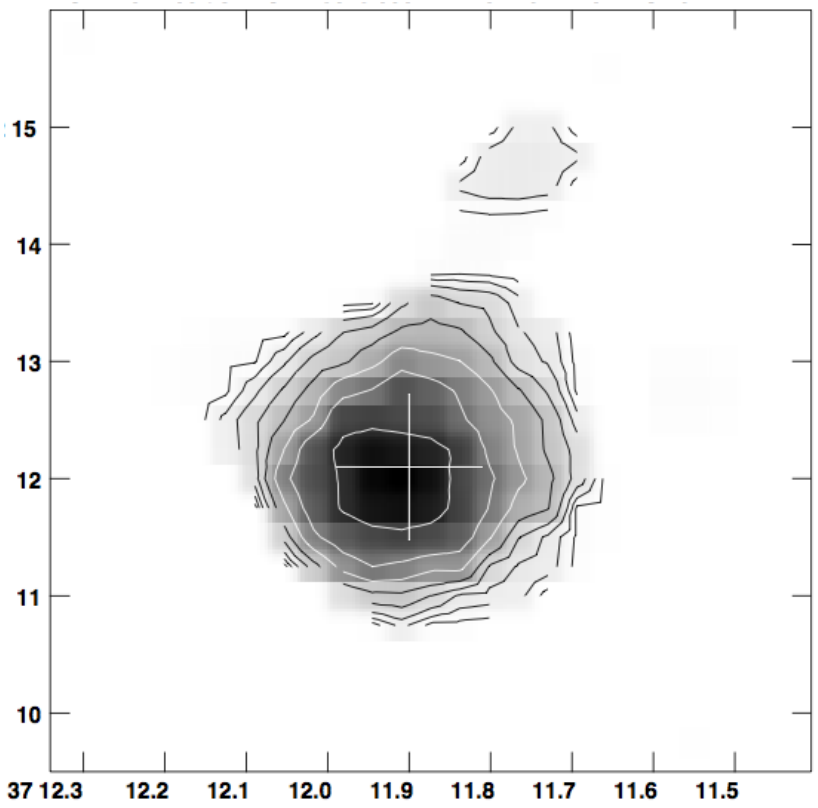
VLA: ‘pseudo-continuum’
2x50MHz channels

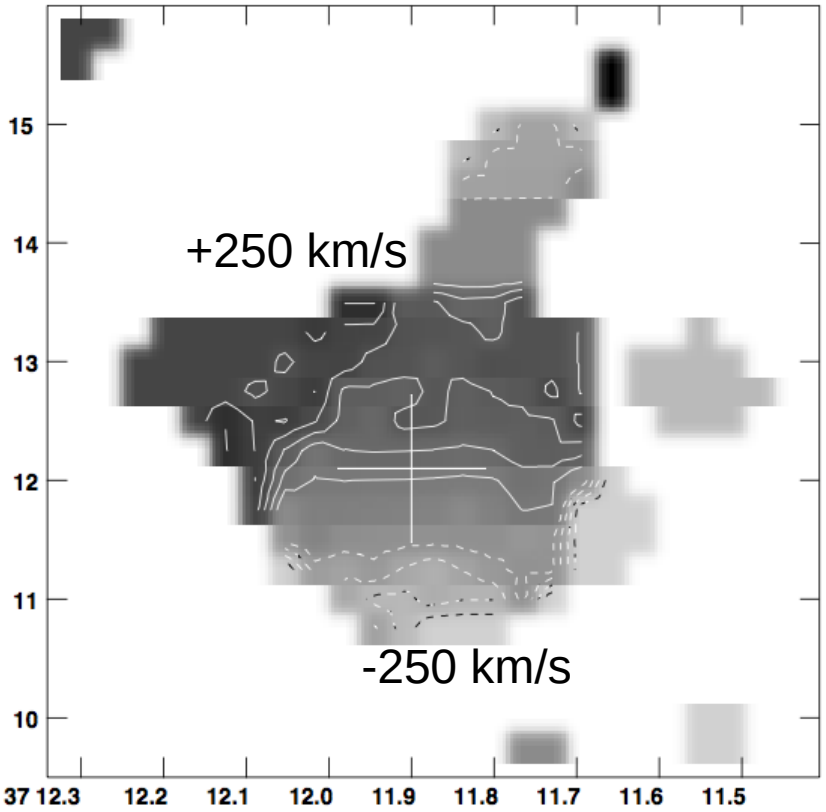


EVLA: well sampled velocity field



GN20 moment images

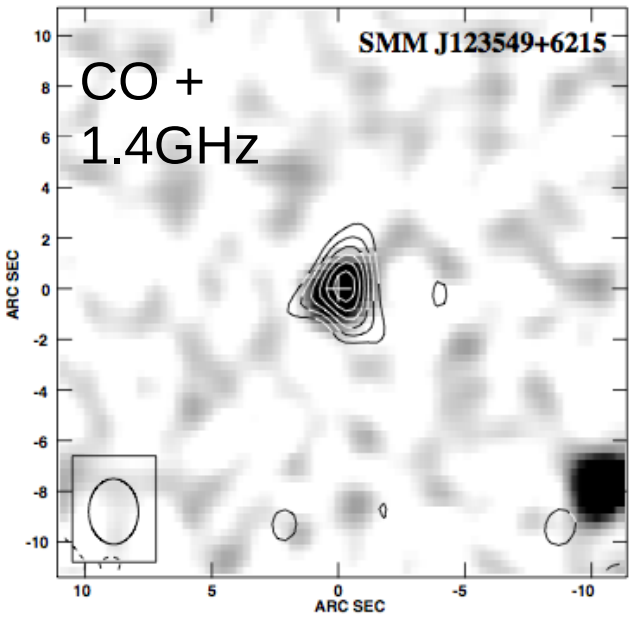


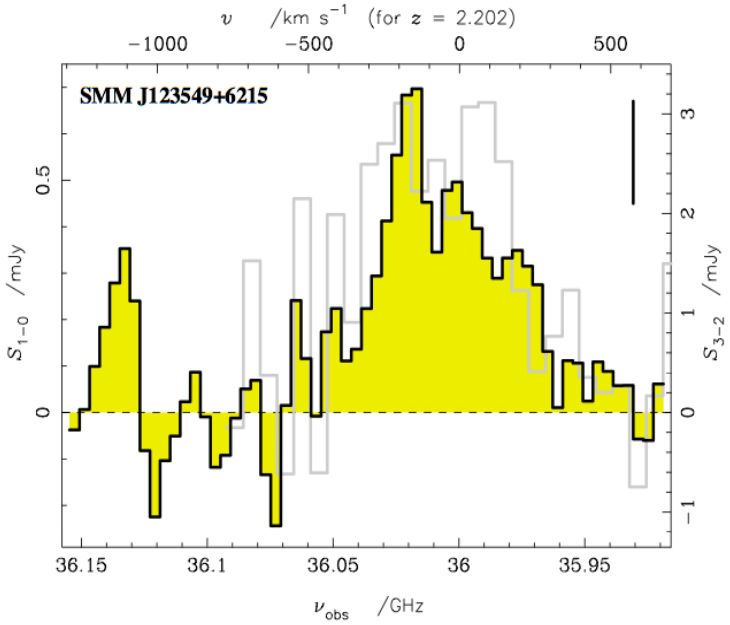


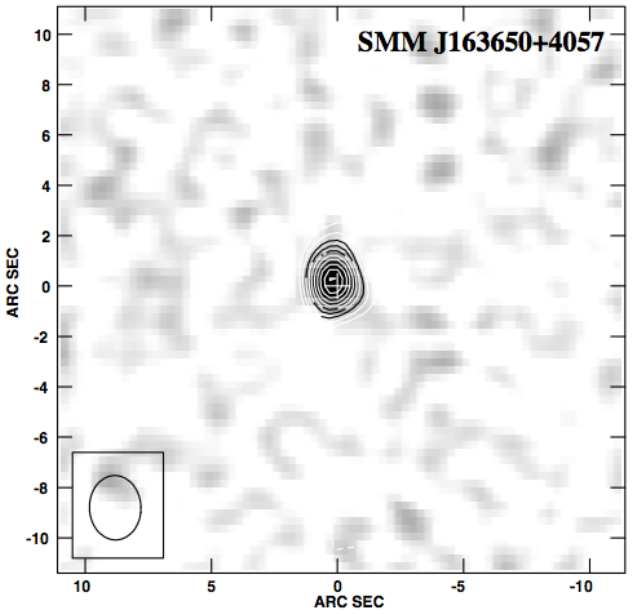
- Low order CO emitting regions are large (10 to 20 kpc)
- Gas mass = 1.3e11 M_o
- Stellar mass = 2.3e11 M_o
- Dynamical mass (R < 4kpc) = 3e11 M_o

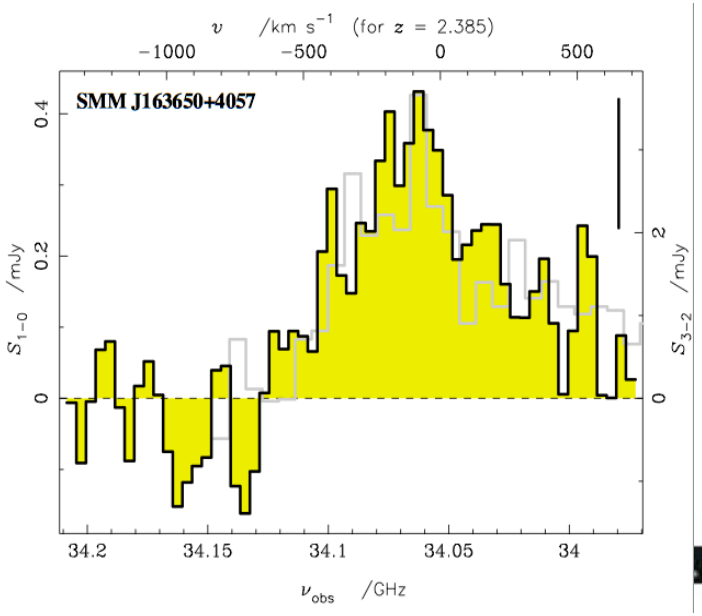
=> Baryon dominated within 4kpc

CO 1-0 in z ~ 2.5 SMGs (Ivison et al.)

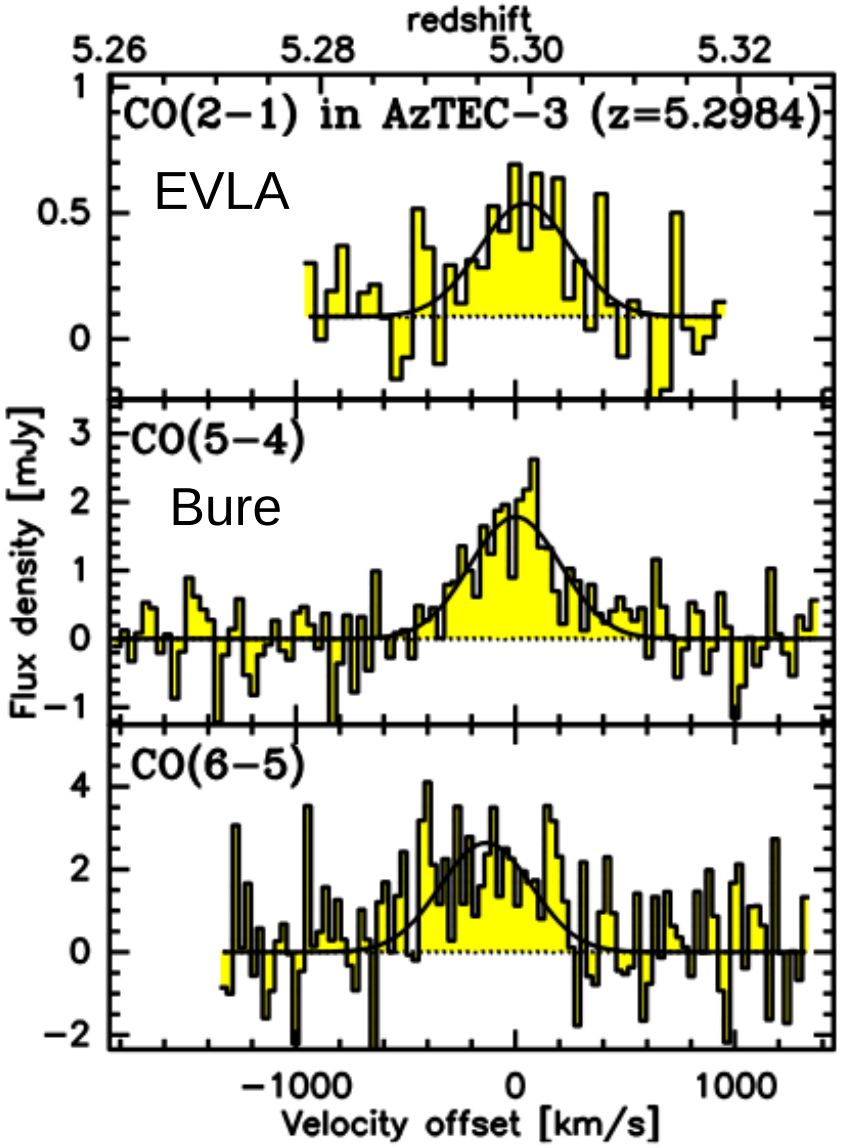


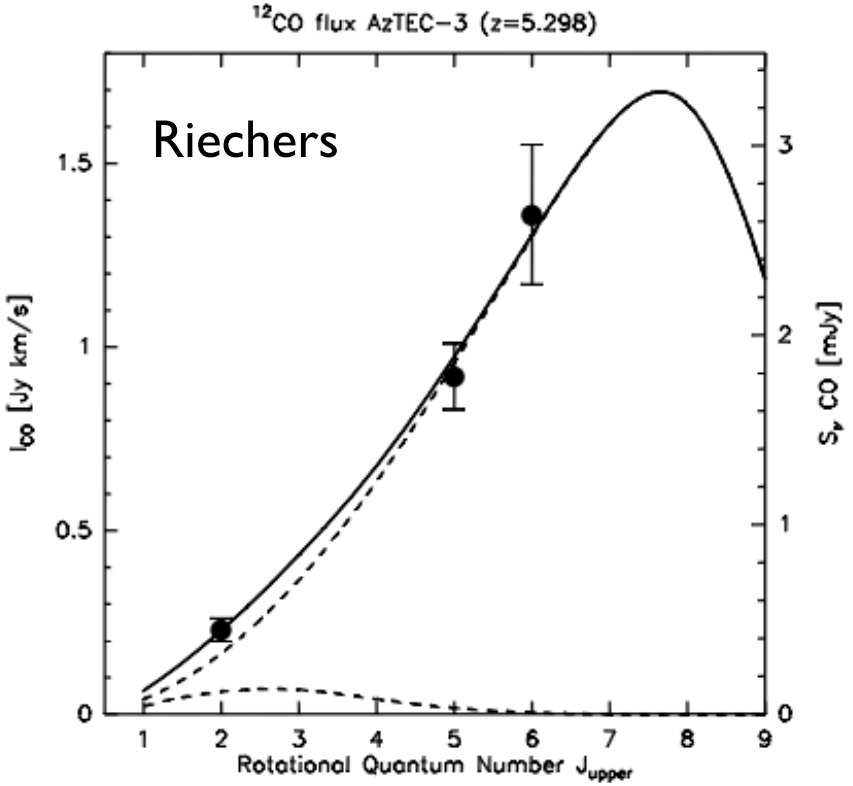






Most distant SMG: z=5.3 (t_{univ} ~ 1Gyr)

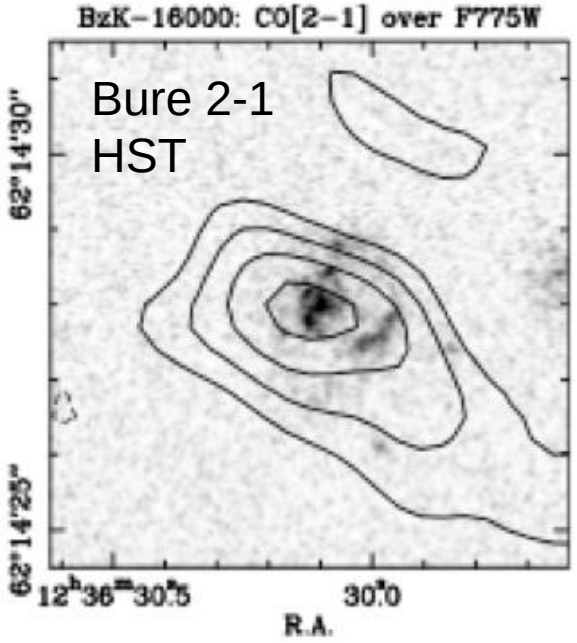


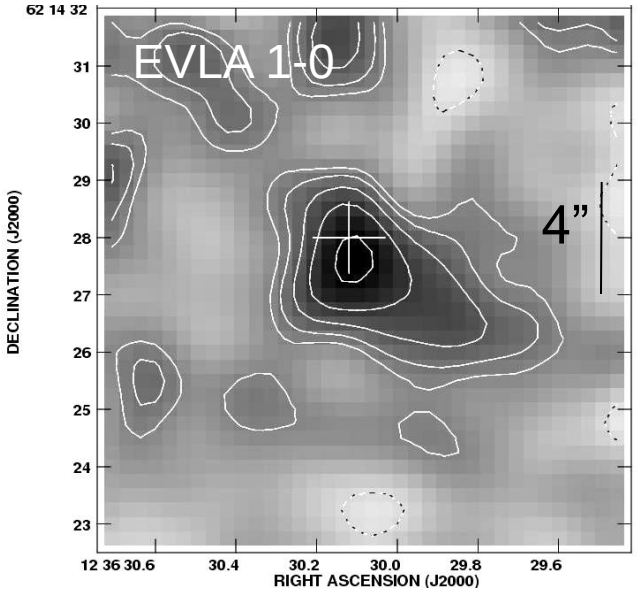


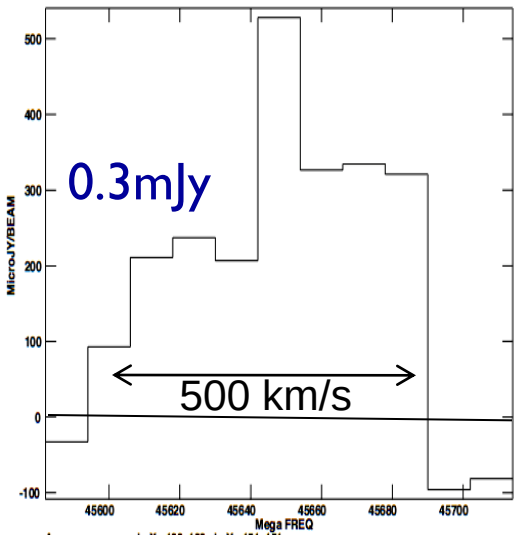
CO excitation => ISM conditions

- n_{H2} ~ $10^{4.3}$ cm^{-3}
- T_K ~ 45 K

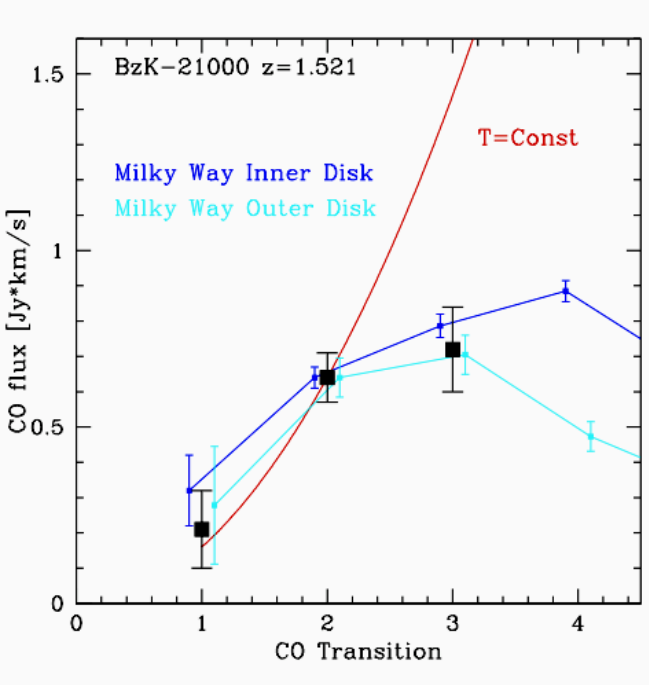
CO 1-0 in normal galaxies at z=1.5 ('sBzK' galaxies)





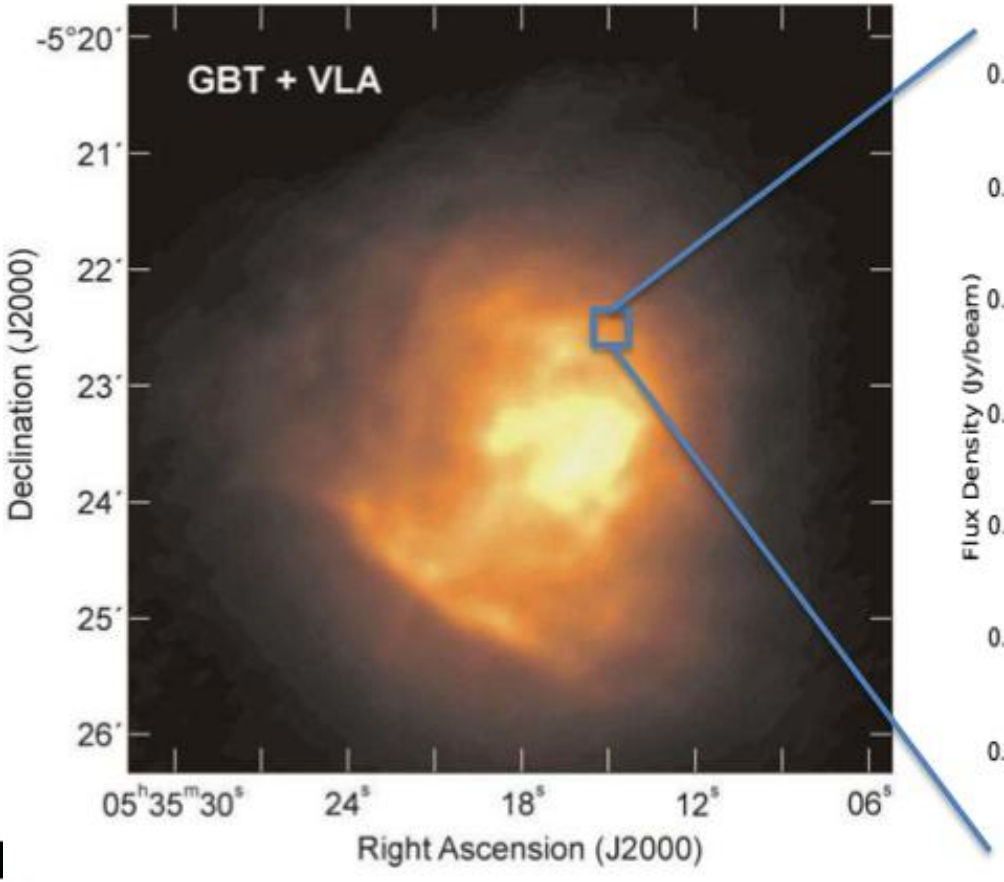


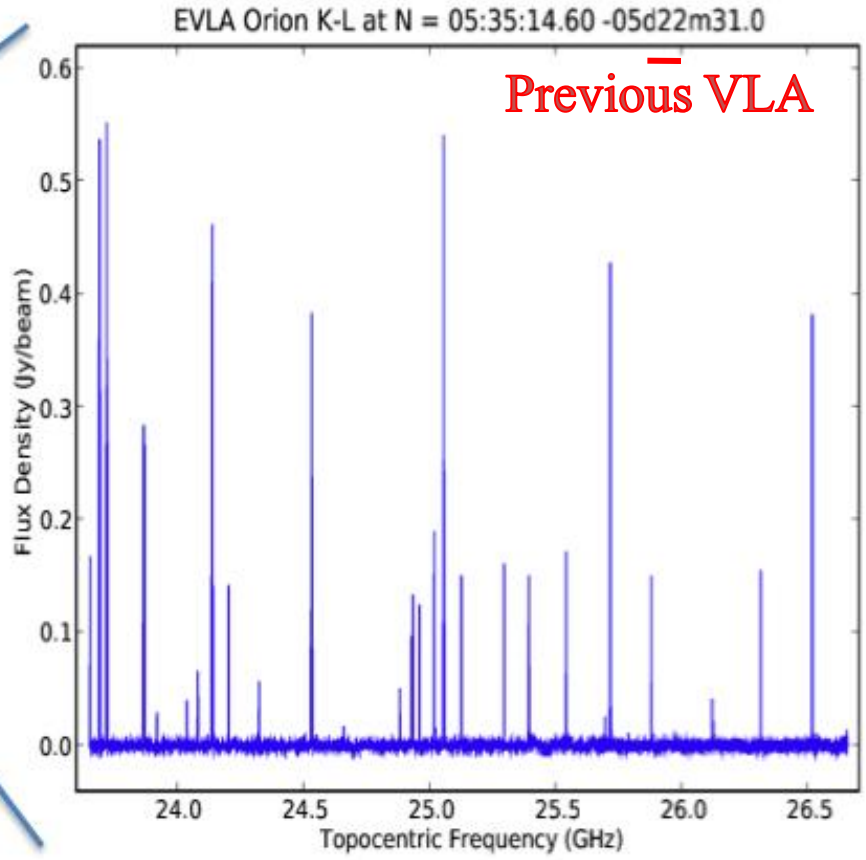
- SFR ~ 10 to 100 M_o/year
- Find: $M_{H2} > 10^{10}\ M_o > M_{stars}$ => early stage of MW-type galaxy formation?
- Again: low order CO is big (28kpc)
- Milky Way-like CO excitation (low order key!)
- 10x more numerous than SMGs



Obscured Universe

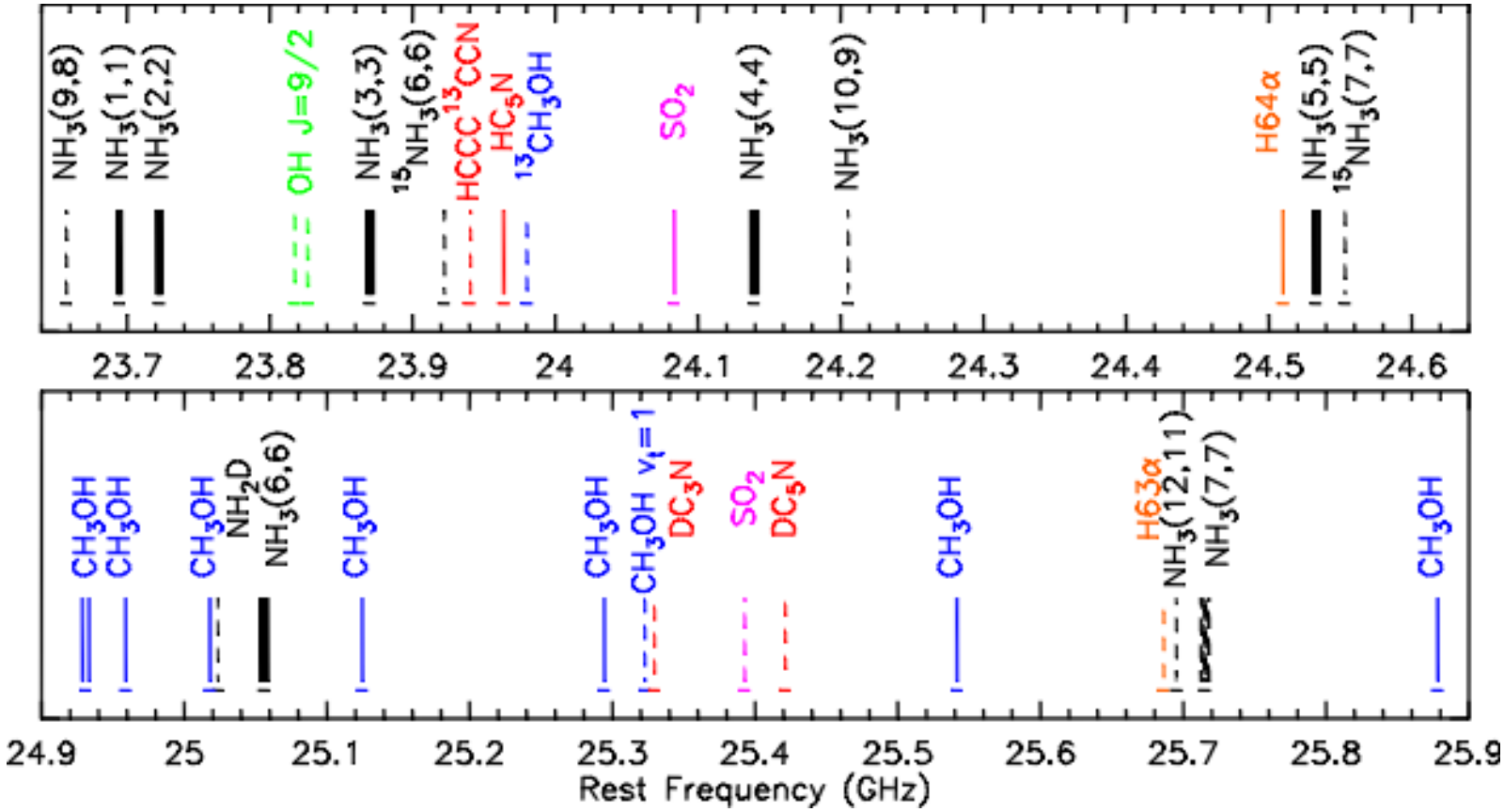
Orion hot molecular core: The hot core lies in the molecular cloud behind the nebula. Hot cores are thought to be signposts of the earliest phase of massive star formation; rich chemistry, high densities and temperatures





3GHz

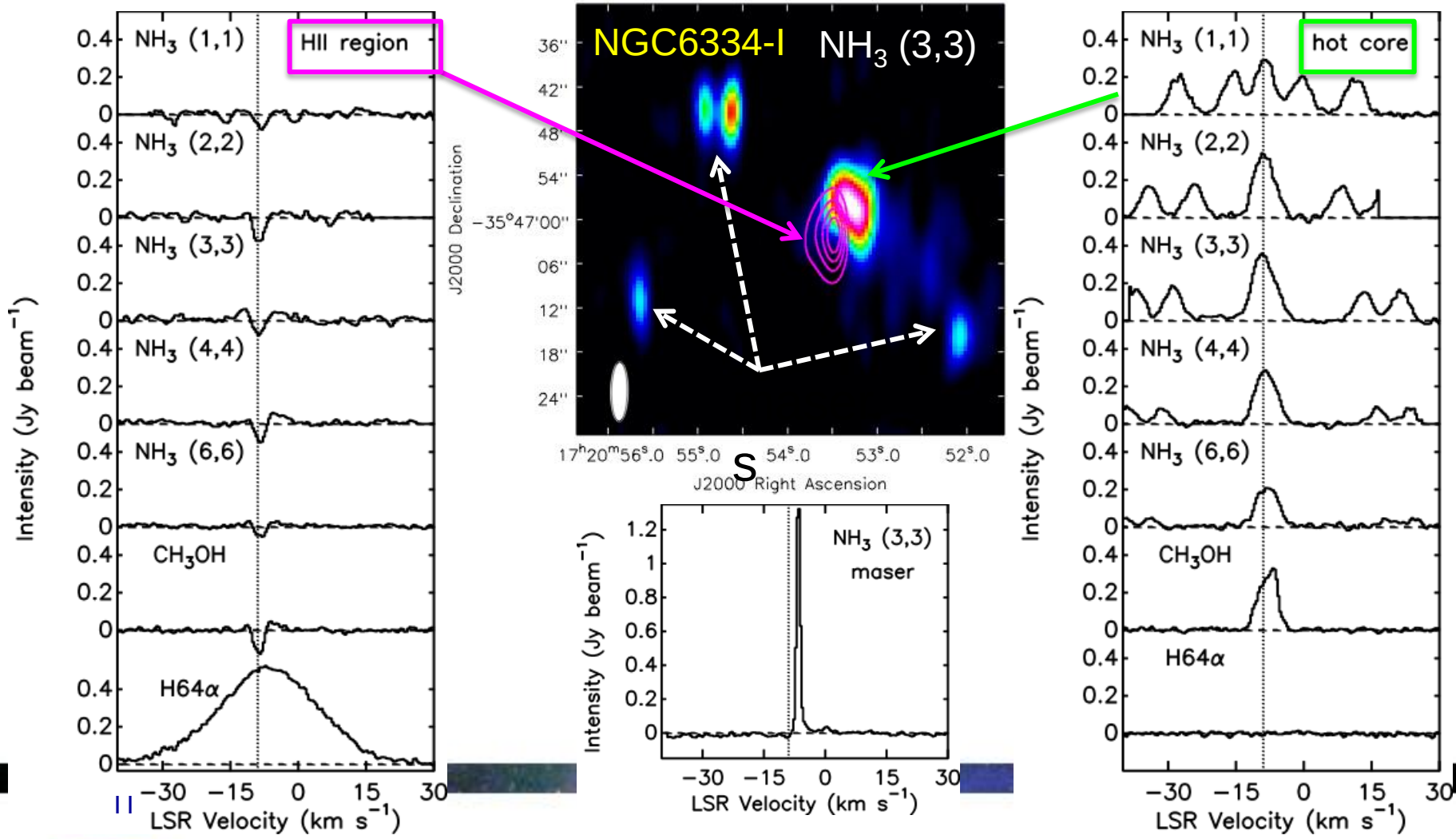
The Power of EVLA WIDAR: A Diagnostic K-band Survey of 30 Massive Protostellar Objects (Brogan + Hunter)



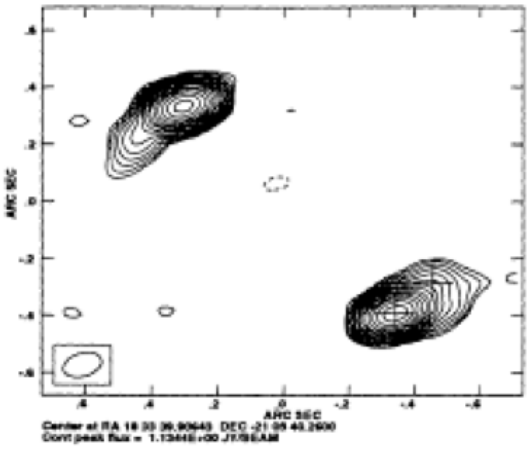
- Ammonia 1,1 to 7,7 – density and temperature
- Radio Recombination Lines – number ionizing photons
- Hot Core Lines (methanol, SO_2)
- Rare diagnostic lines including deuterated species

EVLA K-band: massive young stellar objects in NGC6334-I

- Initial test for start of RSRO project AB1346
- 8 x 8 MHz subbands with 256 channels RR only; referenced pointing
- 10 minutes on source!

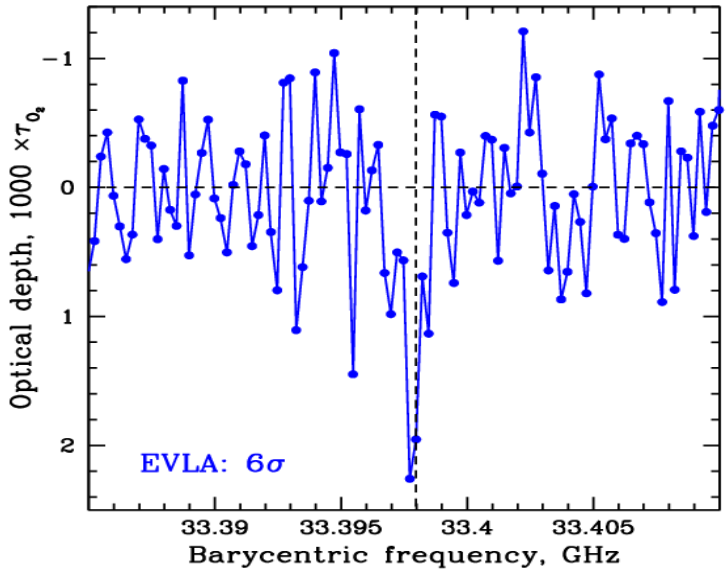


Astrochemistry at high z: absorption by GMCs in dark gravitational lenses

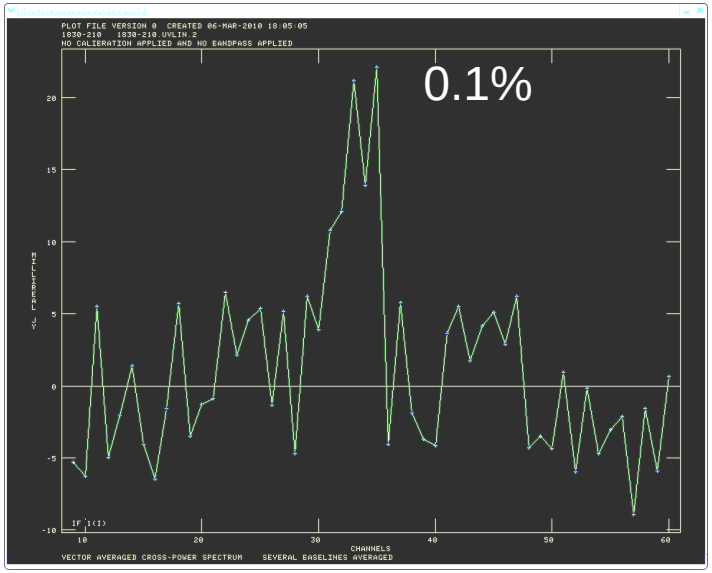


O_2 at z=0.68 (1st extragalactic!)

- $X(O_2) = (1.2 - 2.9) \times 10^{-7}$
- Galactic: $X(O_2)$ □ $N(O_2)/N(H_2) \sim 0.5 \times 10^{-7}$



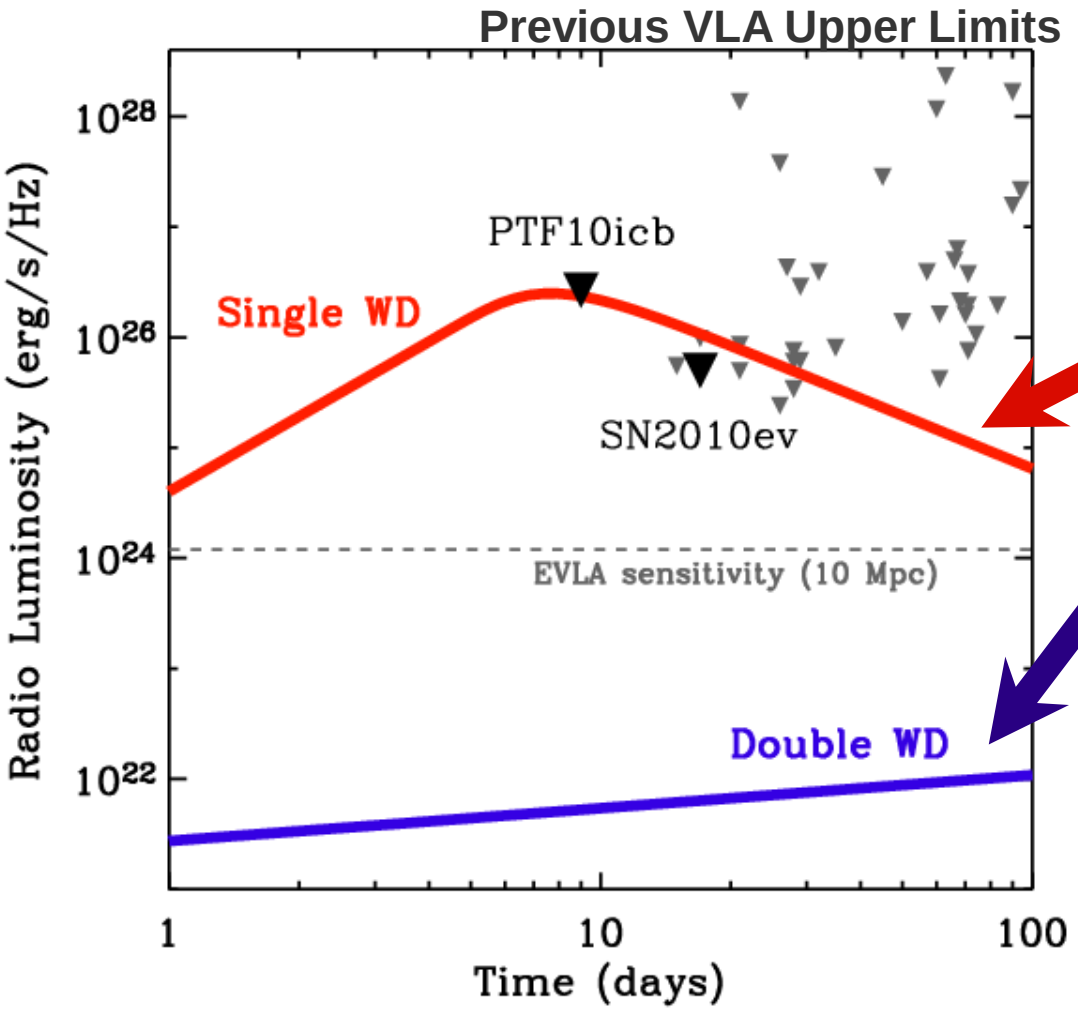
EVLA first light (March 2)
z=0.9 CH stimulated emission



N. Kanekar

NRAO

Transient Universe
Revealing the Progenitors of Type Ia Supernovae



AS1020 (PI Soderberg)
10 hrs RSRO 4-configs.

Observations:
ToO's for all SNe Ia < 30 Mpc (8 per year)

Single White Dwarf:
SN shock-accelerates DONOR star's wind

Double White Dwarf:
SN shock-accelerates ISM

2 EVLA obs since April:
PTF10icb and SN2010ev
(rms 10-20 uJy)

Best limits to date, ***already at odds with SWD model...***

NRAO

(immediate) Future Directions: accepted RSRO programs Realizing DS2010 vision

I. Cosmology and Fundamental Physics

- Soderberg — Exotic Explosions, Eruptions, and Disruptions: A New Transient Phase-Space
- Soderberg — EVLA Can Reveal the Nature of Type Ia Supernova Progenitors
- Myers — An EVLA 30 GHz Survey of the CBI2 COSMOS Deep Field Region
- Russell — Testing the requirements for jet production in accreting black holes
- Fomalont — The Lobes of Fornax-A at 5 GHz

II. Galaxies across cosmic time

- Momjian — An unbiased K,Ka,and Q-band absorption survey at z=0.88582 towards B1830-210
- Owen — CO 1-0 in a proto-cluster at z=2.4
- Aravena — Deep search for CO line emission in a cluster of star-forming galaxies at z=1.5
- Owen — The Magnetized Intracluster Plasma
- Kellermann — Bimodal Luminosity Distribtion of QSOs: Starbursts and AGN?

III. Planetary Systems and Star Formation

- Chandler — Grain growth and sub-structure in protoplanetary disks
- Butler — Observations of Pluto/Charon and the Largest TNOs
- Brogan — A Diagnostic K-band Survey of Massive Young (Proto)stellar Objects
- Takahashi — A Millimeter Study of the Embedded Star-Cluster in the Orion Molecular Cloud
- Hofner — Deep Radio Continuum Observations of Massive Proto-Stars

(immediate) Future Directions: accepted RSRO programs

IV. Galactic neighborhood

- Wrobel A High Resolution Mosaicing of Large-Scale Leo HI Ring (Primordial vs. Stripped)
- Leroy Resolving the Starbursts in Nearby LIRGs and ULIRGs
- Heesen Star formation and magnetic fields in dwarf galaxies
- Kepley Quantifying the Dense Thermal Gas in Nearby Star-forming Galaxies
- Marvil A sensitive, multi-frequency continuum study of M82 and NGC2146
- Momjian Resolved Physics and Chemistry in Nearby Star Forming Galaxies
- Ott The Massive Star/ISM Interplay in the Galactic Center: An EVLA Pilot Study

V. Stars and stellar evolution

- Claussen Imaging Line Surveys of Circumstellar Envelopes: A Pilot Project
- Sokoloski What Shape Are Novae? --- Early Radio Emission from Nova Explosions
- Bastian Dynamic Spectroscopy of the Radio Flares on AE Aquarii
- Hallinan Broadband Periodic Dynamic Spectra of Ultracool Dwarf Pulsars
- Miller-Jones Testing the radio/X-ray correlation in quiescent black hole X-ray binaries
- White Deep Observations of Crowded Stellar Fields

- Continuing legacy: Broad impact
- Special issue for ApJ: planned for Spring 2011

END