



International
Centre for
Radio
Astronomy
Research



ICRAR is a partnership between The University of
Western Australia and Curtin University of Technology

The James Clerk Maxwell Telescope Nearby Galaxies Legacy Survey (NGLS) and Submillimetre Synergies with HI Observations



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NGLS Team

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Also: James Dunlop, Mike Fich, Tracy Webb, Bernd Weferling, Ernie Seaquist, Rob Ivison, Paul Alexander, Dave Green, Thijs van der Hulst, Rupinder Brar, Kristen Coppin, Alexandra Pope, Anna Sajina, Jason Stevens, Steve Eales, David Alexander, Jon Davies, Stéphane Côté, Pat Cote, Carrie Bridge, Mathew Page, Mike Hudson, Mattia Vaccari, Nial Tanvir, Brenda Matthews, Colin Borys, Dimitra Rigopoulou, David Hughes, Eelco van Kampen, Loretta Dunne, Pierre Chanial, Mattia Negrello.

The James Clerk Maxwell Telescope, Mauna Kea, Hawaii

- 15m submillimetre telescope.
- Upgraded 2005-06 in anticipation of new continuum and spectral line instrumentation.
- HARP-B operational in 2007. SCUBA2 being recommissioned.



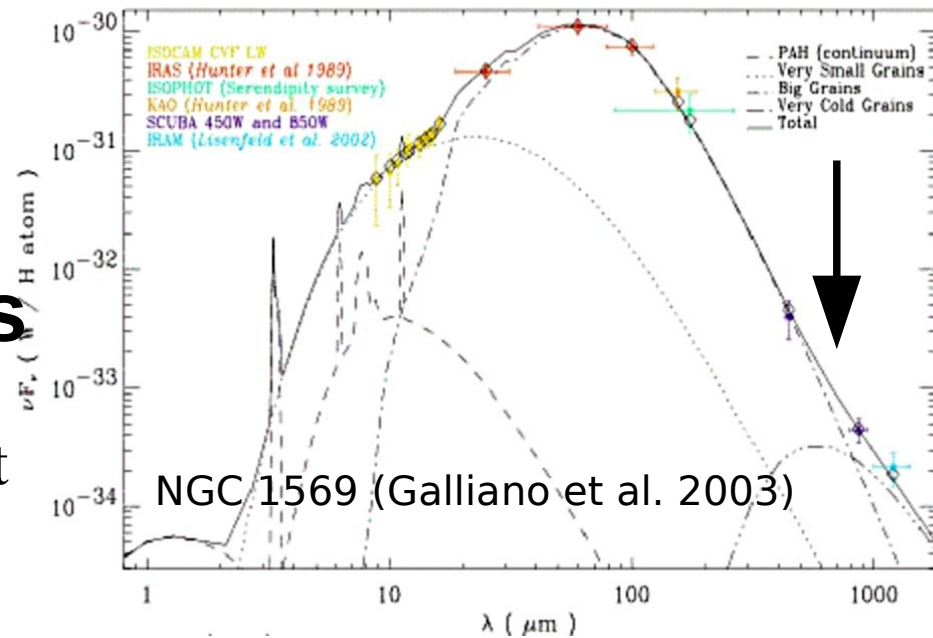
The Nearby Galaxy Legacy Survey (NGLS)

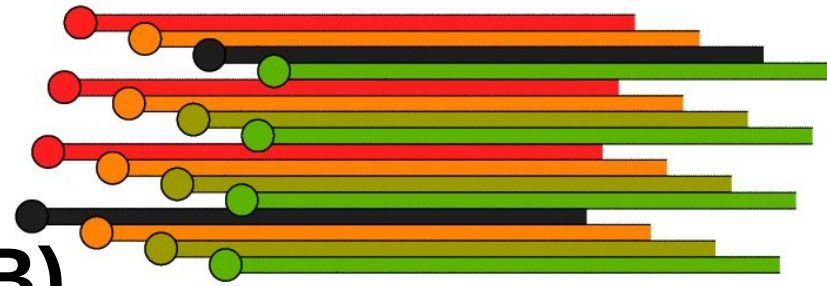
- Submillimetre survey of 155 galaxies, 2-25 Mpc, $b > \pm 25^\circ$, $\text{Dec} > -25^\circ$.
- HI selected sample, 72 field galaxies, 36 in Virgo, 47 SINGS galaxies, types E to Irr.
- Continuum observations at 850 & 450 μm (SCUBA2), and ^{12}CO J=3-2 line observations (HARP-B).
- 325 hours allocated. HARP-B program ran from April 2007 to Nov 2009. SCUBA2 program yet to start.



NGLS Scientific Goals

- Search for evidence of cold dust and measure its mass fraction.
- Measure amount of warm dense molecular gas.
- Search for variations in physical conditions in ISM as a function of galaxy type, metallicity, environment, star formation rate, and mass.
- Measure local submillimetre luminosity function and mass function 100x fainter than previous studies.
- Comparison with other ISM and SF tracers (HI, warm dust, other molecular tracers).





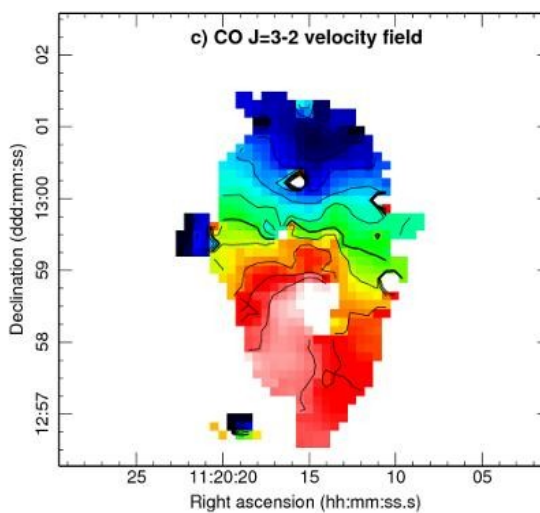
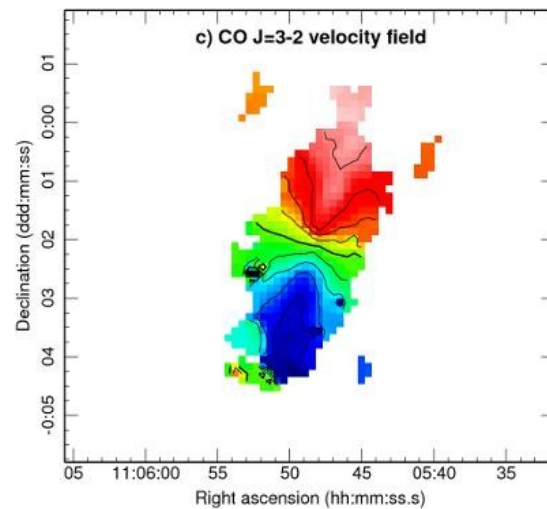
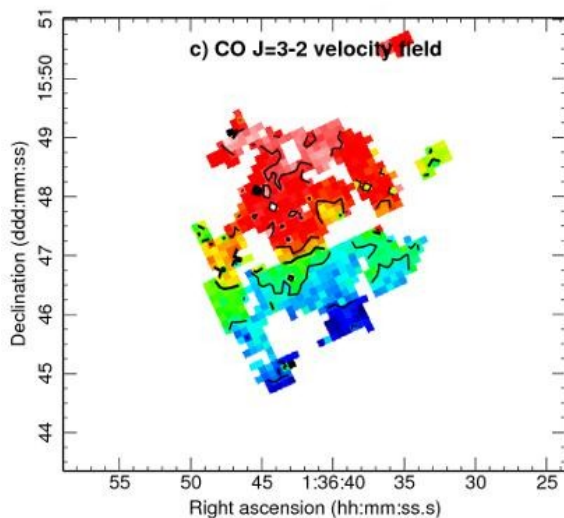
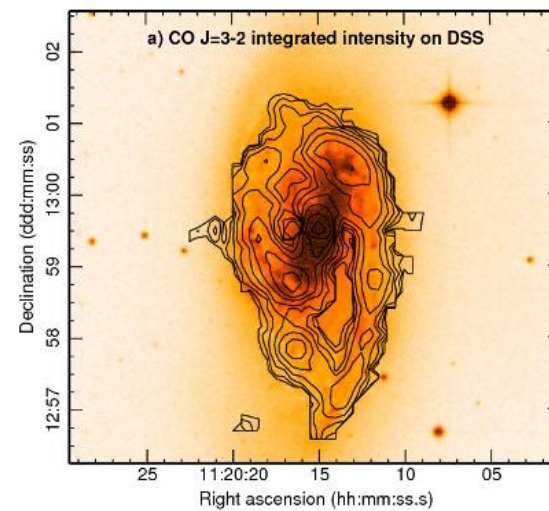
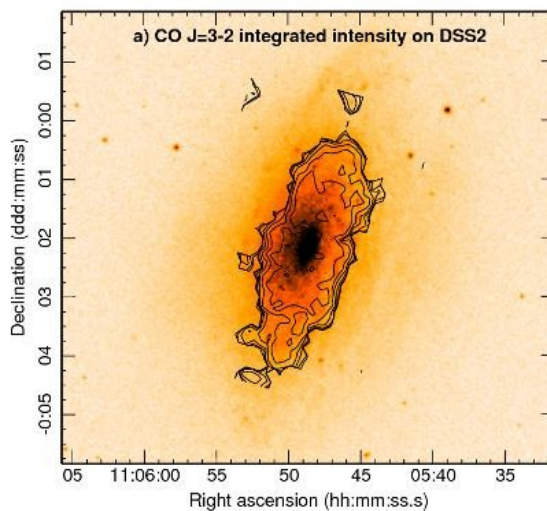
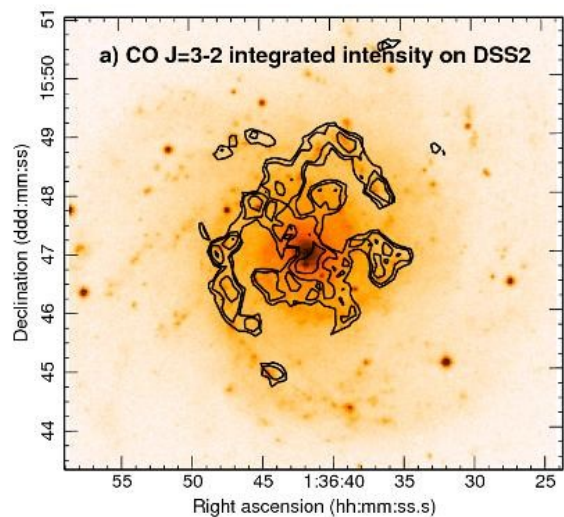
^{12}CO J=3-2 line (HARP-B)

- Each galaxy to be mapped out to $D_{25}/2$ in ^{12}CO J=3-2 line (rest frequency ~ 345 GHz).
- 16 element Heterodyne array in a 4×4 pattern sparsely sampled $2' \times 2'$ FoV, $14.5''$ beams with $30''$ separation, need jiggle ('dither') or raster scanning pattern.
- ACSIS backend, 2000 channels over ~ 1 GHz bandwidth (488.28 kHz resolution, or 0.423 km s^{-1}).
- Target rms of 19 mK (T_A^*) at 20 km s^{-1} binning, which was usually achieved with 70 - 75 s per pointing ($T_{\text{sys}} \sim 500\text{K}$).

Molecular gas in three SINGS spirals

- Warren et al. 2010 (Paper II)
- Three of the strongest ^{12}CO J=3-2 detections.
- All three are SINGS targets, large fields done in raster mode, sub-kpc resolution, extensive ancillary data from other surveys.
- Able to compare multiple ISM components and SF tracers locally.

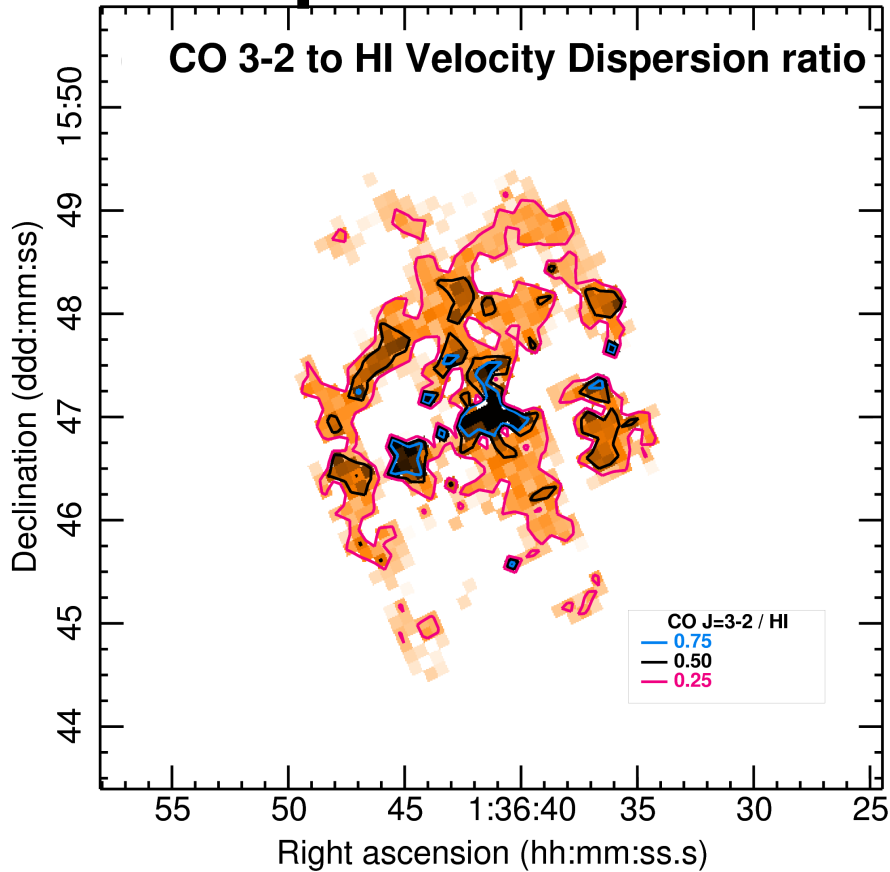
NGC 628, NGC 3521, and NGC 3627



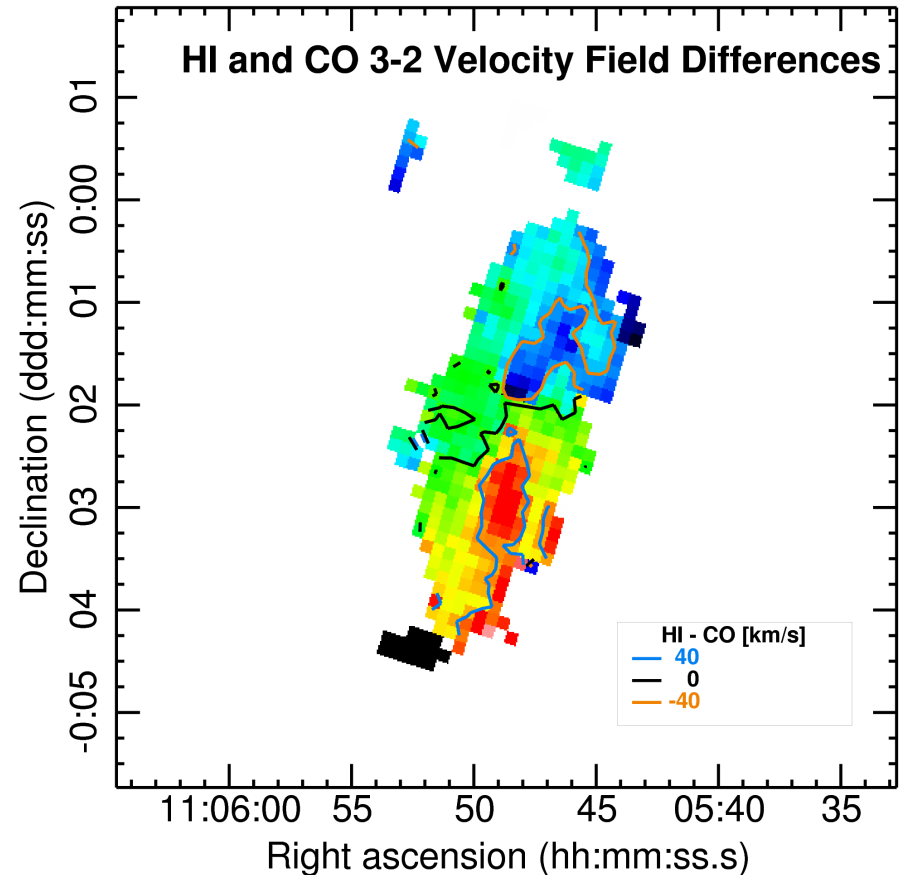
Ancillary Data

- NGC 628, NGC 3521, and NGC 3627 are all included in the SINGS sample (Kennicutt et al. 2003).
- 24 μm and $\text{H}\alpha$ from SINGS \rightarrow SFR using Calzetti et al. (2007).
- H I data from THINGS (Walter et al. 2008).
- NGC 3521 and NGC 3627 have ^{12}CO J=1-0 from Nobeyama 45m telescope (Kuno et al. 2007).
- NGC 628 has ^{12}CO J=1-0 from BIMA SONG (Helfer et al. 2003)
- All ancillary data smoothed to JCMT beam.

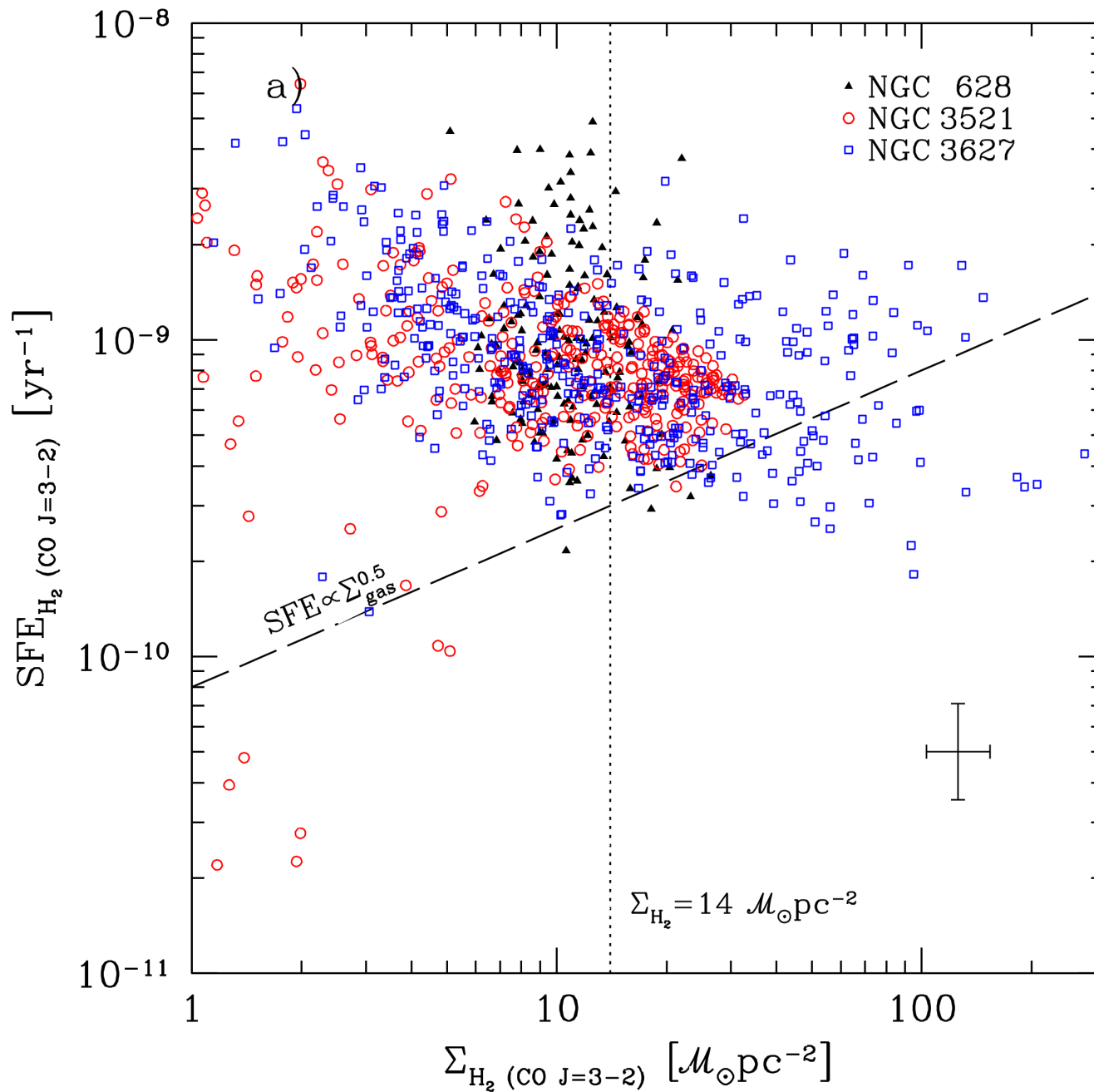
NGC 628 velocity dispersion ratio



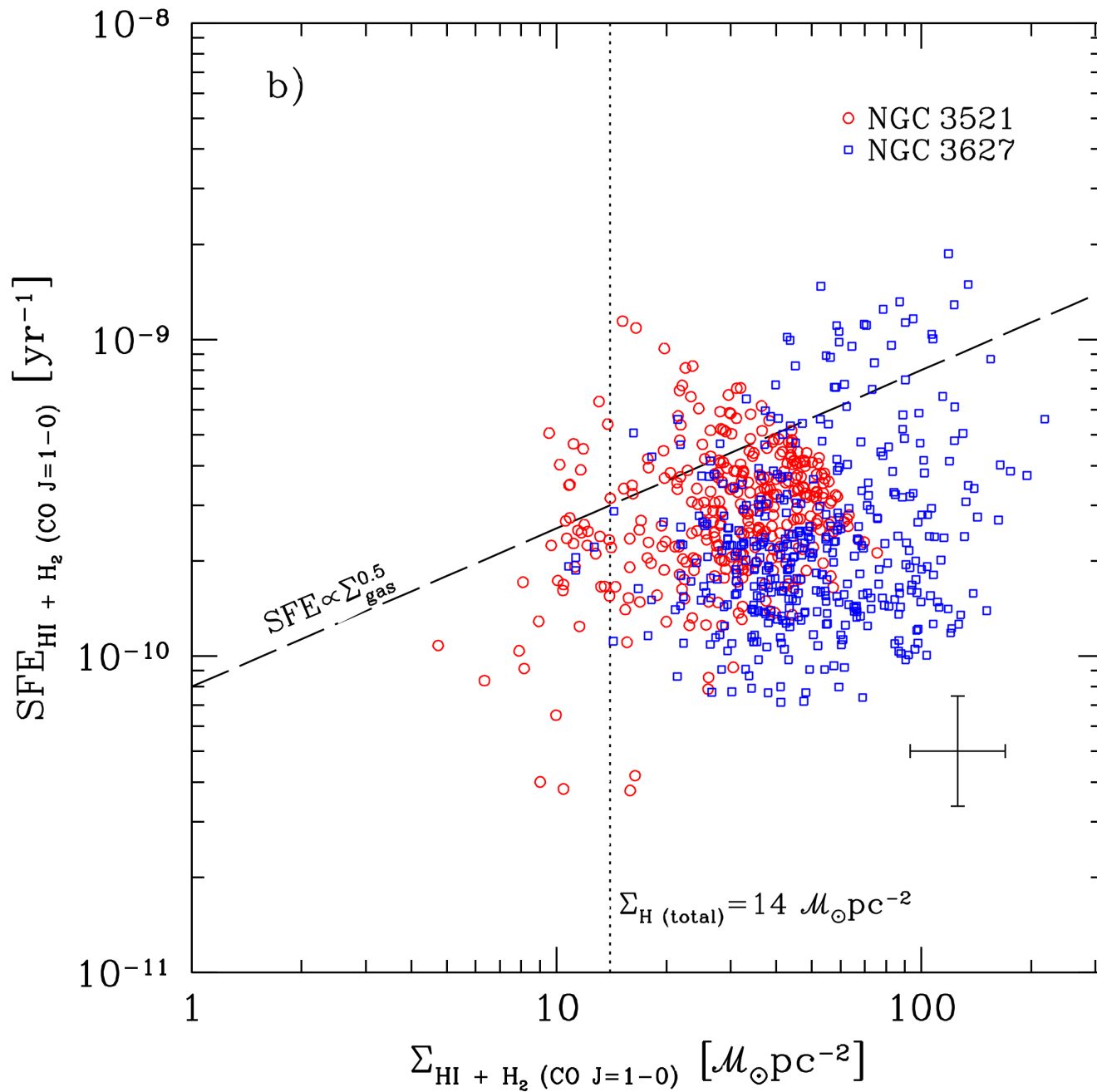
NGC 3521 velocity field difference

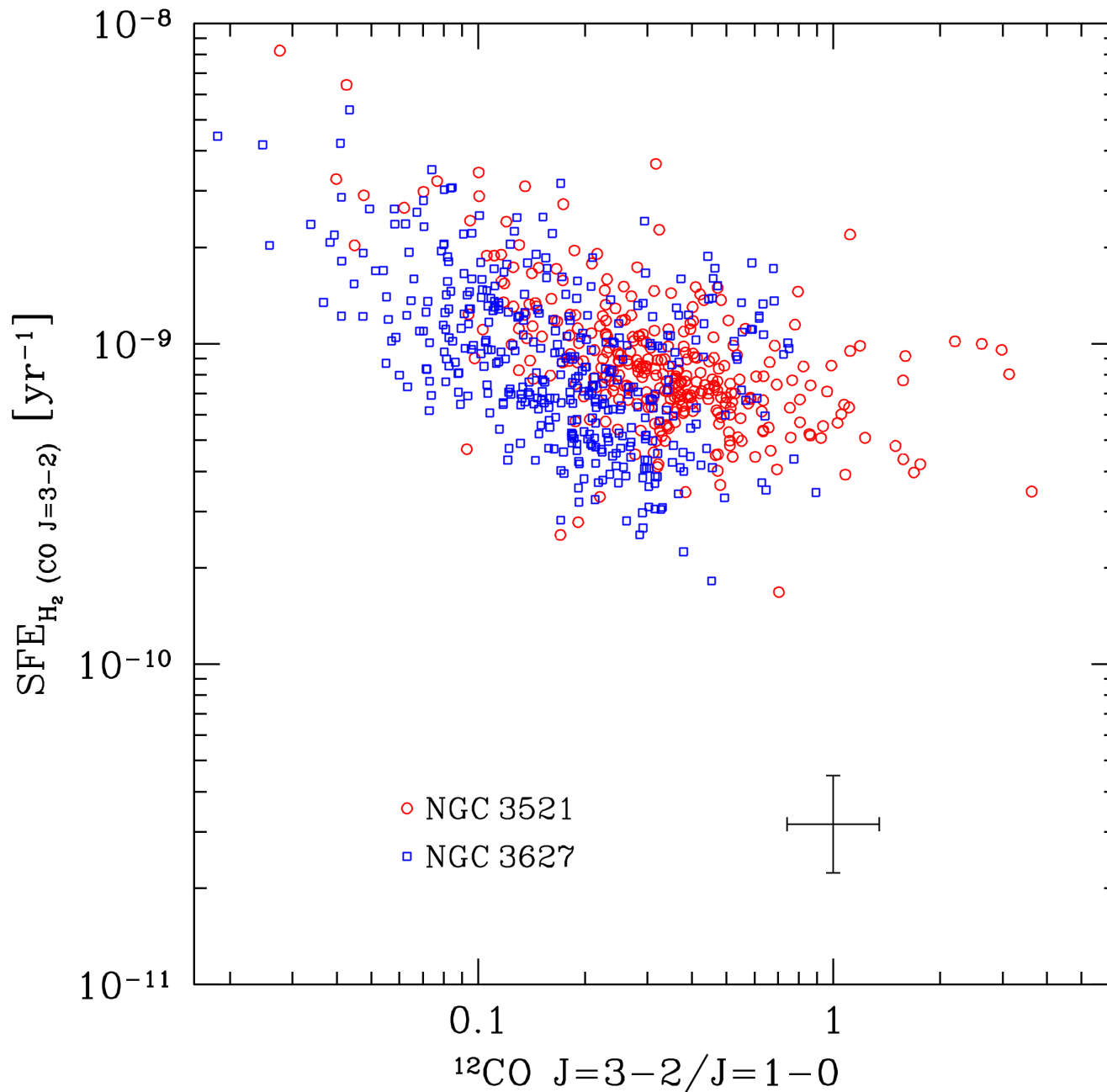


THINGS cubes kindly provided by Fabian Walter



Based on Leroy et al. (2008)





Opposite trend found in M83 by Muraoka et al. (2007)

Other investigations

- Wilson et al. 2009 (Paper I)
 - Investigation of four SINGS galaxies in Virgo.
 - Three have good CO detections.
 - Instantaneous CO gas depletion times 1.1-1.7 Gyr.
 - Environmental effects on depletion time.
- Bendo et al. 2010 (Paper III)
 - Comparison of cold dust, PAHs, CO, and HI in NGC 2403.
 - Gas-to-dust ratio increases monotonically with radius, slope similar to oxygen abundance.
 - CO and PAHs surface brightness uncorrelated on sub-kpc scales.

Other investigations

- Wilson et al. 2010 in press (Paper IV)
 - Analysis of 12 spirals with low dispersion velocities.
 - Average cloud-cloud velocity dispersion $\sim 6 \text{ km s}^{-1}$, about half of the HI vel. disp. in the same galaxies.
 - Molecular gas the critical component determining the stability of gas disc.
- Irwin et al. 2010 in press (Paper V) astro-ph/1008.4058
 - Molecular outflow in NGC 4631.
 - CO follows hot dust component, not cold dust.
 - Anomalous feature in velocity field seen, previously seen in $^{12}\text{CO J}=1-0$ as an expanding shell.

Multi-wavelength Synergies

- CO J=3-2 is most useful in combination with other ISM tracers.
- All NGLS galaxies detected in HI (selection criteria!), but less than half have observations with comparable resolution.
- The 47 SINGS galaxies in our sample are well represented at most wavelengths, especially HI (e.g. from THINGS).
- Many Virgo galaxies have good HI (e.g from VIVA)
- The field sub-sample has little ancillary data.
- WALLABY + WNSHS should cover the whole sample.
- IR (SINGS, KINGFISH, etc.)

Thank You

**(Not quite ideal observing conditions,
Science Verification run, July 2007)**

