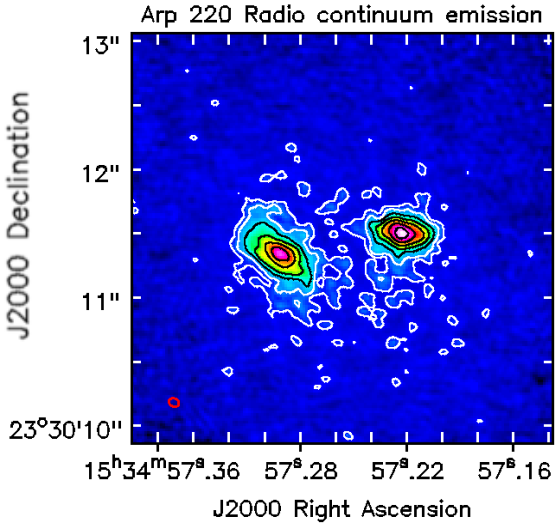
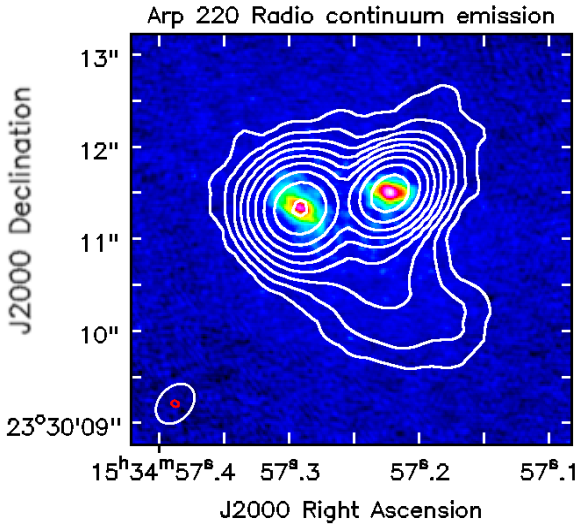
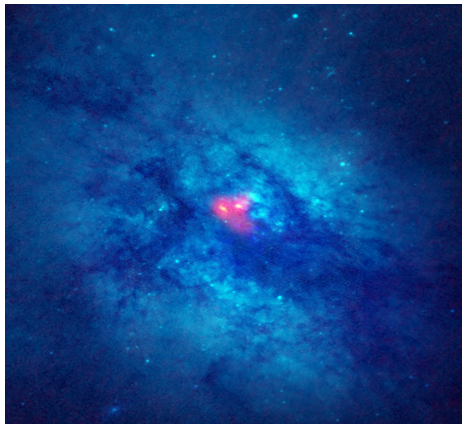
High Resolution Radio Continuum Measurements of the Nuclear Disks of Arp 220







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Local U/LIRGs: Key Questions

Are they really maximal starbursts?

➡ What is the nature of their energy source?

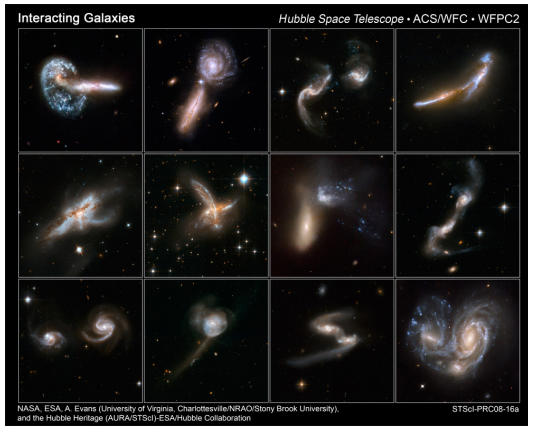
Where do they lie in the S-K law?

➡ Are there really "two sequences?"

What physics govern radio emission from U/LIRGS?

➡ What is their local thermal fraction?

What is their true nuclear size?



GOALS

Radio continuum as a tool to study compact nuclei

Condon et al. (1991), Condon (1992)

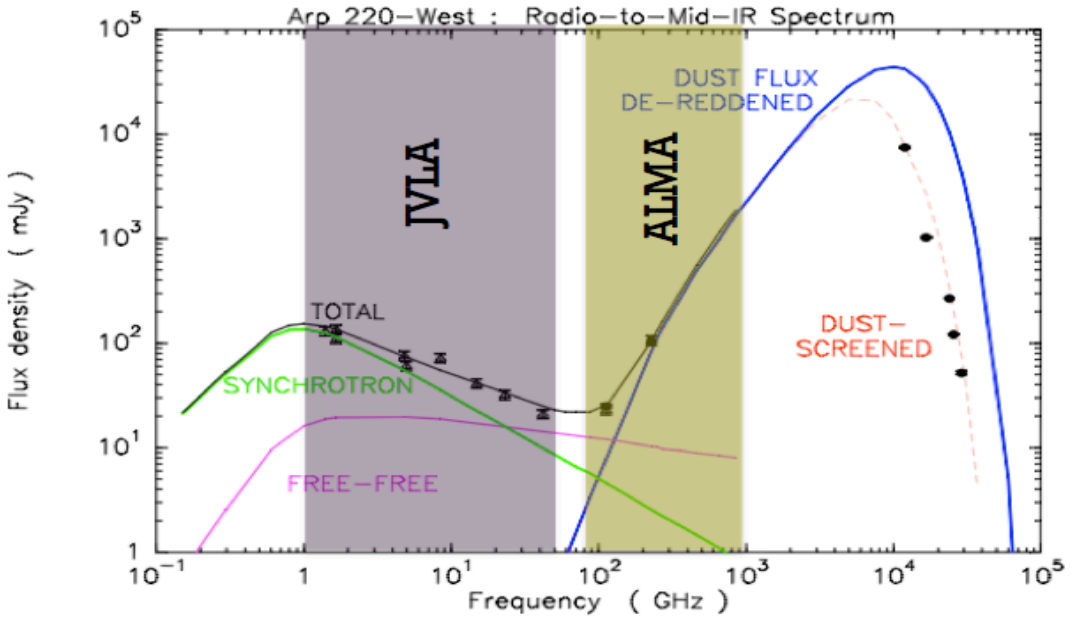
- **Not affected by extinction.**
- Radio interferometers achieve very **high angular resolution.**

True sizes of the nuclear star forming parts.

SF tracer (e.g., Murphy+2012, Eric Murphy's talk, Dillon Dong's poster.)

- **Isolate thermal and non thermal emission**.
- **AGN diagnostic**: Brightness temperatures, sizes (compact cores), SB density.

Downes & Eckart 2007

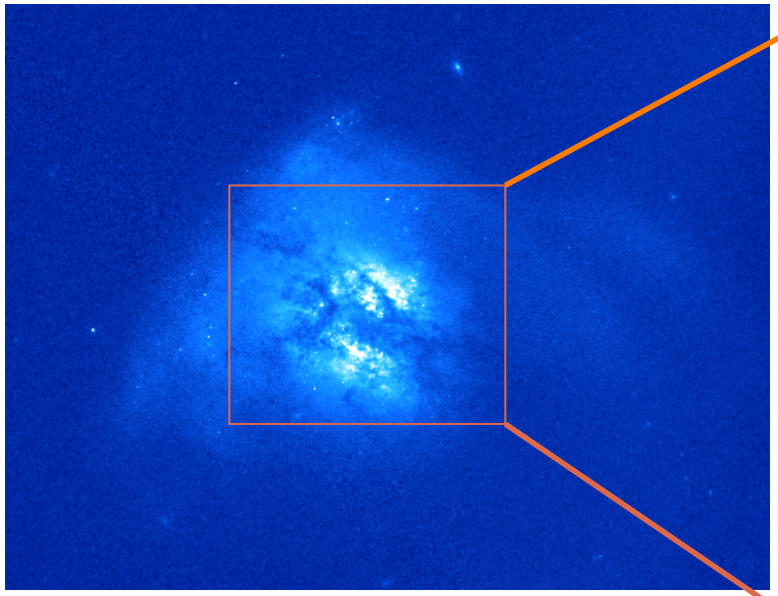


Nature of energy source (SB/AGN)

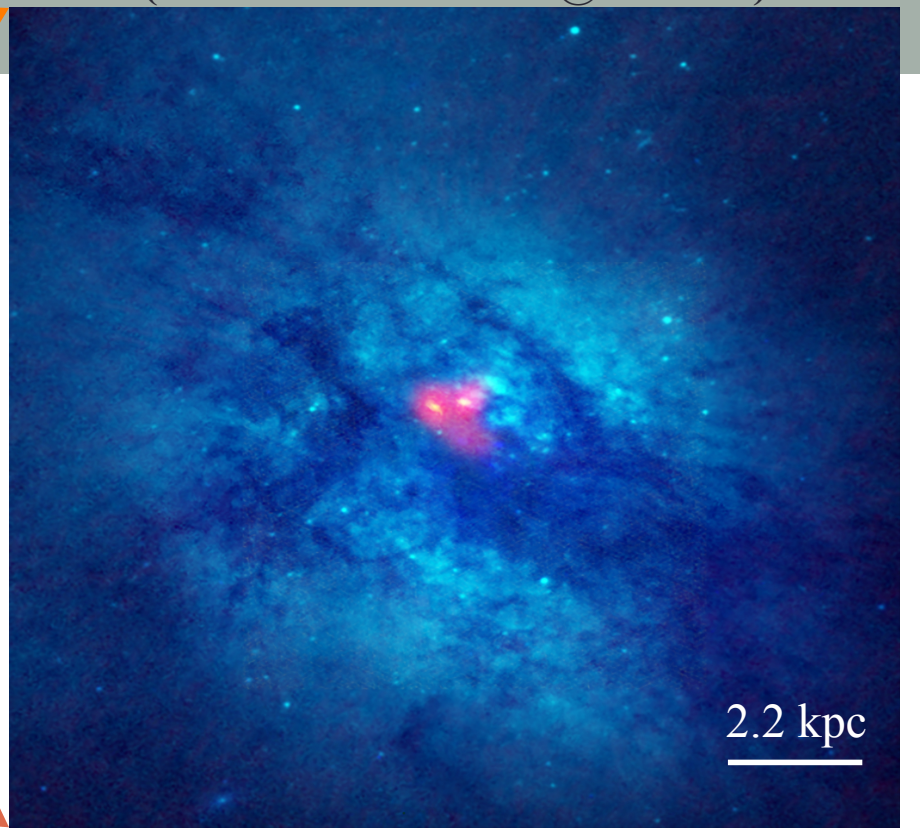
CAVEAT: Not definitive when ruling out AGN!

Arp 220

(Credit: Hubble Space Telescope)



(Credit: Bill Saxton @ NRAO)



- VLA (A, B, C, D configurations)
- 1 out of 22 galaxies (Thesis sample).
- Ka band - 33 GHz: ~ 56 min total on source.
0.08” x 0.06” (30 x 23 pc). rms ~23 μJy/beam.
- C band - 6 GHz: ~ 40 min total on source.
0.48” x 0.35” (117 x 129 pc). rms ~14 μJy/beam.

$L_{IR\ [8\text{-}1000\mu m]} \sim 10^{12.16}\ L_{\odot}$

$d_L = 77.2$ Mpc

1”= 369 pc

Main Results

Barcos-Muñoz et al. submitted

① We heavily **resolved** both nuclei in Arp 220.

② Radio emission physically **coincides** with gas, hot dust and RSN/SNR.

③ 33 GHz emission well described by **exponential** distribution.

④ The nuclear disks are the **most extreme starburst environments** in the local universe.

⑤ **Synchrotron** produces most of the 33 GHz emission. Thermal emission may be suppressed.*

⑥ We find **no new evidence** for a dominant AGN in the western nucleus (but radio is not good at ruling out AGN).*

*Ask if interested

Radio emission physically coincides with gas, hot dust and RSN/SNR

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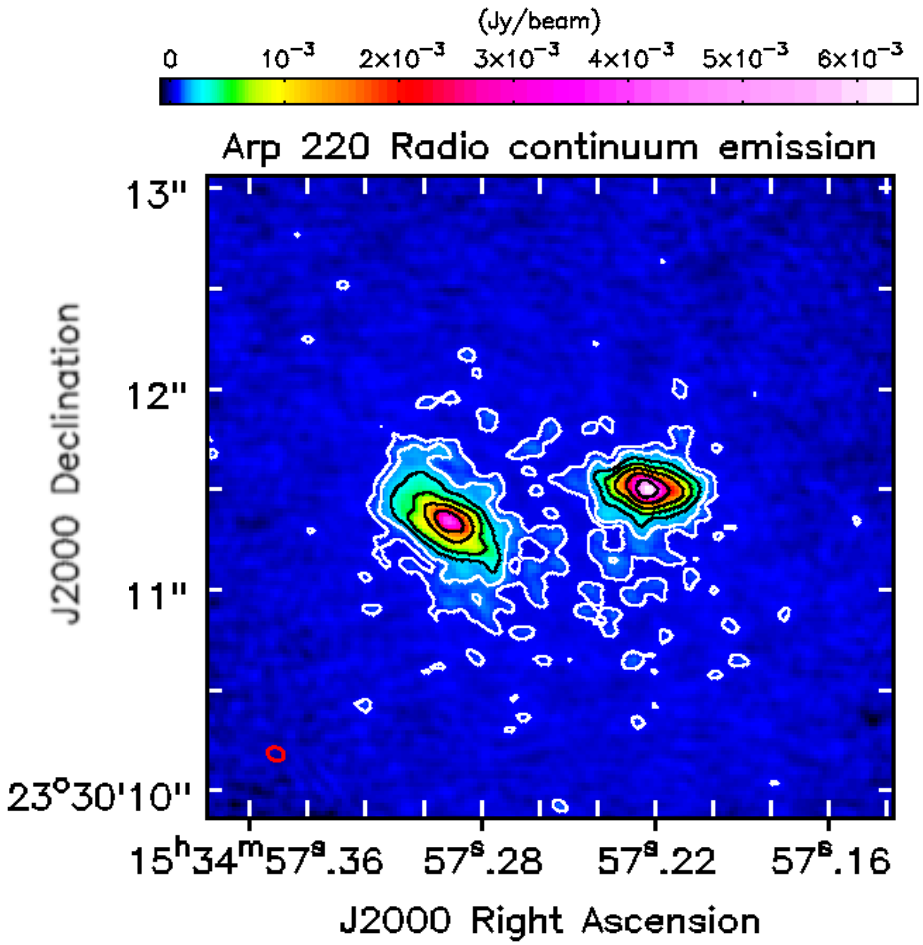
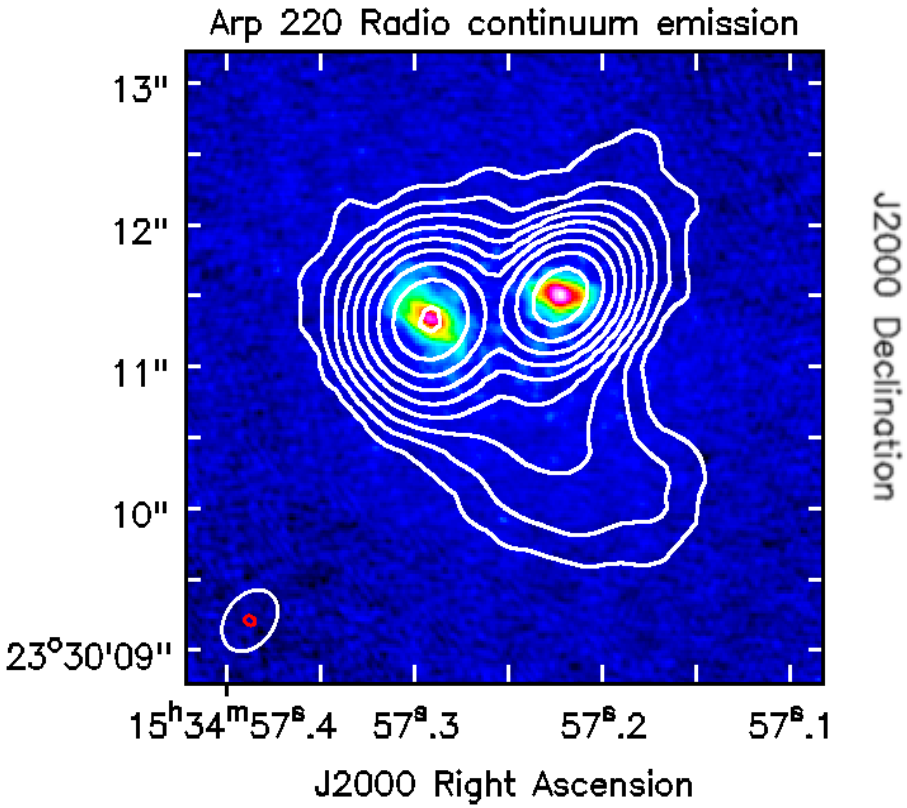
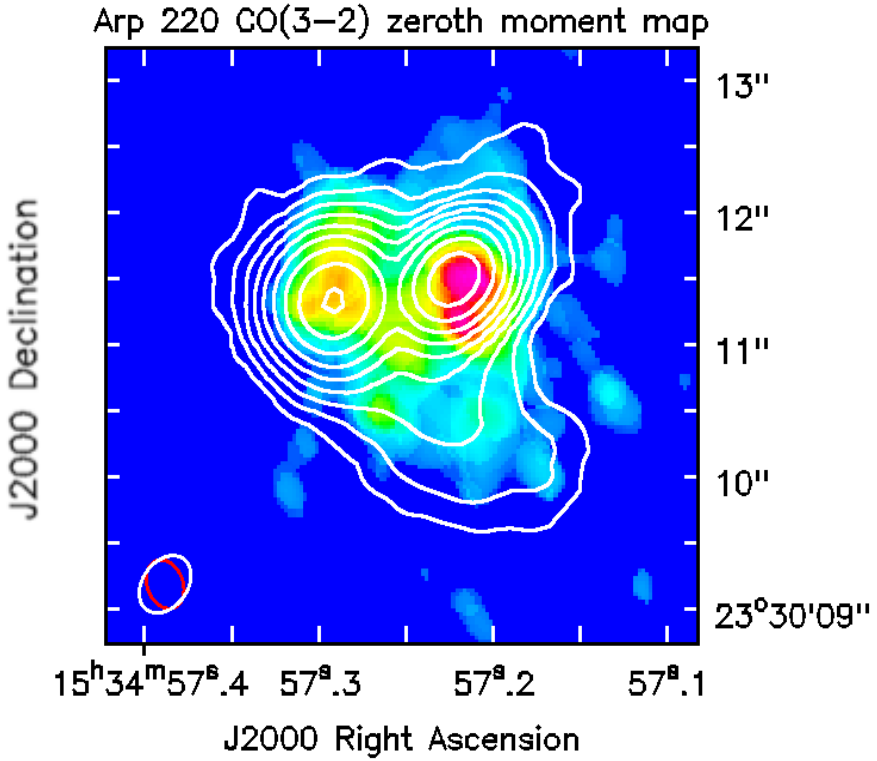


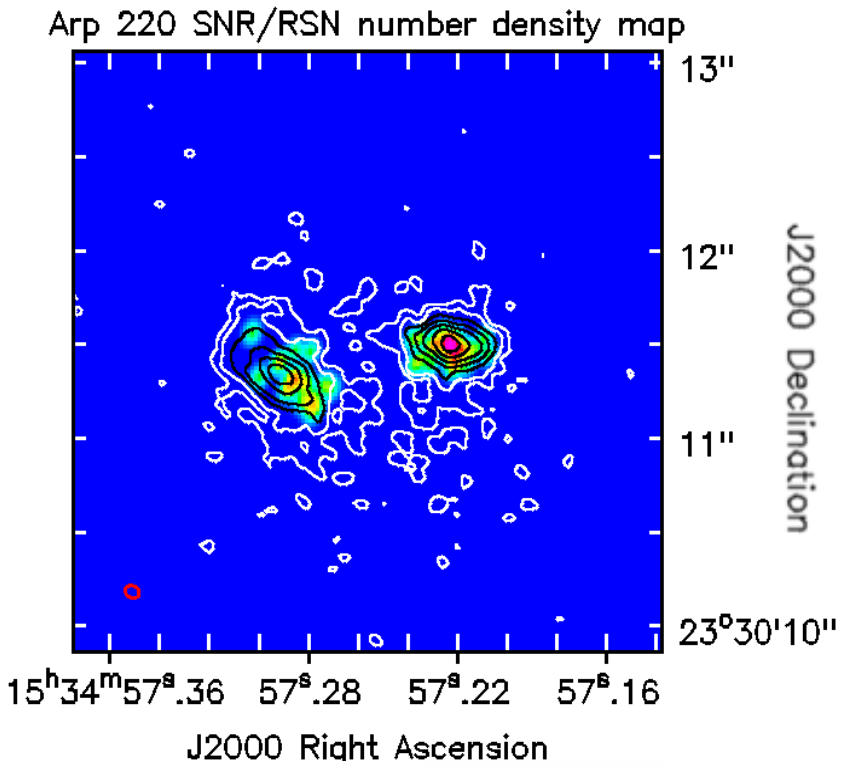
33 GHz



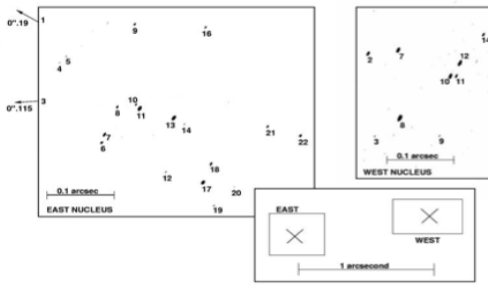
33 GHz + 6 GHz contours

Radio emission physically coincides with gas, hot dust and RSN/SNR



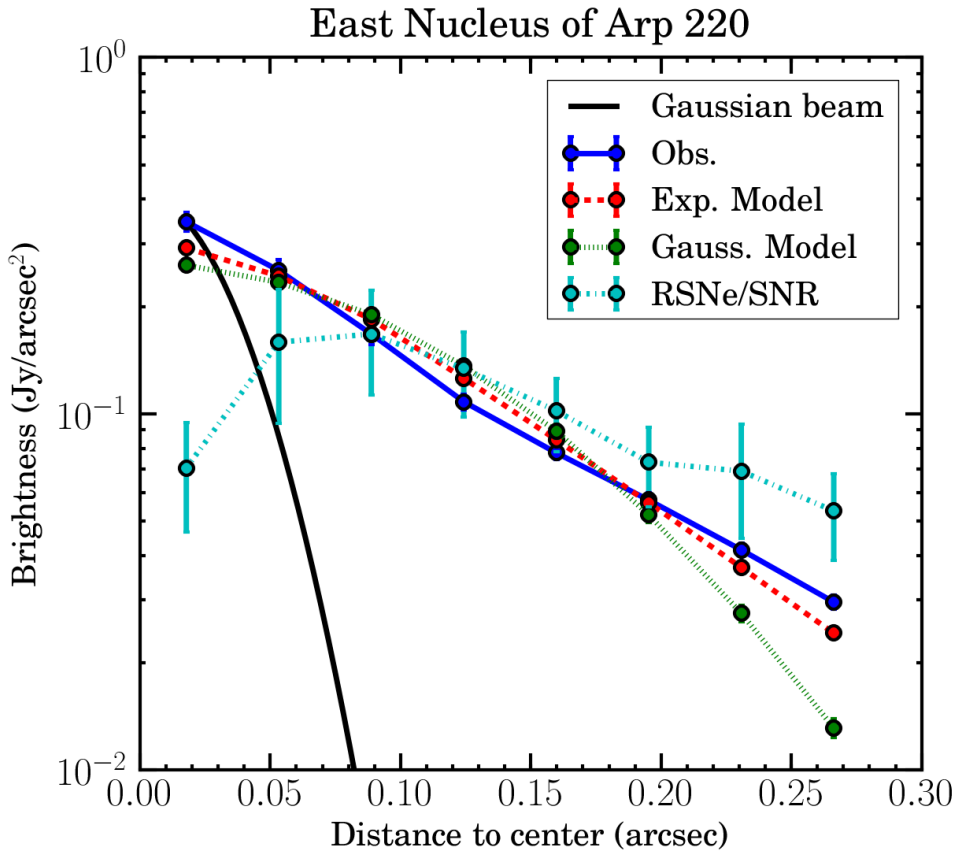


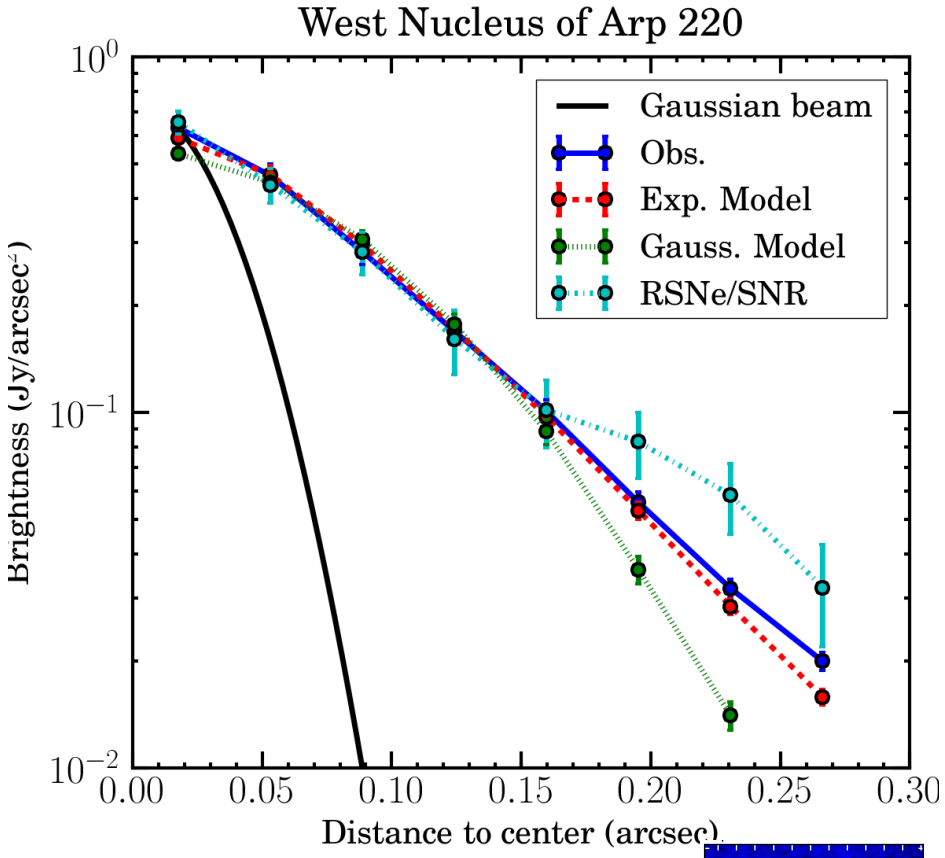
- **6 GHz synchrotron emission originates, broadly, from the same region as CO (3-2) (Sakamoto+08)**
- **33 GHz emission follows distribution of recent star formation**



Lonsdale et al. 2006

33 GHz emission well described by exponential distribution

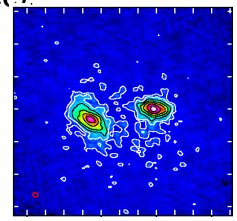




Scale length: ~ 30 pc (east) and 21 pc (west)

R_{50} ~ 51 pc (east) and 35 pc (west)

Barcos-Muñoz et al. submitted



The most extreme SBs environments in the local universe

Derived Physical Quantities

Parameter	East nucleus	West nucleus	Compare to MW
Σ_{SFR} ($M_\odot$ yr^{-1} kpc^{-2})	$10^{3.7\pm0.1}$	$10^{4.1\pm0.1}$	~ 0.1 - 10
Σ_{gas} ($M_\odot$ pc^{-2})	$2.2^{+2.1}_{-1.0}$ x 10^5	$4.5^{+4.5}_{-1.9}$ x 10^5	~ 100
N(H) (cm^{-2})	$2.7^{+2.7}_{-1.2}$ x 10^{25}	$5.6^{+5.5}_{-2.4}$ x 10^{25}	~ 10^{22}
n_{H2} (cm^{-3})	$3.8^{+3.8}_{-1.6}$ x 10^4	$11^{+12}_{-4.5}$ x 10^4	~ 100
Σ_{IR} ($L_\odot$ kpc^{-2})	$4.2^{+1.6}_{-0.7}$ x 10^{13}	$9.7^{+3.7}_{-2.4}$ x 10^{13}	~ 2 x 10^{12}

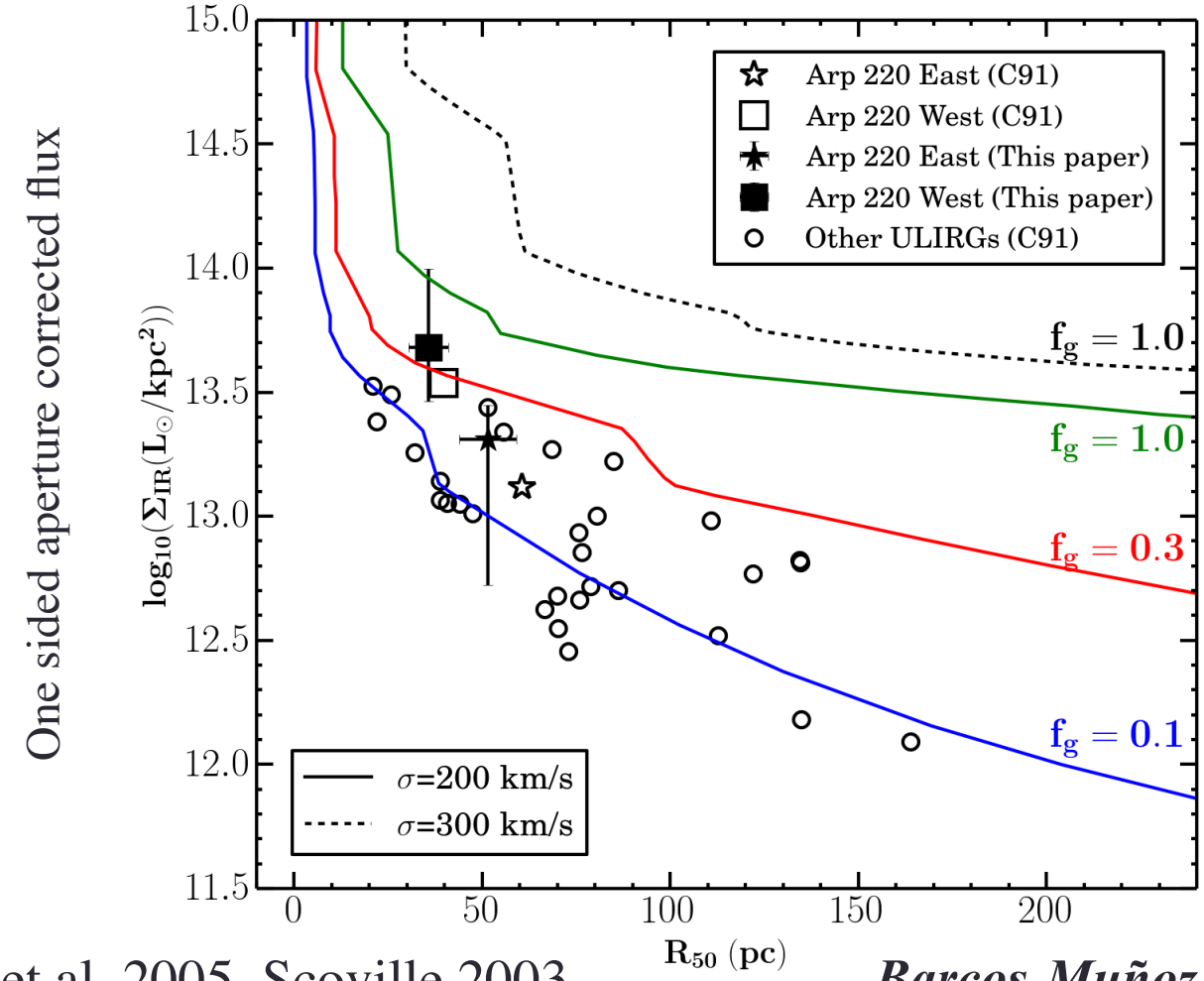
Soifer+2000, Lada+2010

Properties within the half-light radius.

$$\Sigma_{IR} = \left(\frac{L_{IR}[8-1000\mu m]}{2\ A_{50}}\right)$$

Barcos-Muñoz et al. submitted

The most extreme SBs environments in the local universe



Thompson et al. 2005, Scoville 2003

Barcos-Muñoz et al. submitted

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1 system out of 22 ==> Stay tuned!!*

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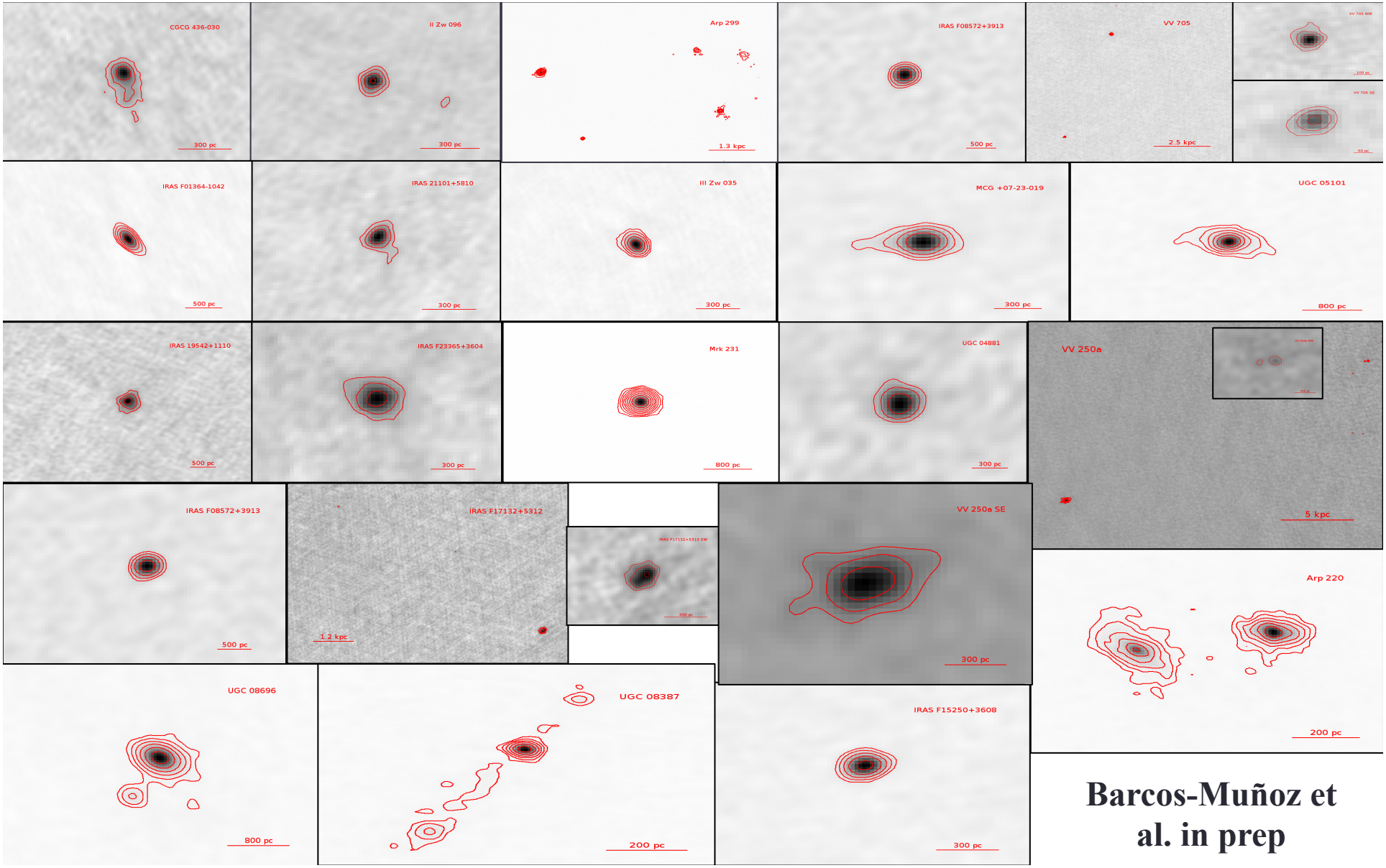

Barcos-Muñoz et al. in prep