The e-MERLIN legacy project *LIRGI*:
Luminous InfraRed Galaxy Inventory

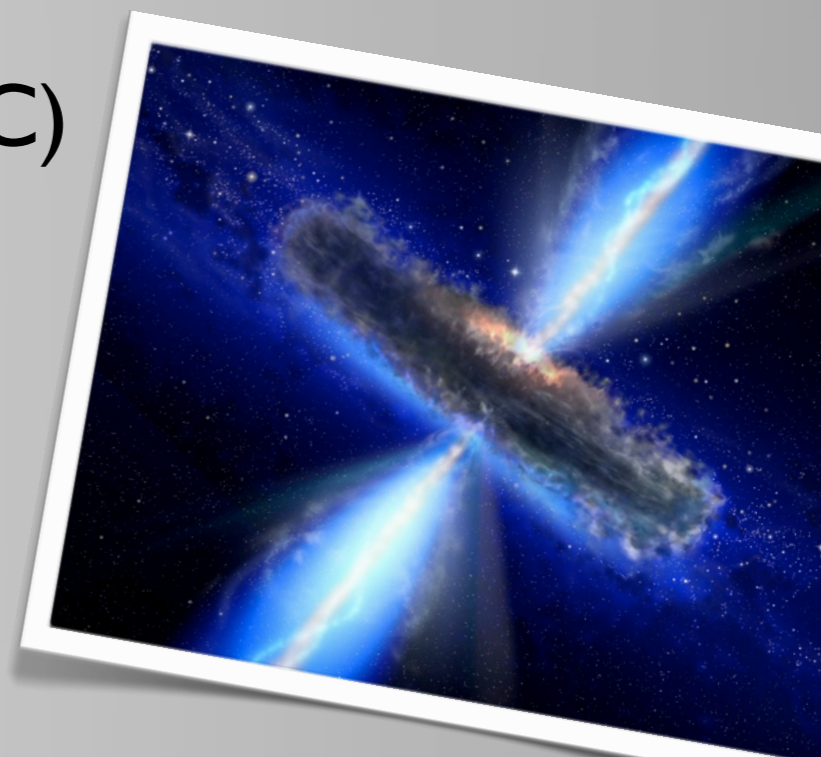Rubén Herrero-Illana (IAA-CSIC)

Eskil Varenius (OSO)
John Conway (OSO)
Miguel Á. Pérez-Torres (IAA-CSIC)
Antxon Alberdi (IAA-CSIC)
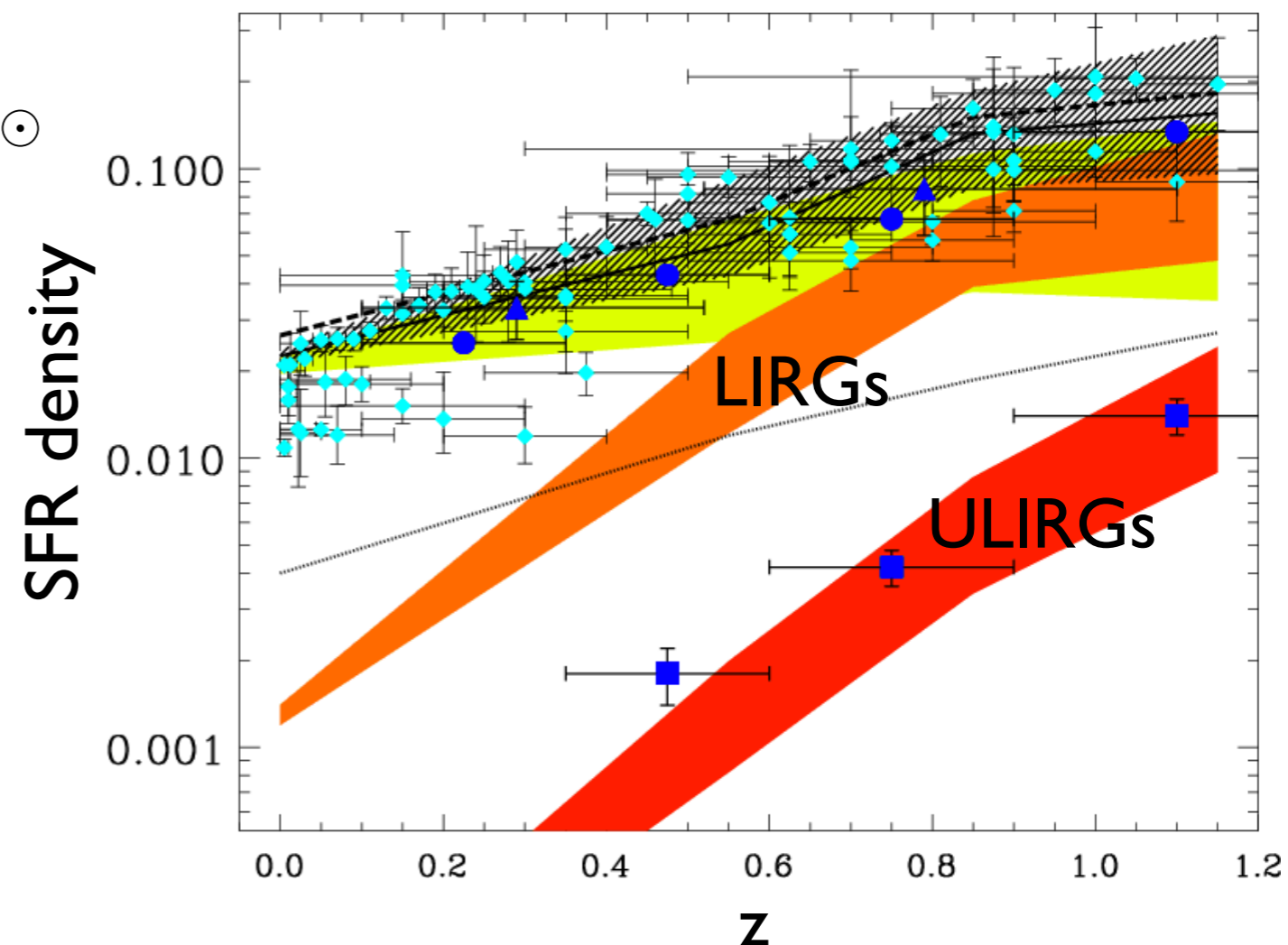Naím Ramírez-Olivencia (IAA-CSIC)

...on behalf of the LIRGI collaboration

LIRGs & ULIRGs

- LIRGs: $10^{11} L_\odot \leq L_{IR} \leq 10^{12} L_\odot$

- ULIRGs: $L_{IR} \geq 10^{12} L_\odot$

- AGN vs Starburst

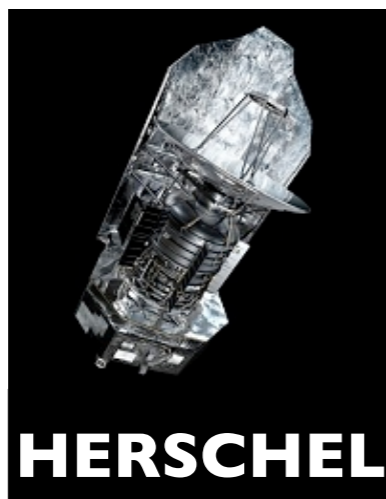- Significant fraction of the SF at high-z took place in (U)LIRGs

Magnelli et al. 2009

Motivation

A major goal of new generation radio/mm/sub-mm facilities is to use high-z objects to trace the star formation history of the Universe
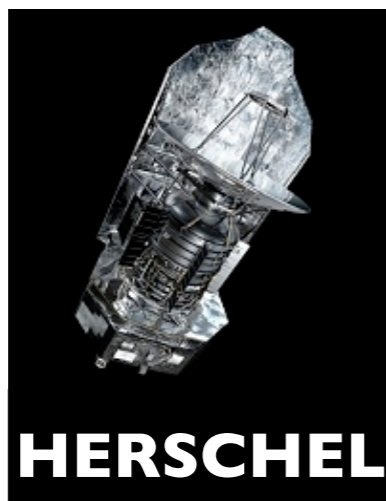
Motivation

A major science goal of the next generation radio/mm/sub-mm facilities is to use high-z observations to chart the star formation history of the universe

LIRGI overview

J. Conway   M. Á. Pérez-Torres

- Luminous Infra-Red Galaxy Inventory   http://lirgi.iaa.es

- 42 of the most luminous northern LIRGs.
  Similar properties to SF galaxies at high-z

- L_{IR} > 11.4   D < 250 Mpc

- Dec > 8°

- 6 and 18 cm observations   -   353 hours

- *rms* of 4 μJy/beam for 4 hours integration time

LIRGI people

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Antxon Alberdi	IAA-CSIC, Granada, Spain
Phil Appleton	NASA Herschel Science Center, Caltech, USA
Willem Baan	ASTRON, The Netherlands
Fabien Batejat	Onsala Space Observatory, Chalmers, Sweden
Rob Beswick	JBCA, Manchester, UK
Luis Colina	DAMIR, Madrid, Spain
John Conway	Onsala Space Observatory, Chalmers, Sweden
Francesco Costagliola	IAA-CSIC, Granada, Spain
Phil Diamond	JBCA, Manchester, UK
Denise Gabuzda	University College Cork, Ireland
Simon Garrington	JBCA, Manchester, UK
Rubén Herrero-Illana	IAA-CSIC, Granada, Spain
Hans-Rainer Klockner	Oxford, UK
Colin Lonsdale	MIT, Cambridge, USA
Iván Martí-Vidal	Onsala Space Observatory, Chalmers, Sweden
Sebastien Muller	Onsala Space Observatory, Chalmers, Sweden
Carole Mundell	John Moores University, Liverpool, UK
Ray Norris	CSIRO, Australia
Miguel Ángel Pérez-Torres	IAA-CSIC, Granada, Spain
Rodrigo Parra	ESO, Chile
Ylva Pihlström	University of New Mexico, USA
Mónica Rodríguez	IAA-CSIC, Granada, Spain
Cristina Romero-Cañizales	IA, Pontificia Universidad Catolica, Chile
José-María Torrelles	CSIC-IEEC, Barcelona, Spain
Eskil Varenius	Onsala Space Observatory, Chalmers, Sweden

The sample

- Obtained from IRAS revised Bright Galaxy Catalogue (*Sanders et al. 2003*)

- $L_{IR} > 11.4$ D < 250 Mpc

- Dec > 8° - Significant source overlap with ALMA

- Complementary to GOALS   (*Armus et al. 2009*)

GOALS Great Observatory All-sky LIRG Survey
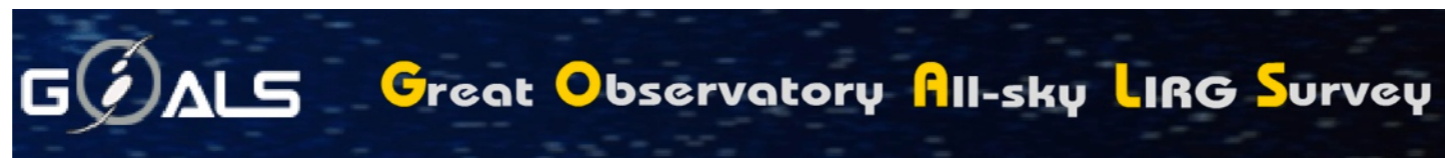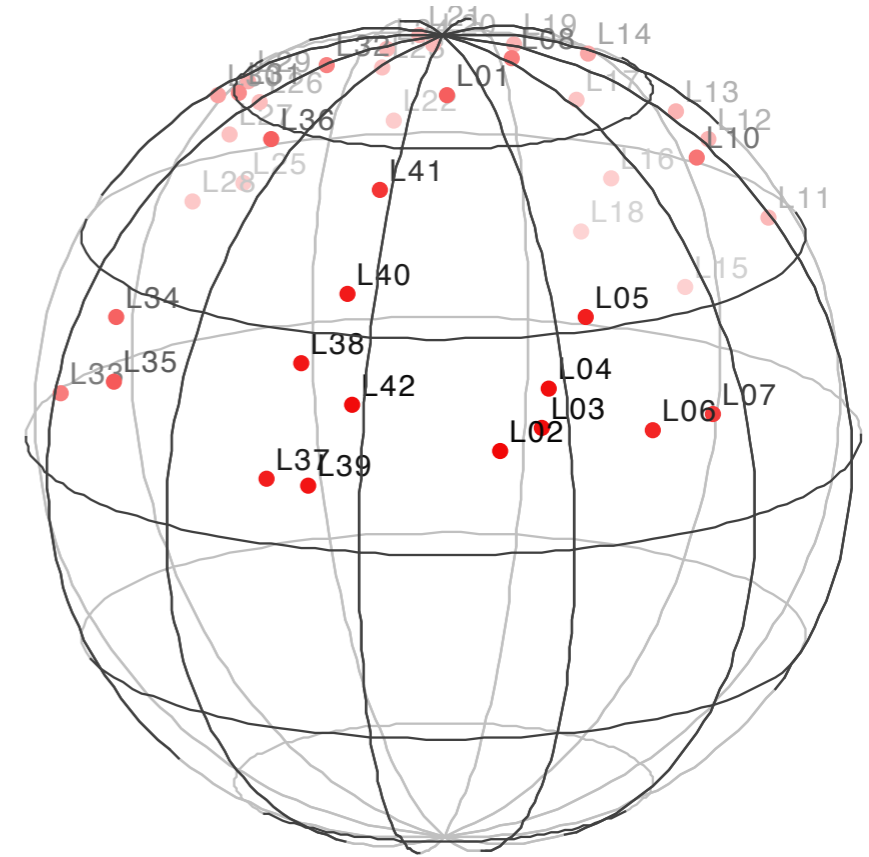
The sample

- 23/42 show Seyfert or LINER activity.

- Most are dominated by the starburst.

q-factor
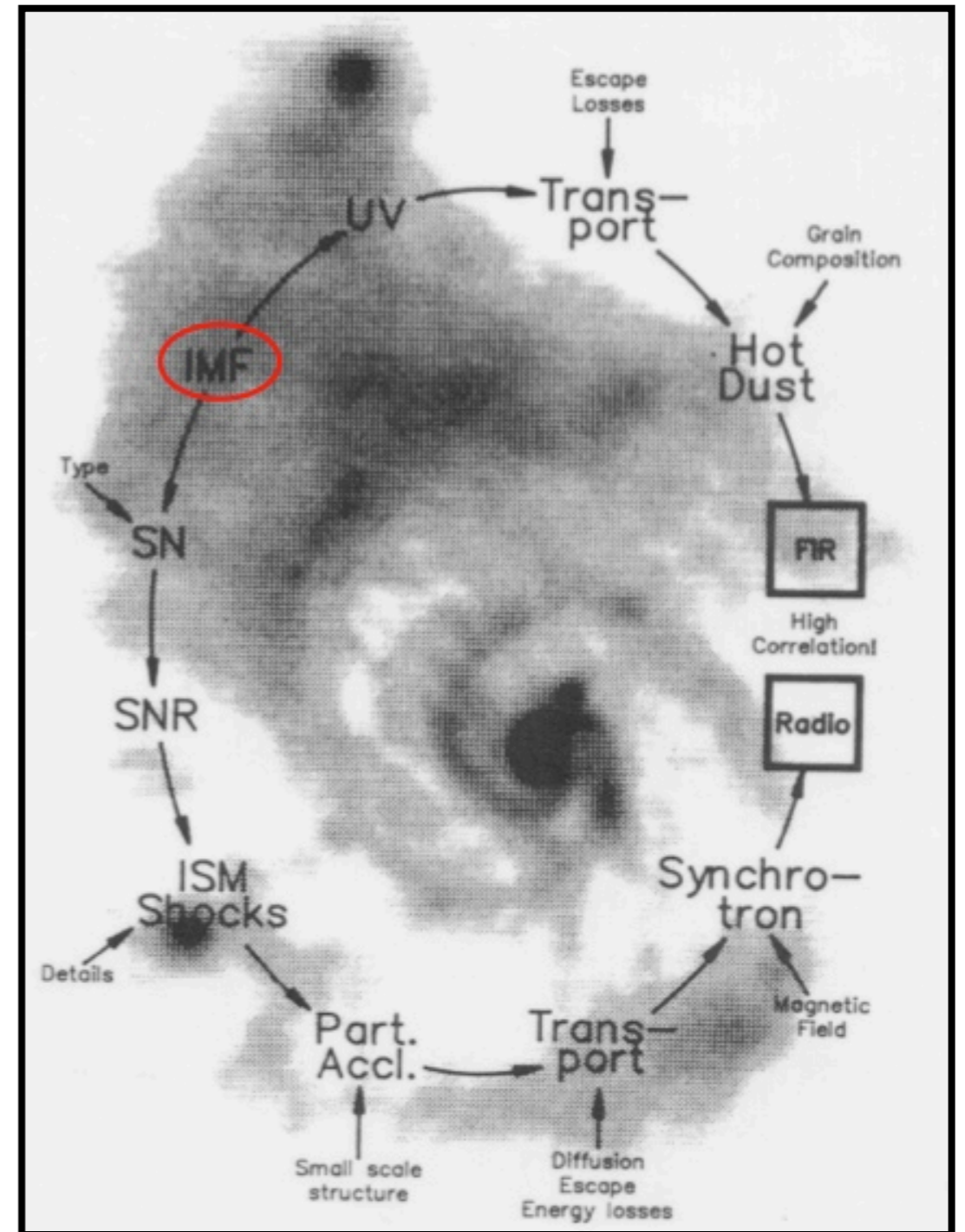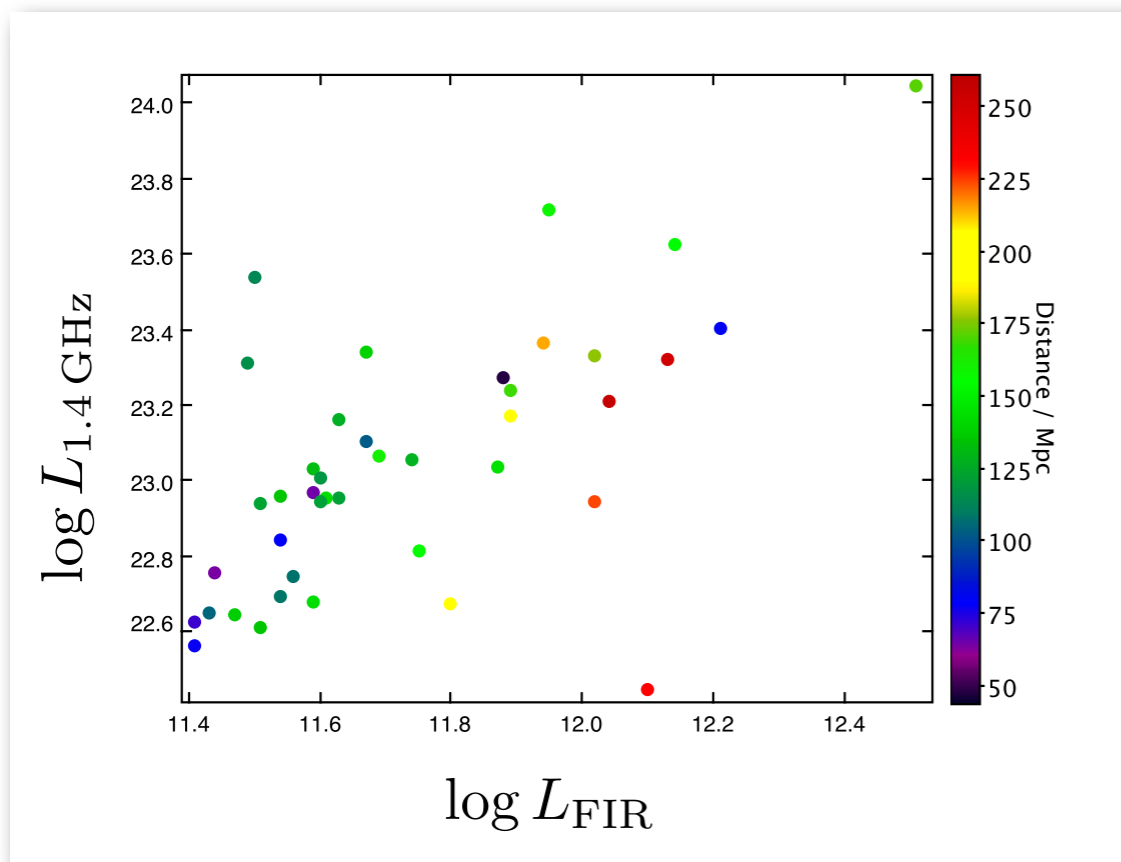
Ekers 1991

The Science behind LIRGI

- Tracing SF via radio continuum requires a deep understanding of these sources: radio to IR correlation? stable IMF?

- LIRGI will:

  - Map the diffuse radio emission, which can provide a reliable estimation of starburst size and structure

  - Trace the free-free absorption with high resolution

  - Perform polarization and rotation measure observations in order to constrain magnetic field strengths

  - Study several molecular transitions (HI, OH, H_2CO) at high-resolution to estimate dynamical masses, and constrain spatial variations in chemistry and physical conditions
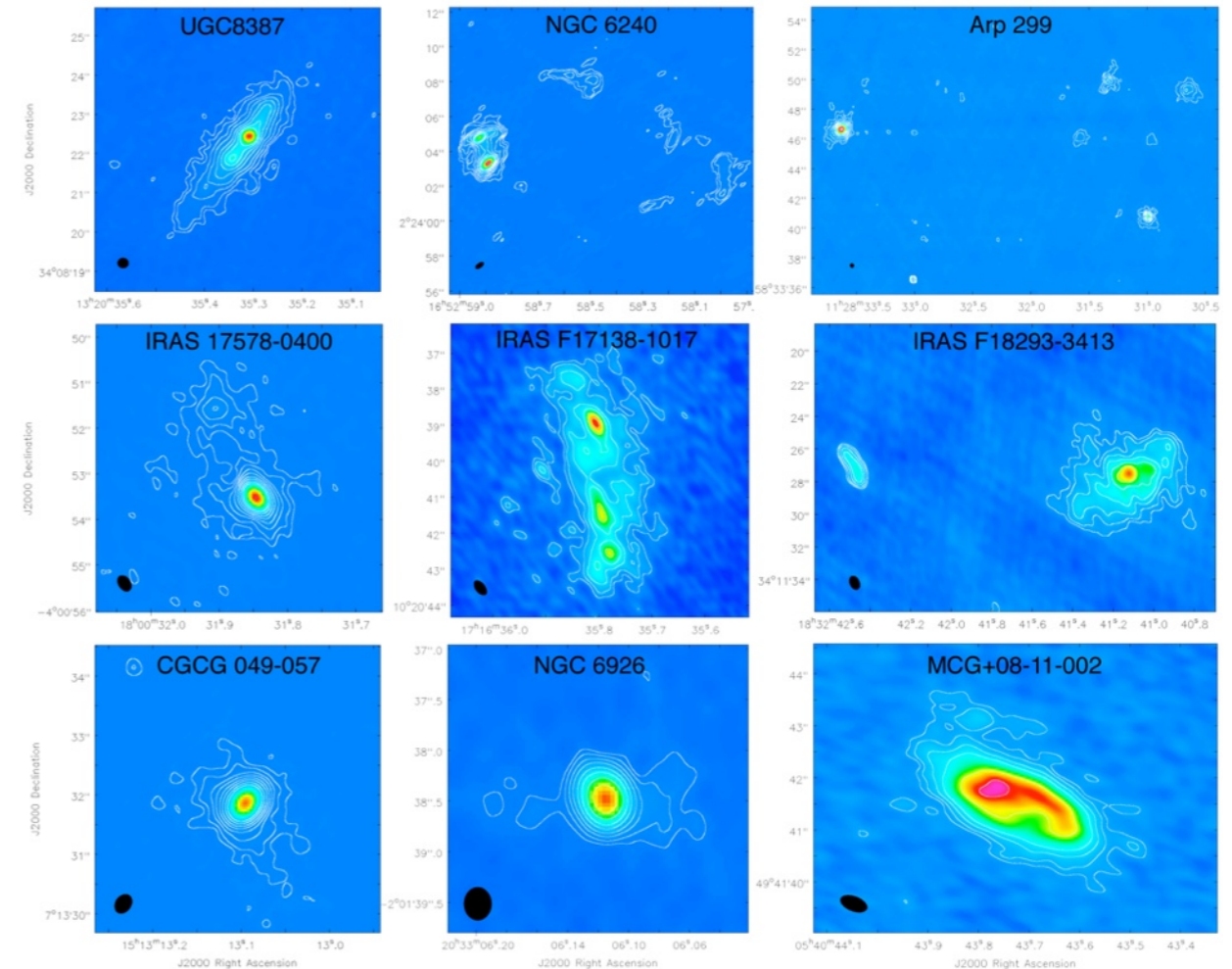
  - Produce a complete atlas of uniform quality images.

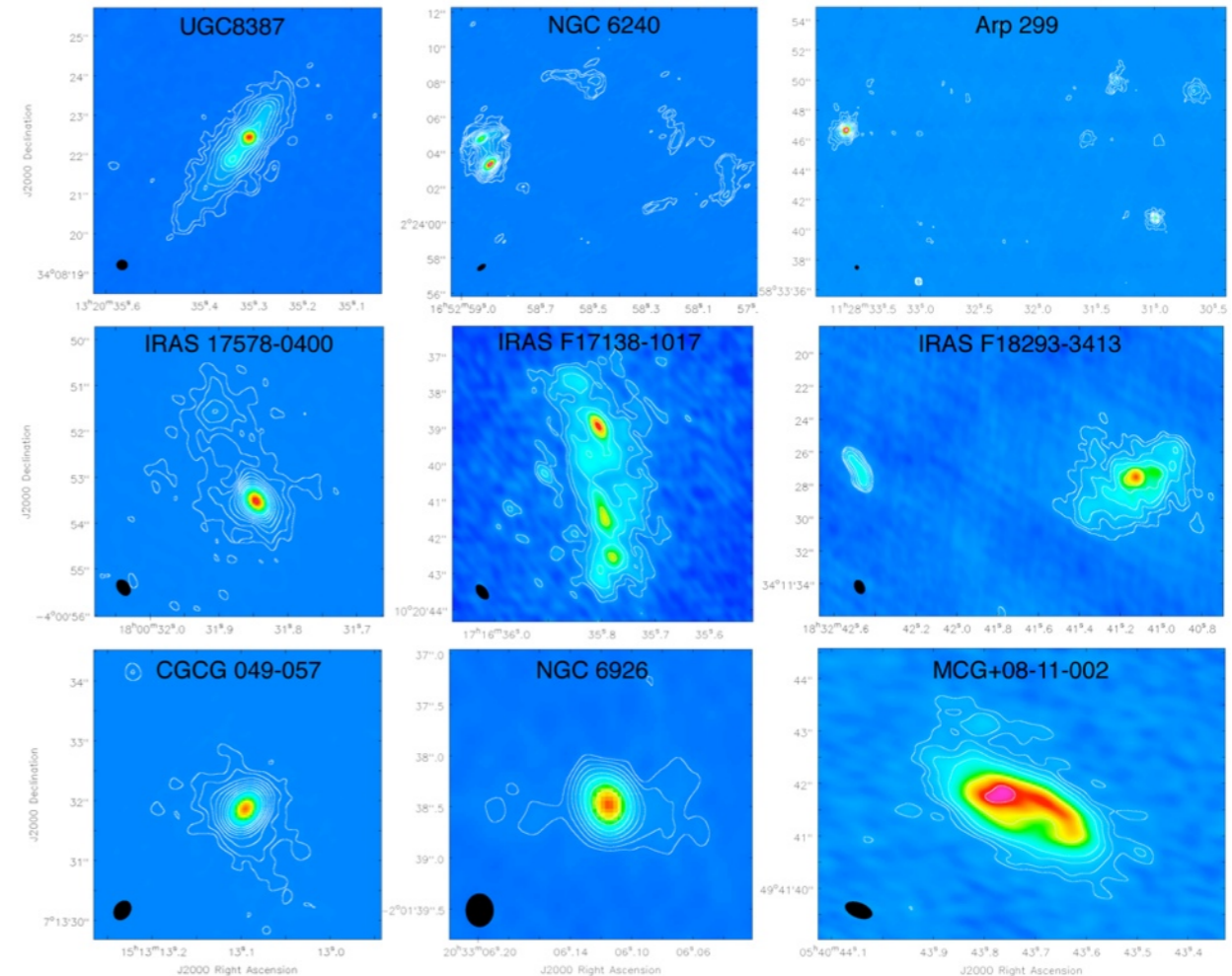# *LIRGI'ing with the VLA*
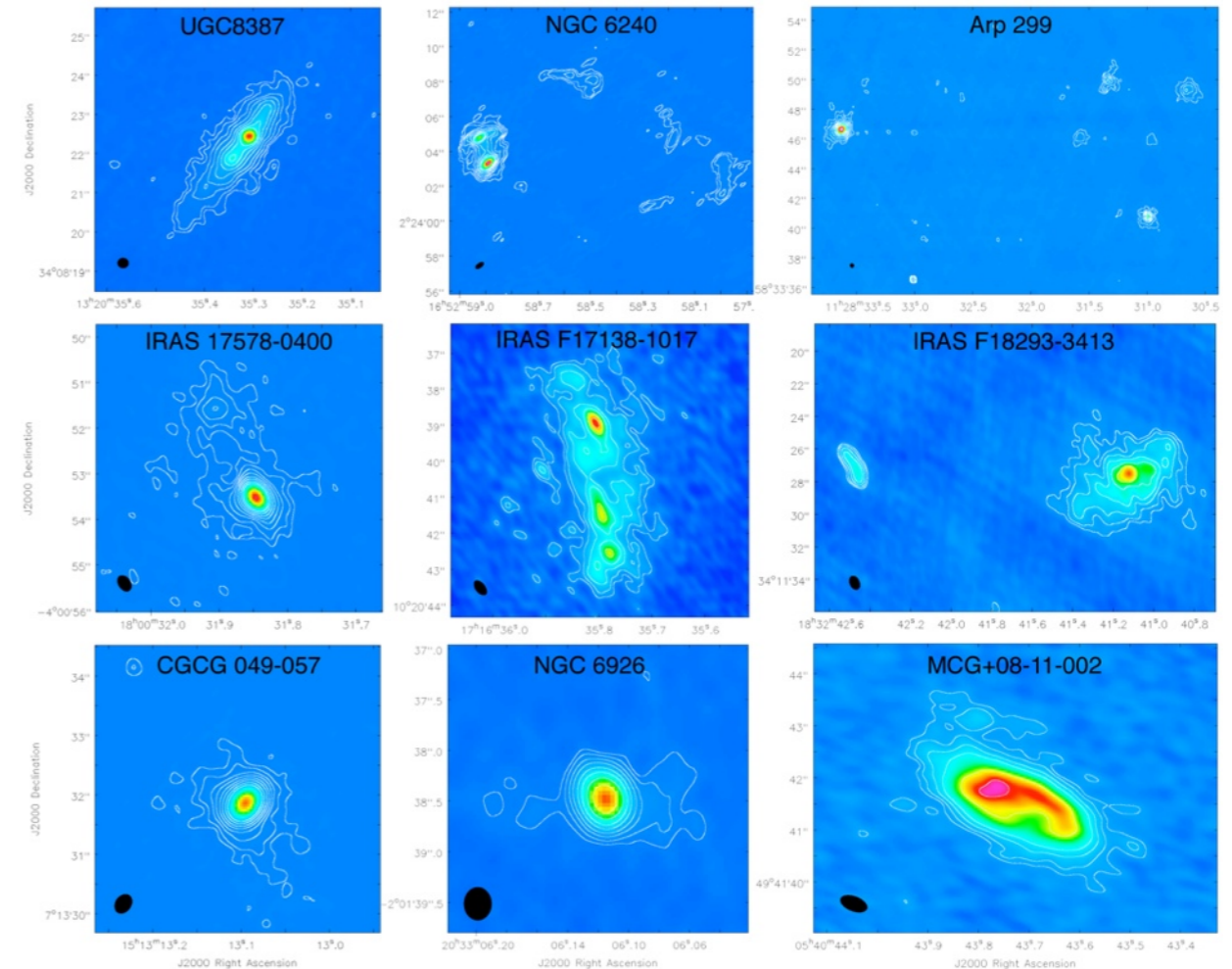
Resolution (mas)	VLA	e-MERLIN
L-band	1300	150
C-band	330	40

LIRGI'ing with the VLA

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Q-band	150 (B-config)	
	40 (A-config)	

LIRGI'ing with the VLA

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	40 (A-config)	

- Pixel-to-pixel comparison.

- Thermal VS non-thermal emission: clock to date starburst.
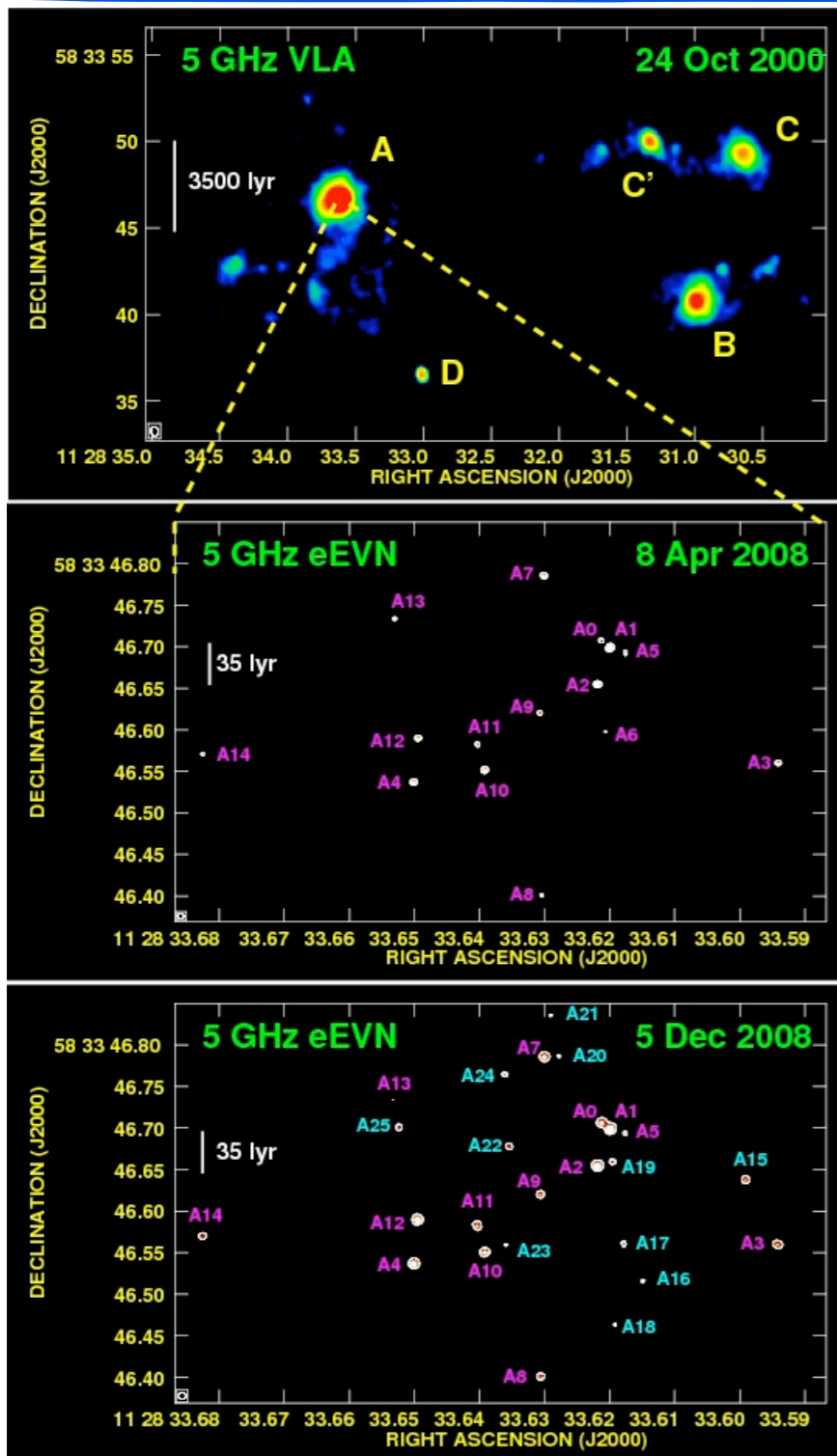
LIRGI'ing with the EVN
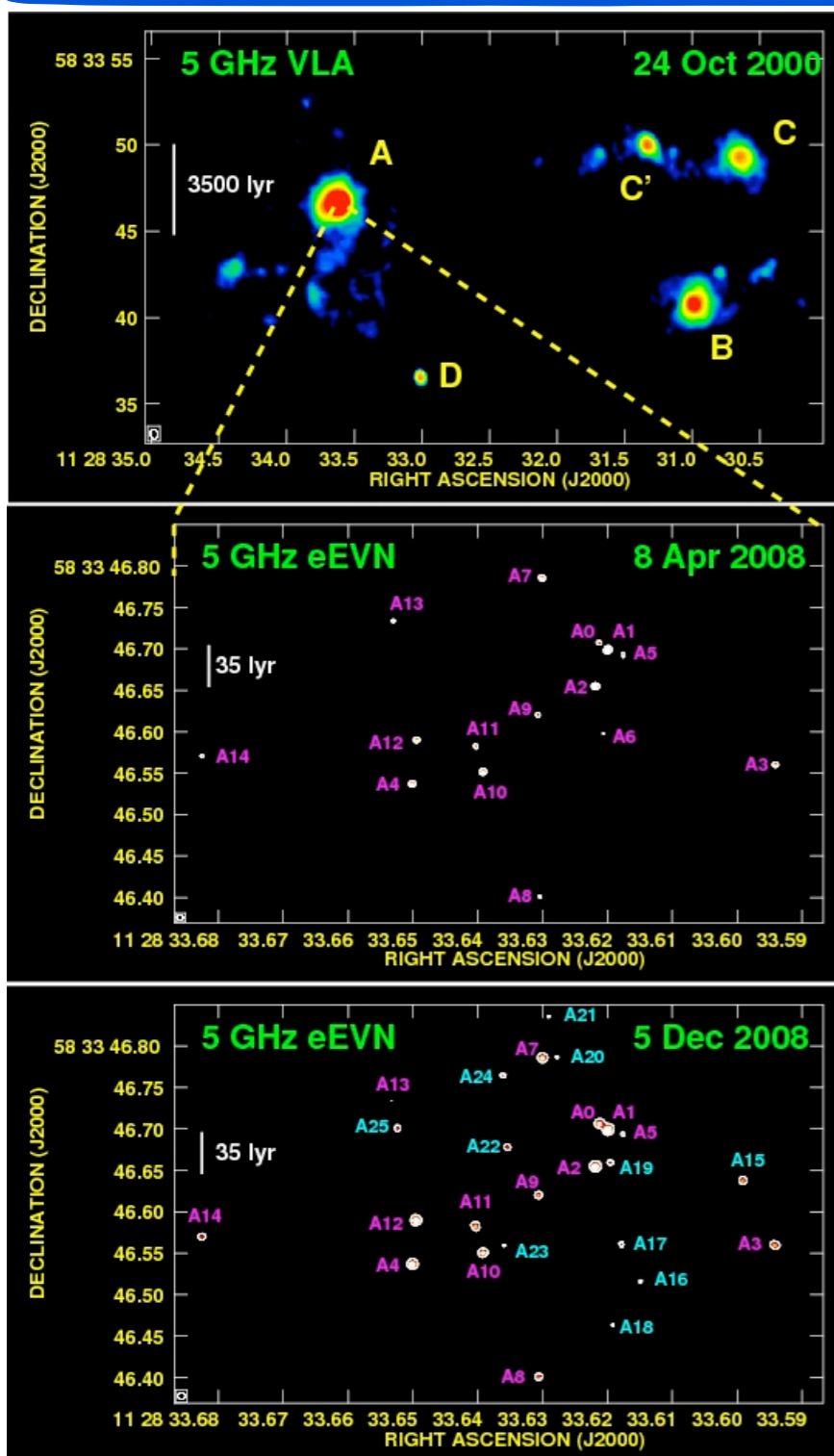
Arp 299 A: C-band

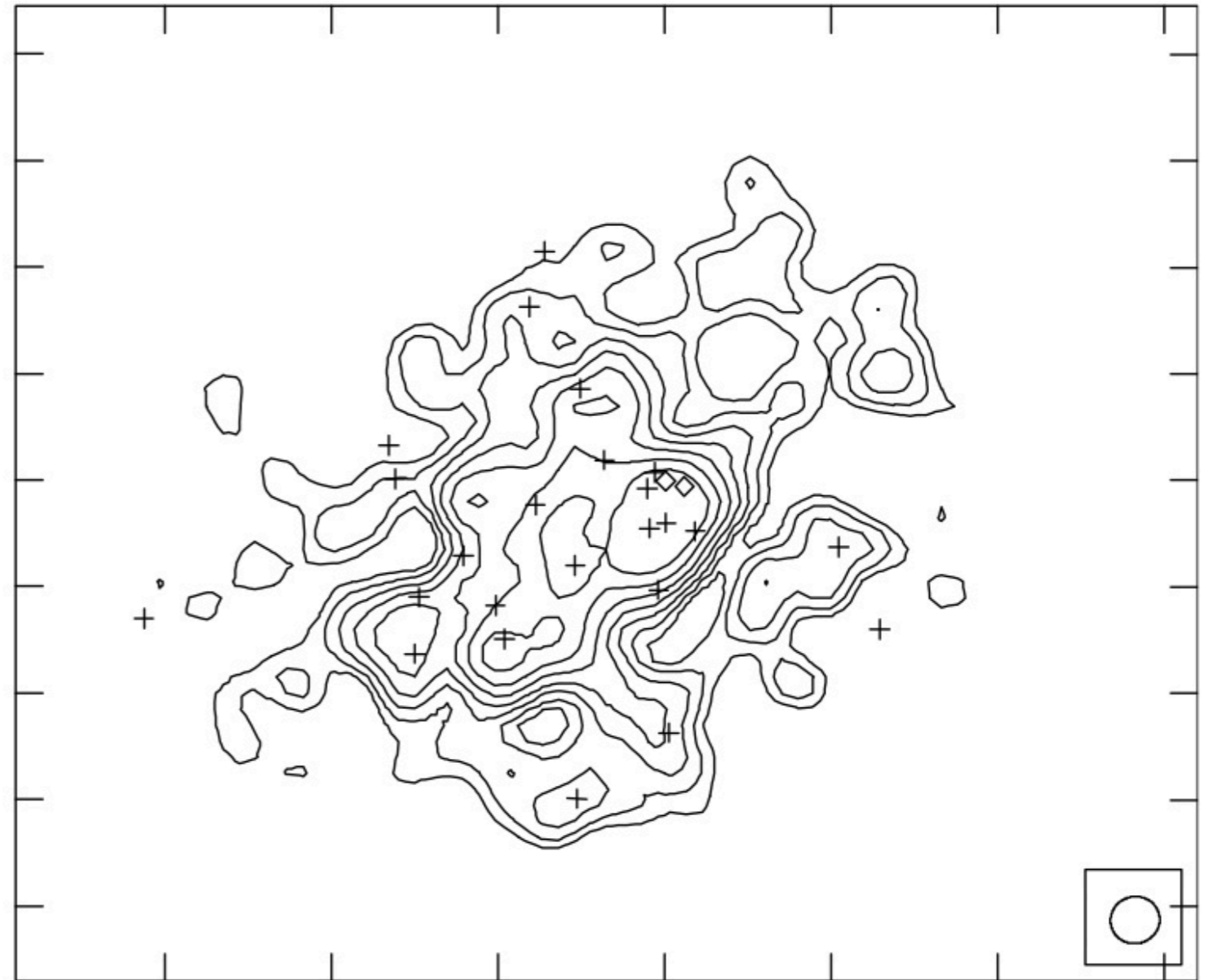*Pérez-Torres et al. 2009*
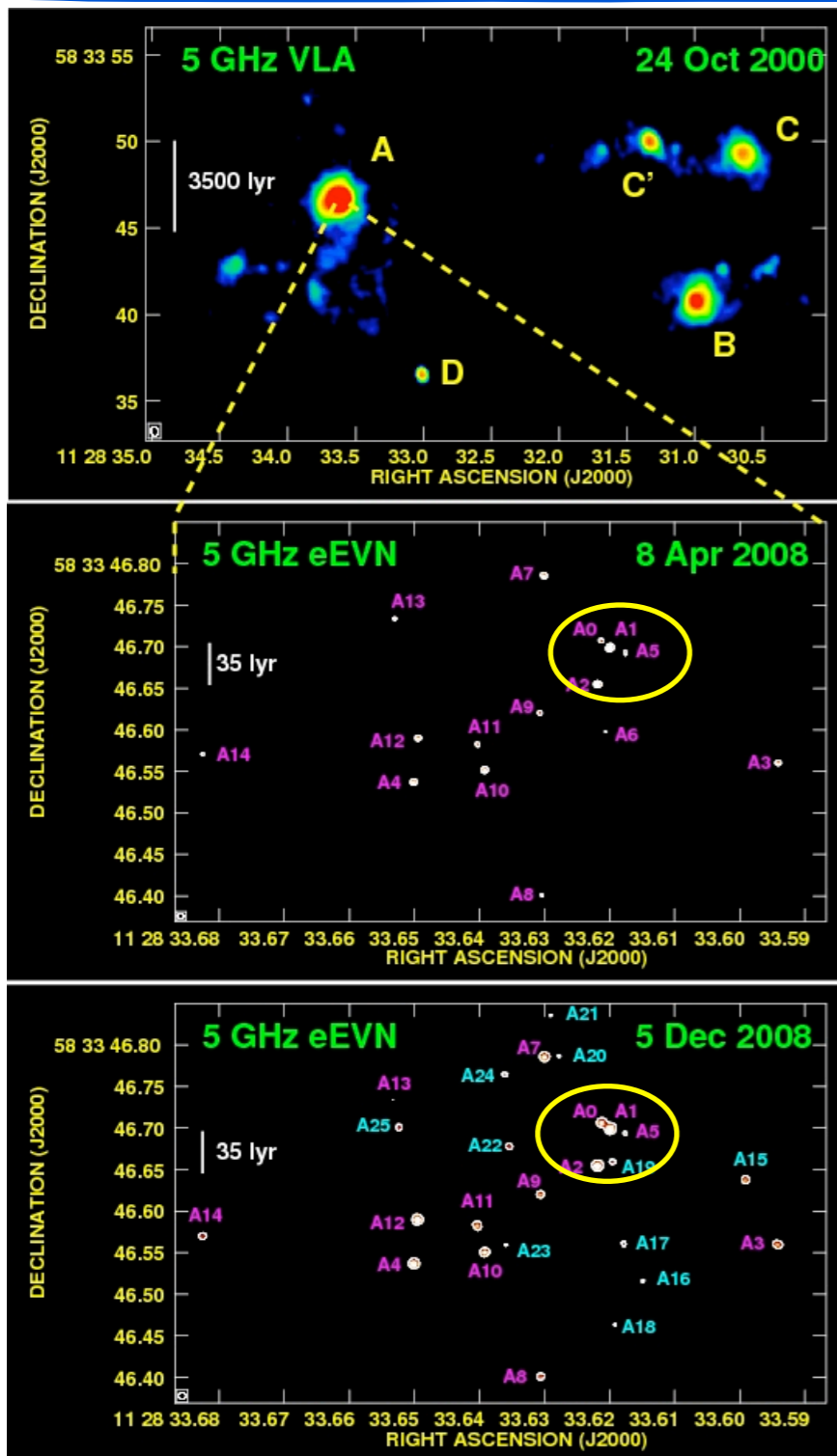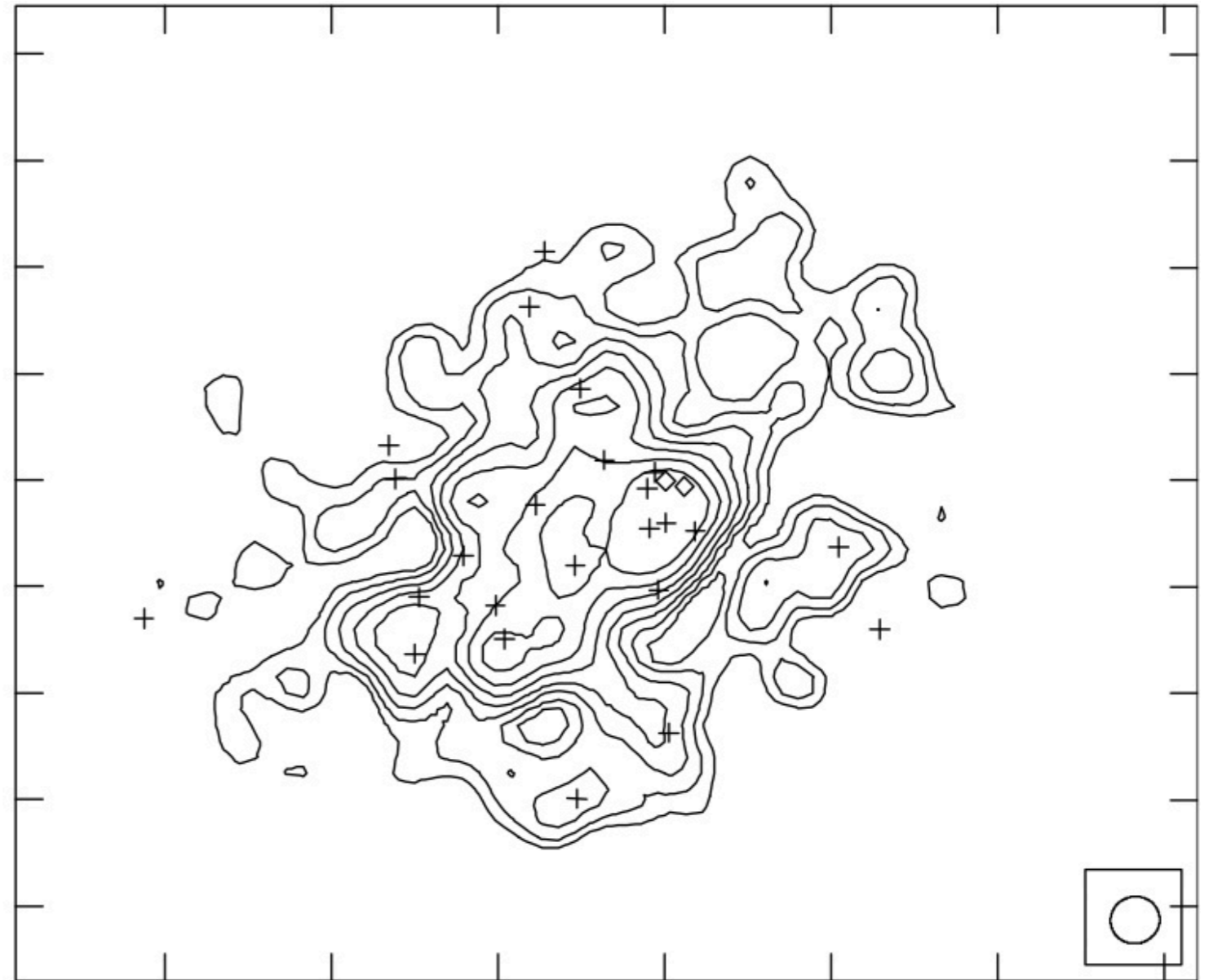
LIRGI'ing with the EVN

Arp 299 A: C-band

Pérez-Torres et al. 2009

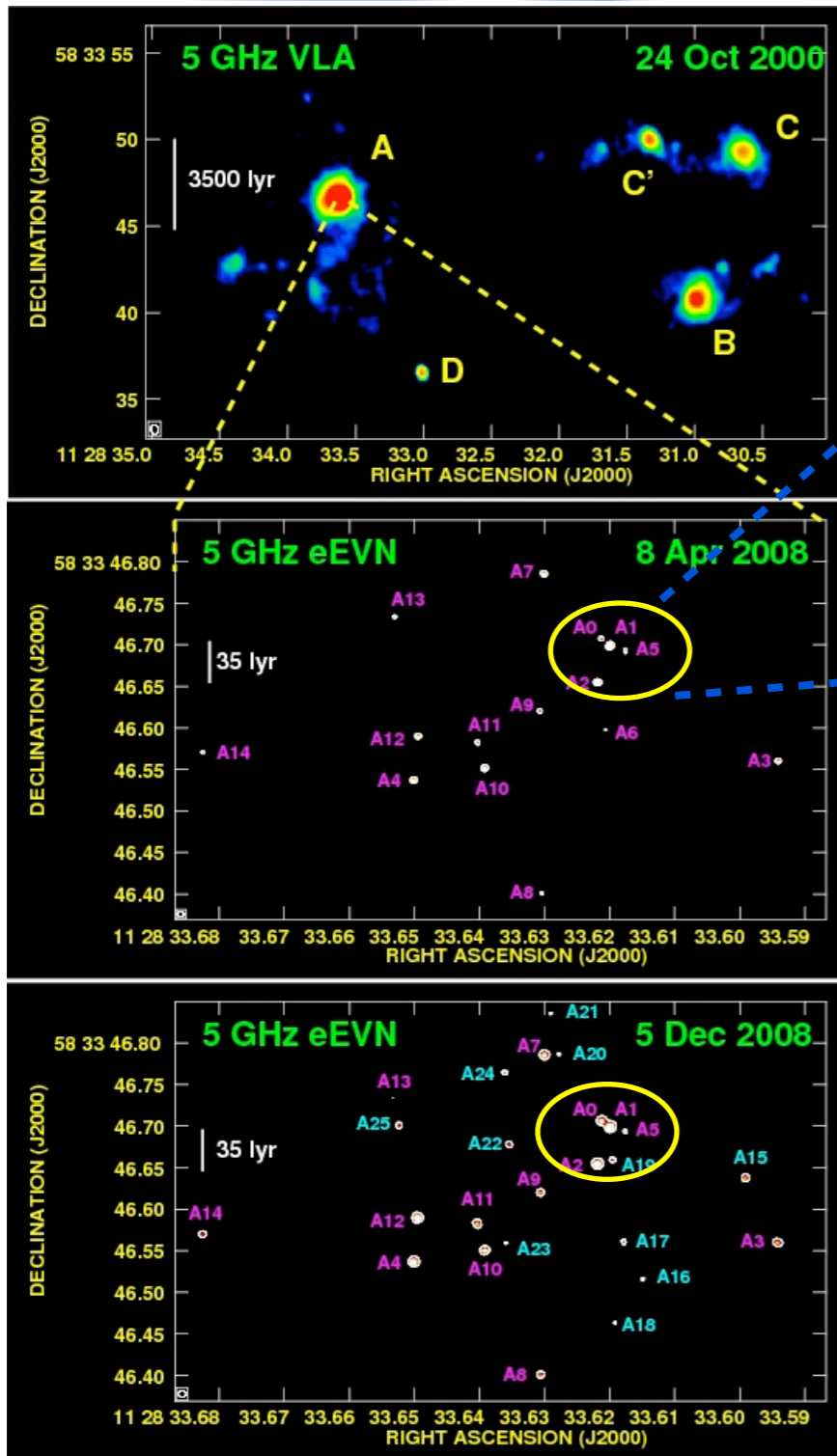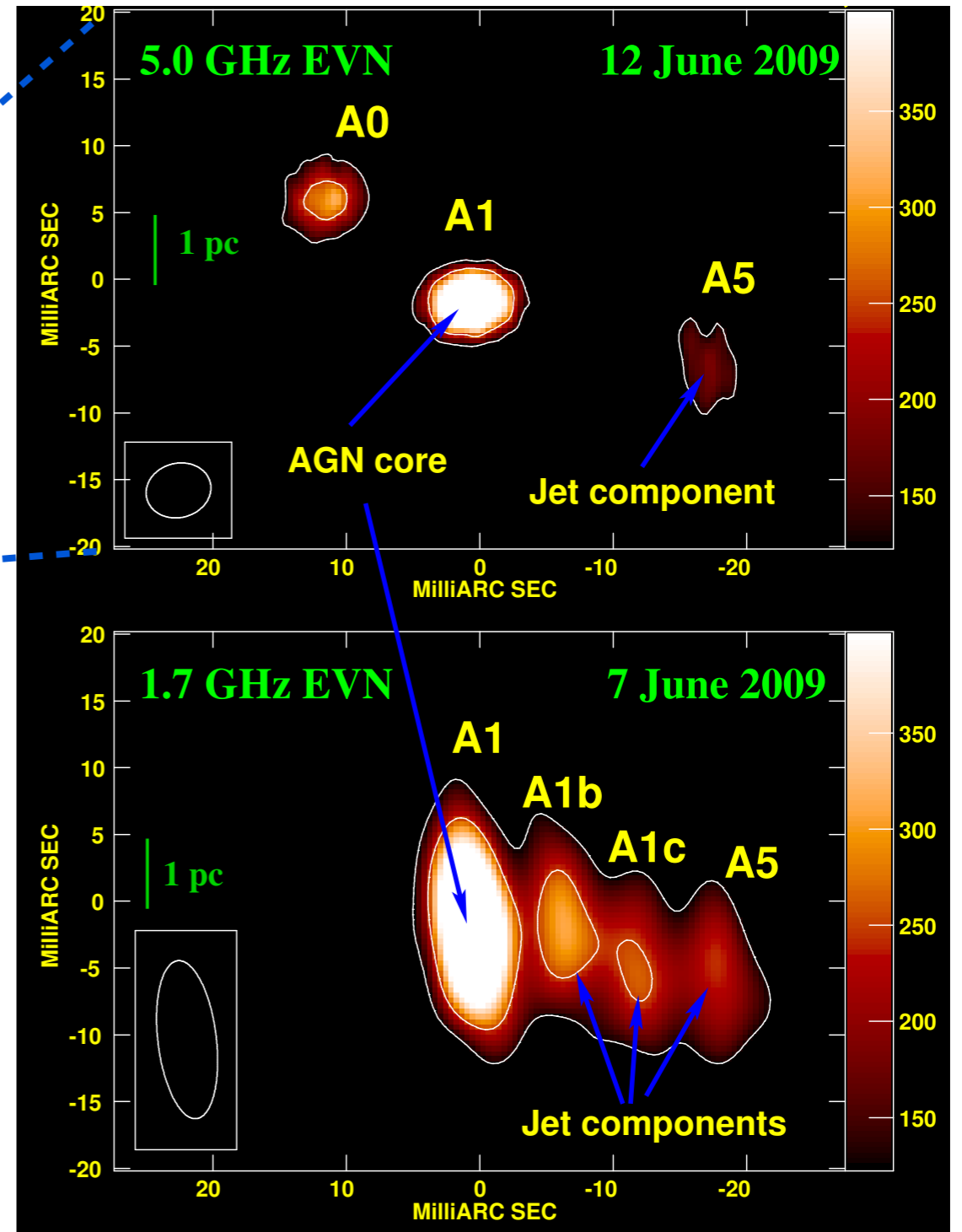Bondi et al. 2012

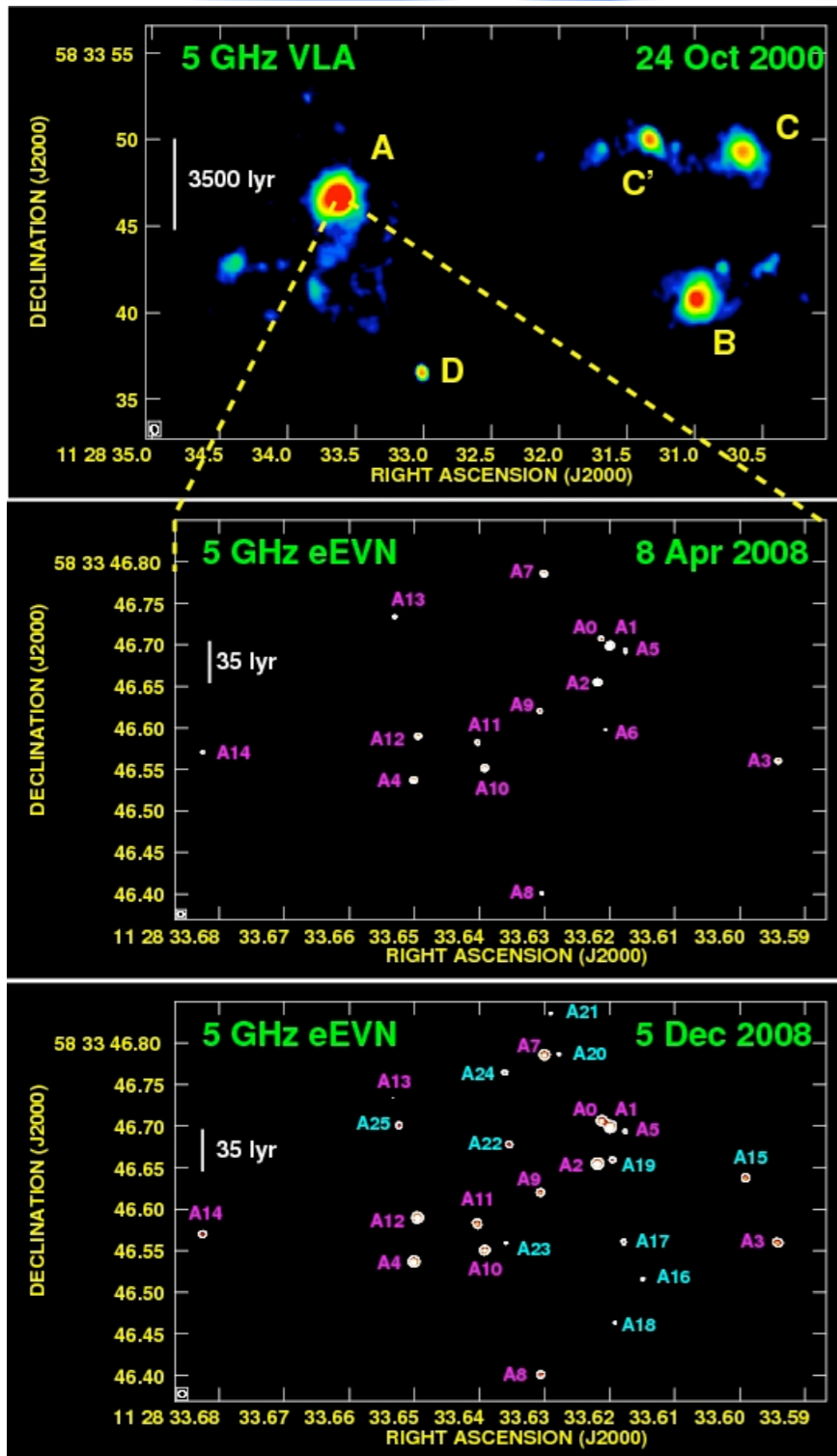# LIRGI'ing with the EVN

Arp 299 A: C-band

Pérez-Torres et al. 2009

Bondi et al. 2012

LIRGI'ing wit

Arp 299 A: C-band

5 GHz VLA — 24 Oct 2000

3500 lyr

5 GHz eEVN — 8 Apr 2008

35 lyr

5 GHz eEVN — 5 Dec 2008

35 lyr

Pérez-Torres et al. 2009

5.0 GHz EVN — 12 June 2009

A0

A1

A5

1 pc

AGN core

Jet component

1.7 GHz EVN — 7 June 2009

A1

A1b

A1c

A5

1 pc

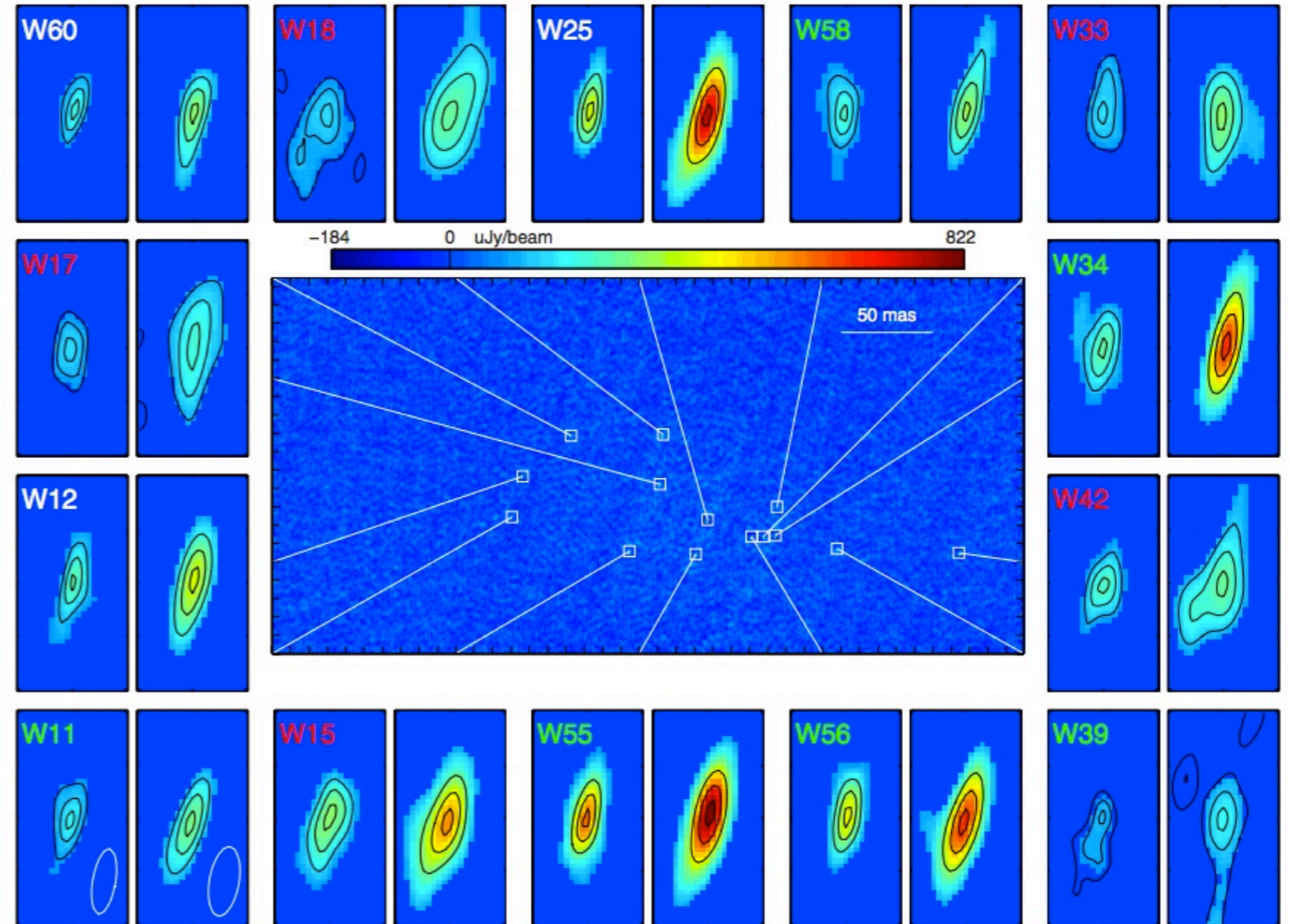Jet components

Pérez-Torres et al. 2010

LIRGI'ing with the EVN

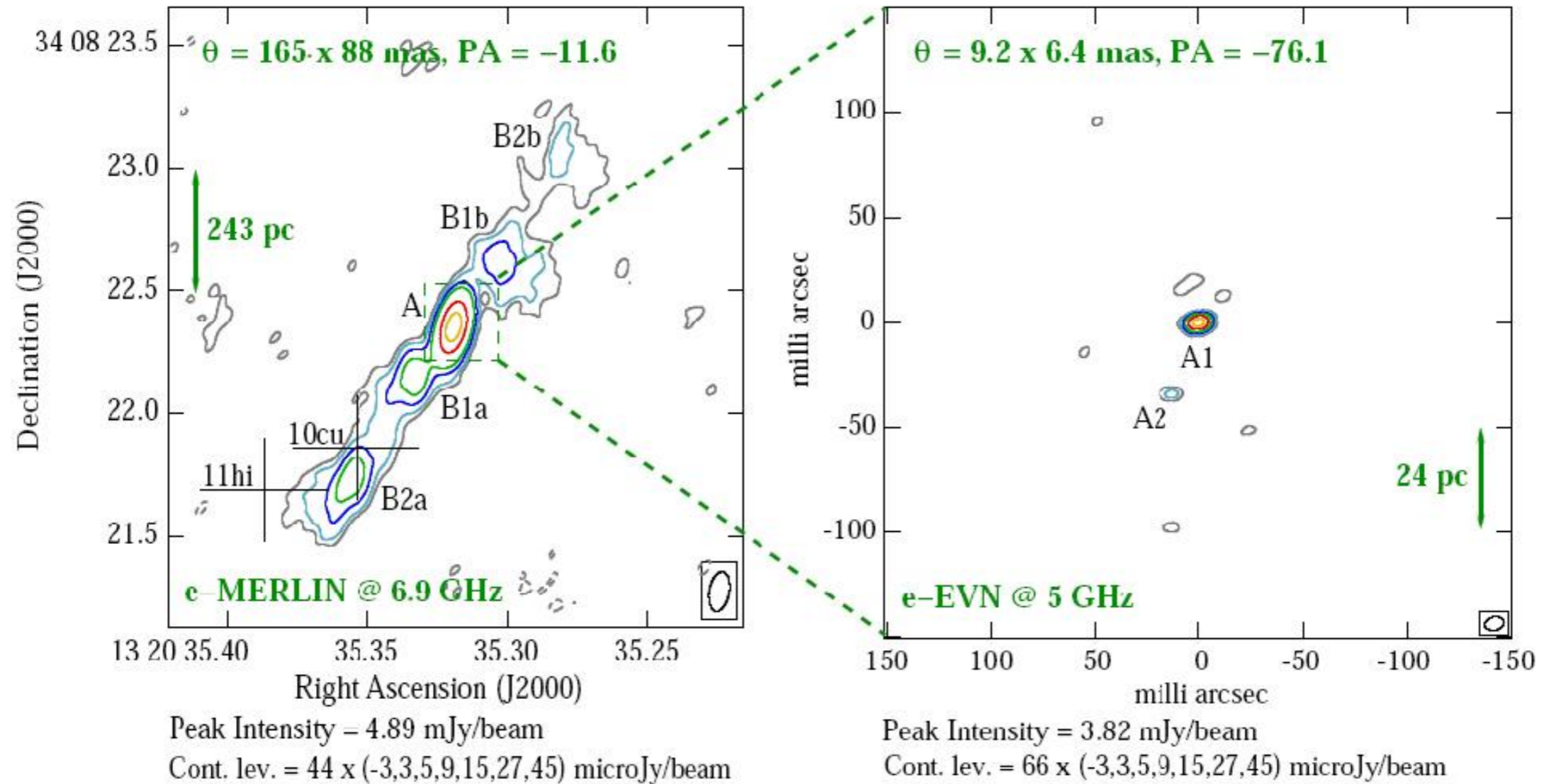**Arp 299 A: C-band**

Pérez-Torres et al. 2009
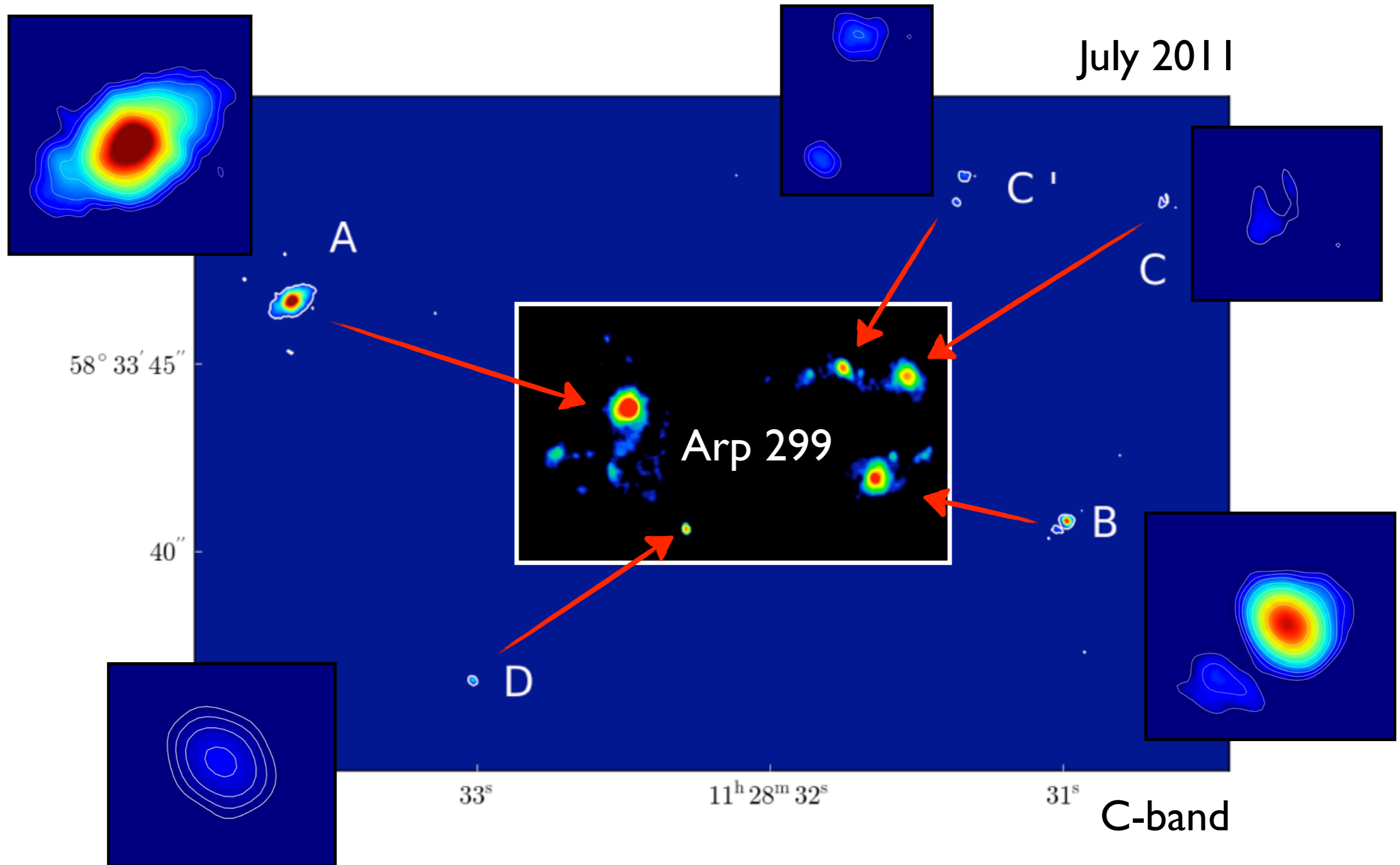
Arp 220 W: X- and S-band

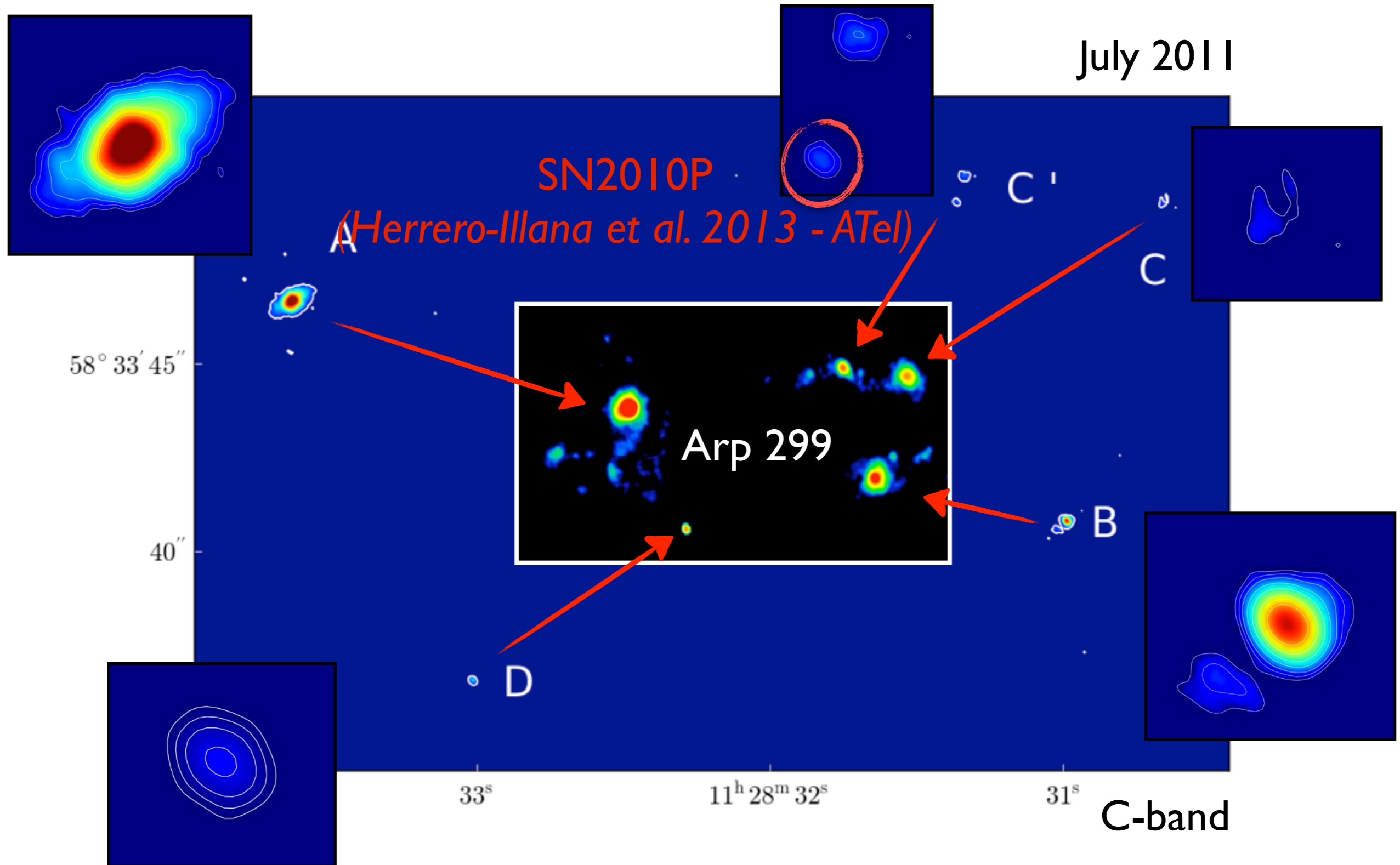*Batejat et al. 2011*

LIRGI'ing with the EVN

IC 883

Romero-Cañizales et al. 2012

LIRGI - First observations

July 2011

Arp 299

A

C'

C

B

D

58° 33' 45"

40"

33ˢ   11ʰ 28ᵐ 32ˢ   31ˢ

C-band

LIRGI - First observations

July 2011

SN2010P
(Herrero-Illana et al. 2013 - ATel)

A

C '

C

B

D

Arp 299

58° 33′ 45″

40″

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C-band

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(Herrero Illana et al. 2012, ATel)

(Romero-Cañizales et al. 2014)

C-band

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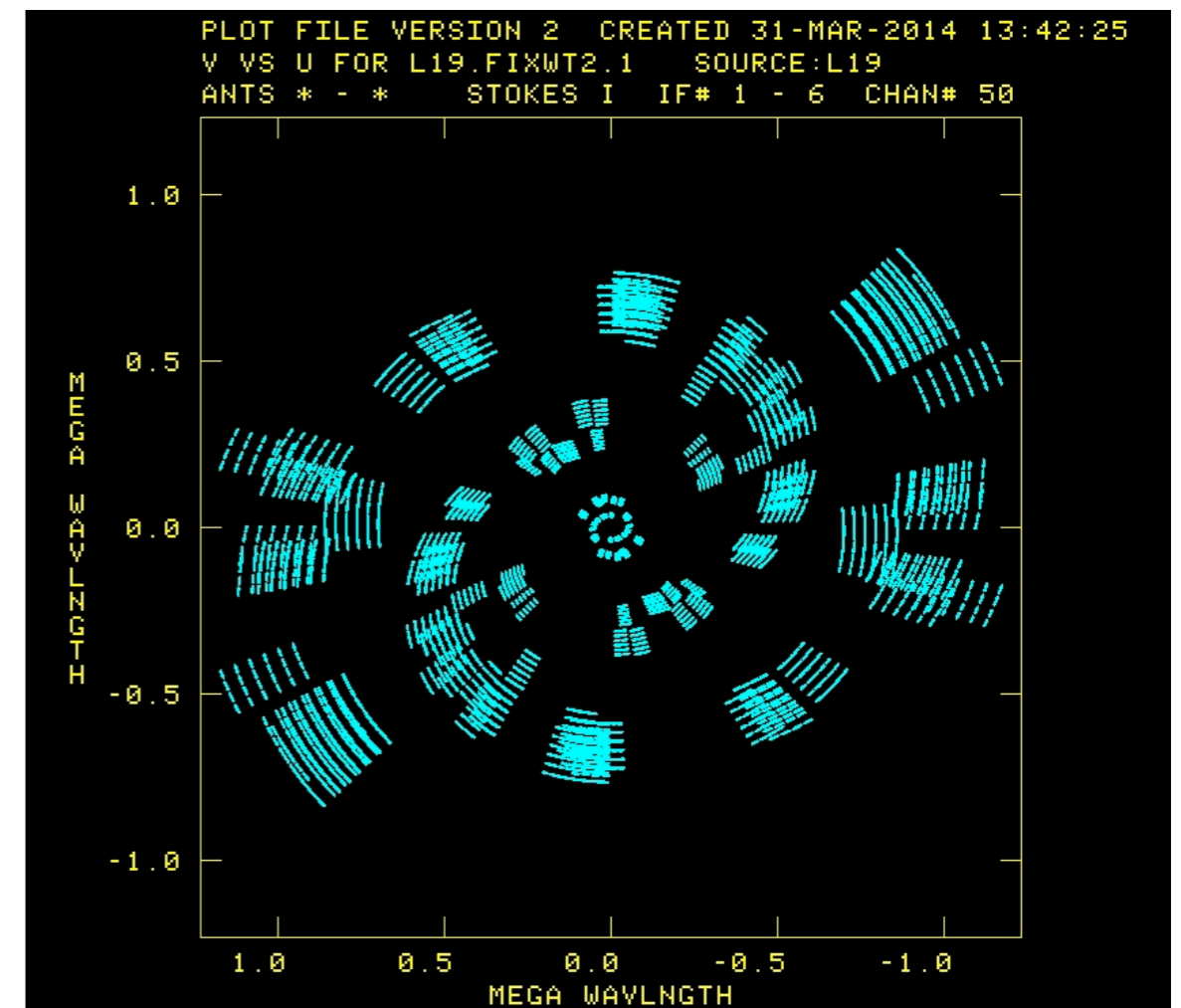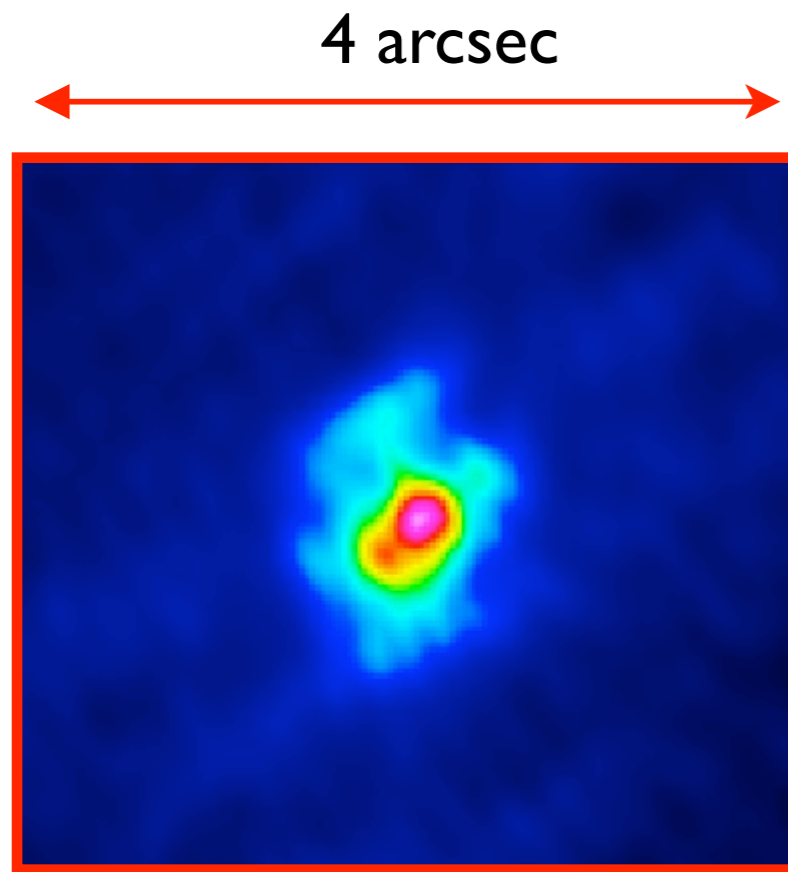C-band
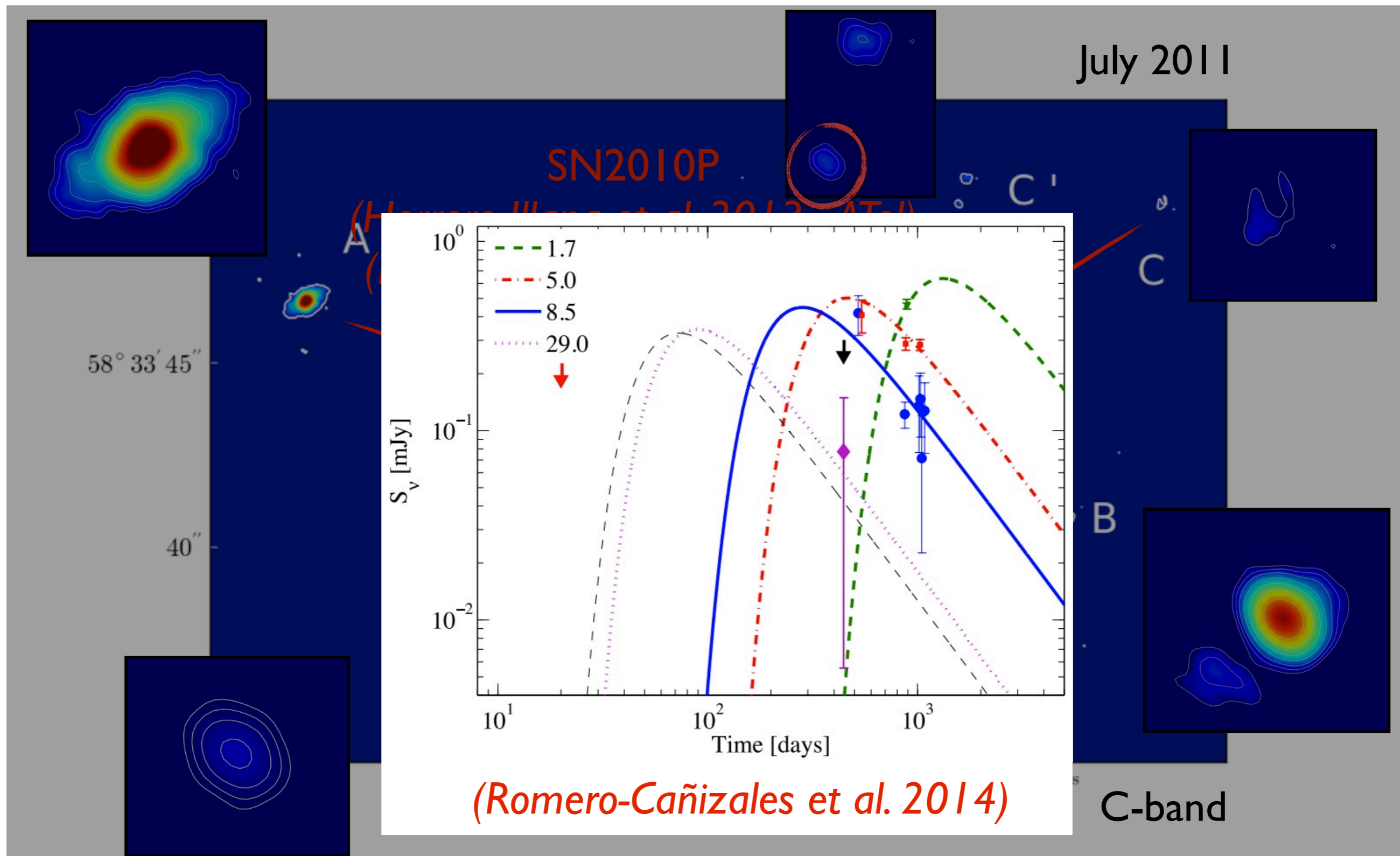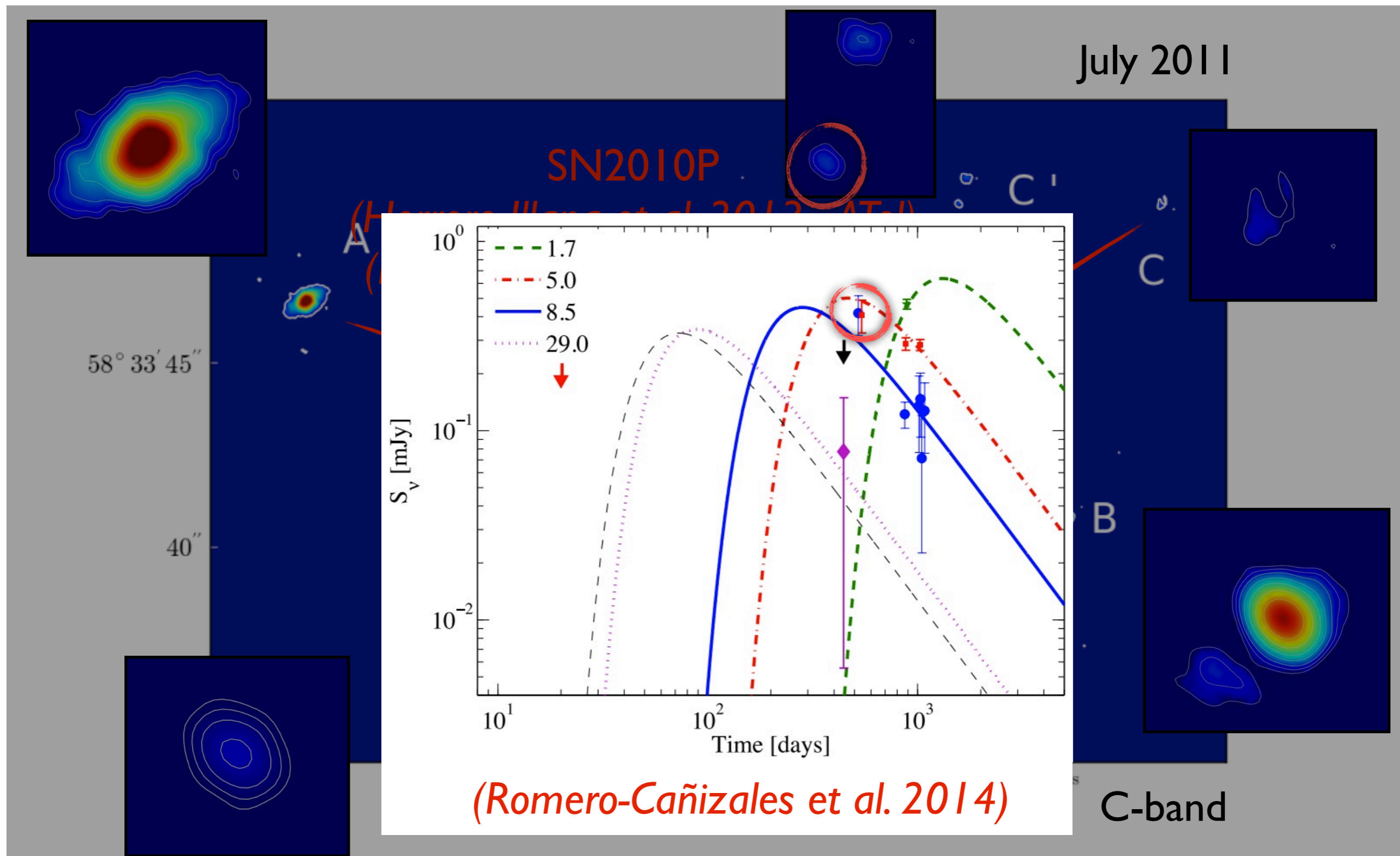
LIRGI - First observations

- No regular observations yet

- Six sources observed in 8-10 Feb

- L-band
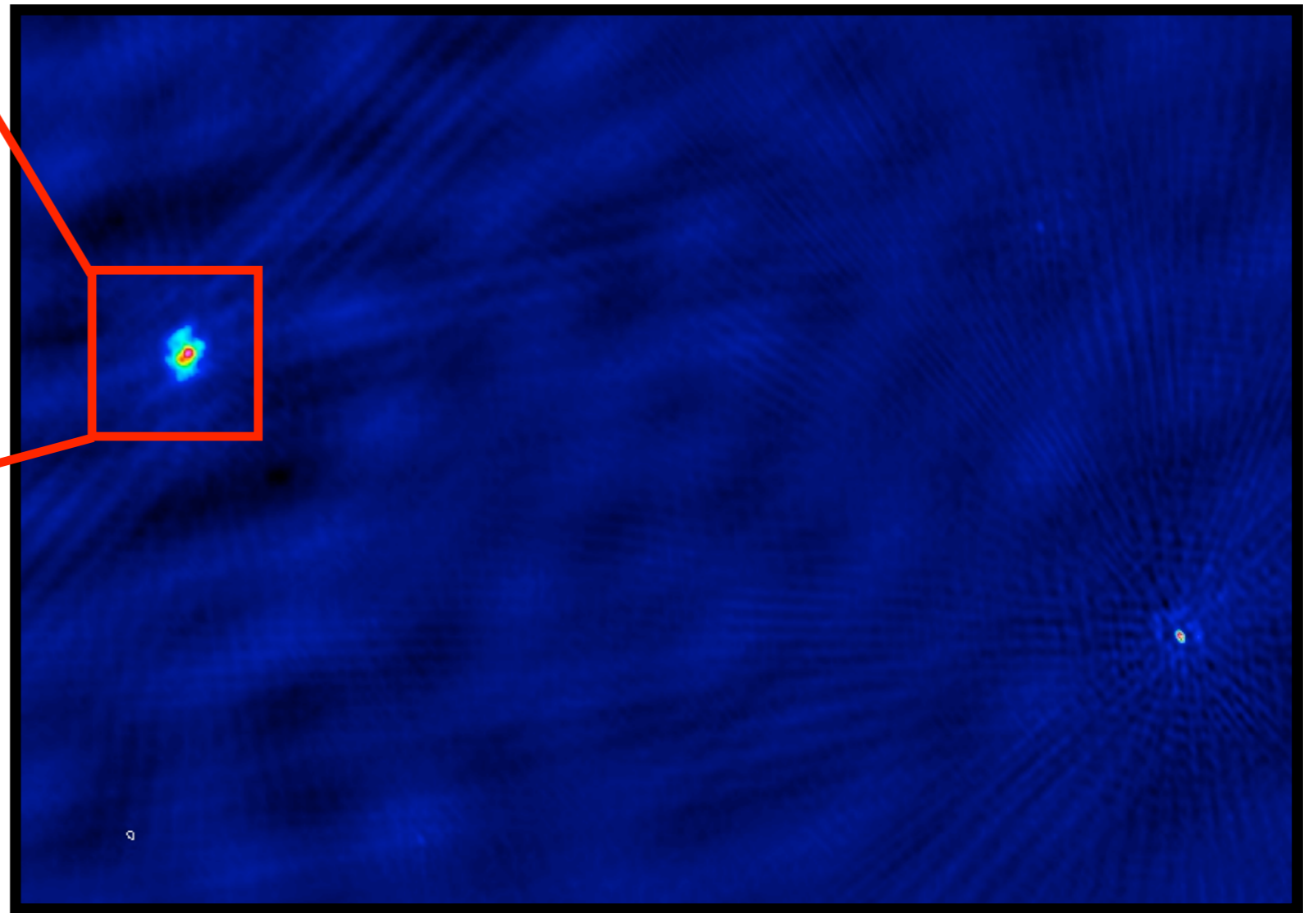
- Intense flagging needed

uv coverage for 4 hours

LIRGI - First observations

4 arcsec

- L-band observations: Arp 299.

- On-source time: 4.3 hours.

- No single scan of flux calibration involved all antennas.

- Wrong spectral setup.

rms ~ 55 μJy/beam   0.20x0.10 arcsec

LIRGI - Bottom lines

☑ LIRGI will allow to establish a phenomenological sequence and timescale for the evolution of a nuclear starburst for a statistically significant sample of (U)LIRGs in the local universe

☑ Important legacy to the community: a uniformly observed sample of (U)LIRGs in the nearby universe. Reference for future studies to be carried out with new instruments (JVLA, ALMA, LOFAR, SKA...)

http://lirgi.iaa.es

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Thank you!

http://lirgi.iaa.es

Additional material

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