IC883 and PGC043234: the stories of steady and intermittent accretion onto a SMBH

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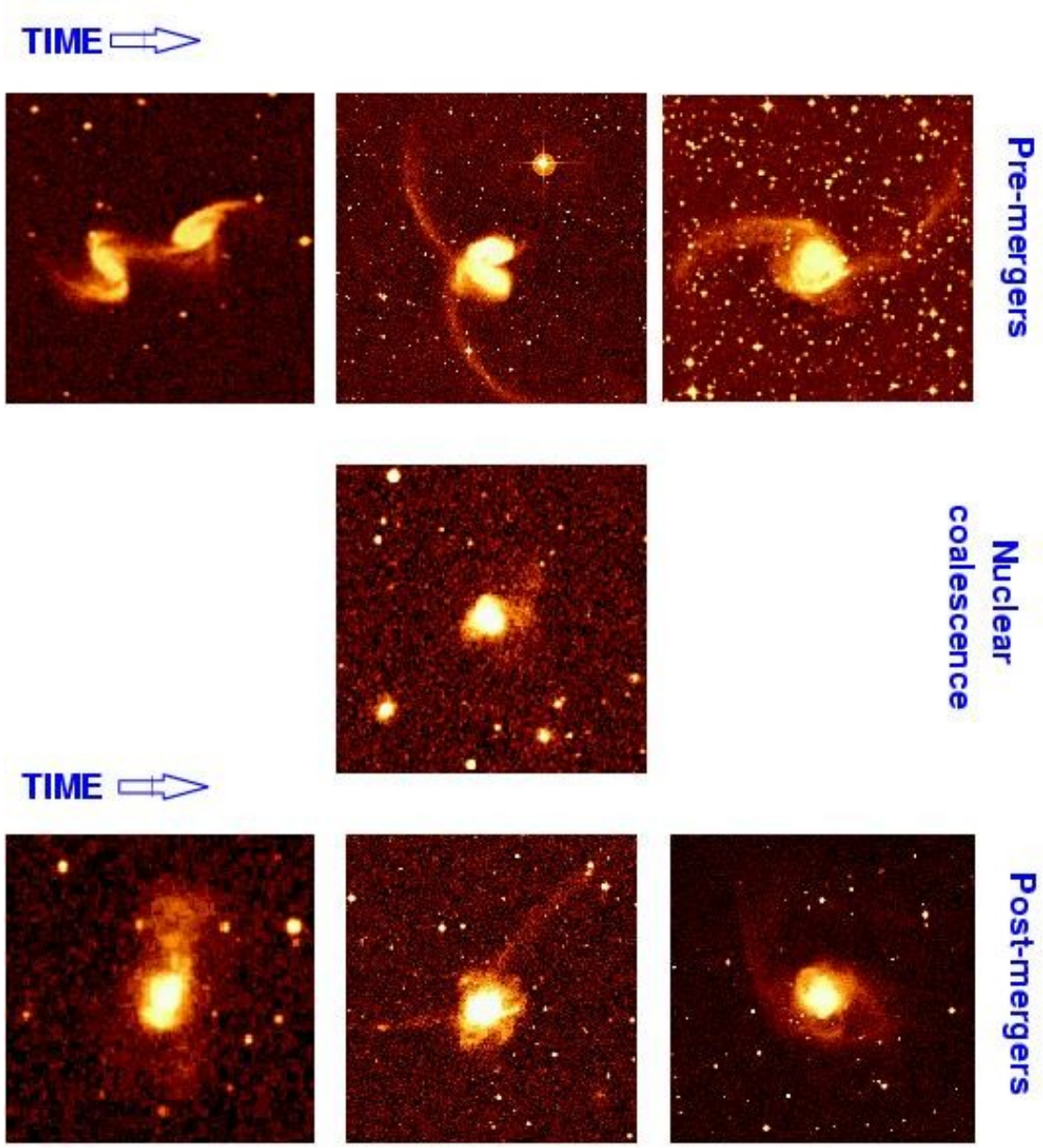
MILLENNIUM INSTITUTE OF ASTROPHYSICS

NÚCLEO DE ASTRONOMÍA udp
FACULTAD DE INGENIERÍA

Tuorla-Tartu annual meeting, 29.09.2016

Mergers



↪ enhance SF and AGN activity

↪ transform the morphology of the interacting galaxies

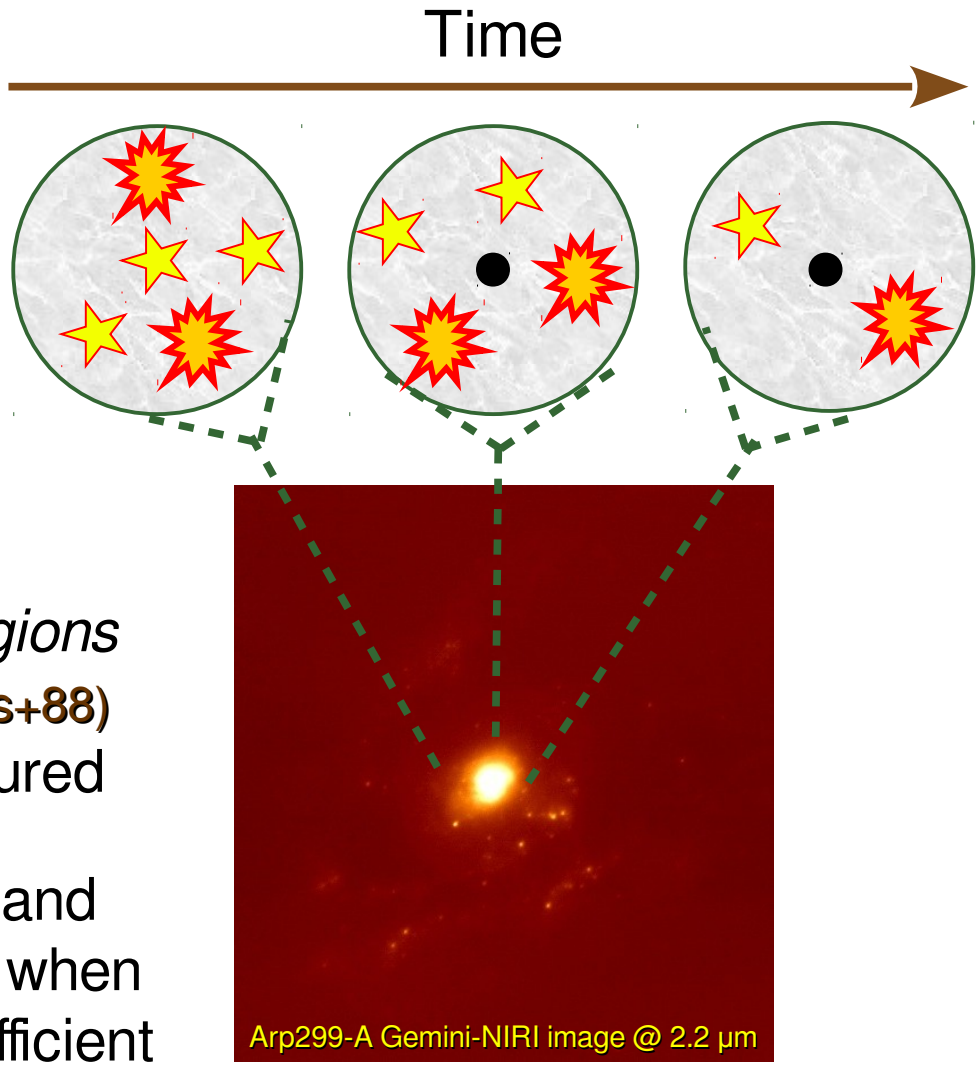
Taken from Antonis Georgakakis' page:
http://www.mpe.mpg.de/~age/mergers.html

Starburst vs AGN energetics – a matter of time?

Classification of IR selected galaxies:

- IR luminosity
- Merger stage

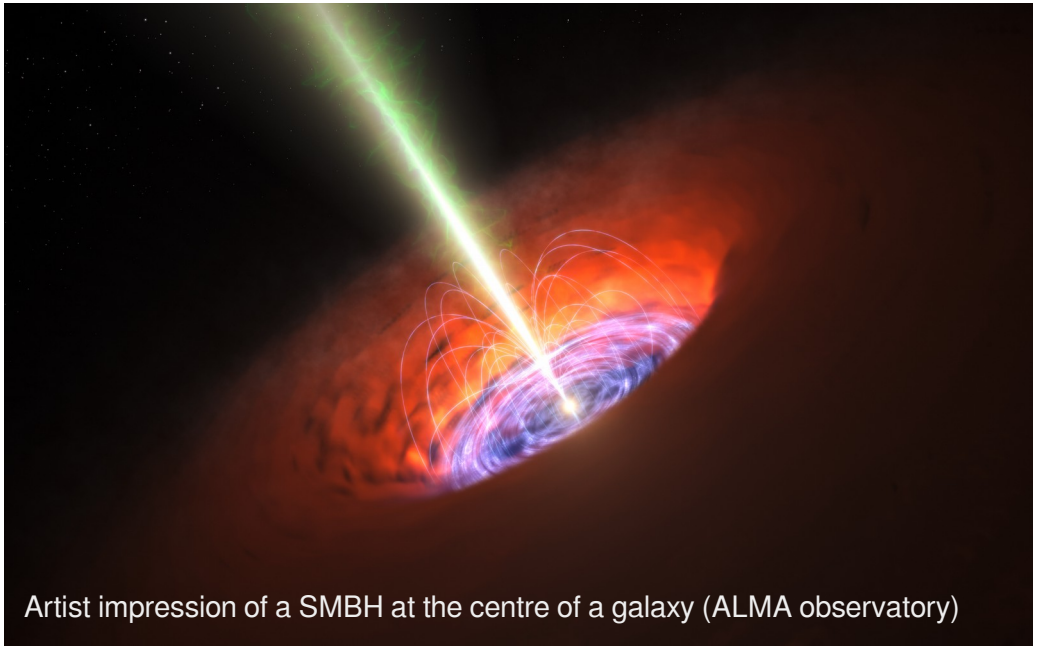
(Yuan+10)



What is expected:

- SFR increases *in the central regions* of interacting galaxies (e.g., Sanders+88)
- AGN is also triggered, but obscured (Satyapal+14)
- SF decays due to SN feedback and gas exhaustion in about 200 Myr, when the accretion onto a BH is more efficient (Wild+09)

Accretion onto a SMBH (10^6 – $10^{9.5}$ $M_\odot$)



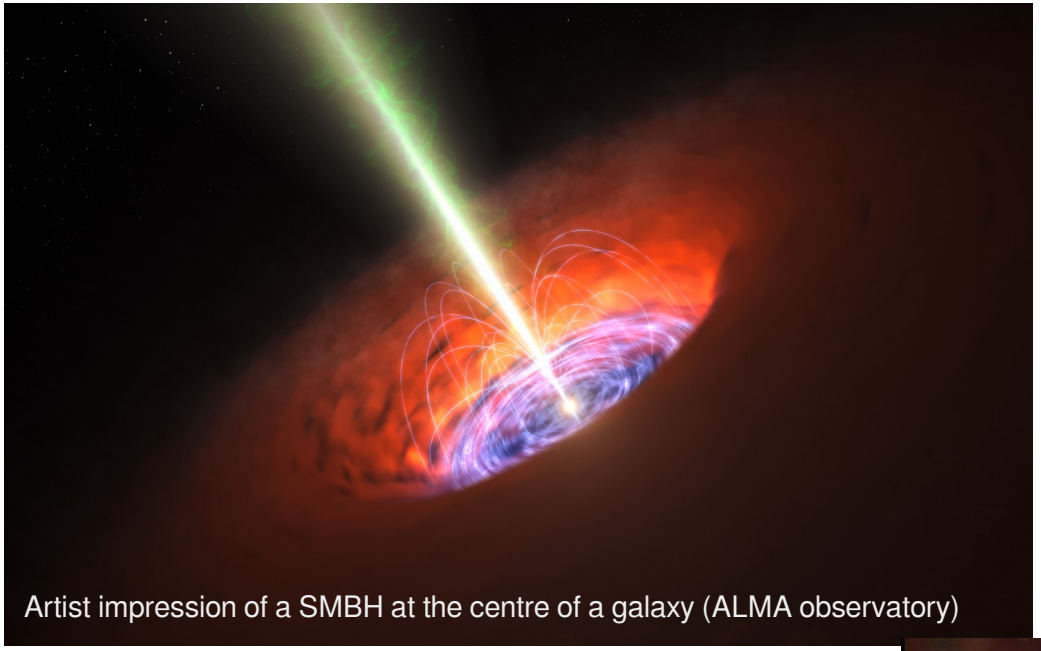
Artist impression of a SMBH at the centre of a galaxy (ALMA observatory)

Accretion rate

High

Low

Accretion onto a SMBH (10^6 – $10^{9.5}$ $M_\odot$)



Artist impression of a SMBH at the centre of a galaxy (ALMA observatory)

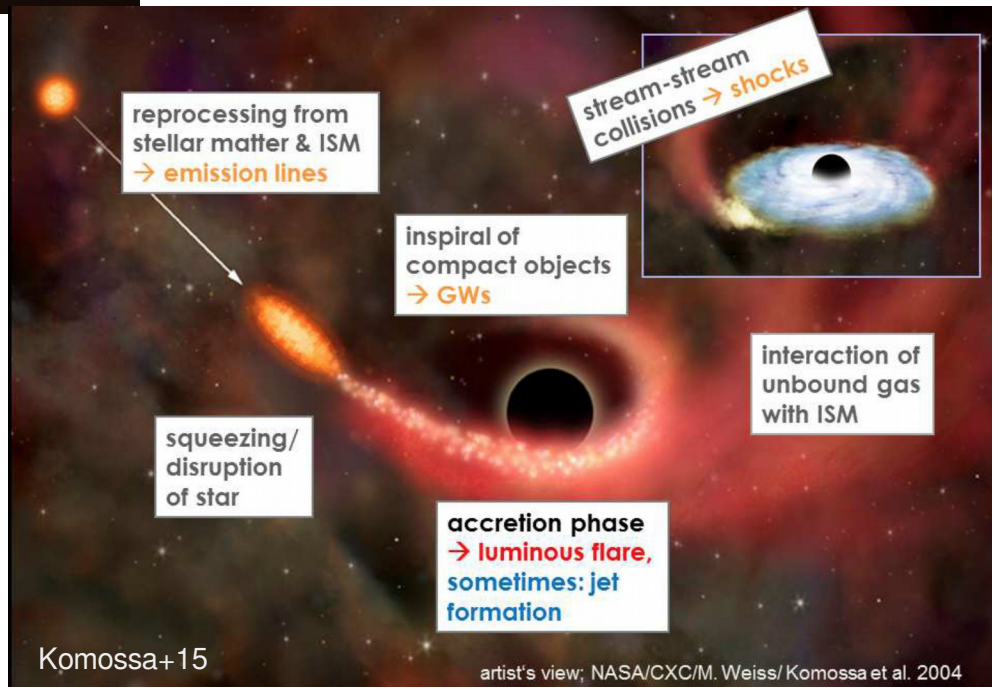
Accretion rate

High

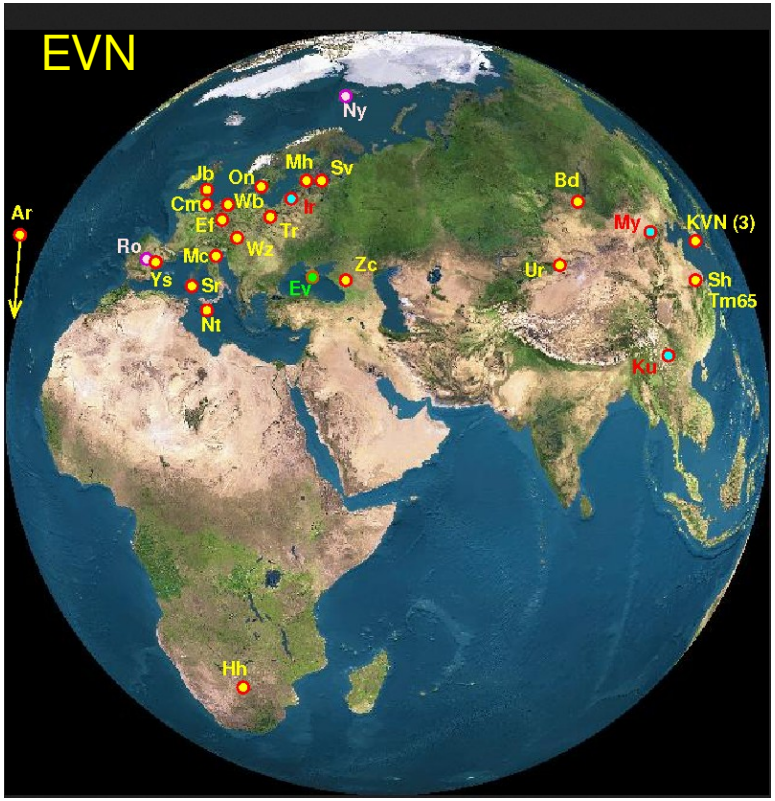
Low

Tidal Disruption Events (TDEs) – Tracing dormant or actively accreting SMBHs? Causing AGN changing look?

Preference for post-starburst hosts (Arcavi+14; French+16)

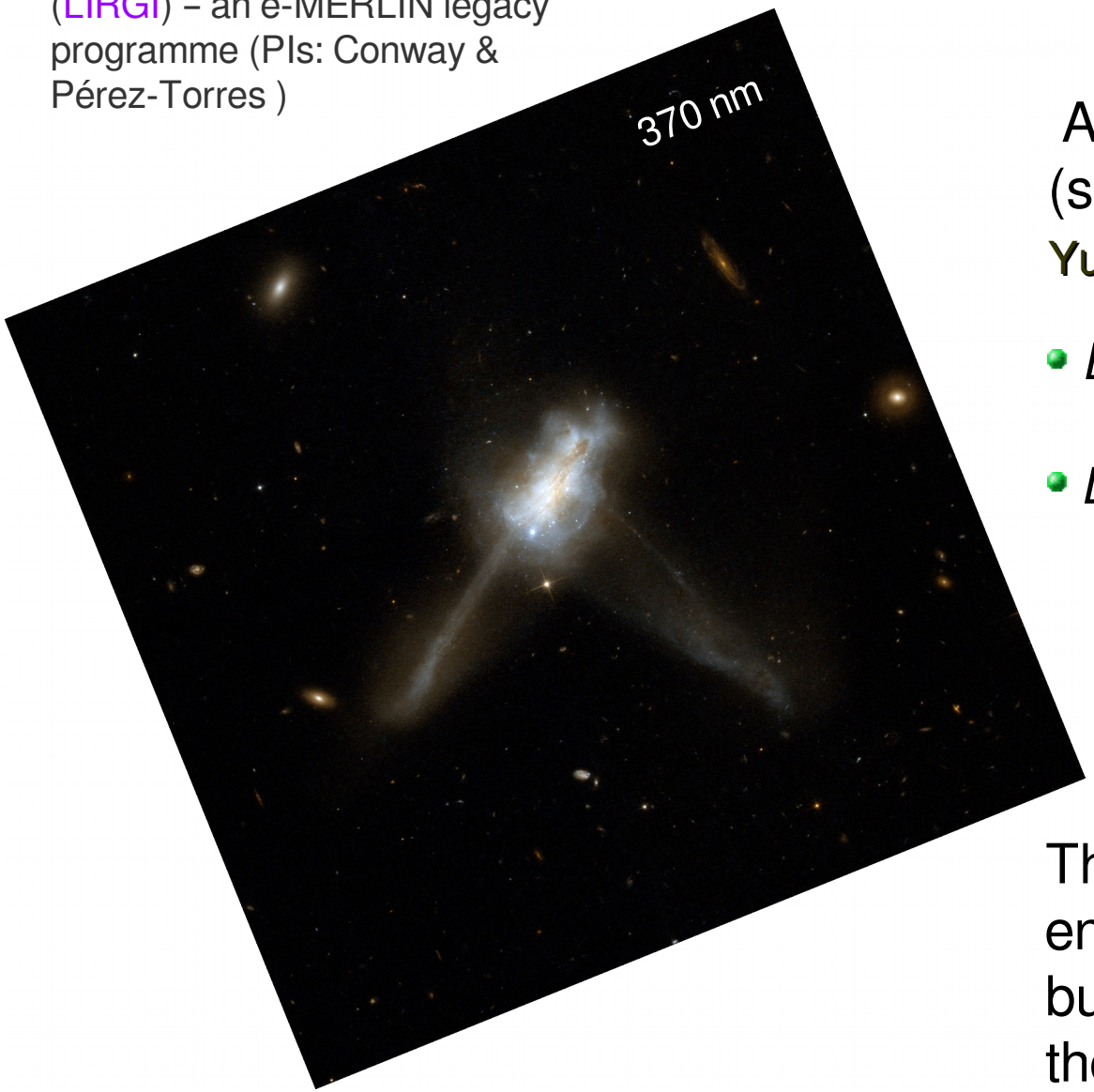


Instruments



IC883

A target from the Luminous InfraRed Galaxy Inventory (LIRGI) – an e-MERLIN legacy programme (PIs: Conway & Pérez-Torres)



NASA, ESA, the Hubble Heritage (STScI / AURA)-ESA/Hubble Collaboration, and A. Evans

Advanced stage merger (starburst-AGN composite, **Yuan+10**)

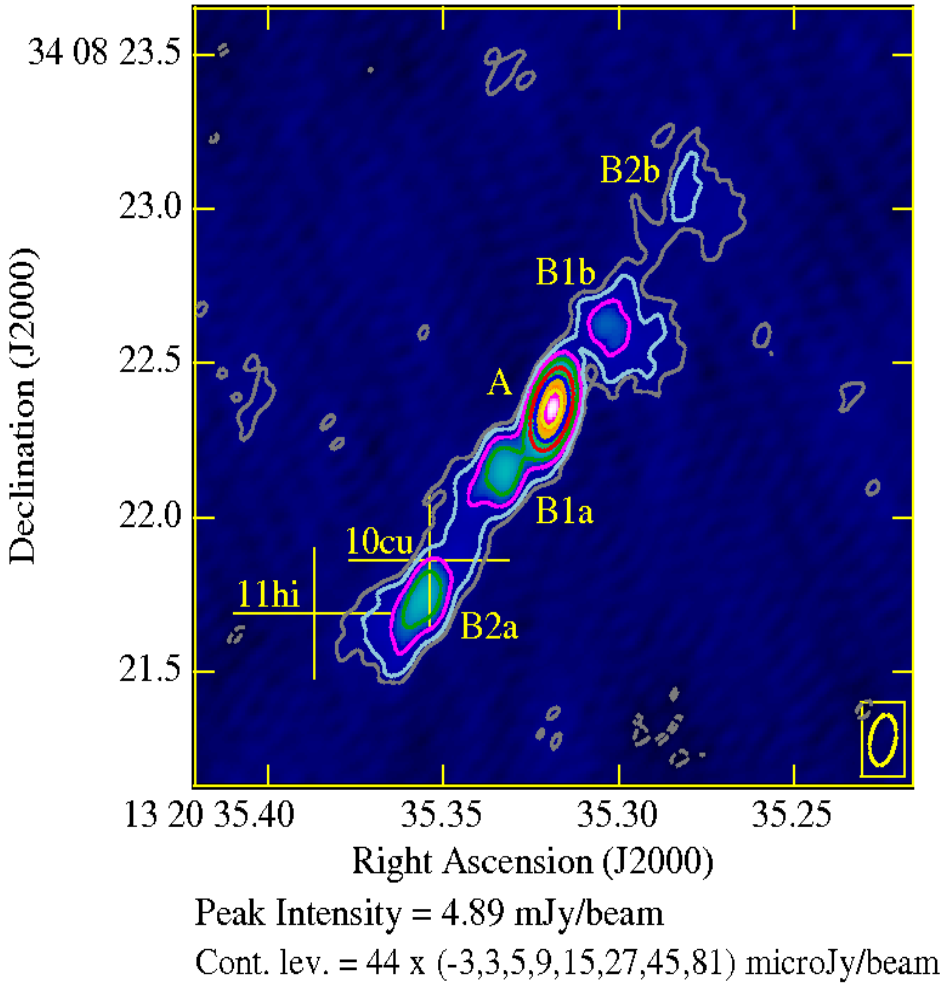
- D ~ 100 Mpc ⇒ 1 mas ~ 0.5 pc
- L_{IR} ~ 4.7 x 10^{11} $L_{\odot}$

$$\nu_{CCSN} \approx 1.3\ \mathrm{yr}^{-1}$$

The starburst dominate the energetics of the system, but there should be an AGN therein: [Ne V] line.

Two SNe within a year – Radio follow-up with e-MERLIN

SNe 10cu & 11hi not detected...



Romero-Cañizales +12

(the first pubblication based on e-MERLIN data)

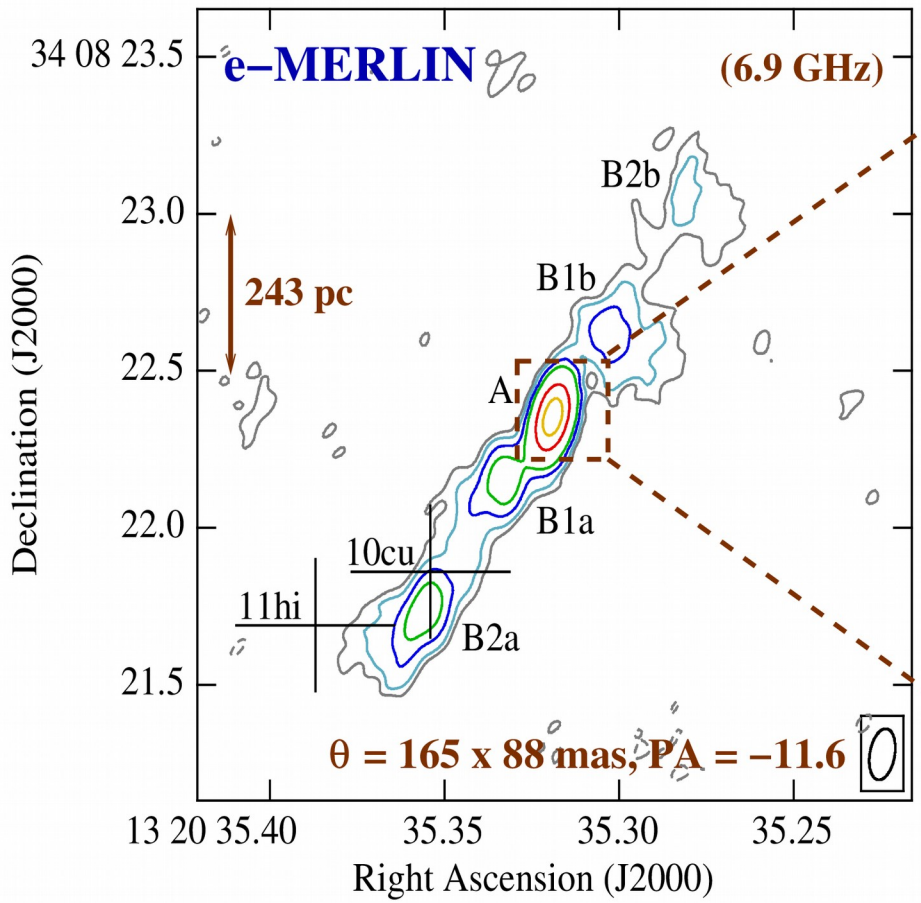
~ 1 kpc radio structure at 140° resembles that of the warped ring of molecular gas (Downes+Solomon98)

Each radio component has a CO (2-1) clump counterpart

B2a has the highest concentration of molecular mass (4×10^8 $M_\odot$) but A is the dynamical centre of the ring.

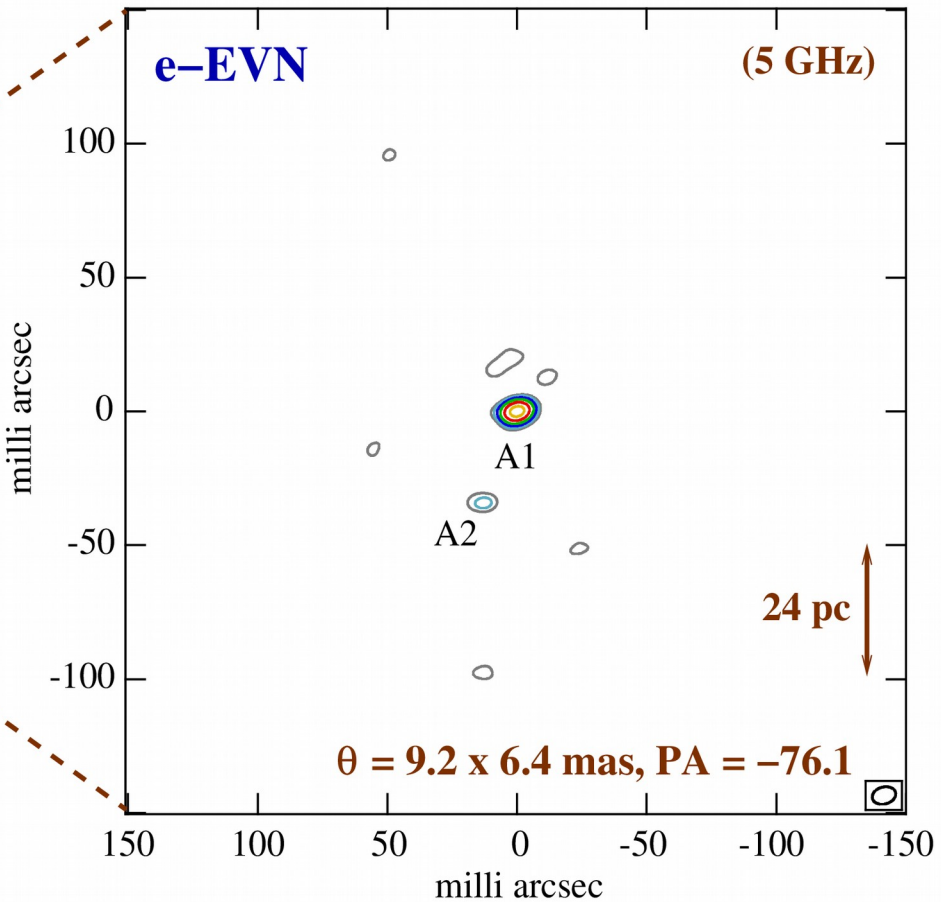
Zauderer+16

e-MERLIN + e-EVN observations



Peak Intensity = 4.89 mJy/beam

Cont. lev. = 44 x (-3,3,5,9,15,27,45) microJy/beam

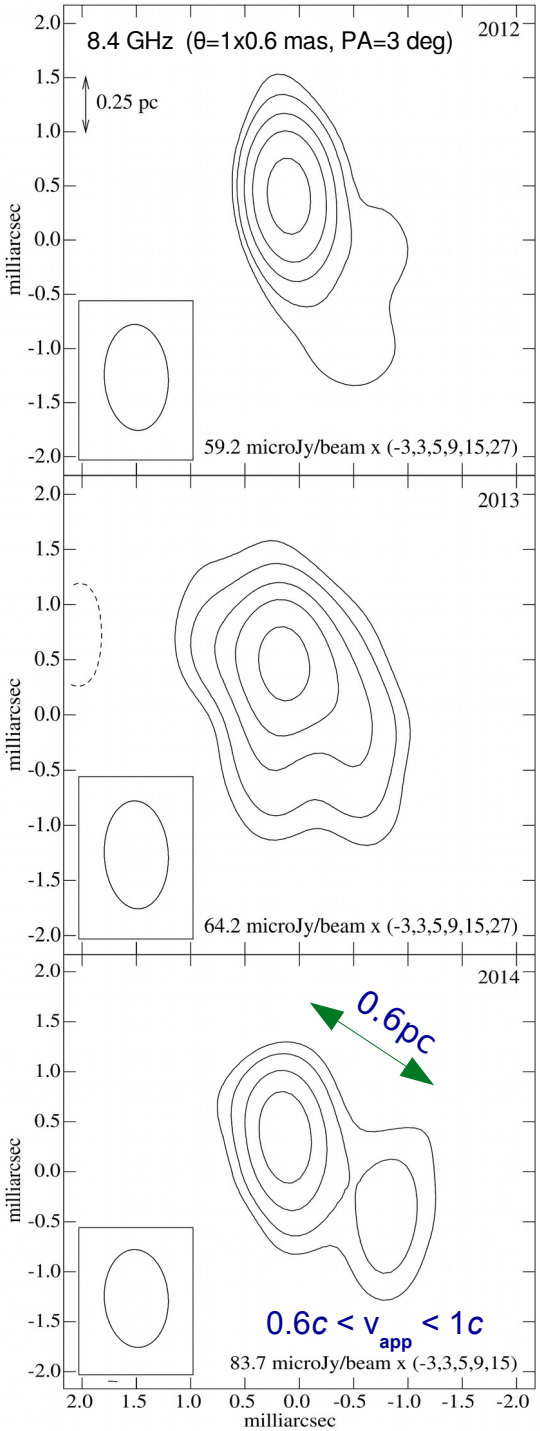


Peak Intensity = 3.82 mJy/beam

Cont. lev. = 66 x (-3,3,5,9,15,27,45) microJy/beam

AGN & SB together?

IC883: nuclear region

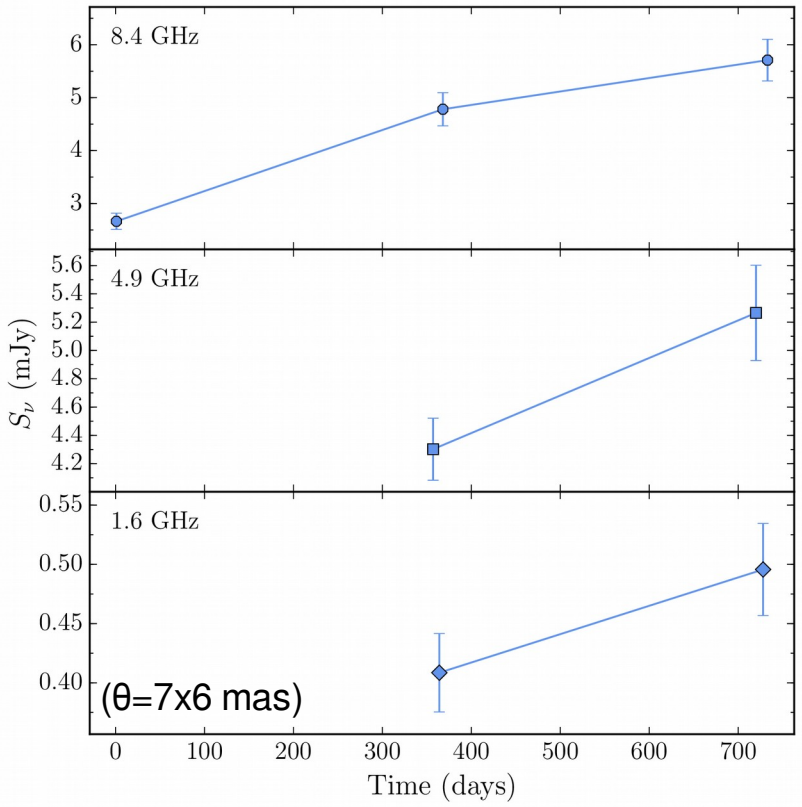


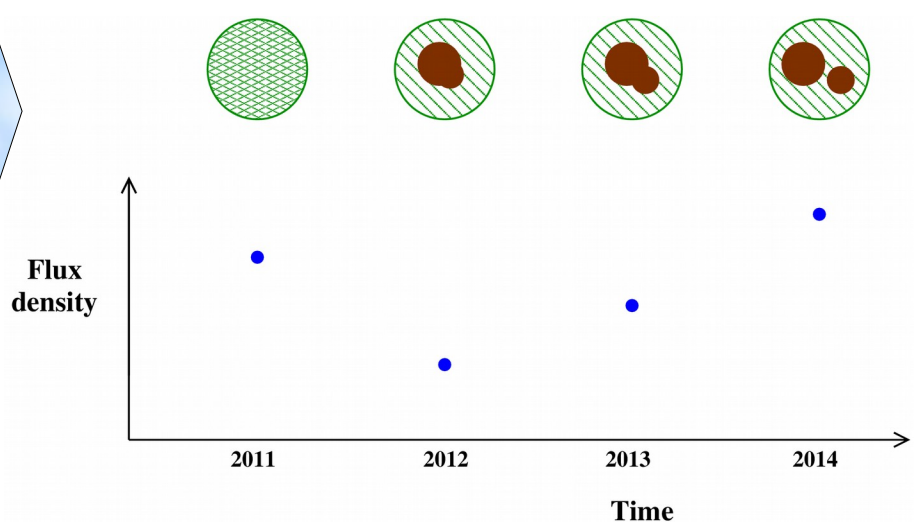
New ejected component at 8.4 GHz: not present in VLBA observations from 15.05.2011 at the same frequency (although at slightly lower resolution).

- The jet-like component was probably ejected sometime between May 2011 and November 2012 $\Rightarrow$ it has moved at an apparent speed of $0.6\ c < v < 1\ c$
- The jet dies out fast? No signs of it at $\theta > 2$ ...

Romero-Cañizales, Alberdi, Ricci +16 (submitted to MNRAS)

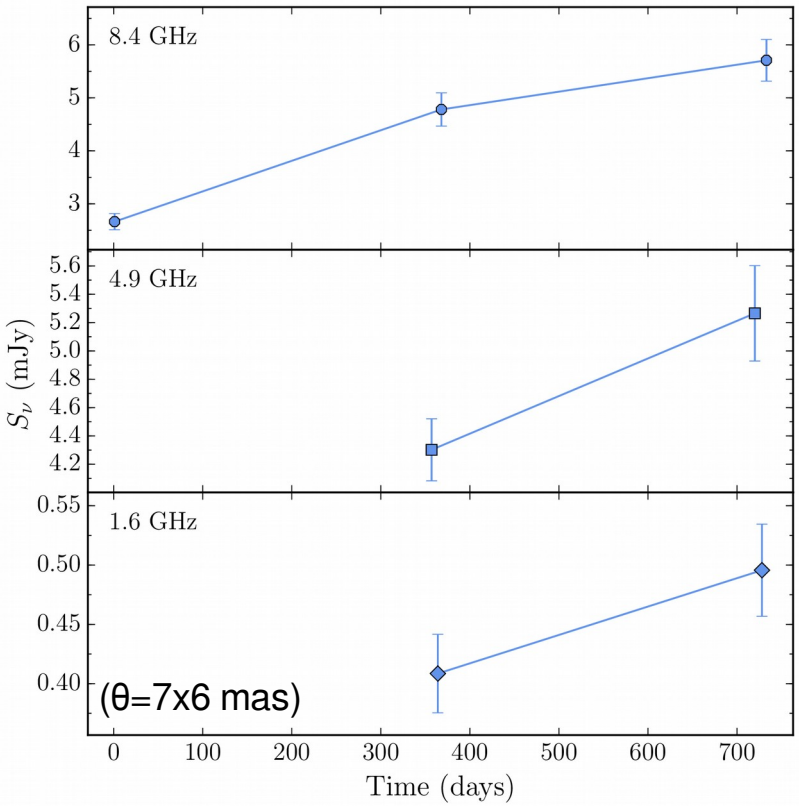
IC883: recurrent activity?

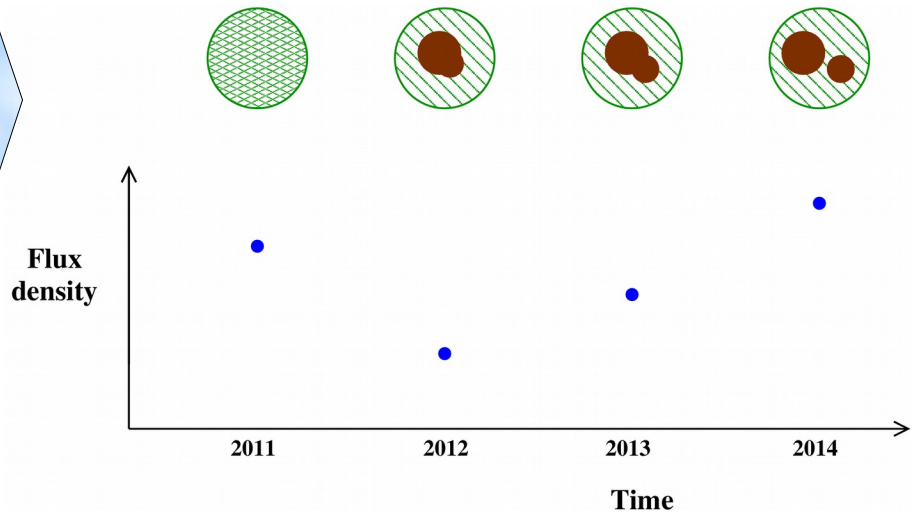


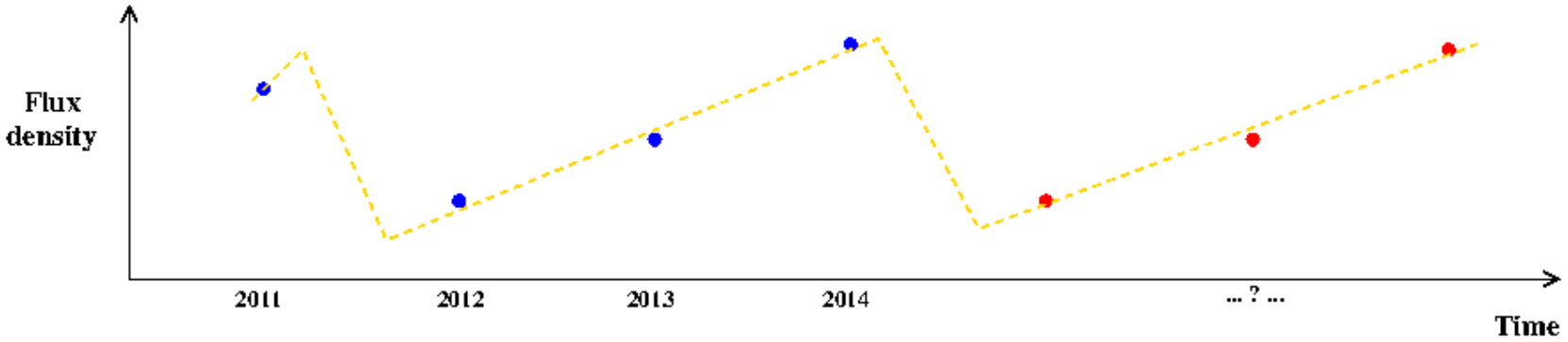


Increase in flux ⇒ new jet at all frequencies

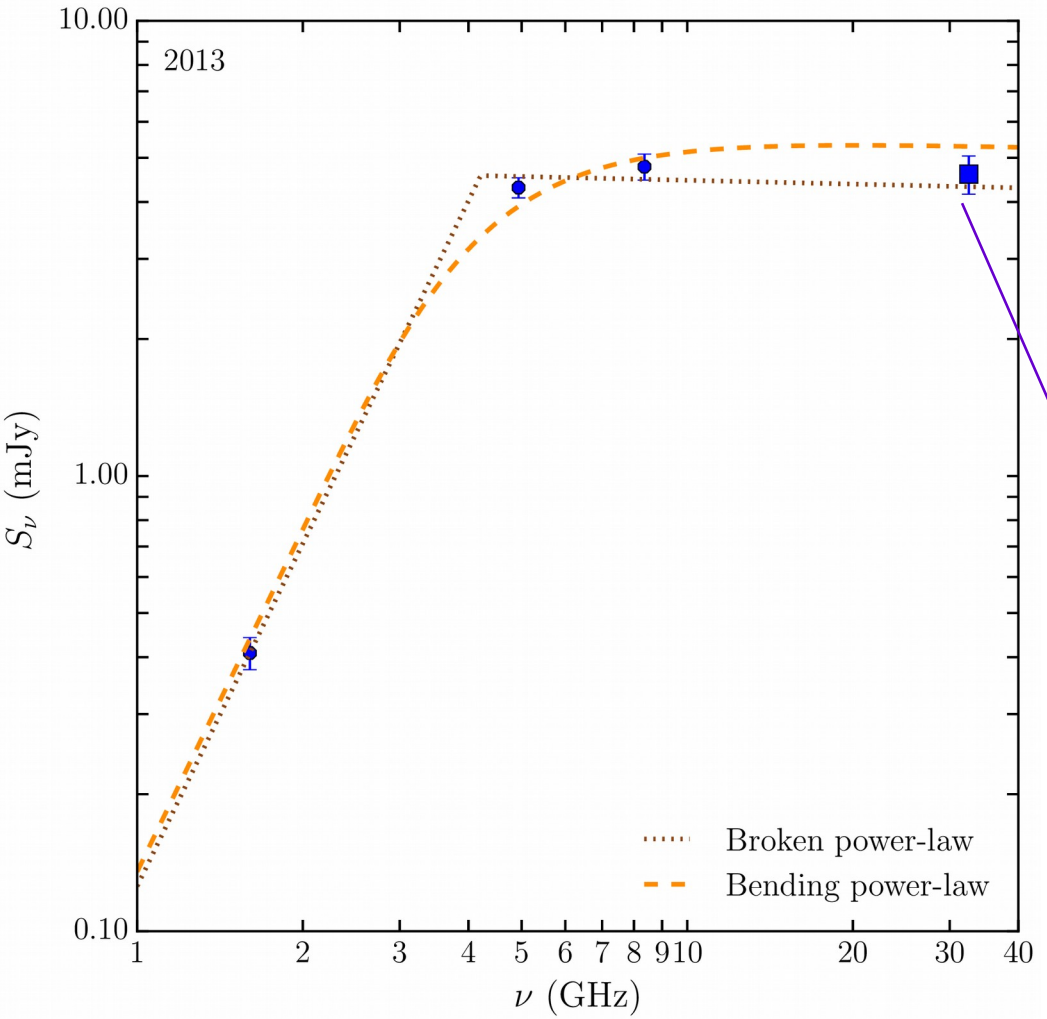
IC883: recurrent activity?

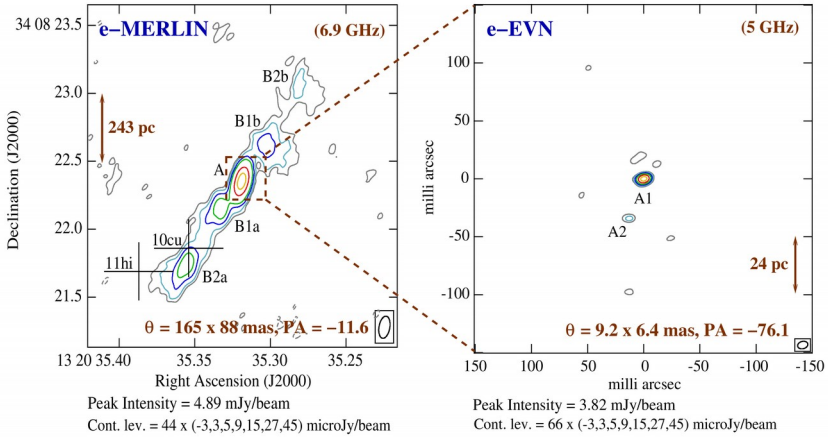


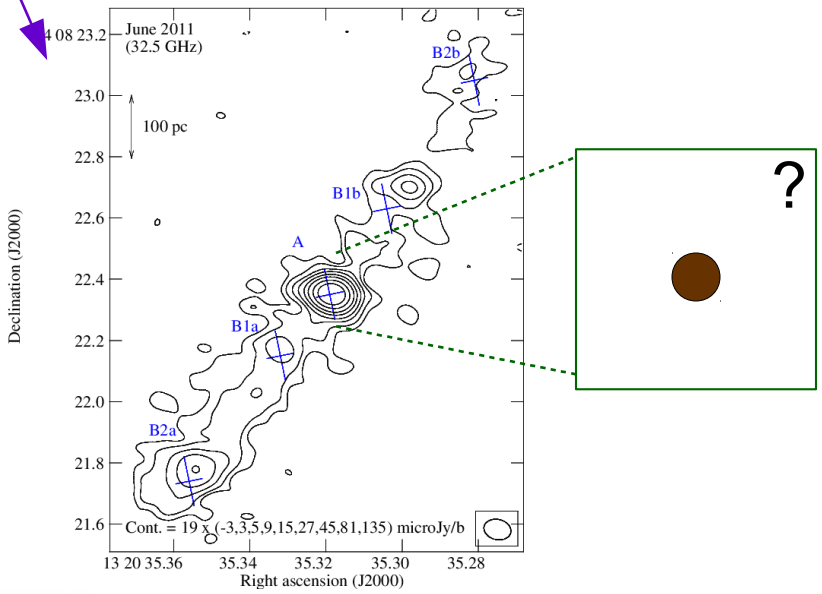




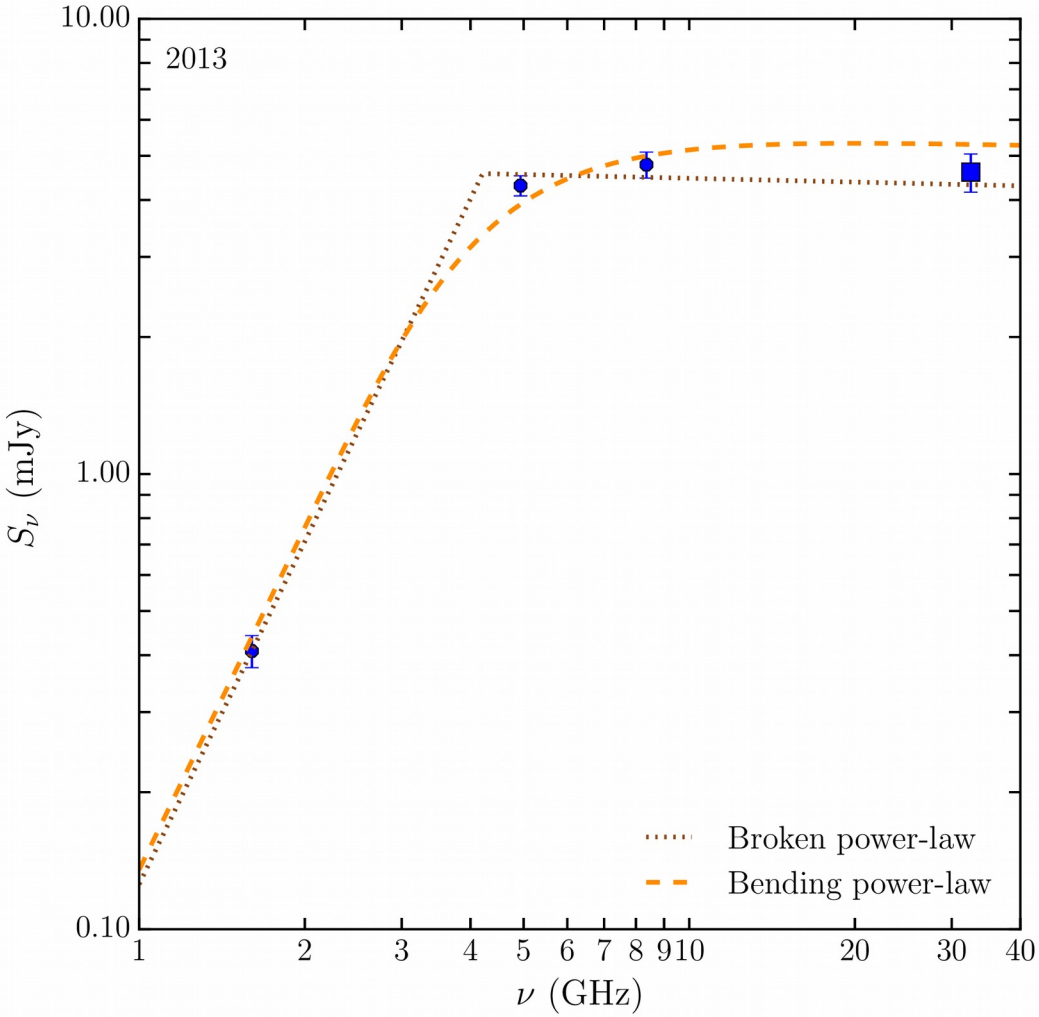
IC883: radio SED







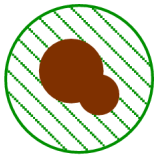
IC883: radio SED



- The core ($L_{8.4GHz}$ > 1x10^{28} erg s^{-1} Hz^{-1}) has a flat spectrum between 5 and 8.4 GHz (and even up to 32.5GHz), but it is highly absorbed at 1.7 Ghz

- A Gigahertz Peaked Spectrum source candidate? (the least luminous one!)

IC883 – what radio emission tells us



R = 7.3 pc

$L_R = 1.3 \times 10^{39}$ erg s^{-1}

B_{eq} = 2.5 mG

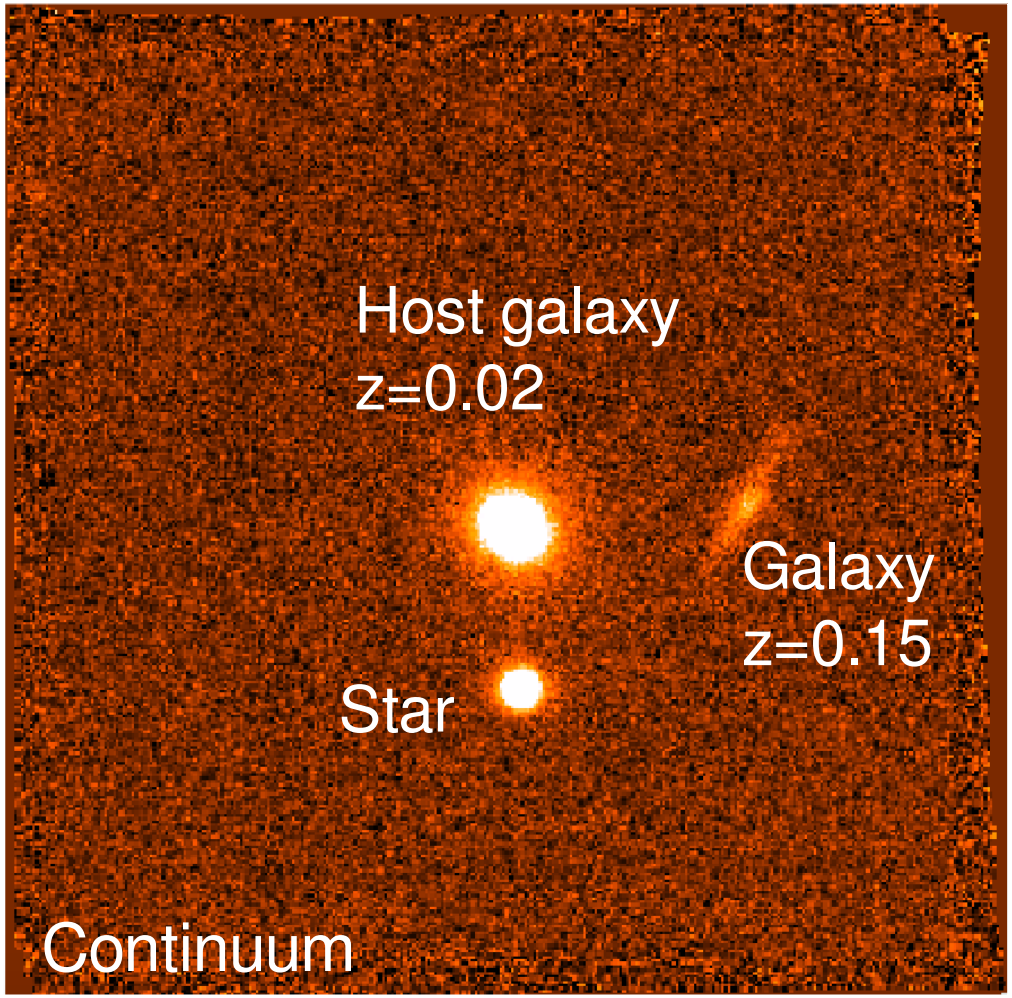
$\tau_{syn} \sim 3 \times 10^3$ yr

1 – 10 mG for other GPS sources (Tyul'Bashev 2001), but an order of magnitude larger than for other LIRGs in an advanced merger (Drzazga+11)

Other young sources have been previously reported (Tingay+03) with luminosities below the average for GPS sources

GPS source in an active star-forming galaxy? (Norris+12)

PGC 043234 – the host ASASSN-14li



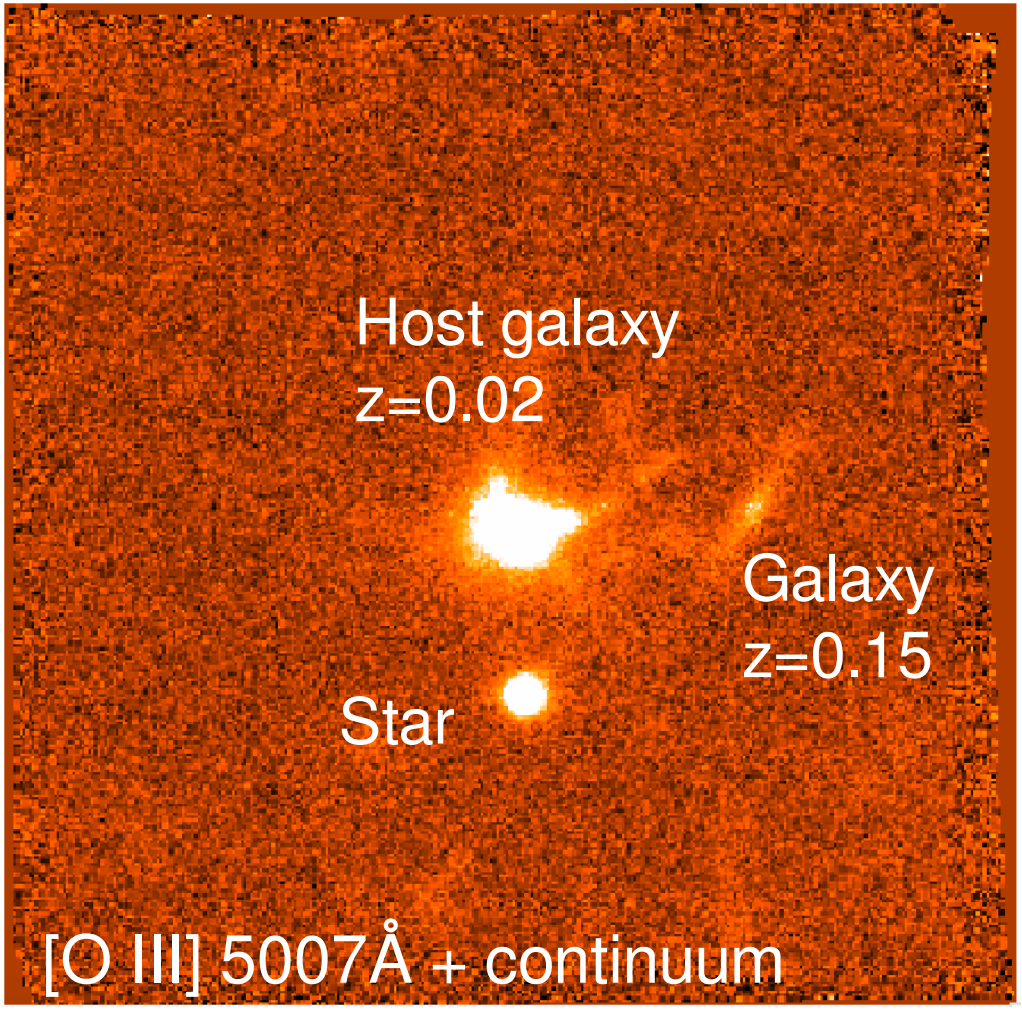
VLT MUSE (1'x 1')
obtained as part of the AMUSING project (PI: J. Anderson, T. Kruehler, L. Galbany)-

✱ ASASSN ✱ All-Sky Automated Survey for Supernovae

Post-starburst galaxy in the Coma supercluster

- D ~ 90.3 Mpc ⇒ 1 mas ~ 0.44 pc
- In the continuum looks pretty boring...
- Host of ASASSN-14li: one of the few TDEs displaying both thermal (X-rays, optical, UV) and non-thermal radio emission

PGC 043234 – the host ASASSN-14li

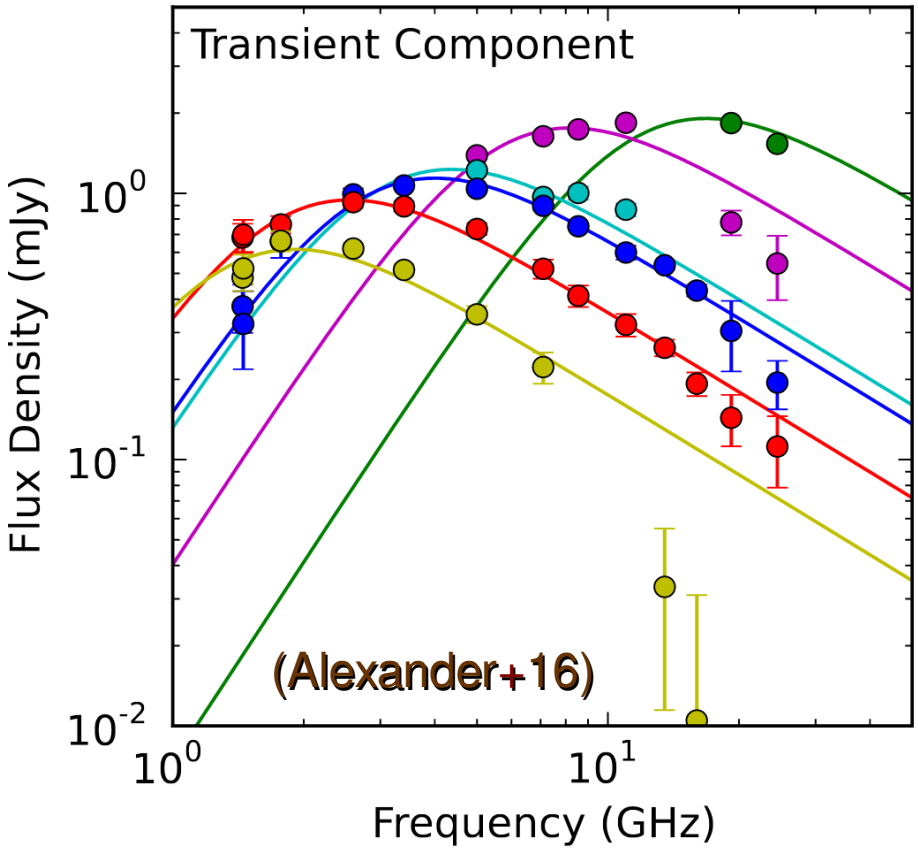


VLT MUSE (1'x 1')
obtained as part of the AMUSING project (PI: J. Anderson, T. Kruehler, L. Galbany)-

Post-starburst galaxy unveiled as a merger remnant with a low-luminosity Type II AGN prior to ASASSN-14li. Star-formation is negligible.

Prieto+16 (submitted to ApJL)
arXiv:1609.00013

ASASSN-14li at low-resolution radio observations



VLA (Alexander+16)
AMI & WSRT (van Velzen+16)

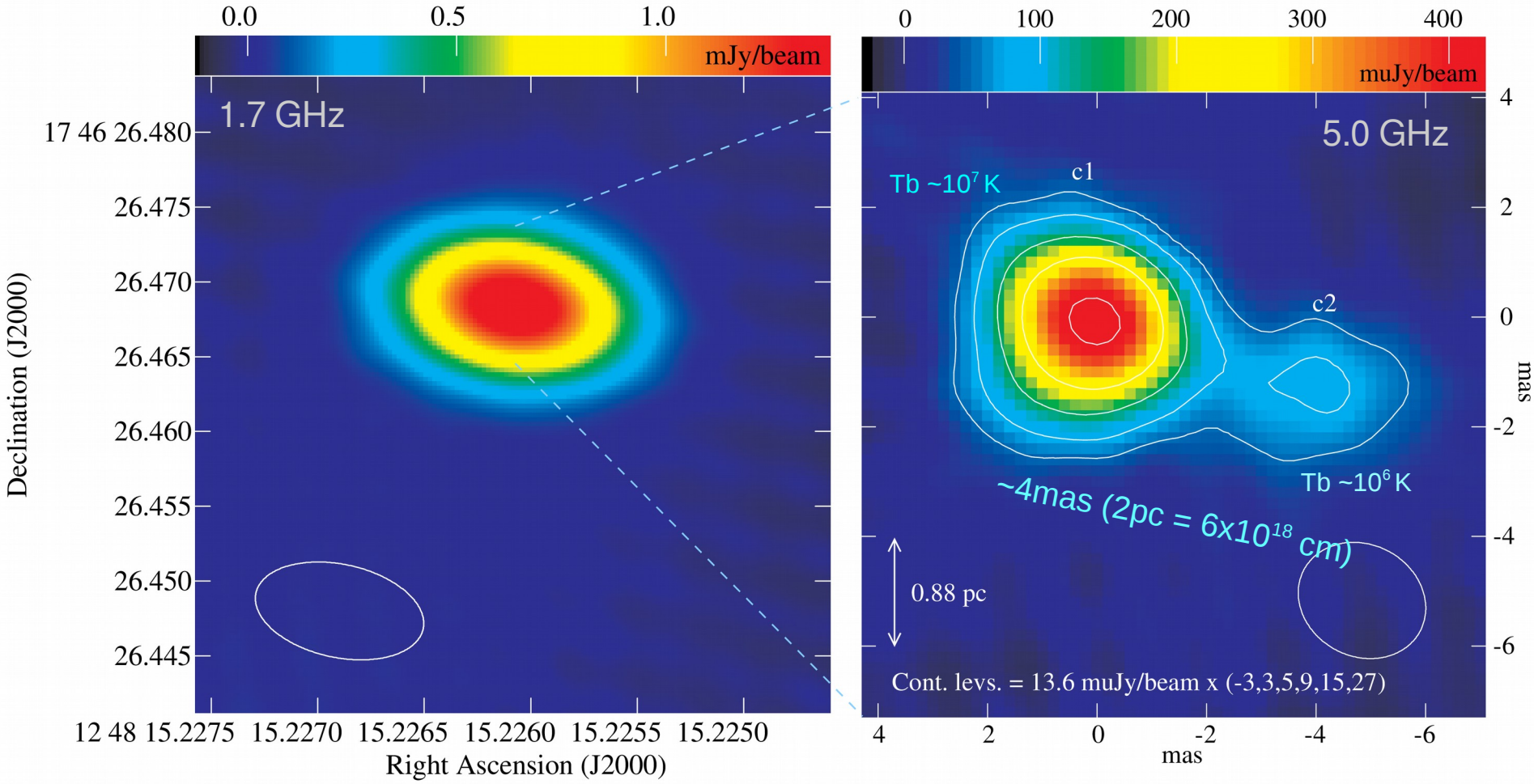
Radio emission: steady source ($S_\upsilon \approx S_0(\upsilon/1.4\mathrm{GHz})^{-1}$) and a non-relativistic outflow.

Old radiative age?

(~ 10^7 yr; Murgia+11)

Romero-Cañizales, Prieto, Chen +16 (submitted to ApJL)
arXiv:1609.00010

EVN observations (June 2015)



1) If c2 was ejected on August 11-25 2014 → v_{app} ~ 7.3c – 7.7c

   ✻ The first TDE jet directly imaged? ✻

2) If v_{app} ~ 0.04c – 0.12c → c2 was ejected 50 to 150 years ago

3) Dual BH system (M_{BH} ~10^6 – 10^7 $M_\odot$ → R~10^{18} – 10^{19} cm)

Take away points:

The EVN has allowed us to:

- ✔ Find unequivocal evidence of the AGN activity in IC883, potentially representing the least luminous (L_{5GHz} ~ $6x10^{28}$ erg s^{-1} Hz^{-1}) and one of the youngest (~$3x10^{3}$ yr) gigahertz-peaked spectrum sources.

- ✔ Resolve the radio emission of ASASSN-14li and its host. The nature of the components is not clear, though. But stay tuned to see the results of our upcoming observations!

Thanks for your attention!