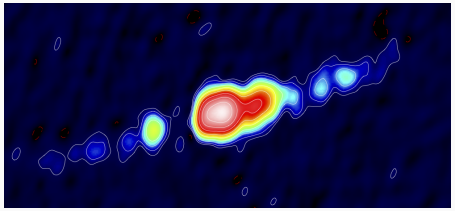


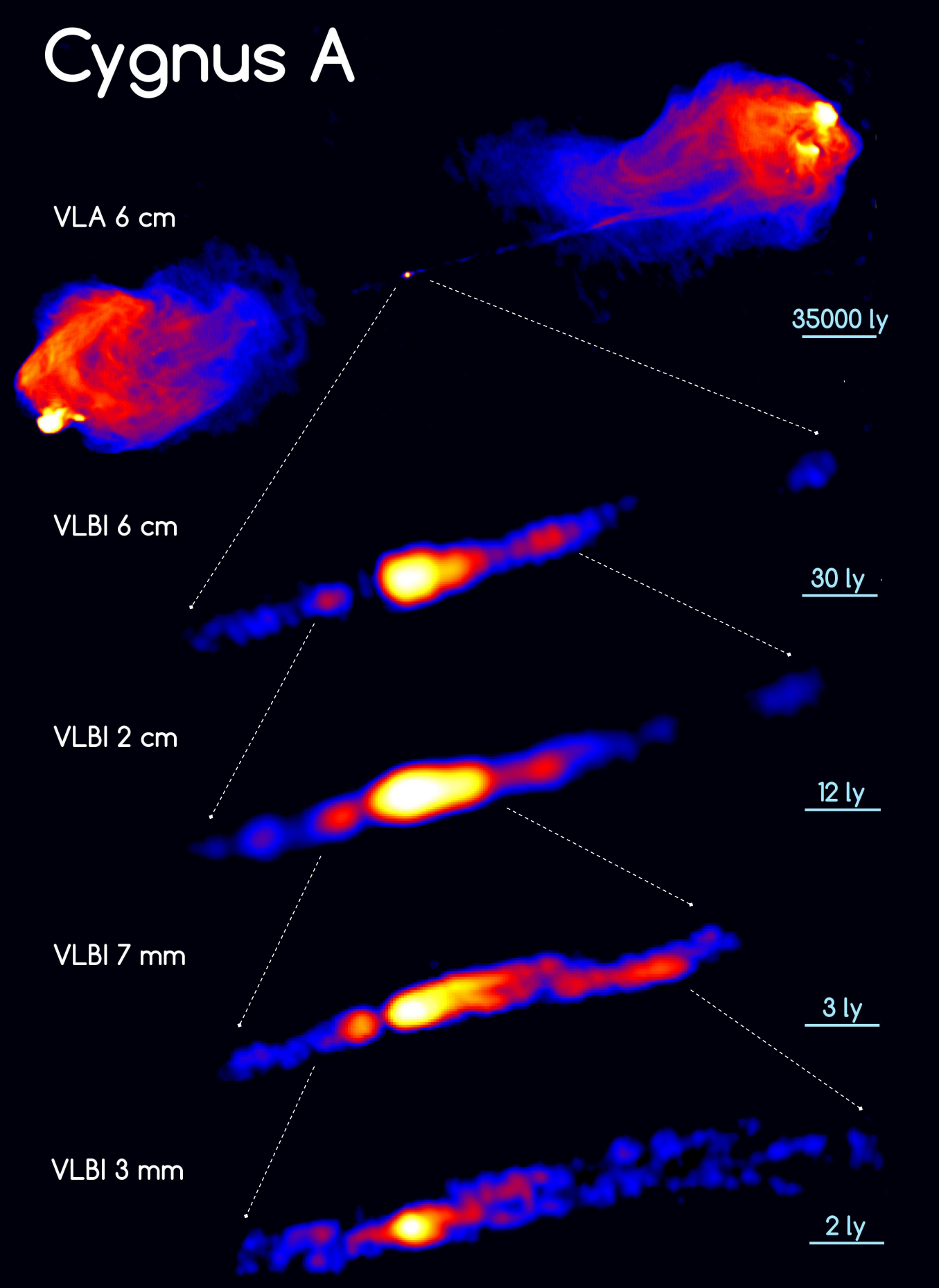
Does Cygnus A harbour a binary supermassive black hole?

Uwe Bach, Bia Boccardi, Thomas Krichbaum, Andrei Lobanov et al.

October 8, 2018

Max-Planck-Institut fuer Radioastronomie, Bonn

Outline


Cygnus A
VLA 6 cm
35000 ly
VLBI 6 cm
30 ly
VLBI 2 cm
12 ly
VLBI 7 mm
3 ly
VLBI 3 mm
2 ly

A new transient source

Discovery of a Radio Transient in Cygnus A

ATel #9495; *D. A. Perley (Dark Cosmology Centre, NBI), R. A. Perley, and C. L. Carilli (NRAO)*
on 13 Sep 2016; 23:52 UT
Credential Certification: Daniel Perley (dperley@dark-cosmology.dk)

Subjects: Radio, Request for Observations, AGN, Transient

Tweet Recommend 2

We report the detection of a new radio source close to the nucleus of Cygnus A. Observations taken with the Very Large Array at frequencies between 8-20 GHz in July 2015, and between 20-50 GHz in August 2016, reveal a point source at the following location (J2000): RA = 19:59:28.32385 Dec = +40:44:01.9165 The source is detected at all frequencies and cleanly resolved from the Cygnus A nucleus; the separation is 0.395" (=430 pc). The positional accuracy (as registered against the nucleus) is approximately 3 mas. The flux density of this source is 4 mJy at 10 GHz, with a spectral index of alpha ~ -0.2 (F_nu ~ nu^alpha). The source shows no evolution (or perhaps a slight brightening) between 2015 and 2016, although the non-overlapping frequency coverage precludes an exact flux comparison. Archival VLA observations of this location taken in 1989 show only the

→ We proposed: Full EVN observations at 1.3cm, 6cm, and 18cm on October 1st 2016.

... in the mean time

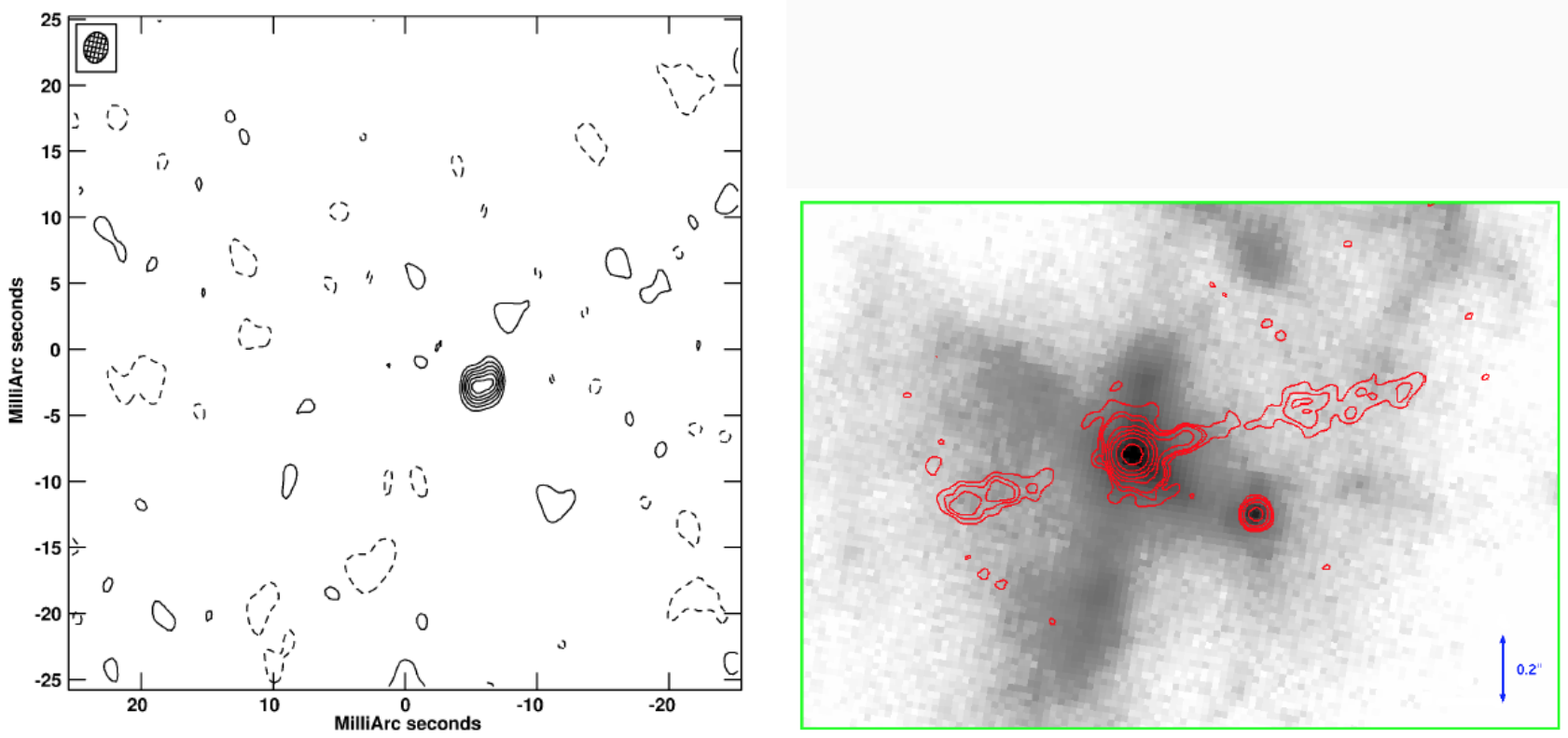
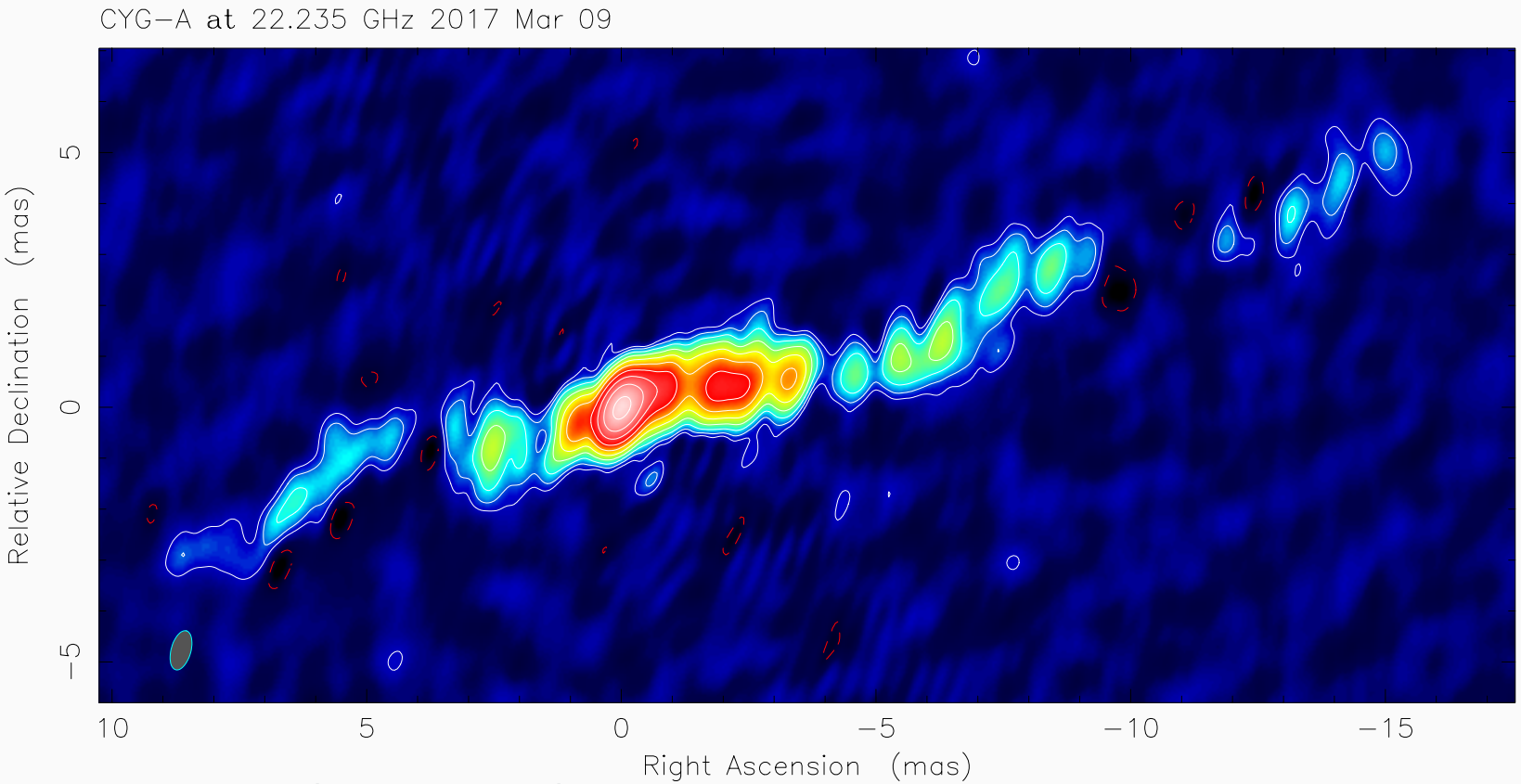


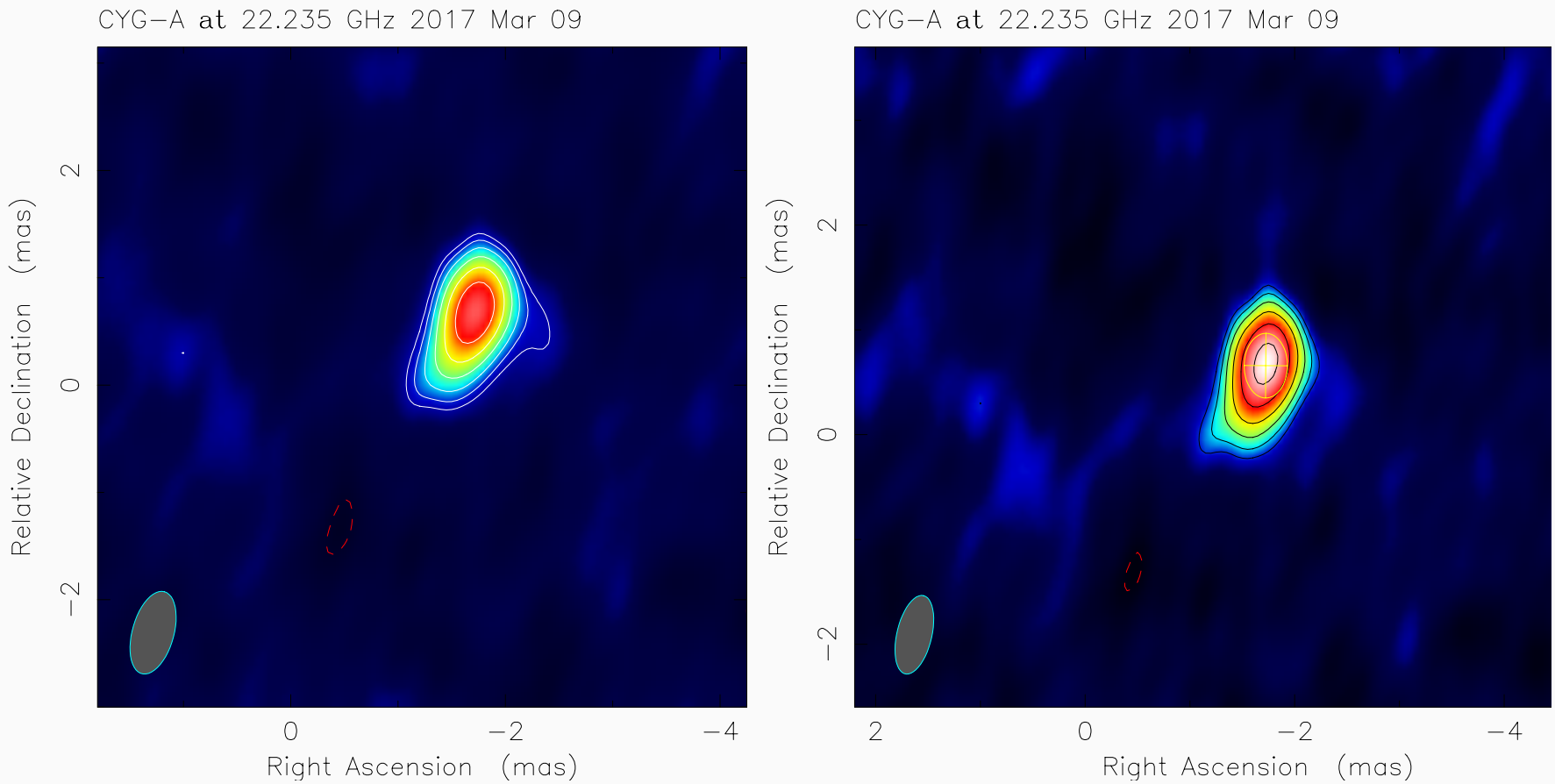
Figure 1: Left: VLBA image of the A-2 field at 3.6 cm at a resolution of 2.3 mas×1.8 mas. The total flux is 3.8 mJy. **(credit: Perley et al., 2017, ApJ, 841, 2)**. **Right:** Composite of the VLA 35 GHz image in contours and the Keck NIR image (Perley et al. 2017, Canalizo et al. 2003). The new radio source is consistent with a bright NIR component 0.42 arcsec offset from the nucleus.

EVN observations at 1.3 cm



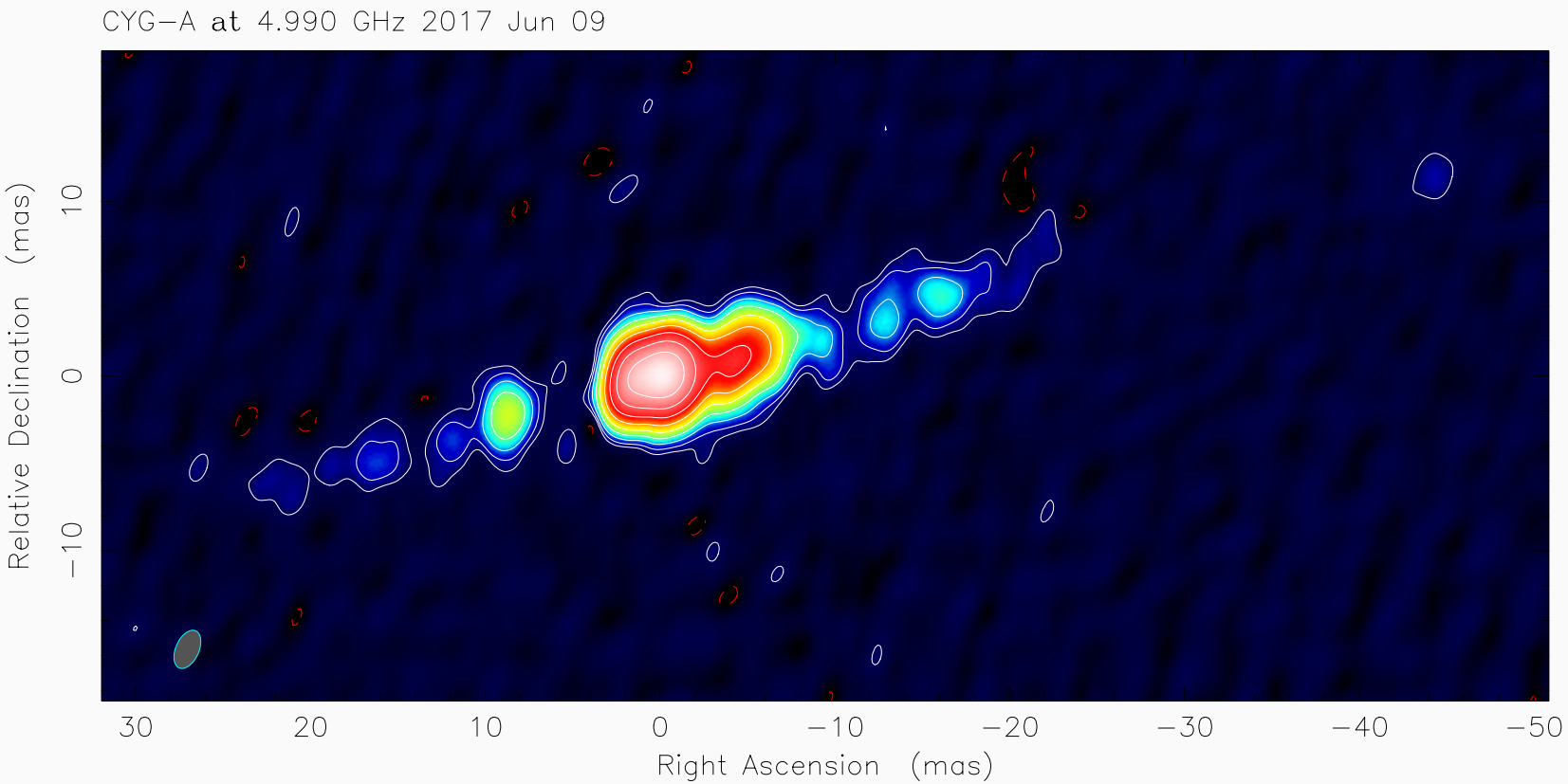
- Full EVN (15 stations) observed on March 9, 2017 at 22.2 GHz
- Beam of $0.33 \times 0.76\,\mathrm{mas}$ at P.A. $-13°$. Noise level at $\sim 0.15\,\mathrm{mJy/beam}$
- Peak flux $317\,\mathrm{mJy/beam}$, lowest contour at $0.5\,\mathrm{mJy/beam}$

EVN observations at 1.3 cm, the transient



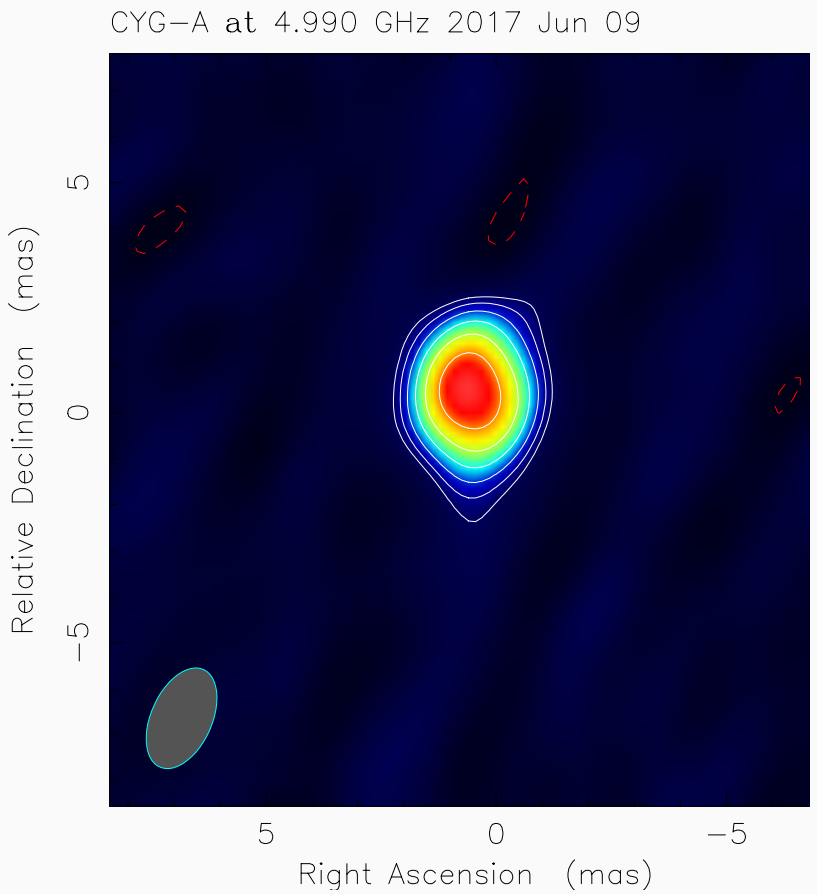
- Peak flux 1.7 $\mathrm{mJy/beam}$, noise level at $\sim$ 0.08 $\mathrm{mJy/beam}$, lowest contour at 0.25 $\mathrm{mJy/beam}$
- Gaussian component of 3.0 $\mathrm{mJy/beam}$ and a size of $0.4 \times 0.6\,\mathrm{mas}$ at P.A. $-0.4°$, corresponding to $\mathrm{T_B} \approx 5 \times 10^7$ K

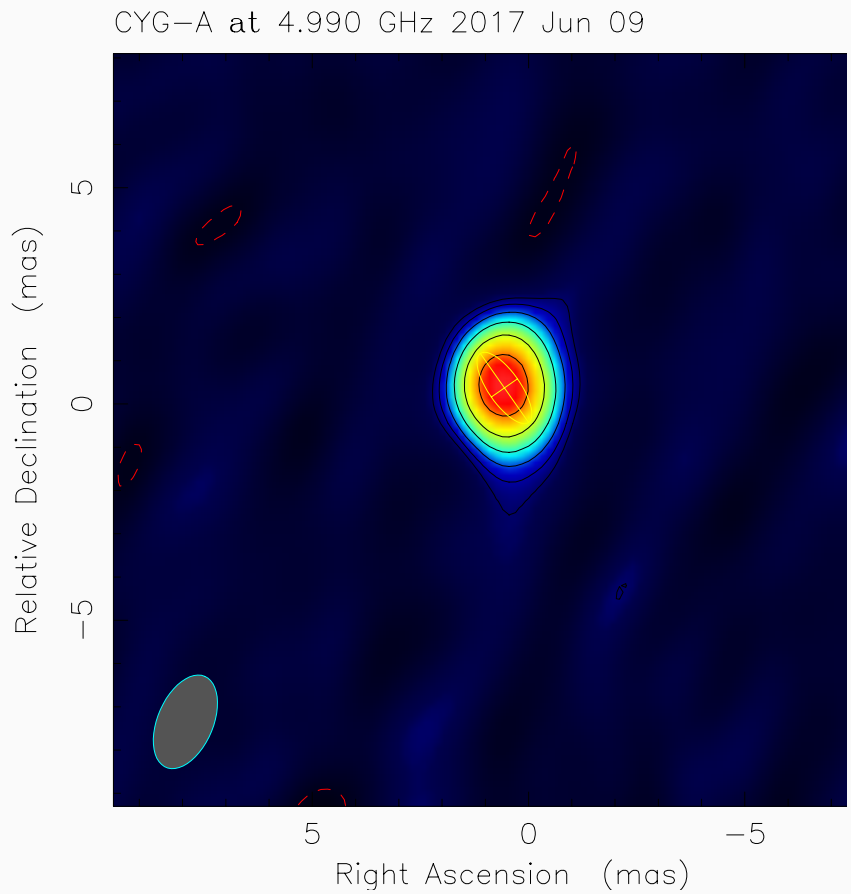
EVN observations at 6 cm



- Full EVN (15 stations) observed on June 9, 2017 at 4.99 GHz
- Beam of $1.33 \times 2.32\,\mathrm{mas}$ at P.A. $-24°$. Noise level at $\sim 0.12\,\mathrm{mJy/beam}$
- Peak flux $190\,\mathrm{mJy/beam}$, lowest contour at $0.4\,\mathrm{mJy/beam}$

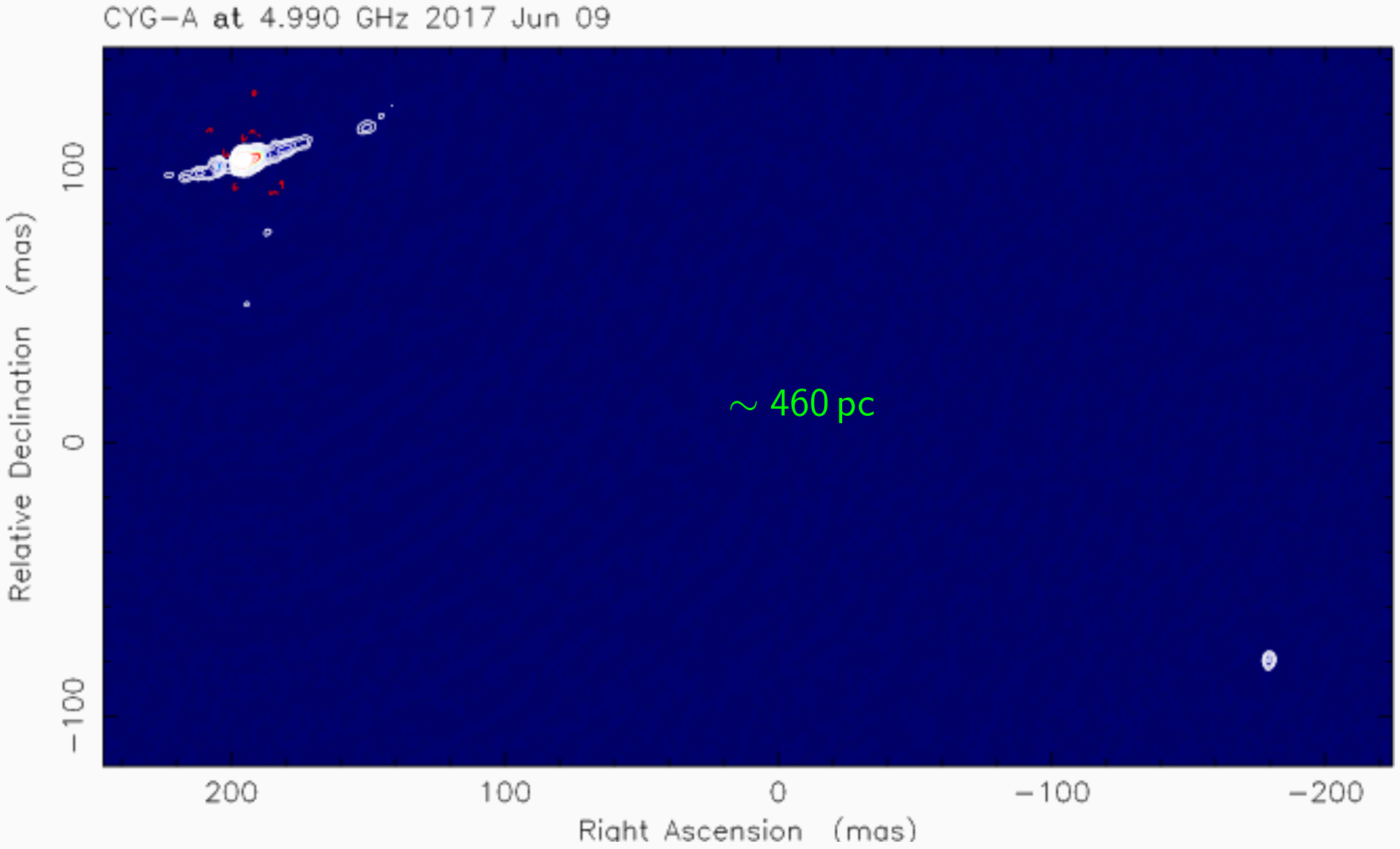
EVN observations at 6 cm, the transient



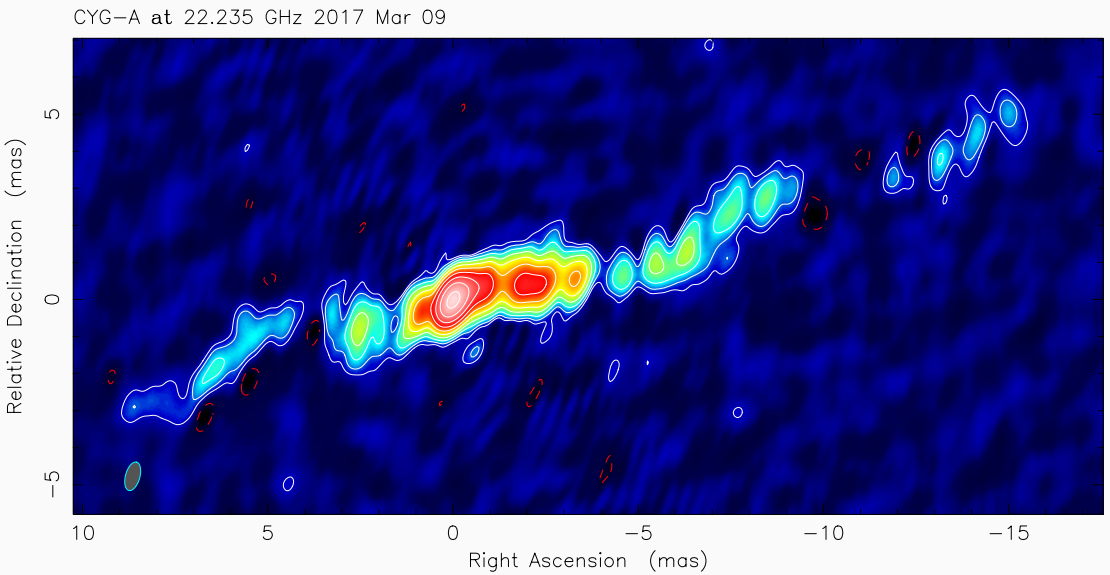


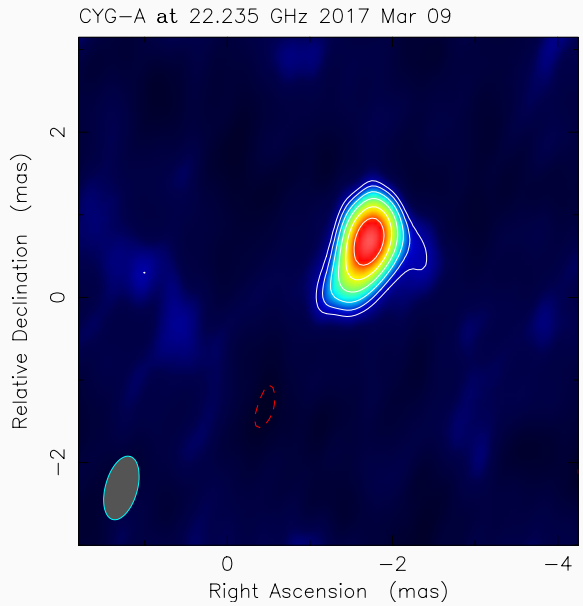
- Peak flux 2.2 $\mathrm{mJy/beam}$, noise level at $\sim$ 0.09 $\mathrm{mJy/beam}$, lowest contour at 0.3 $\mathrm{mJy/beam}$
- Gaussian component of 4.1 $\mathrm{mJy/beam}$ and a size of 0.5 $\times$ 0.8 mas at P.A. 35°, corresponding to $\mathrm{T_B} \approx 3 \times 10^8$ K

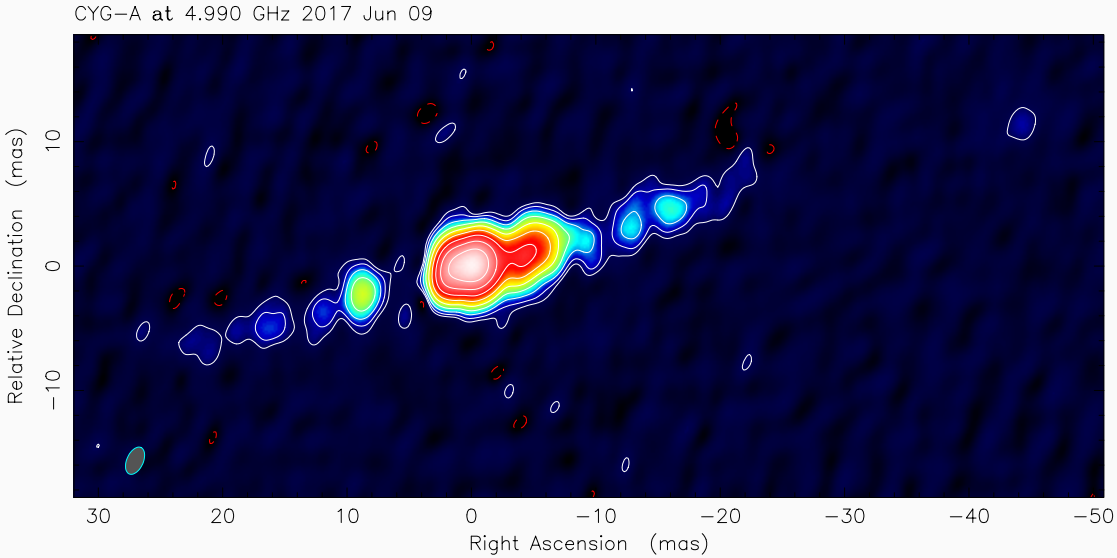
EVN observations at 6 cm, the whole picture

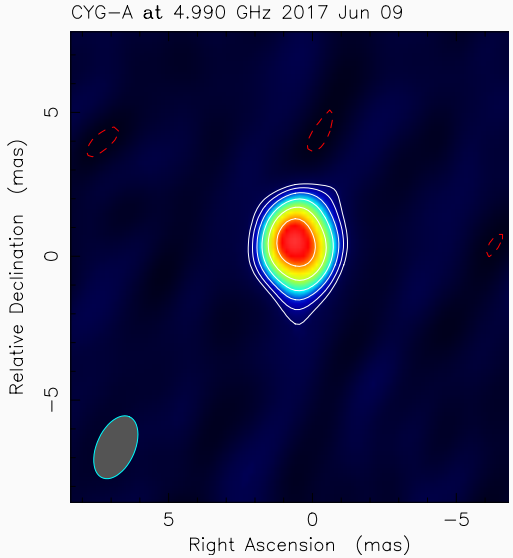


Spectral analysis



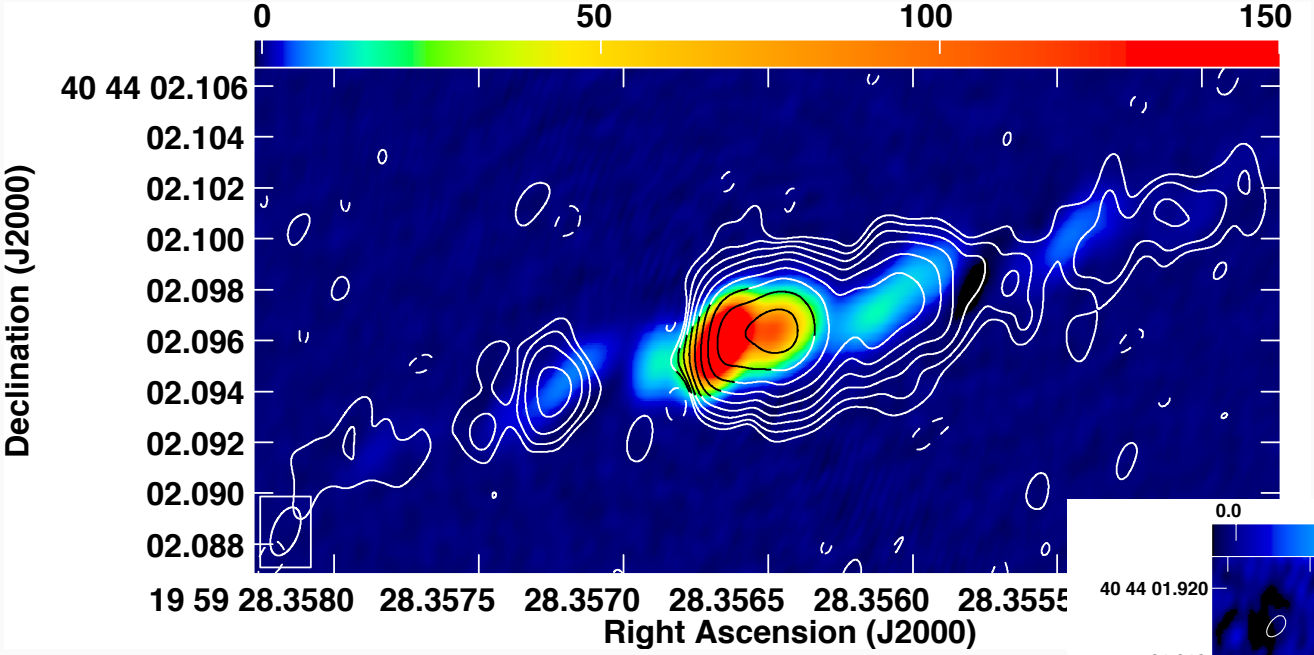




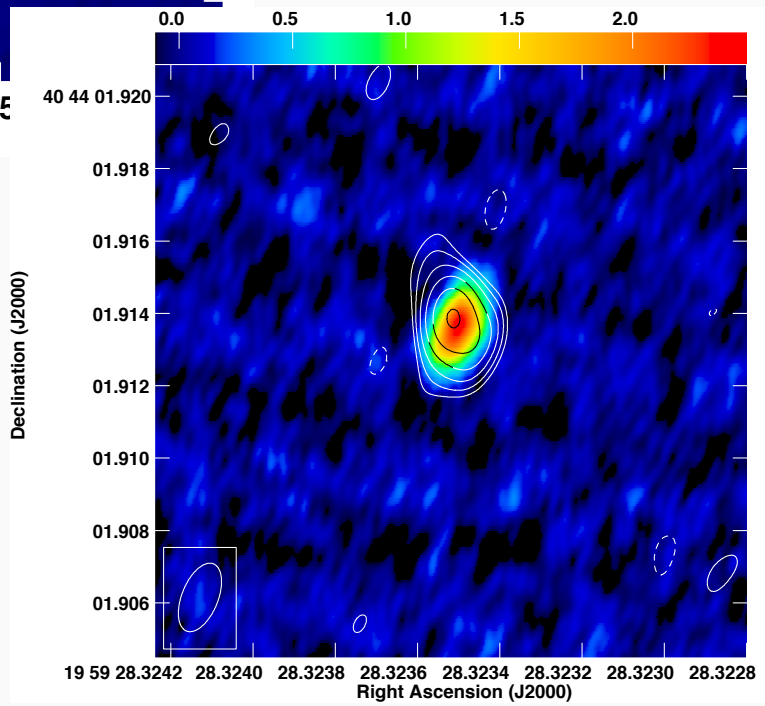


→ Shift 5 GHz images by -2.2 mas in RA and 0.3 mas in DEC.

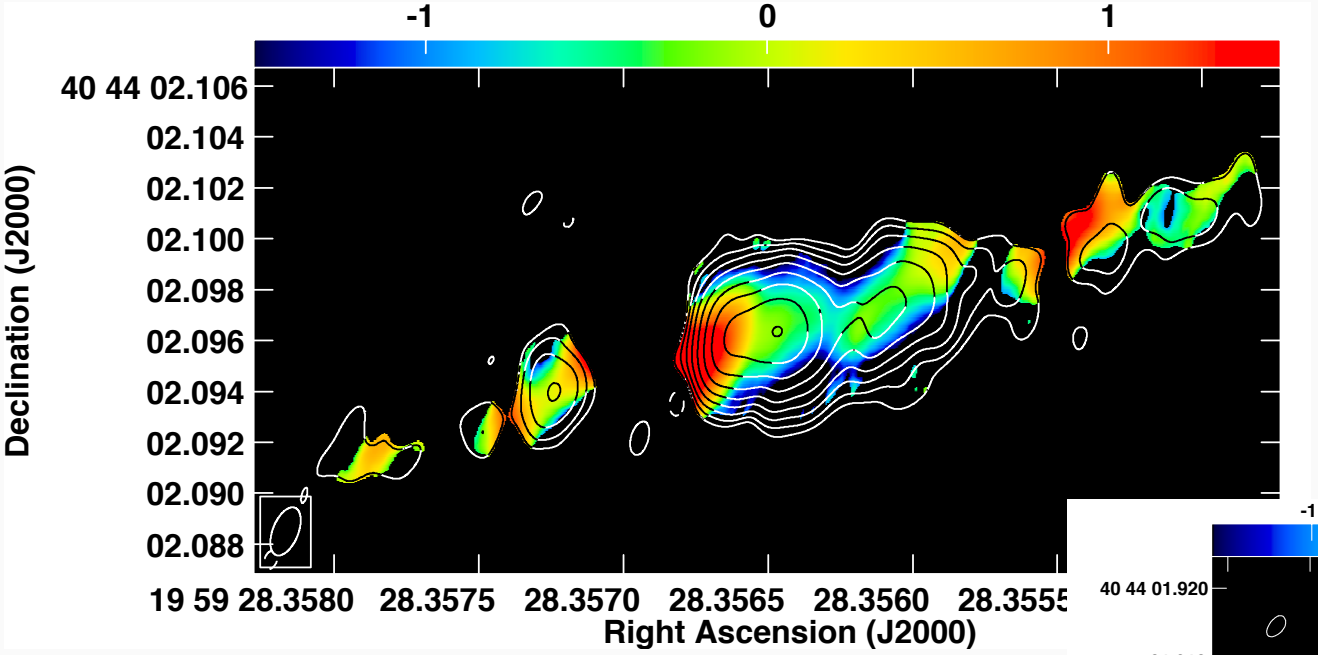
Spectral analysis II



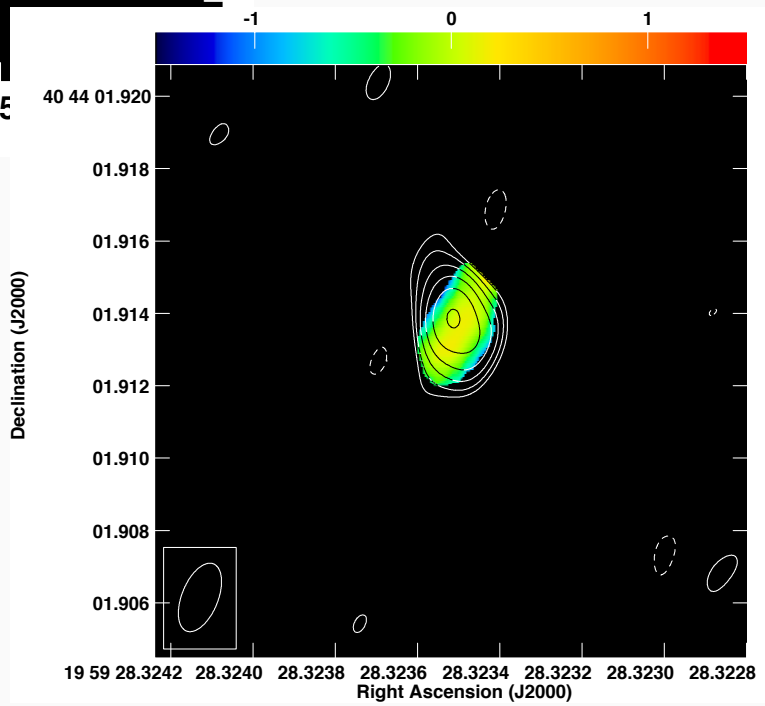
- 22 GHz in colors
- 5 GHz in contours



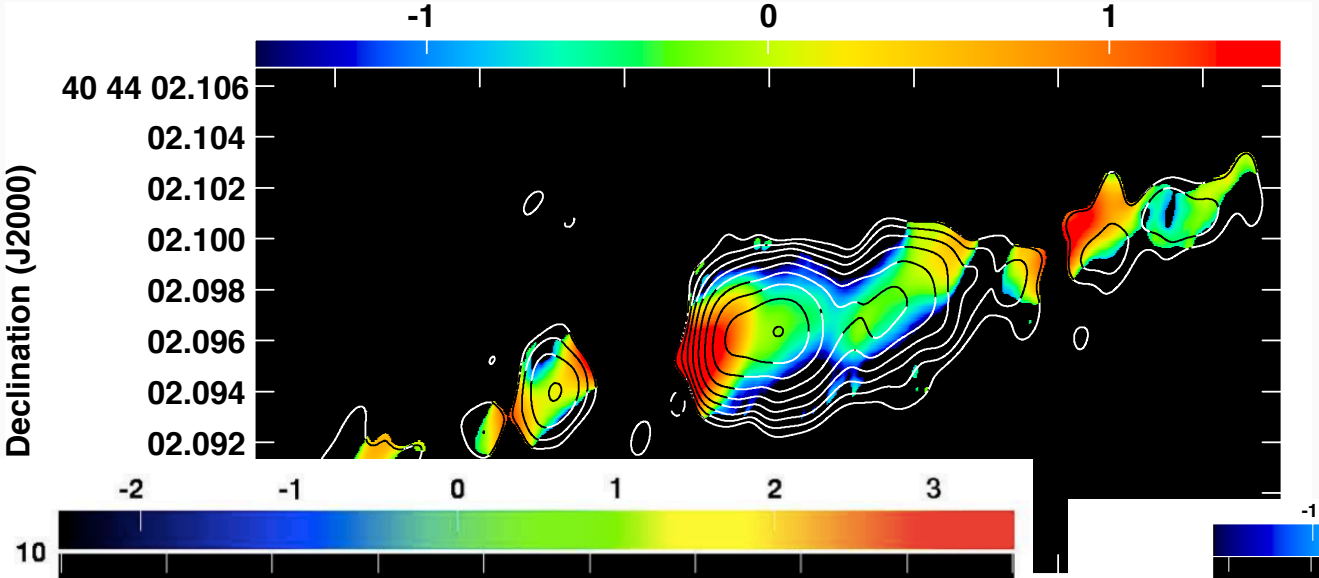
Spectral analysis III



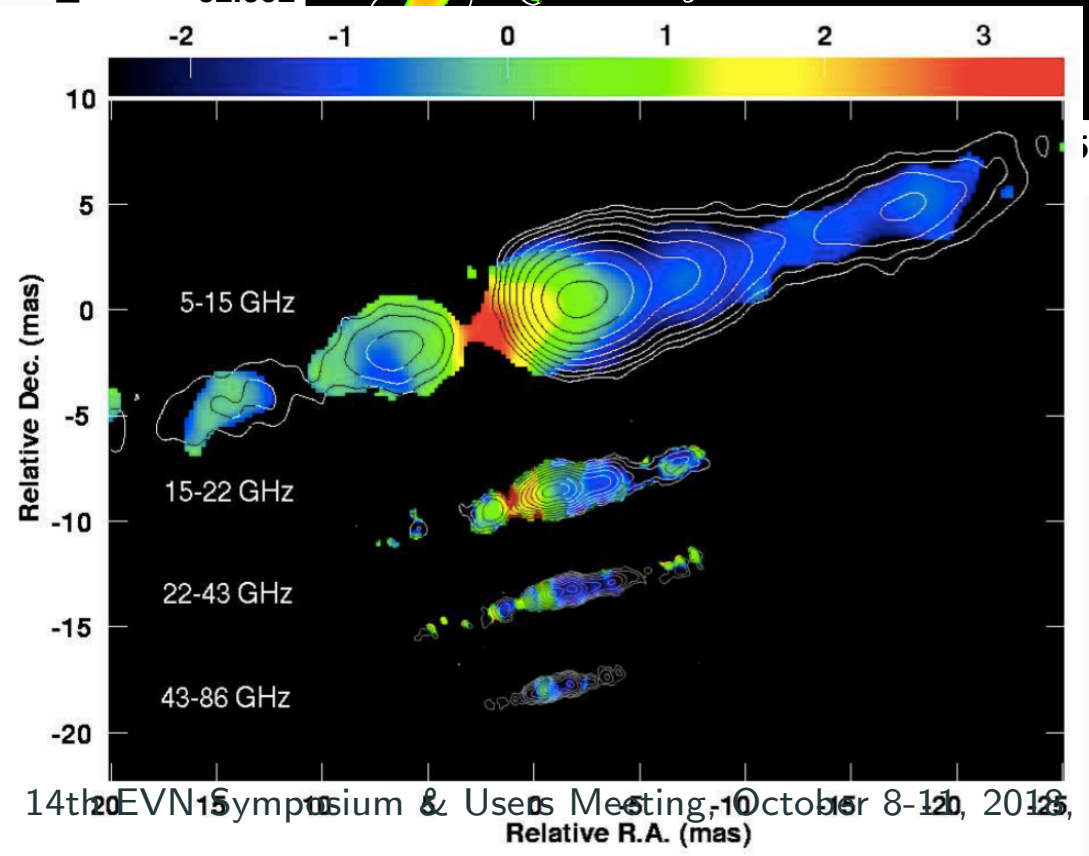
$$S \propto \nu^{\alpha}$$

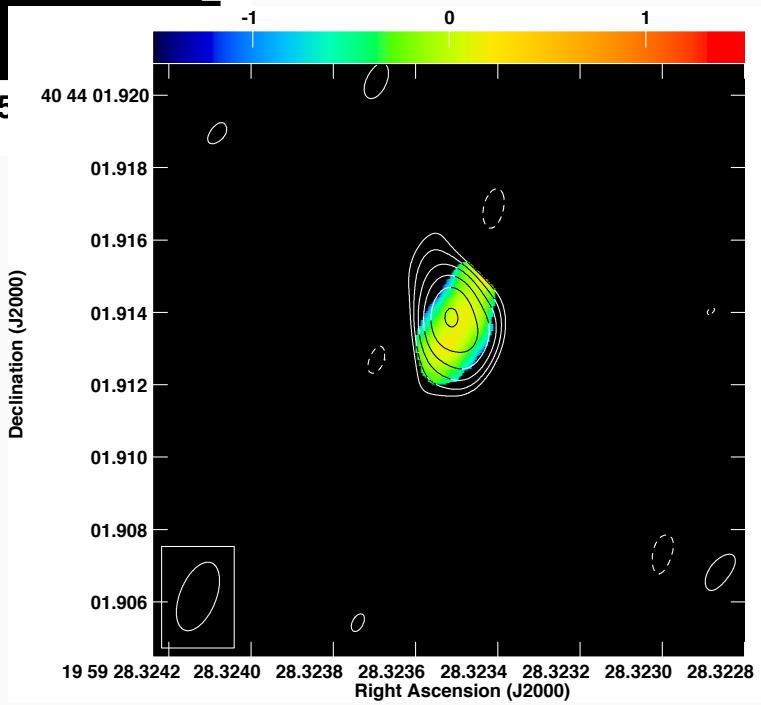


Spectral analysis III



$$S \propto \nu^{\alpha}$$





Summary

- The new source is well detected at a SNR of about 25-30 at 5 and 22 GHz.
- It is quite compact with $T_B \approx 3 \times 10^8$ at 5 GHz
- The size is less than 0.5 pc at the distance of Cygnus A
- The flux density corresponds to a radio luminosity of $L_\nu \approx 6 \times 10^{29}$ erg/s/Hz.
- There is no measurable motion within 8 month.
- It is found at the same position as a bright NIR feature.

$\rightarrow$ It likely belongs to the Cygnus A radio galaxy.
$\rightarrow$ Spectral properties and the high T_B suggest synchrotron emission.

Possible scenarios

The source could be:

- An exotic type of a luminous supernova.
  - There are know supernovae that are so luminous.
  - Slow variability would mean it is older.
- A second (super)massive black hole becoming active
  - Properties fit well to an AGN.
  - Could be supermassive with low accretion
  - or less massive with higher accretion
- ...

Thank you!