Does Cygnus A harbour a binary supermassive black hole?

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Introduction

About Cygnus A

A new transient source

Observations and Results

EVN observations at 1.3 cm: March 9, 2017

EVN observations at 6 cm: June 9, 2017

Spectral analysis

Summary & Possible scenarios
About Cygnus A

- One of the first and strongest extra-galactic radio sources and a prototype for FRII radio galaxies
- Nearby, \( z = 0.0561 \) corresponding to 250 Mpc and a resolution of \( 1 \text{ mas} \sim 1.1 \text{ pc} \) and \( 0.1 \text{ mas} \sim 400 \) Schwarzschild radii (\( R_s \))
- Prominent two sided jets on parsec scales.
- Large viewing angle \( \sim 75^\circ \) → less relativistic effects
A new transient source

→ We proposed: Full EVN observations at 1.3cm, 6cm, and 18cm on October 1st 2016.
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 $0.33 \times 0.76 \, \text{mas}$ at P.A. $-13^\circ$. Noise level at $\sim 0.15 \, \text{mJy/beam}$
- Peak flux $317 \, \text{mJy/beam}$, lowest contour at $0.5 \, \text{mJy/beam}$
EVN observations at 1.3 cm, the transient

- Peak flux 1.7 mJy/beam, noise level at ≈ 0.08 mJy/beam, lowest contour at 0.25 mJy/beam
- Gaussian component of 3.0 mJy/beam and a size of 0.4 \times 0.6 \text{mas} at P.A. –0.4°, corresponding to $T_B \approx 5 \times 10^7 \text{K}$
EVN observations at 6 cm

- Full EVN (15 stations) observed on June 9, 2017 at 4.99 GHz
- Beam of $1.33 \times 2.32$ mas at P.A. $-24^\circ$. Noise level at $\sim 0.12$ mJy/beam
- Peak flux 190 mJy/beam, lowest contour at 0.4 mJy/beam
EVN observations at 6 cm, the transient

- Peak flux 2.2 mJy/beam, noise level at $\sim 0.09$ mJy/beam, lowest contour at 0.3 mJy/beam
- Gaussian component of 4.1 mJy/beam and a size of 0.5 $\times$ 0.8 mas at P.A. 35°, corresponding to $T_B \approx 3 \times 10^8$ K
EVN observations at 6 cm, the whole picture

CYG-A at 4.990 GHz 2017 Jun 09

~ 460 pc

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Spectral analysis

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

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- 22 GHz in colors
- 5 GHz in contours
Spectral analysis III

$S \propto \nu^\alpha$
Spectral analysis III

\[ S \propto \nu^\alpha \]
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.

→ It likely belongs to the Cygnus A radio galaxy.
→ 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 known 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
- ...

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Thank you!