What is the turnover frequency and fractional polarization of the 3C48 core during flaring stage?

1 Introduction

In June 2018 something extraordinary was noticed during processing a routine VLBI experiment for measurement of the Earth rotation: 3C48, aka J0137+3309, B0134+329, aka quasar #2, suddenly changed its position at 60 mas. Changes in AGN position, usually attributed to changes in structure, were known for decades, but 3C48 position jump was two orders (!!) of magnitude greater than anything reported before. The source was observed with VLBI in 1996 and 2004. An et al. (2010) studied VLBI images of these source in detail. 3C48 has a ultra-compact hot spot that is not totally resolved at 8 GHz. We quickly suggested that
brightening of the core. We conducted the targ
on 2018.07.20.

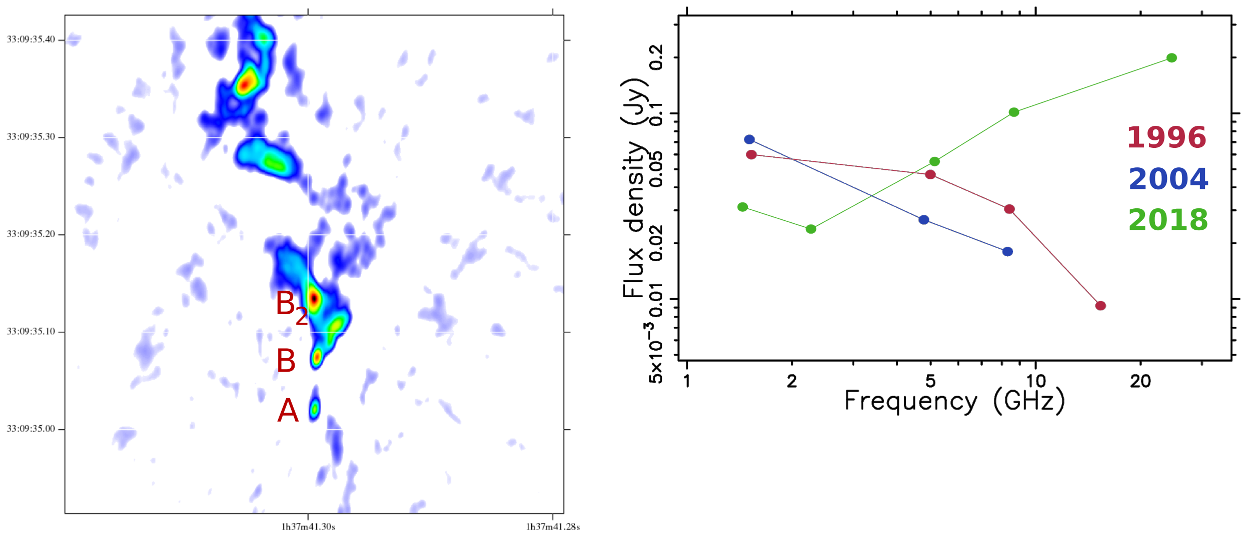

Figure 1: *Left:* VLBA image of 3C48 at 1.44 GHz on 2018.07.20. Component **A** is the core, component **B** is a compact steep-spectrum hot spot, component $\mathbf{B_2}$ is the extended steep-spectrum radio-loub. *Right*: Spectra of the core at different epochs. Flux densities at epochs 1994 and 2004 are taken from An et al. (2010). Flux densities at epoch 2018 is taken from ouor VLBA observations.

These observations have confirmed that the core has changed both the brightness and its spectral index tremendously (see Figure 1). We have established that before 2018 the reported 3C48 coordinates corresponded to the position of the hot sport because it was the brightest compact detail of the object that time. After 2018, the most compact component became the core that is 58 mas away from the component B and within 0.8 mas of Gaia position.

New observations have shown that the 3C48 core spectrum drastically changed since 2004. While the spectrum prior the flare was falling, and flux density at 22 GHz was below 10 mJy, i.e. below the KVN detection limit, its spectrum after the flare is raising, reaching peak flux density 200 mJy at 22 GHz without any sign of flattening.

Our VLA observations on 2018.08.31 shown that 3C48 has fractional polarization at 43 GHz at a level 7%, while its fractional polarization before the flare was below 1%.

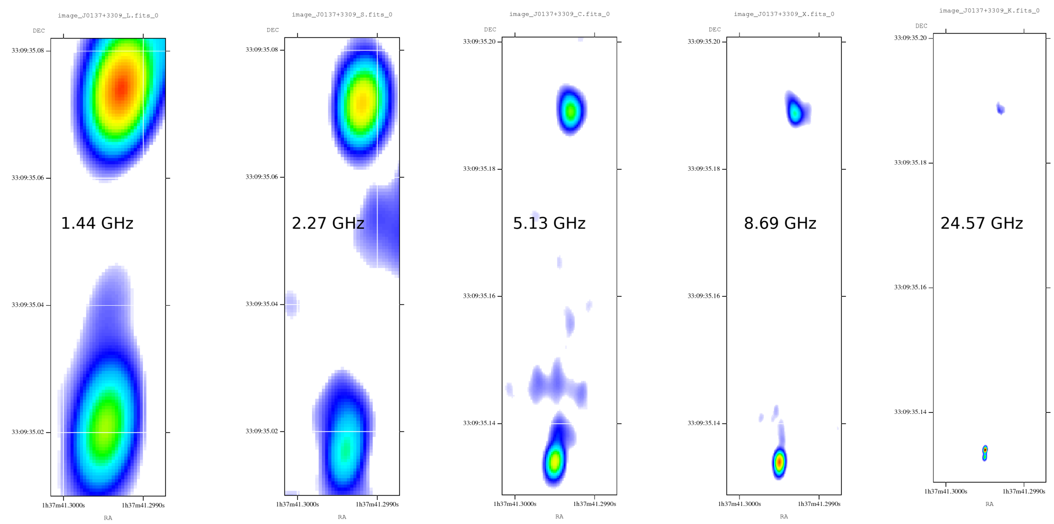

Figure 2: 3C48 multi-frequency images on 2018.07.20. B-componenent is on the top, A component is down.

2 Proposed observations

We propose the target of opportunity observations of 3C48 with the KVN at 22, 43, 86, and 129 GHz. We set two goals: 1) to continue the spectrum in Figure 1 at higher frequencies and determine the turnover frequency; 2) determine fractional polarization. We want to determine the turnover frequency or to get is low limit if the turnover frequency is above 129 GHz. The turnover frequency will allow us to set a constrain on the electron density during the flaring stage. As we see in Figure 1, the spectrum of the core is very different in the flaring stage wrt quiescent stage. Changes in polarization detected with VLA at 43 GHz suggest 3C48 may have a detectable fractional polarization at higher frequencies. Change of the polarization fraction with frequency will shed light on changes of the magnetic field strength. Since 3C48 was the VLA polarization calibrator, abrupt change in its polarization has a large impact on the analysis pipeline of radio-polarimetry observations.

We request the director discretion time, since we do not know how long the source will be in the flaring stage. 3C48 Radioastron observations are scheduled in October 2018.

3 Technical approach

We propose observations with frequency switching between 22/86 GHz and 43/129 GHz in 8Gbps dual-polarization mode. We will observe several polarization calibrators in the vicinity of 3C48. Dual-band observations will allow us to exploit phase transfer between frequency approach. We ask for 1 hour on-source time for each pair of frequencies. That will allow to detect fractional polarization as low as several procents. Including overheads for observing amplitude calibrators (planets) and polarization calibrators, the total time requesst is 3 hour.

References

An, T., et al., 2010, MNRAS, 402, 87A.