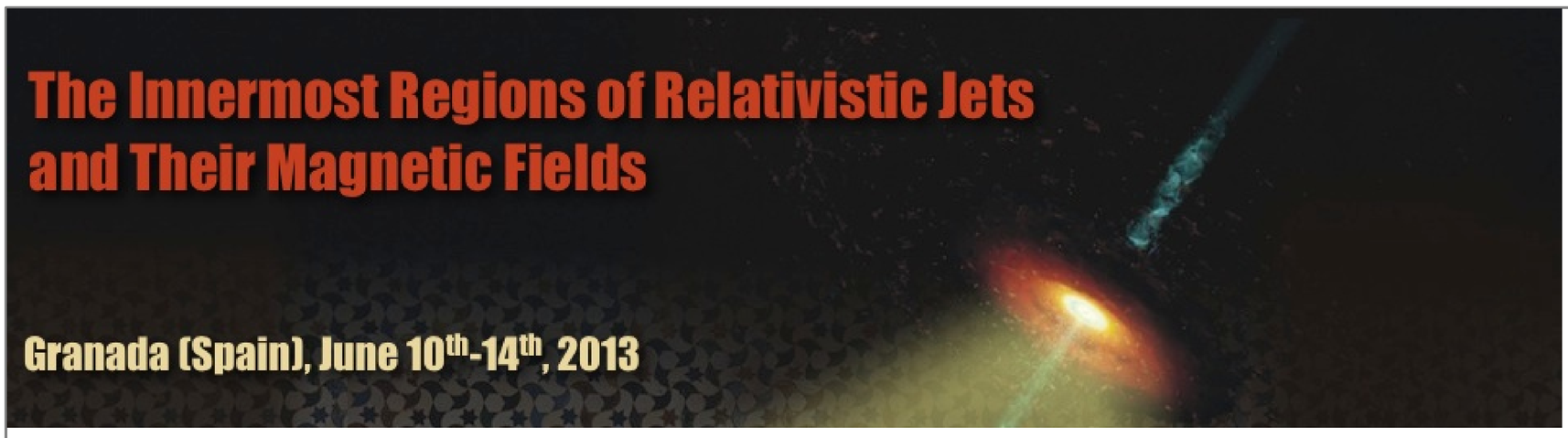

ASC Lebedev

MULTIFREQUENCY VLBI FOLLOW UP STUDY OF A STRONG γ-RAY FLARES IN THE BLAZARS 3C273 AND 3C279

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3C273

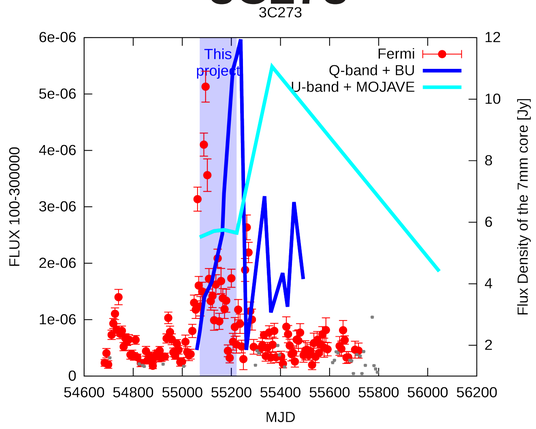


Fig. 1a Light curves of 3C273

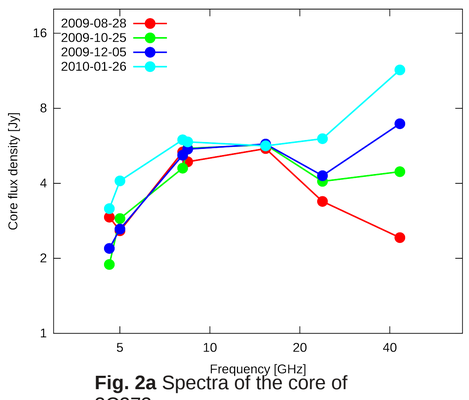


Fig. 2a Spectra of the core of 3C273

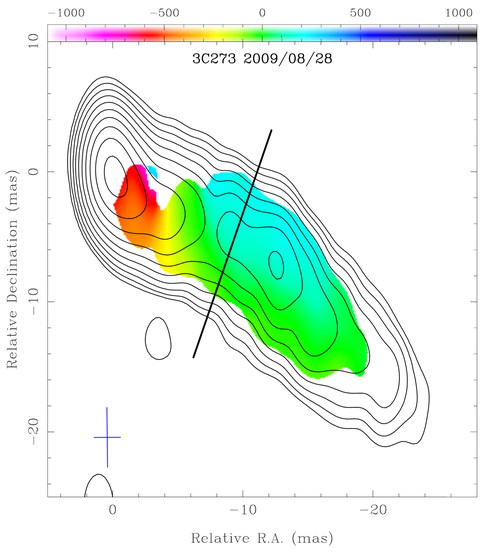


Fig. 3 Faraday Rotation Measure map of 3C273. Jet width in polarization is more than 3 times beamwidth.

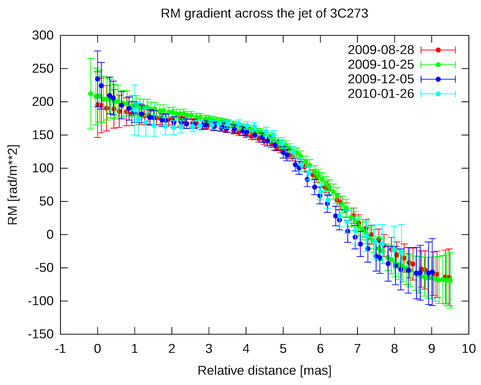


Fig. 4 Faraday Rotation Measure gradients across the jet of 3C273

Fig 5a Distribution of linear polarization corrected for Faraday Rotation of 3C273. All 4 epochs are displayed.

3C279

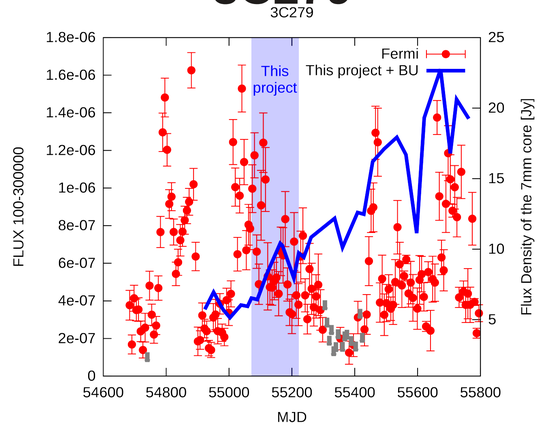


Fig. 1b. Light curves of 3C279

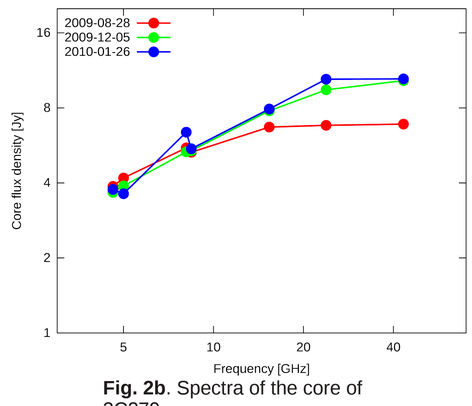
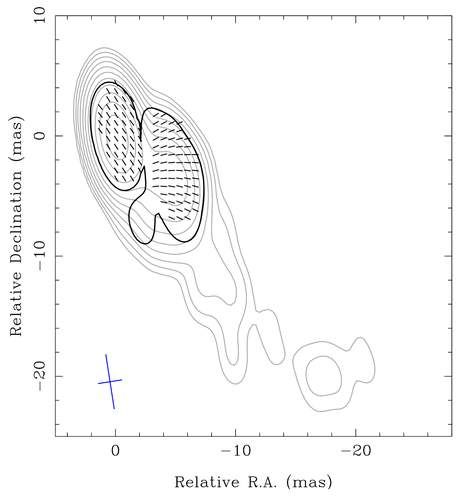
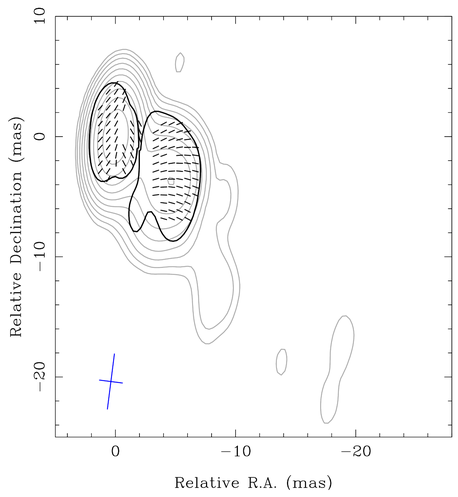


Fig. 2b. Spectra of the core of 3C279





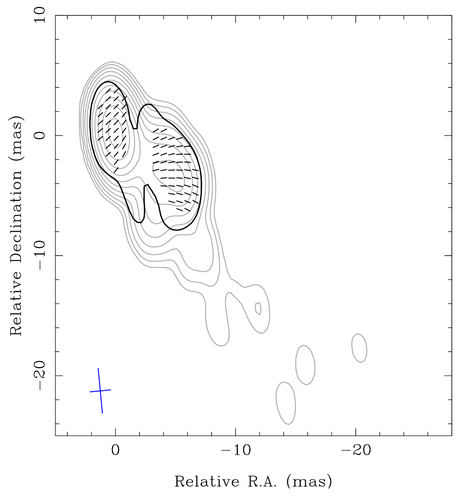


Fig 5b Distribution of linear polarization corrected for Faraday Rotation of 3C279. Epochs are 2009-08-28, 2009-12-05, 2010-01-26 from top to bottom.

ABSTRACT

We present results of a five month long VLBA campaign to observe 3C273 and 3C279 which was triggered by and started immediately after a strong γ-ray flare detected by *Fermi* LAT from 3C273 in August 2009 while 3C279 was also in its active γ-ray state.
We have detected flares in the parsec-scale radio cores of both 3C273 and 3C279. The observed radio flare in 3C273 at 7 mm peaks with a delay of 140-200 days after the γ-ray one. A close connection between γ-ray and parsec-scale radio emission in the blazars is supported.

DATA

A very strong flare happened in blazar 3C273 in September 2009 . We used weekly averaged data that is provided by LAT team and is available online[1]. The blazar 3C279 meanwhile was also in active γ-ray state exhibiting flux variations up to the order of magnitude.
We triggered a series of multifrequency (C[6.5 and 6 cm], X[3.7 and 3.6 cm], U[2cm], K[1.3 cm] and Q[7 mm] bands.) follow up VLBA observations after *Fermi* LAT detected an increase of γ-flux of 3C273 by a factor of 3. First observation was conducted on 28 August 2009 and after that γ-flux rised even more peaking on 26 September 2009 (MJD 55100). Totally we observed 4 epochs (3 for 3C279) which covered all stages of γ-flare of 3C273 (fig. 1a).
To improve our temporal coverage we also used Boston University[2] (BU) 7 mm data and MOJAVE[3] 2 cm data. EVPA calibration was made with use of UMRAO[4], MOJAVE and VLA[5] data. We estimate overall accuracy of EVPA calibration to be 2.5° at C and X bands, 2° at U band, 7° at K and Q bands.

DATA ANALYSIS

From comparison of lightcurves of 3C273 we estimate radio-to-γ delay to be 140−200[d] . There were no more such powerful events in γ-rays in 3C273 in recent time, so we believe that these flares in γ-ray and radio are connected. Kinematics analysis of 7 mm data reveals newborn component in 2010. Estimated ejection epoch is ≈ 114 days after the γ-ray flare. Following Pushkarev et.al.[6] we recalculate time delay into a deprojected distance between a region of γ-rays and radio waves emission:In case of 3C273 this implies $\Delta r = 3.1-3.8$pc

Fig. 1a and 1b show *Fermi* γ-rays light curves overlaid with 7 mm core and 2 cm core light curves for 3C273 and 7 mm core light curve for 3C279. Each shows evident flares in every band. It is clear that peaks of the flares occurres with delay while wavelength increase.
Fig. 2a and 2b show spectral evolution of VLBI core components of 3C273 and 3C279 respectively. Lower frequencies in both cases are almost unaffected by vigorous perturbations that happen in the core and increase flux density at higher frequencies. 3.6 cm flux density of 3C279 on 2010-01-26 is affected by model fitting systematics.

POLARIZATION

Here we present polarization data analysis only for 4 lower frequencies. Illustration of Faraday Rotation Measure (RM) map for 3C273 is shown in Fig. 3. Black line indicates position of a slice arcoss the jet.
3C273 is famous for gradients of RM distribution across the jet[7,8]. We also detected reliable gradients on all epochs. Moreover as shown in Fig. 4 all 4 epochs display magnificently identical gradients.
To reveal intrinsic orientation of polarization vectors we corrected EVPA distribution for Faraday Rotation.
3C273: No polarized emission is detected from the VLBI core at 6 cm waveband. Also we did not detect any significant changes in intrinsic direction of polarization vectors or fractional polarisation in the region closest to the core where polarization is detected at all epochs (~1.5 mas from the core downstream the jet). Moreover the whole pattern of linear polarization remains unchanged througout all our observations (see Fig.5a)
3C279 on the contrary shows changes in intrinsic EVPA direction in vicinity of the VLBI core. Direction of EVPA changes by 60 degrees in a period of 4 month while polarization in extended structure does't change much. This could be caused by changing in syncrotron opacity or blending with a new born but still unresolved optically thin component. (see Fig. 5b)

SUMMARY

- γ-ray and radio band flares in 3C273 are related. 7 mm light curve of 3C273 lags relative to γ-ray one and 2 cm lags relative to7 mm as we believe due to opacity effects. We estimate deprojected distance between γ-ray and 7 mm radio emission sites to be $\Delta r = 3.1-3.8$ pc. γ-ray emission region is located closer to the jet base than the 7 mm VLBI core.
- Spectra of both 3C273 and 3C279 show that higher frequencies are affected first and show flux density increase while flux density on lower frequencies remains almost constant
- Polarization structure of 3C273 at lower bands is very weakly variable which also hints at the innermost parts of the jet to be the source of gamma-rays. Faraday Rotation Measure gradients accross the jet of 3C273 are detected and stable over time of ~5 month.
- A flip by 60 degrees in EVPA of the core region of 3C279 is detected and deduced to be connected with changes in physical conditions during active state of 3C279 in γ-rays and 7 mm radio

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