VLBI Monitoring of 3C 84 in Gamma-ray Active Phase


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Special thanks to Jun Kataoka

Fermi meets Jansky
Discovery of GeV γ-ray from Perseus

- Gamma-ray emission is associated with NGC1275 (Abdo+ 2009, Kataoka+ 2010)
- NGC1275 is also known as 3C84 at radio wavelengths
- CSO-like (two-sided jets) morphology (size~10 pc) => non-blazar source
Fermi gamma-ray flux is ~10 times higher than upper limit constrained by EGRET

Radio

- 1985-2005: decay
- 2005~: flare

Central 1-pc core is possible site of radio brightening
So far, SED is modeled in a framework of blazar scenario with moderate beaming.

One-zone SSC model
\[ v_{\text{jet}} = 0.83c, \theta_{\text{jet}} = 25 \text{ deg} \]  
(Abdo+ 2009)

VLBI observation (\(\gamma\)-ray quiet phase)
- Head advance speed \(~0.5c\)  
  (Asada+ 2006)
- Sub-pc jet speed \(~0.2c\)  
  (Dhawan+ 1998)
- Viewing angle \(~30-55\text{ deg}\)  
  (Walker+ 1997)
VLBI & Single Dish Monitoring

**VLBI data**
- VERA & JVN @ 8 & 22 GHz
- 14 epochs between 2006/05–2009/04
- Typical resolution $1 \times 0.7$ mas (~0.3 pc)

**Single dish data (provided by U. Bach)**
- 1994-2009
- Effelsberg 100-m telescope
- Obtained from regular pointing and calibration observations
Observation date is denoted by year/(day of the year)

Assumed C1 is stationary
Radio flare is originated in the central 1 pc, accompanying the ejection of new jet component (C3).
Radio: increase on year timescale. Month-timescale variation is not clear (undersampling).

Gamma-ray: no clear trend on year timescale, but some variation on month timescale.

Comparison with Fermi 1-year lightcurve
Kinematics of new component

Apparent speed of new component: $0.23 \pm 0.01c$

One-zone SSC model $\Rightarrow \sim 0.83c$ (Abdo+ 2009)

Signature of Deceleration?

Apparent slow jets were also observed in BL Lac objects (Mrk 421, Mrk 501, ...)
Jet Precession?

1995
(y-ray quiet phase)

2007
(no gamma-ray obs.)

2009
(y-ray active phase)

VLBA@43GHz
(Dhawan+ 1998)
Radio flare of 3C84 is originated in the central ~1 pc, accompanying the new component ejection.

There is no clear Correlation between radio and gamma-ray lightcurves on year timescale.

Apparent speed of new component is ~0.23c, which does not agree with pure SSC model.

More to come: Ongoing project with VERA @ 43 GHz (9 epoch, 80 hr) will answer the kinematics in more detail.