

# The Quasar Movie Project: Coordinated VLBA and Multi-waveband Monitoring of the Gamma-ray Quasars 3C273 and 3C279

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An ongoing Fermi GI cycle 3 program for an unprecedented densely-sampled 15-86 GHz VLBA and broadband SED monitoring of two archetypical gamma-ray quasars, 3C273 and 3C279, is described.

## Motivation for a densely-sampled VLBA+SED monitoring

- Our understanding of the  $\gamma$ -ray production mechanisms in active galactic nuclei depends on where in the AGN jet the  $\gamma$ -ray emission originates. Theoretically it is easier to produce GeV  $\gamma$ -rays through inverse Compton scattering if the emission site is located close to the base of the jet, within the broad line region. On the other hand, several cases of correlated events in  $\gamma$ -rays and in the VLBI data have been reported placing the  $\gamma$ -ray zone parsecs away from the central engine (e.g. Marscher et al. 2010, Agudo et al. 2011).
- Multi-wavelength monitoring is the key tool to investigate this issue. However, flux variability studies do not directly give the location of the variable component. Therefore VLBI imaging at the highest achievable angular resolution is very important.
- Blazars tend to show complicated correlations between different frequency bands, which underlines the need of both densely sampled SED monitoring as well as densely sampled VLBI monitoring.
- Multi-wavelength VLBI monitoring at high frequencies allows measurements of the magnetic field and particle energy densities close to the core (Savolainen et al. 2008). These measurements can be used to further constrain emission models.

## Observing strategy and participating telescopes

- The program began in October 2010 and it will run until October 2011.
- Our aim is to combine very dense multi-frequency monitoring with the Very Long Baseline Array at sub-parsec linear resolution with SED and optical polarization monitoring. With the VLBA we observe 3C273 and 3C279 on average every 20 days at 15, 24, 43 and 86 GHz in the polarimetric mode. This allows us to produce "movies" of the structural, spectral and polarization evolution of the jets at sub-parsec resolution.

### Participating telescopes

Instrument	Wavelength	Polarimetry	Cadence
<i>Fermi</i> -LAT	$\gamma$ -rays	No	Normal survey mode
<i>Swift</i>	X-rays/opt.	No	$\sim 20$ d
KVA	opt.	Yes	$\sim 7$ d
SPM	opt.	Yes	$\sim 30$ d
REM	opt./NIR	No	$\sim 30$ d
OAGH	opt.spect./NIR	No	$\sim 30$ d
<i>Herschel</i>	Far-IR	No	8 pointings/source approved
SMA	mm	No	$\sim 5$ d
IRAM 30-m	mm	Yes	$\sim 30$ d POLAMI project
VLBA	radio/mm	Yes	$\sim 20$ d
Effelsberg	radio	Yes	$\sim 30$ d F-Gamma program

In addition to the telescopes listed above, we have made use of public data from the Yale SMARTS project (Chatterjee et al. 2011). Several amateur astronomers have also participated in our program through an AAVSO campaign.

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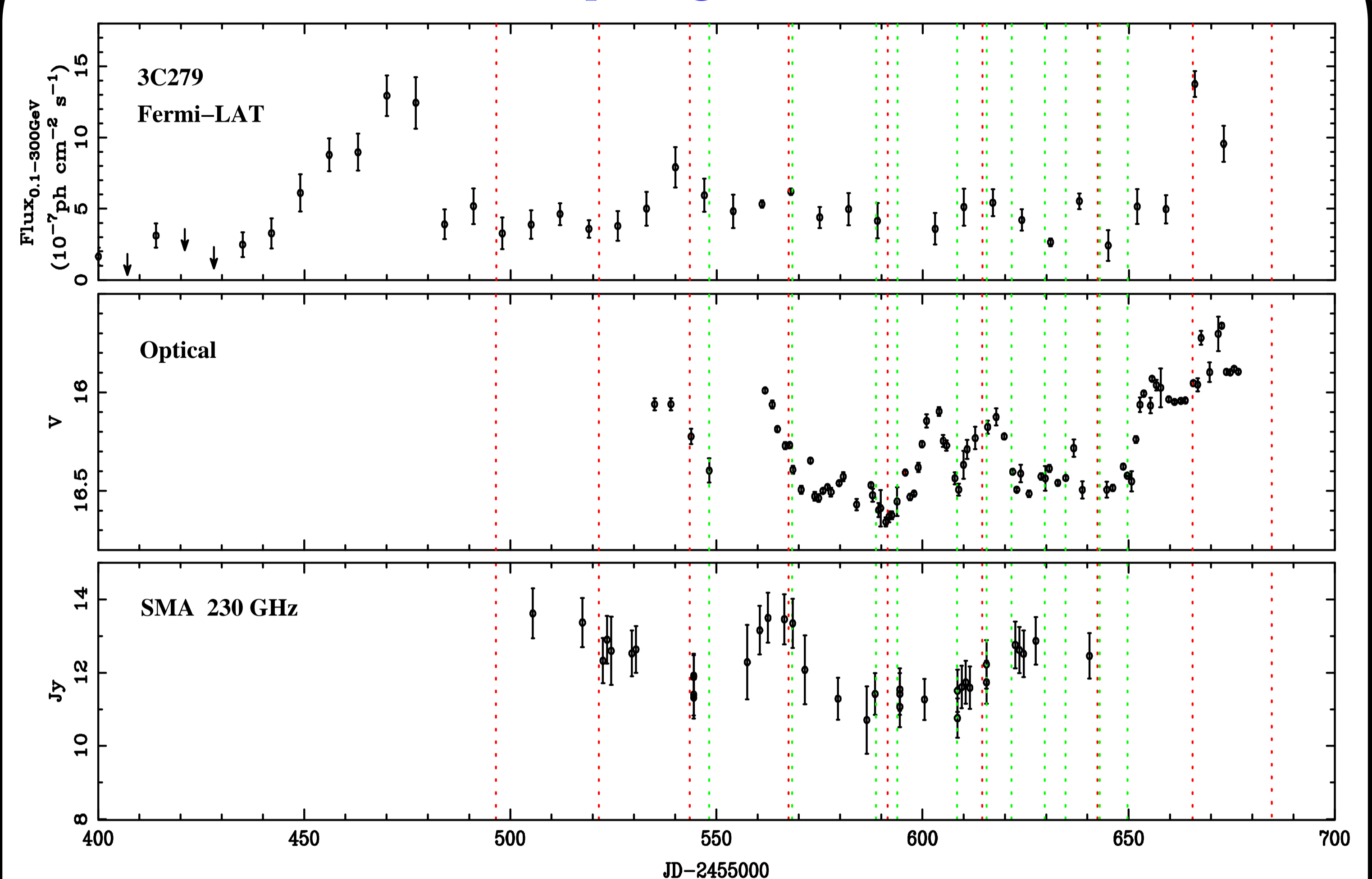
### Acknowledgments

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### References

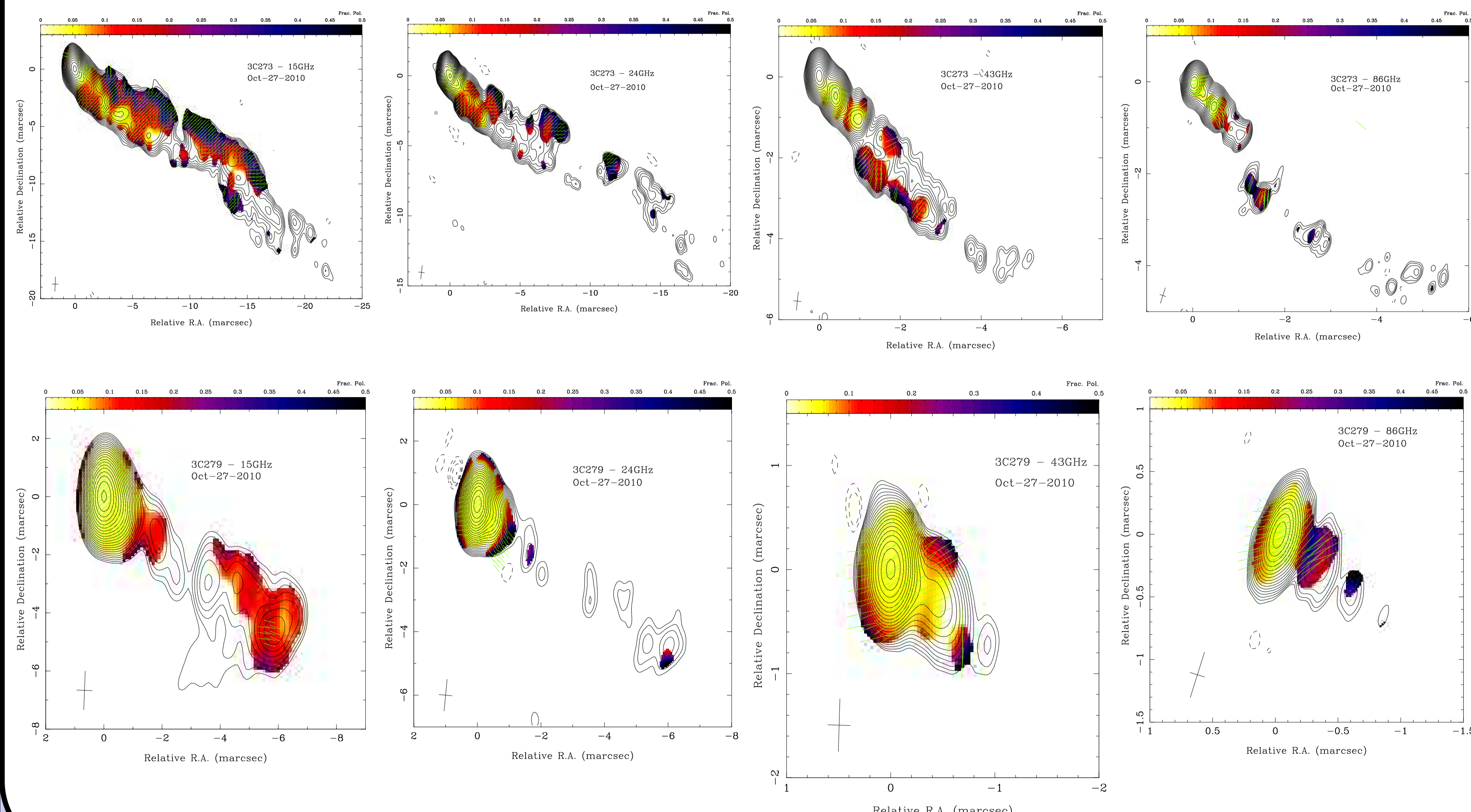
Agudo, I. et al. 2011, *ApJ* 726, 13 Marscher et al. 2010, *ApJ* 710, 126  
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## Example light curves



Example light curves of 3C279 illustrating the activity of the source before and during the first half of the campaign and showing VLBA observing epochs (red lines) as well as *Swift* observing epochs (green lines). The top panel shows the public *Fermi*/LAT light curve produced by the LAT team using an automated analysis. We note that this light curve is presented here for illustrative purposes only. The middle panel shows V-band optical light curve from our campaign, and the bottom panel shows 230 GHz SMA light curve. As can be seen from the light curves, our on-going monitoring will cover well the flare that started in April 2011 providing a detailed account of the events around the VLBI core at the time of the  $\gamma$ -ray flare.

## Examples of VLBA observations



Here we show polarimetric VLBA images of 3C273 and 3C279 at 15, 24, 43 and 86 GHz from the first observing epoch, Oct 27 2010. Contours show the Stokes I image and the degree of linear polarization is shown in colors. The polarization angle is marked by ticks. We note that also the 86 GHz polarization data are fully calibrated. The 0.1 mas angular resolution at the highest frequency corresponds to 0.3 and 0.6 pc linear resolution at the distance of 3C273 and 3C279, respectively.

When the program is finished, we'll have 18 such data sets taken with 20-day intervals. This will allow very detailed comparison of structural, spectral and polarization evolution in the parsec scale jet with variability in the SED and in polarization at different wavebands.