

The AGN radio-gamma connection: monitoring of gamma-ray activity and mm polarization in the Fermi era



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Changes in the polarization properties are often related to variations in the level of gamma-ray activity in blazars. We exploit the database of mm-polarization observations from the Plateau de Bure interferometer to look for connections with the gamma-ray light curves of *Fermi* blazars.

Abstract

The surveying capabilities of the *Fermi*-LAT have triggered several multi wavelength campaigns aimed at constraining the physical properties of gamma-ray AGNs (typically blazars) with coordinated low frequency observations. The results of such campaigns suggested that the high energy variability has a deep relation with the emission at mm wavelengths and the core polarization. We have therefore explored the rich database of calibrators observed at the IRAM Plateau de Bure interferometer (PdBI), which are by definition bright and compact radio sources, i.e., typically blazars. The PdBI data provide a continuous - though somewhat irregular - monitoring of the millimeter polarization properties of 95 sources. We focus on the mm-wavelength and gamma-ray data taken since June 2008, and we present three lines of research, which are promising for an insight on the physical conditions in blazar jets: (1) a study of a sample of moderately bright gamma-ray sources ($> \sim 5 \times 10^{-9}$ ph cm $^{-2}$ s $^{-1}$ above 1 GeV), with a relatively high number of polarization detections ($>=6$); (2) a study of all the sources with a large number of polarization observations and detected in gamma rays, independently on their gamma-ray flux; (3) a statistical study of the polarization properties of the populations of gamma-ray detected and undetected sources in the whole sample of IRAM calibrators.

The Plateau de Bure Interferometer



- located in French Alps at 2500m elevation
- 6x15m telescope interferometer, with baseline up to 760m
- 80-270 GHz frequency range
- Calibration requires frequent observations of bright, compact sources:
 - typically blazars! ($S_{90} > 0.2$ Jy, Dec > -20 deg)

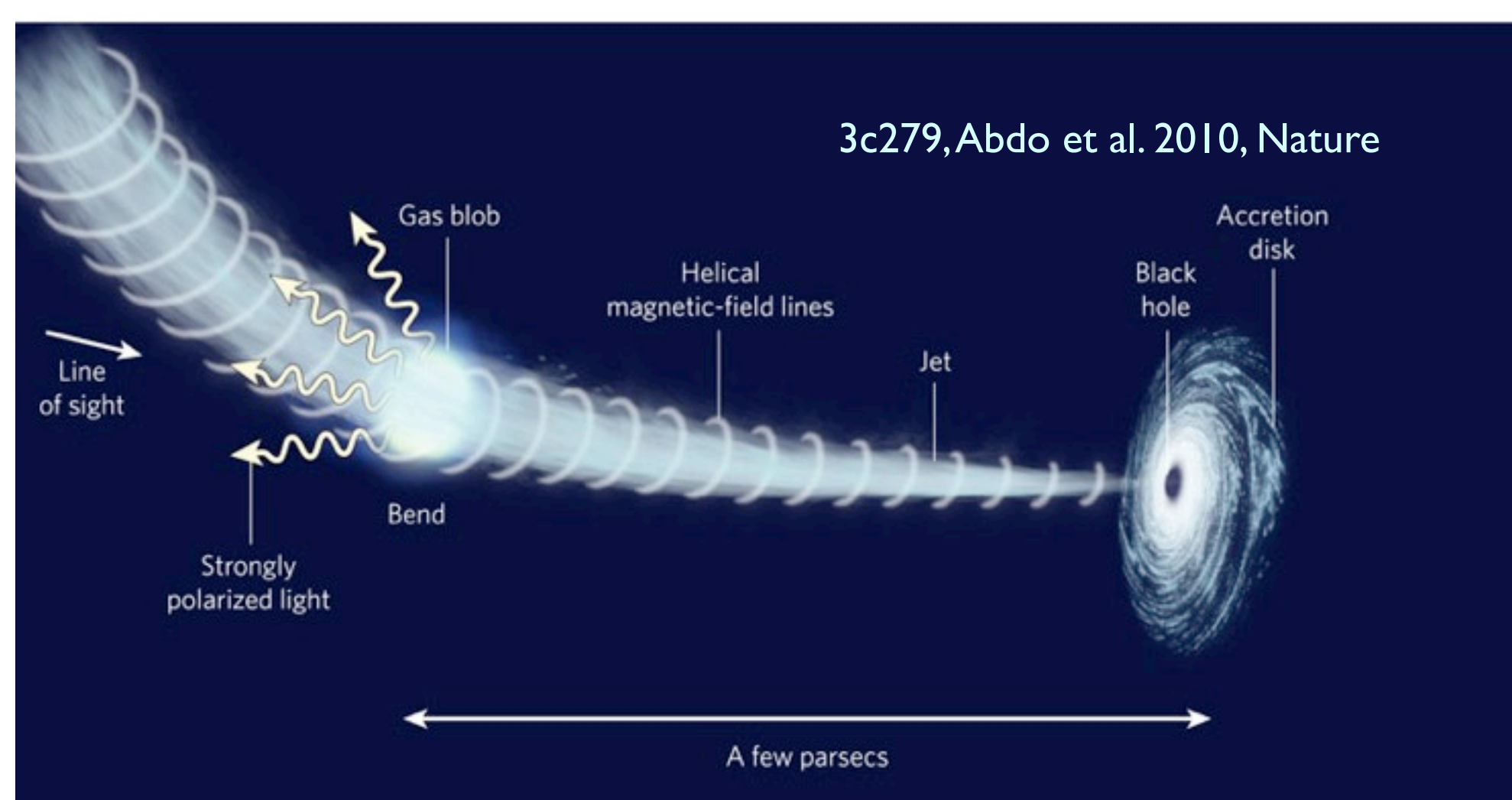
The *Fermi* Large Area Telescope



The Large Area Telescope onboard the *Fermi* satellite is an electron-positron pair-conversion telescope sensitive to gamma rays with energies in the range from 20 MeV to more than 300 GeV (Atwood et al. 2009). Compared with its predecessor EGRET, the LAT has a larger field of view (~ 2.4 sr), a larger effective area (~ 8000 cm 2 for > 1 GeV on-axis photons), and an improved angular resolution ($\Theta_{68} \sim 0.6$ deg at 1 GeV for events in the front section of the tracker). The entire sky is observed by *Fermi* every 3 hours in a survey mode.

Gamma-rays and mm-polarization

Because of self-absorption at lower frequencies, the most compact regions in AGNs are most prominent in the mm-wavelength band. Moreover, polarized radiation tracks magnetic fields, shock regions, and changes in polarization properties (intensity and position angle) have been often associated with gamma-ray variability.



Sample #1

- sources that are
 - moderately bright in gamma rays ($> 5 \times 10^{-9}$ ph cm $^{-2}$ s $^{-1}$, above 1 GeV),
 - and have a relatively high number of polarization detections ($> \sim 6$)
- 0954+556 (4C55.17), 1055+018, 1308+326, 1827+062, 2251+158 (3C454.3)
- plus any of 0235+164, 0716+714, 0727-115, 1253-055 (3C279) if more mm-polarization data become available
- produce and compare gamma-ray light curves and evolution of the mm-wavelength polarization properties over the time range of the PdBI observations

Sample #3

- The full sample, 86 sources
- statistical study of the polarization properties of the populations of gamma-ray detected and undetected sources.

The IRAM calibrator sample

- sample presented by Trippe et al (2010, A&A 515, 40), data between Jan 2007 and Dec 2009
- 441 measurements for 86 sources, with 73 of them detected at least once
- median fractional polarization over all sources $\sim 4\%$
- fractional variabilities up to $\sim 60\%$
- Data continue to accumulate, we are currently working on list $>$ June 2009

This project

- Divide the 86 sources on the basis of gamma-ray brightness and number of mm-polarization observations
1. high gamma-ray flux and many mm-polarization observations
 2. gamma-ray detected sources (regardless of flux) with many mm-polarization observations
 3. full sample of calibrators, irrespective of gamma-ray detection

Sample #2

- sources with large number of polarization observations and detected in gamma rays, regardless of flux
- with at least a few (6) pol-detections (we discard unpolarized sources, like 0316+413)
- 0507+179, 0851+202 (OJ287), 0954+556, 0954+658, 1030+611, 1040+244, 1055+018, 1308+326, 1418+546 (OQ530), 1827+062, 2251+158
- look at the mm-wavelength polarization curve searching for jumps in fractional polarization, swinging of the electric vector position angle, etc. If something interesting stands out by eye, look at the gamma-ray data in the surrounding period