GeV-radio correlation in Markarian 421

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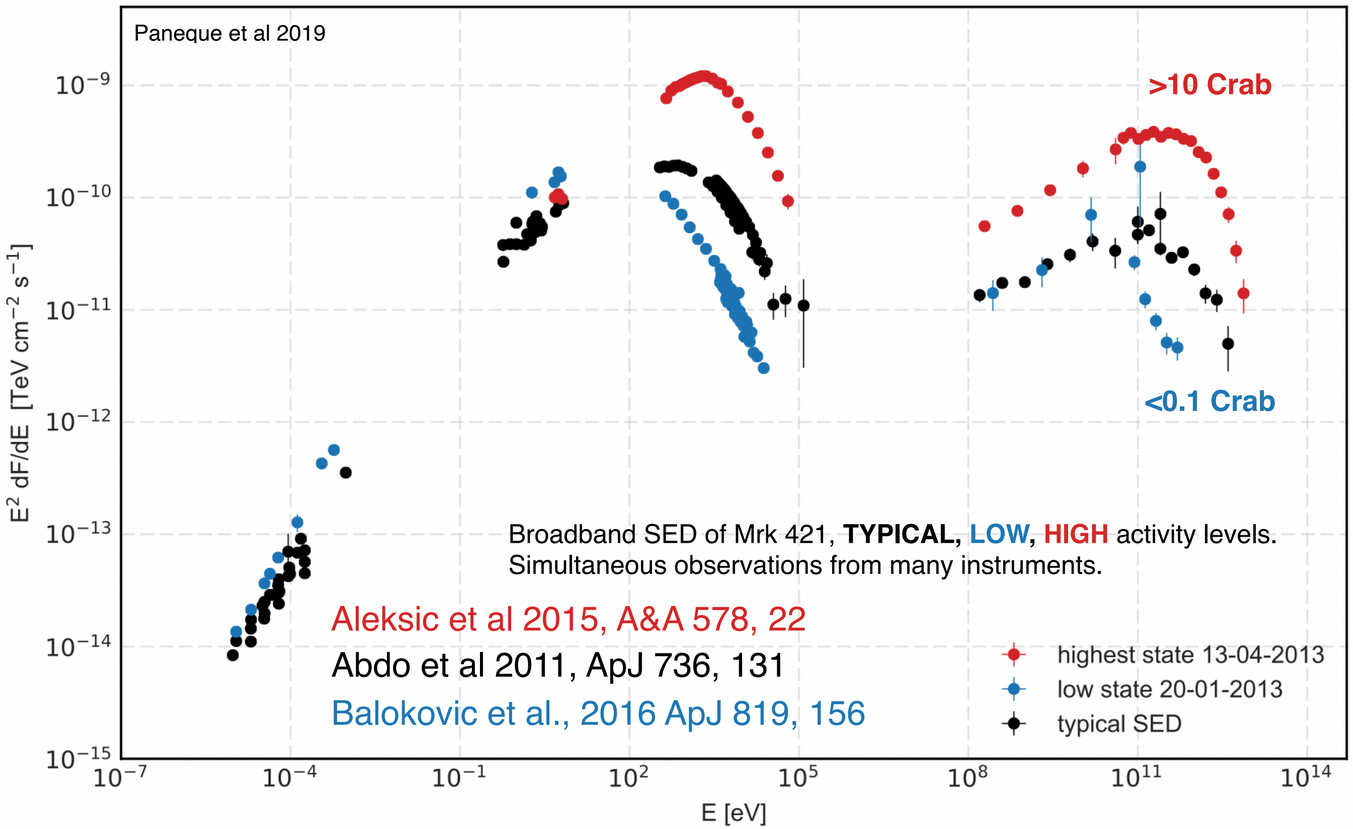
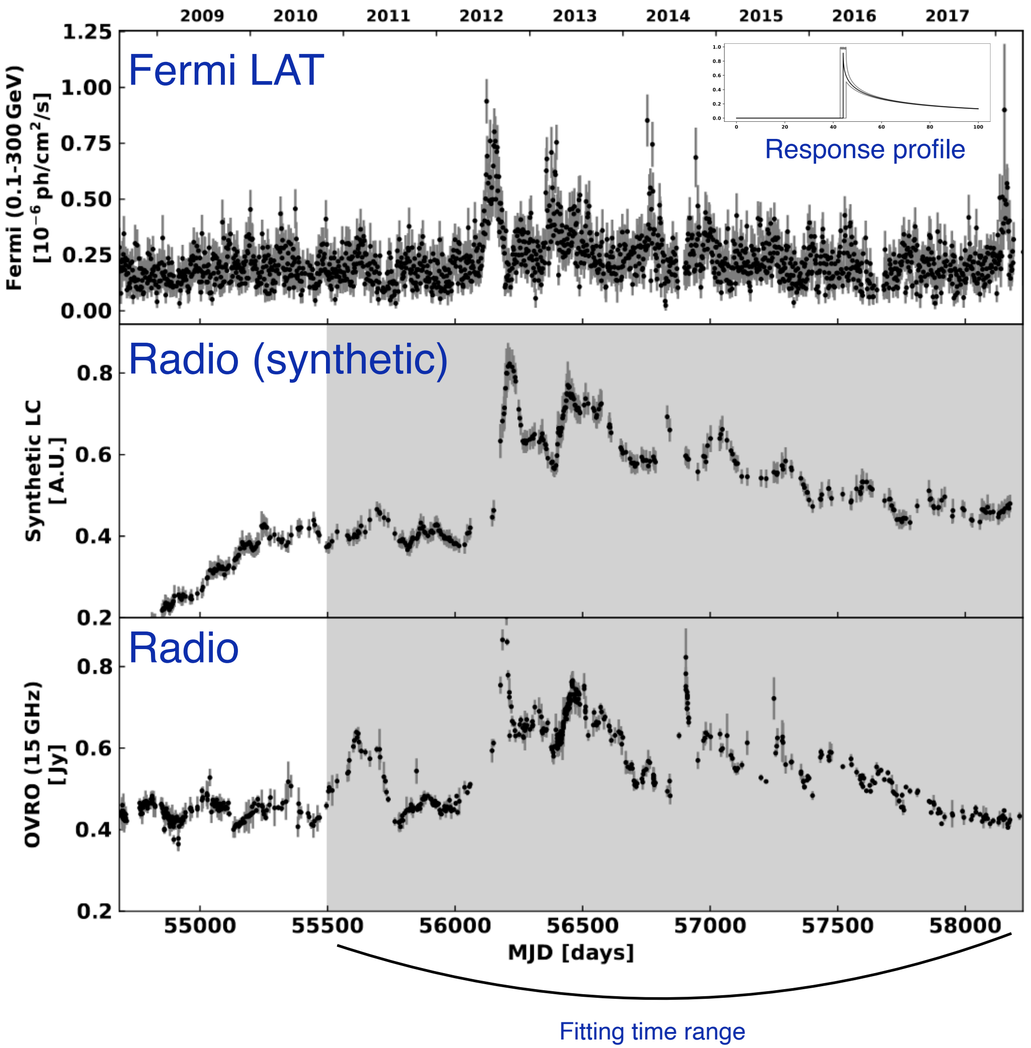
Mrk 421: overview

- Mrk 421 is HBL blazar:
  - Bright and nearby blazar, z=0.031 (~122-133 Mpc)
  - Imagined with VLBA up to <0.01-0.1 pc (<100-1000 rg)
  - Has a well defined jet structure extending for 4.5 mas (2.67 pc)
- Low energy hump:
  - synchrotron emission during relativistic electrons cooling
- High energy hump:
  - leptonic models:
    - one-zone SSC model (Celotti et al. 1998, Abdo et al. 2011)
    - multi-zone SSC model (Aleksić et al. 2015, Zhu et al. 2016)
  - hadronic models (Zech et al. 2017)
  - lepto-hadronic models:
    - synchrotron-proton model (Mastichiadis, Petropoulou 2013)
    - neutrino emission (Petropoulou 2015, Dermer et al. 2010)



Data and results

- Mrk 421 observations from November 2010 to April 2018:
  - Mrk 421 was found in various states: typical, low, high
  - Regular unbiased radio observations
- Results:
  - F_{var} values are the lowest in the radio and GeVs, 0.18 and 0.2 respectively
  - Radio and GeV are widely correlated with GeV leading by 40-50 days
  - Observed variability and correlations are compatible with one-zone SSC scenario
  - The radio emission can be reproduced accurately convolving the GeV light curve with a delayed asymmetric response (a fast rise and a slower decay after a delay of ~43 days) (Türler et al. 1999, Esposito et. 2015)
  - Fast radio flares (MJD 55528 and 56897) cannot be reproduced (evidence for an additional mechanism/zone)



Response profile and best-fit parameters

$$S(t) = \begin{cases} 0 & t < \Delta t \\ A \exp\left(-\left(\frac{t-\Delta t}{t_{decay}}\right)^{\phi}\right) & t \geq \Delta t \end{cases}$$

Parameter	Value
A	1.4×10^5
t_{decay}	7.64 days
ϕ	0.36
Δt	44.1 days