High Energy Flares of Blazars: The Case of 3C 279

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Introduction

- 3C 279 is a flat spectrum radio quasar (FSRQ) at z = 0.536
- It emits strong and variable radiation throughout the EM spectrum
- One of the first FSRQs to be detected by EGRET (Hartman+, 1992, ApJ, 385, L1)
- A subject of various MW campaigns since the launch of *Fermi* satellite

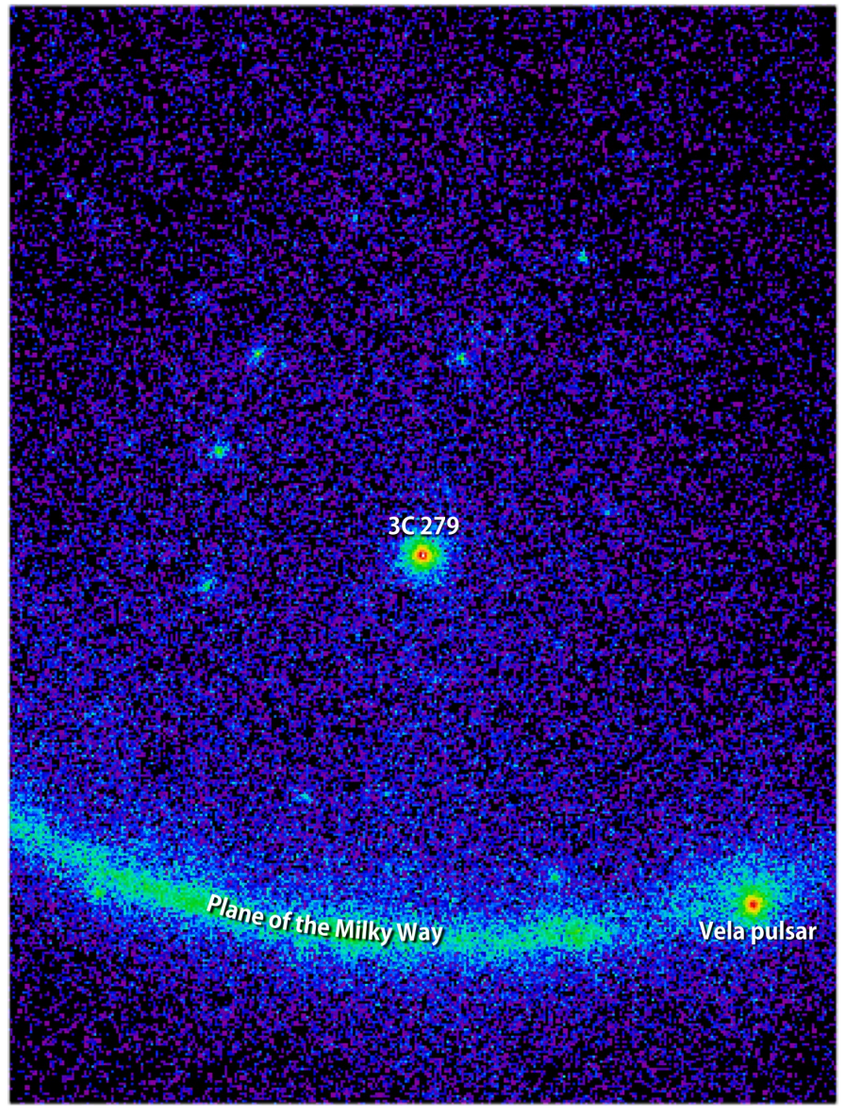
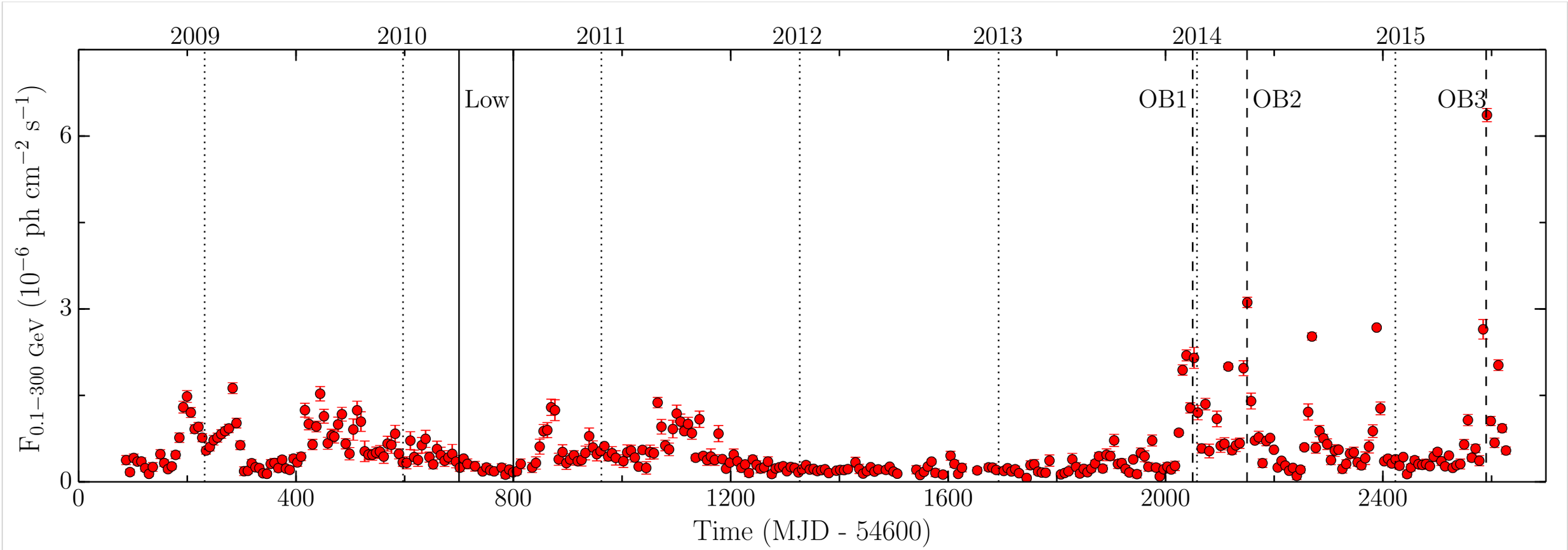


Image credit: NASA/DOE/Fermi LAT Collaboration

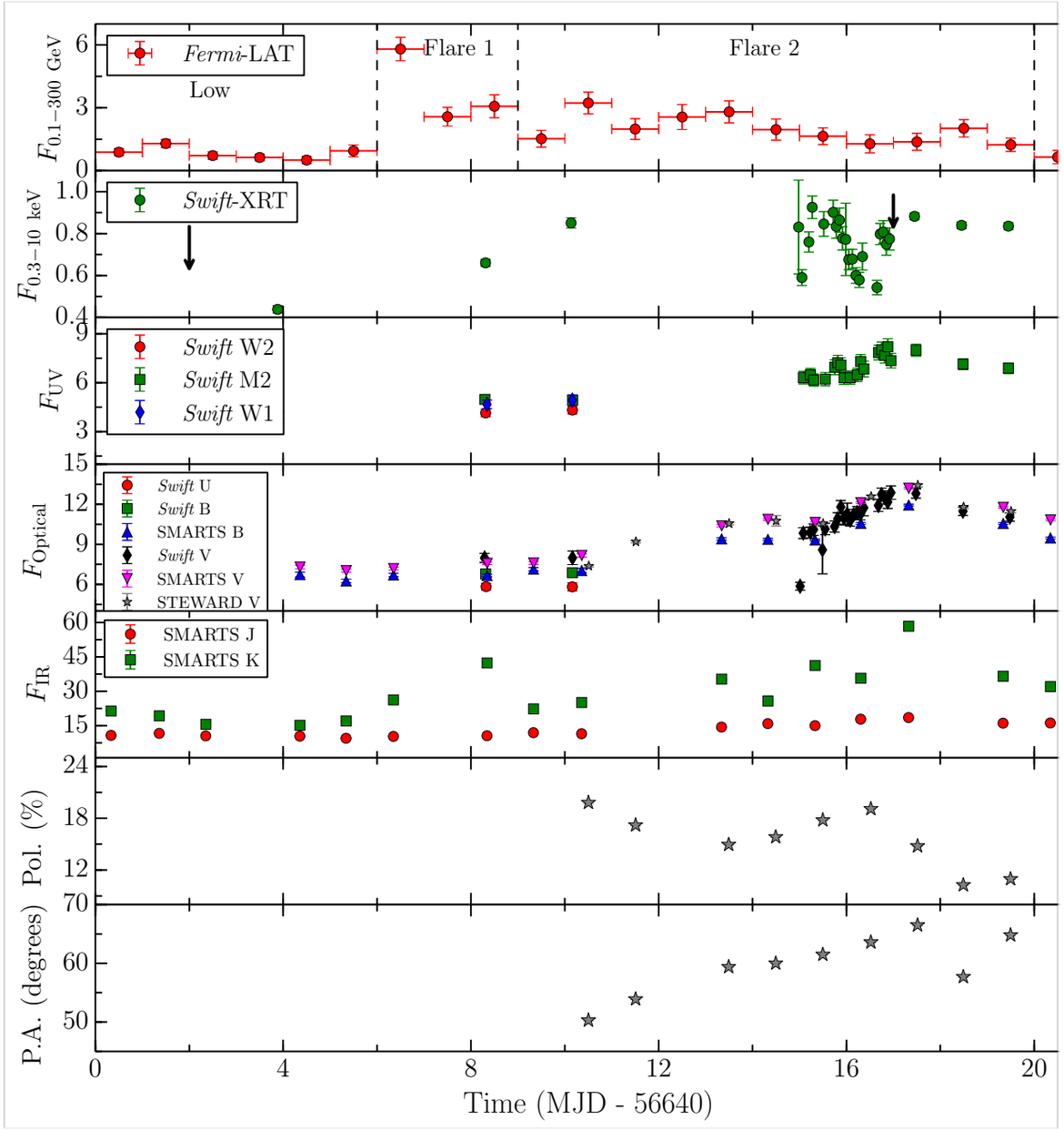
Introduction



- Multiple episodes of γ-ray flaring activities seen by *Fermi*
- Three of them (& a low state) are selected for a detailed study
  - OB1: 2013 December; OB2: 2014 April; OB3: 2015 June

2013 December Flare

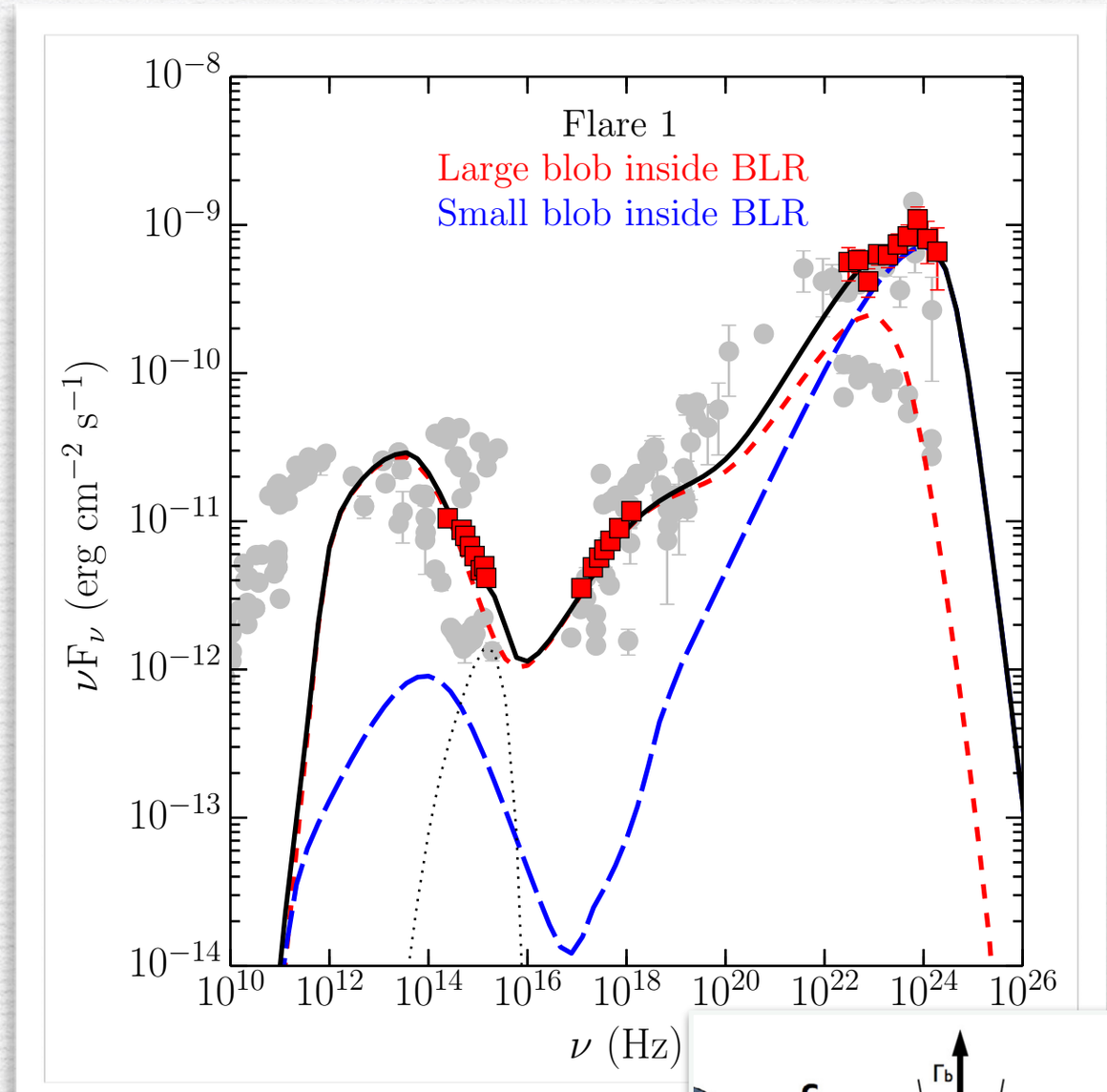
- The highest measured γ-ray flux is ~ 1.2 x 10^{-5} ph cm^{-2} s^{-1}
- The shortest γ-ray and X-ray flux doubling times ~ 3 hrs
- Available observations suggest the uncorrelated variability behavior
- This doesn't support conventional one-zone leptonic models



(Paliya+, submitted)

2013 December Flare

- An extremely hard γ-ray spectrum is observed
- Comparison of the shapes of the optical-UV and γ-ray spectra provides another clue to the failure of one-zone leptonic emission scenario
- Two independent approaches are adopted
  - A two-zone leptonic emission



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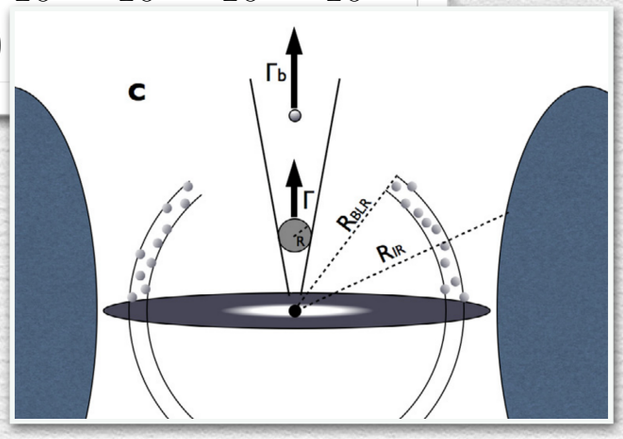
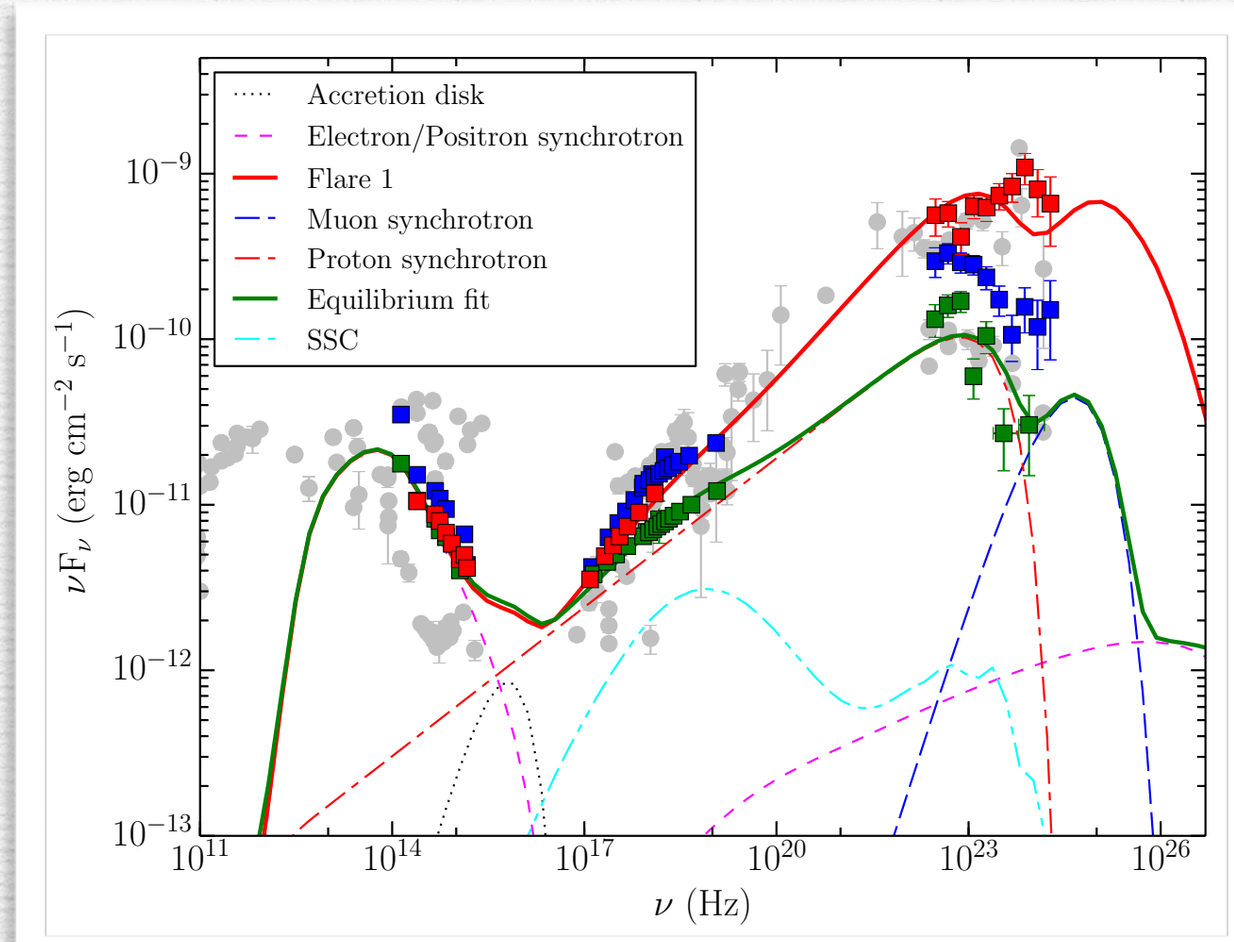


Tavecchio+, 2011, A&A, 534, 86

2013 December Flare

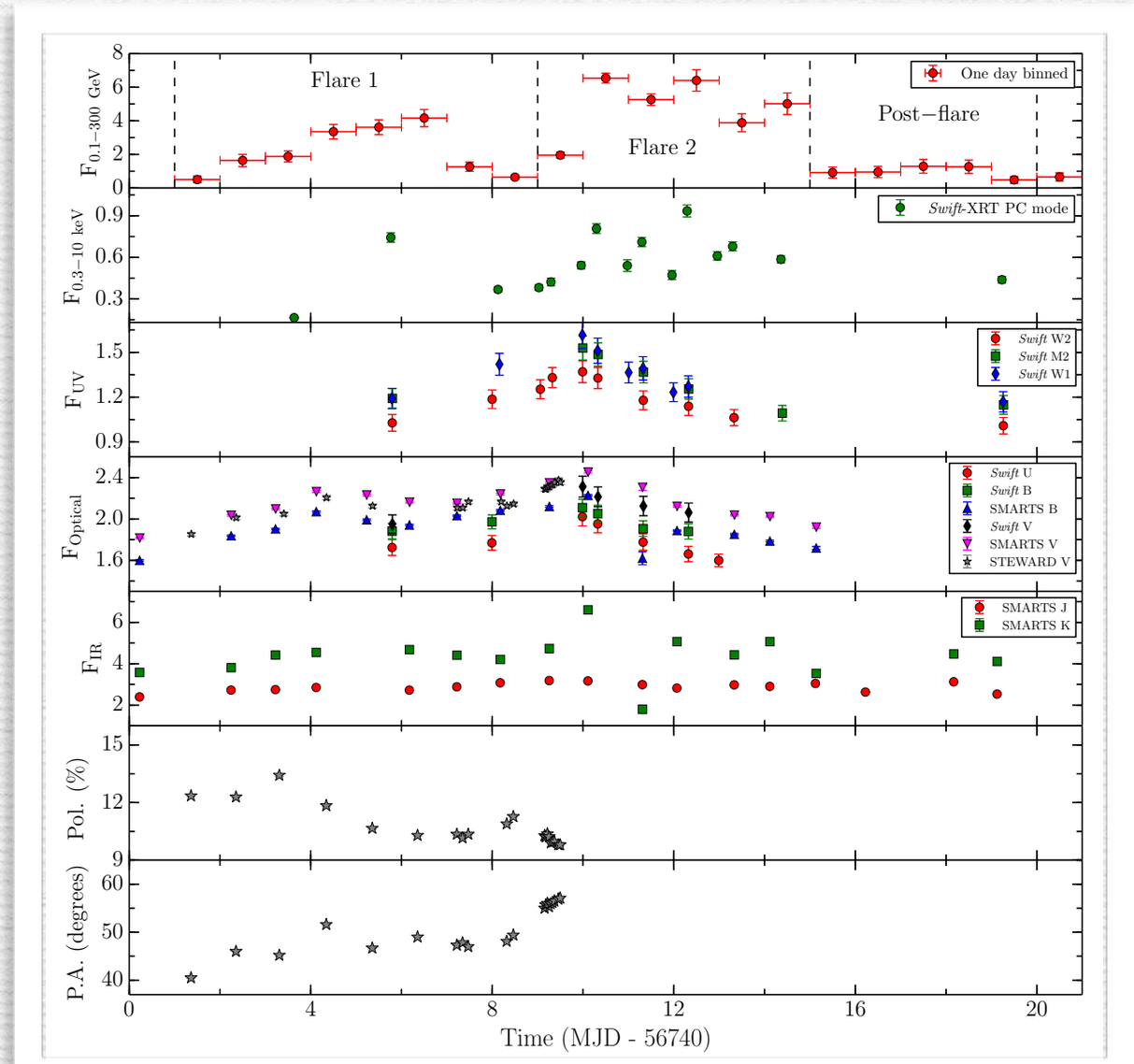
- An extremely hard γ-ray spectrum is observed
- Comparison of the shapes of the optical-UV and γ-ray spectra provides another clue to the failure of one-zone leptonic emission scenario
- Two independent approaches are adopted
  - Lepto-hadronic processes



(Paliya+, submitted)

2014 April Flare

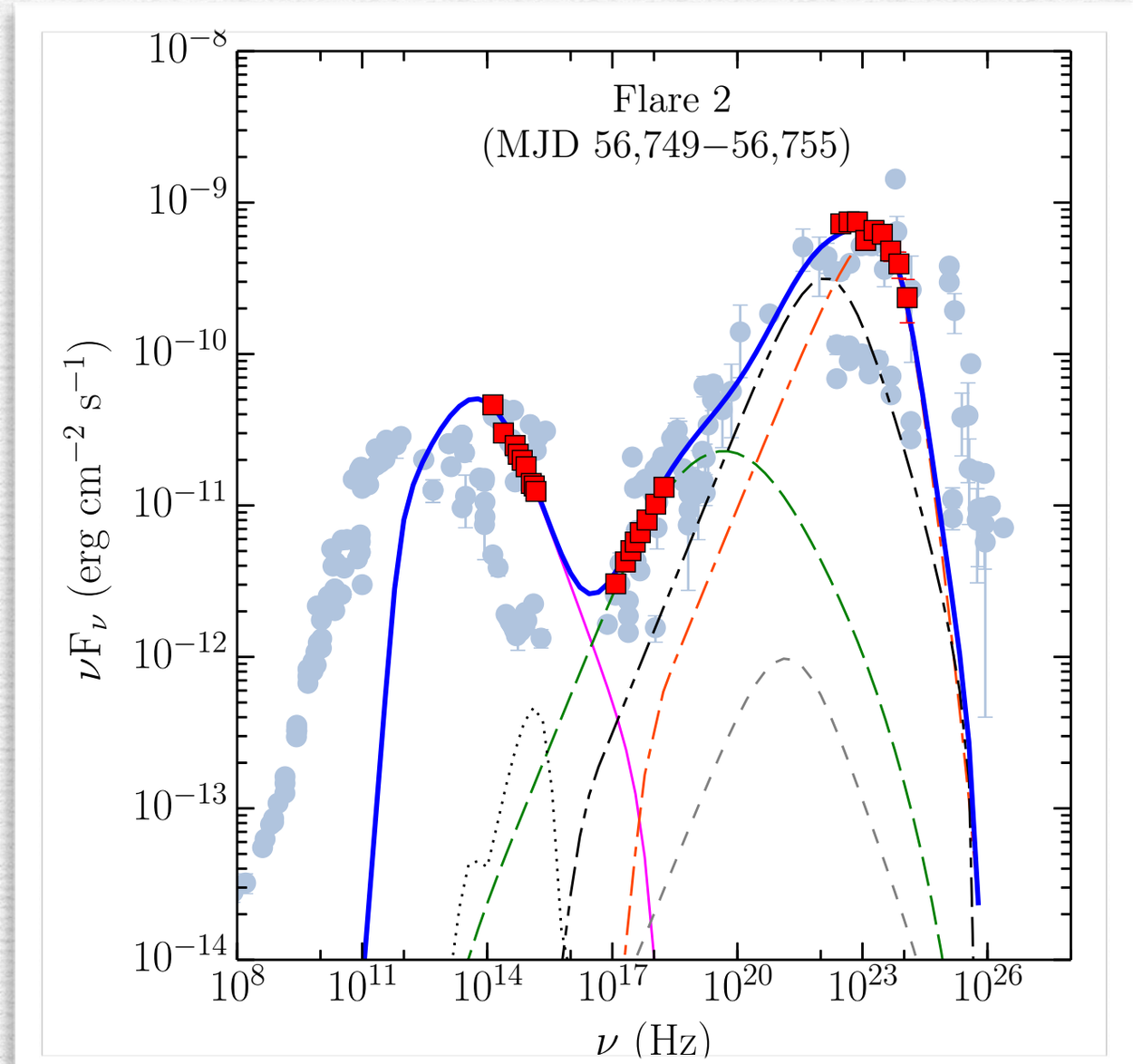
- A bright γ-ray flare with amplitude similar to 2013 flare
- The shortest γ-ray variability time ~1 hr
- The flux enhancement is seen at all the wavelengths, thus supporting one-zone/co-spatiality of the origin of the radiation



(Paliya+, 2015, ApJ, 803, 15)

2014 April Flare

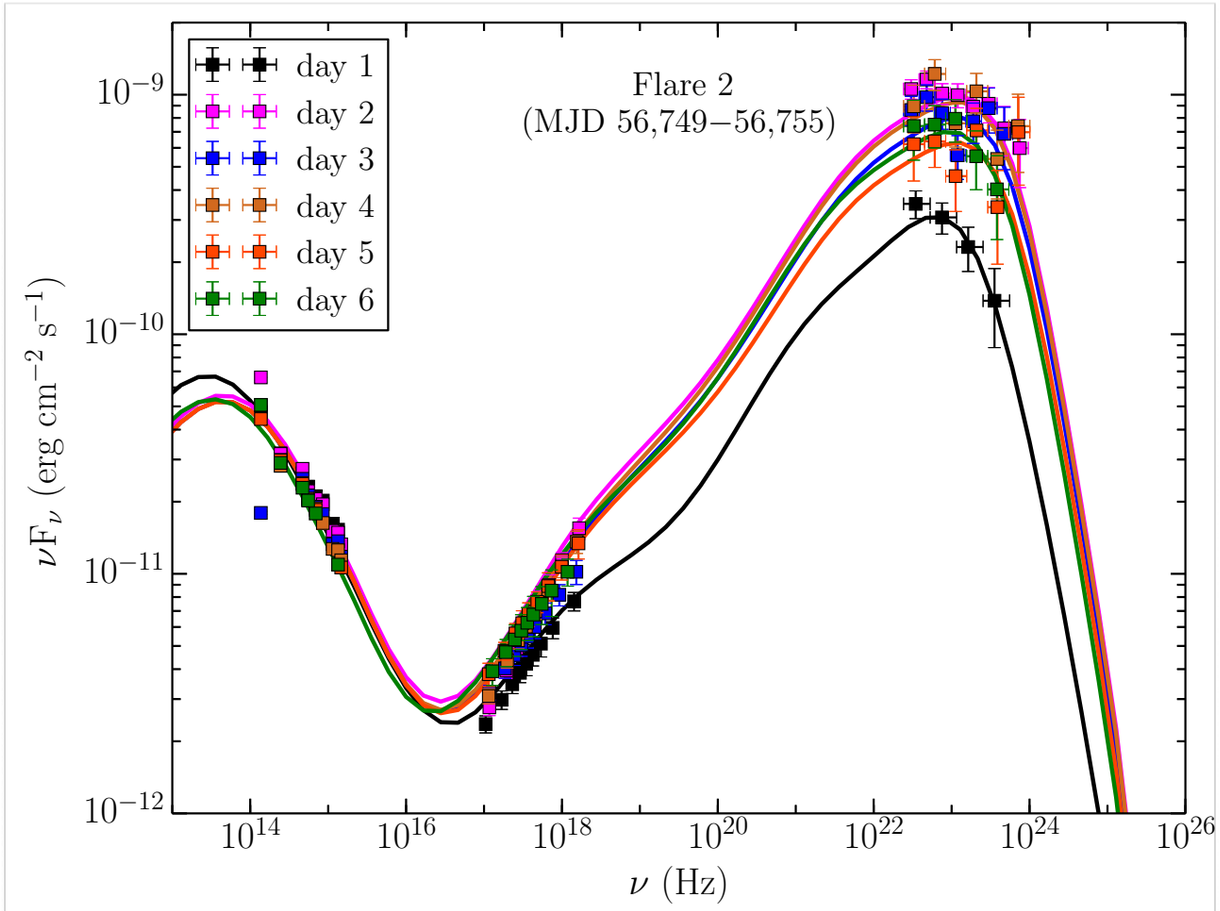
- At the peak of the flare, the γ-ray spectrum was curved
- The curvature is explained as a combination of EC-BLR & EC-torus processes with Klein-Nishina mechanism playing a role
- The emission region was located at the outer edge of the BLR

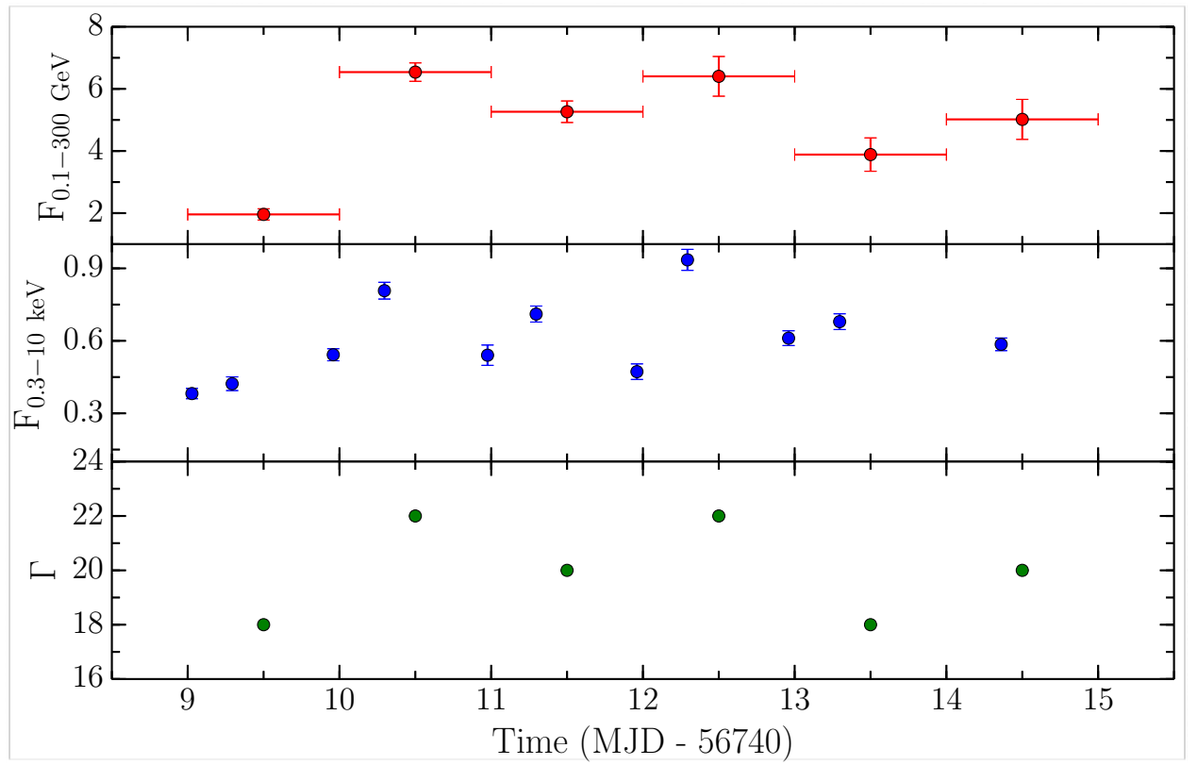


(Paliya+, 2015, ApJ, 803, 15)

2014 April Flare

(Paliya+, 2015, ApJ, 803, 15)

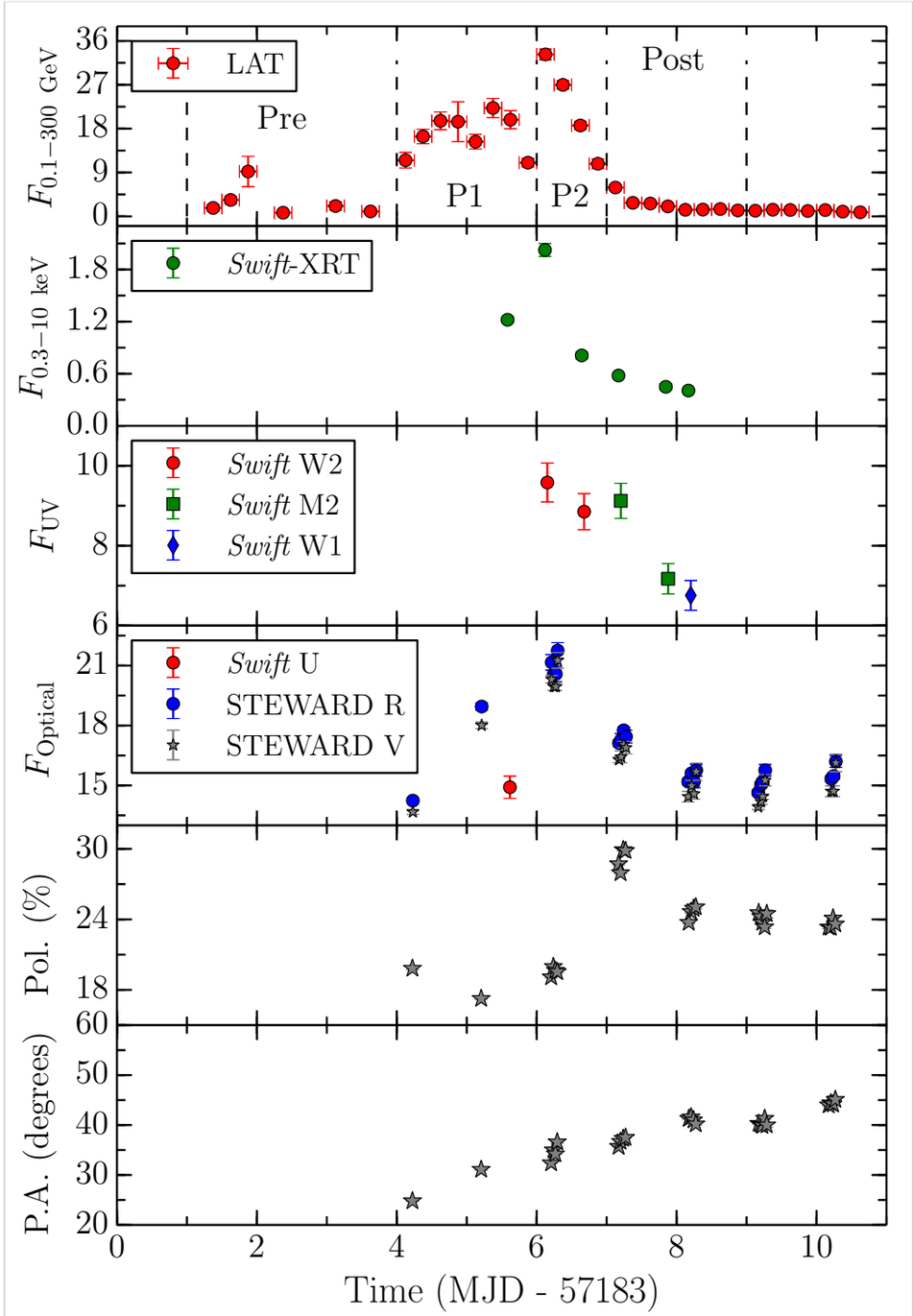




- The modeling of the fine time binned SEDs indicated the increase in the bulk Lorentz factor as a primary cause of the flare

2015 June Flare

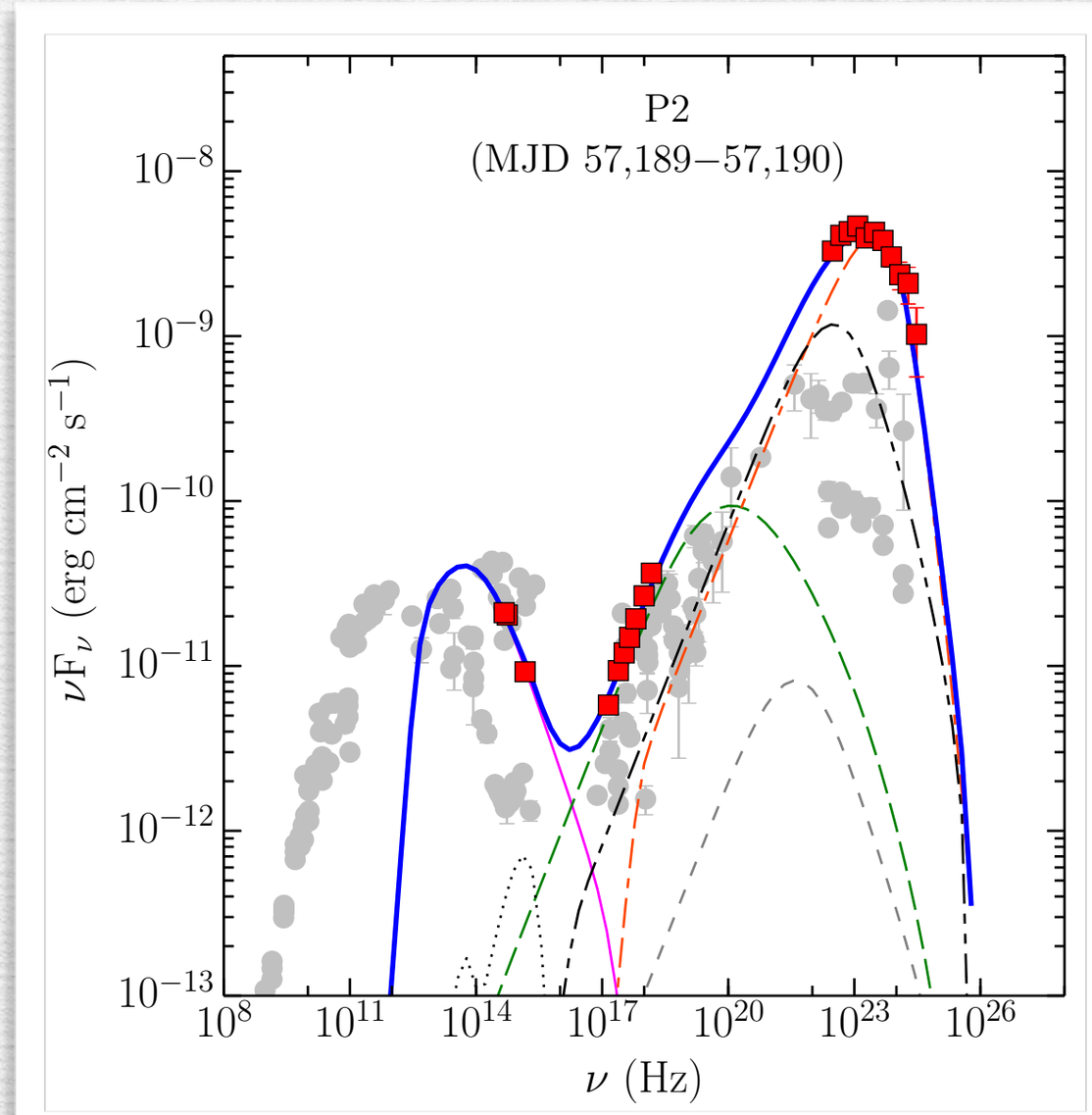
- The brightest γ-ray flare ever detected from 3C 279
- The highest measured γ-ray flux is ~4 x 10^{-5} ph cm^{-2} s^{-1}
- Similar to 2014 April flare, this event also showed correlated variability behavior across the EM spectrum



(Paliya+, prep.)

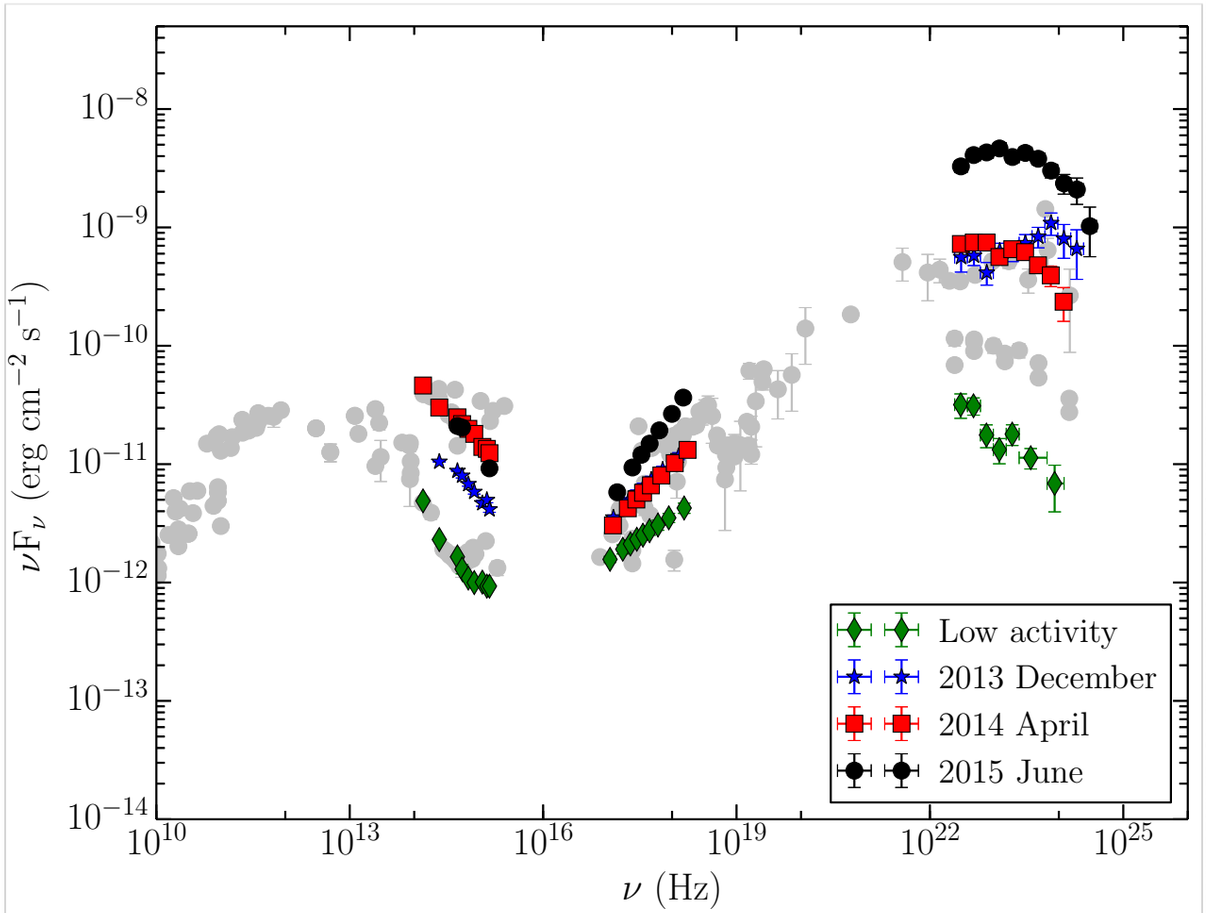
2015 June Flare

- A one-zone model successfully explains the observations
- The γ-ray spectrum showed a significant curvature similar to that seen in 2014 April flare
- The location of the emitting region was again found to be at the outer edge of the BLR



(Paliya+, prep.)

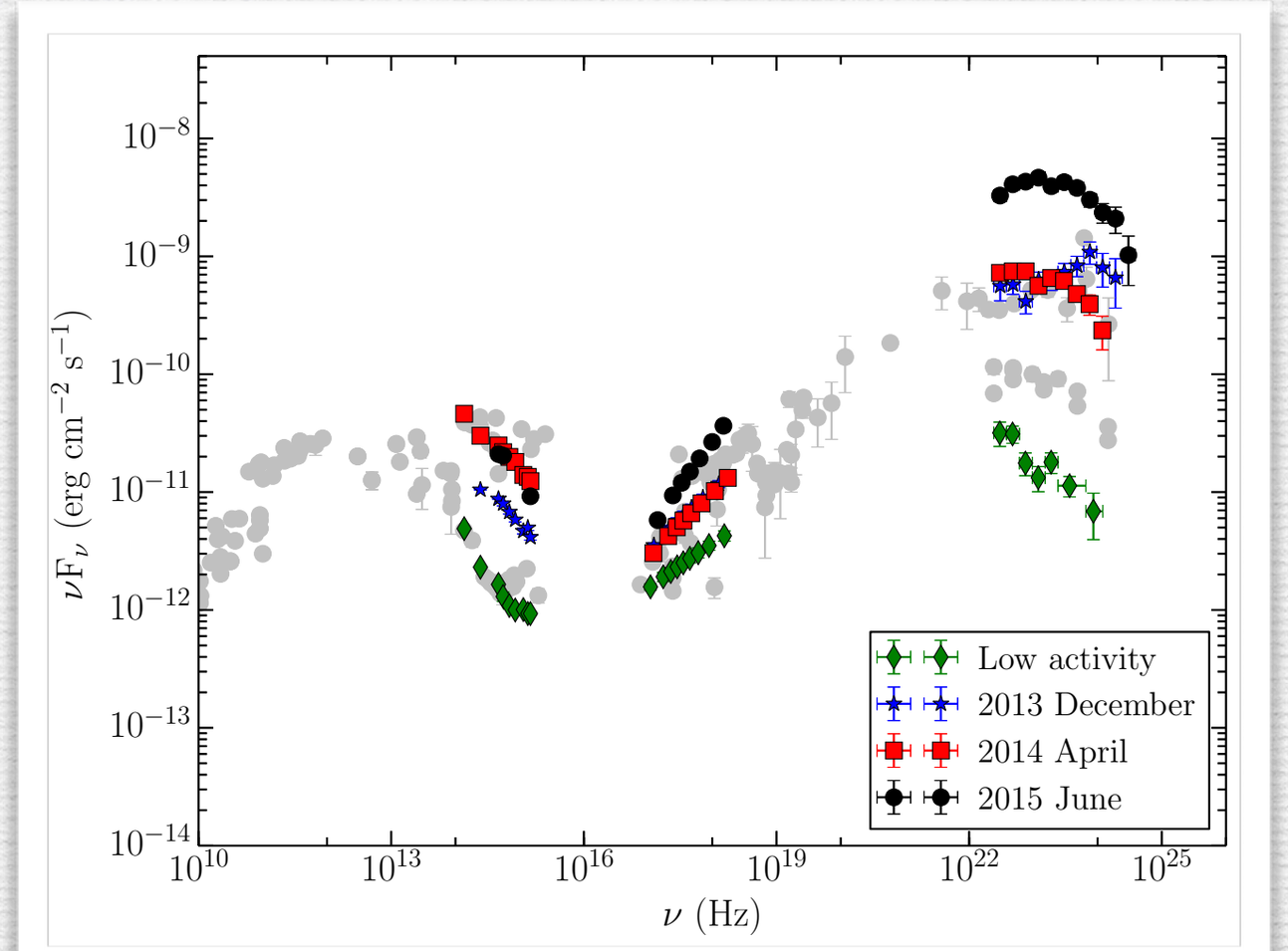
Summary



(Paliya+, prep.)

Summary

- These three γ-ray flares displayed the dominance of a variety of the physical processes powering the jets of 3C 279
- The observations reflect the complexity involved in understanding the radiative mechanisms working in blazar jets
- A deep multi-wavelength monitoring may reveal similar features from other blazars also



(Paliya+, prep.)

Thank you