Detection of a Large and Fastest Swing in the Optical Polarization Angle in the Blazar S5 0716+714 during the Unprecedented Multi-frequency Flare in February 2015

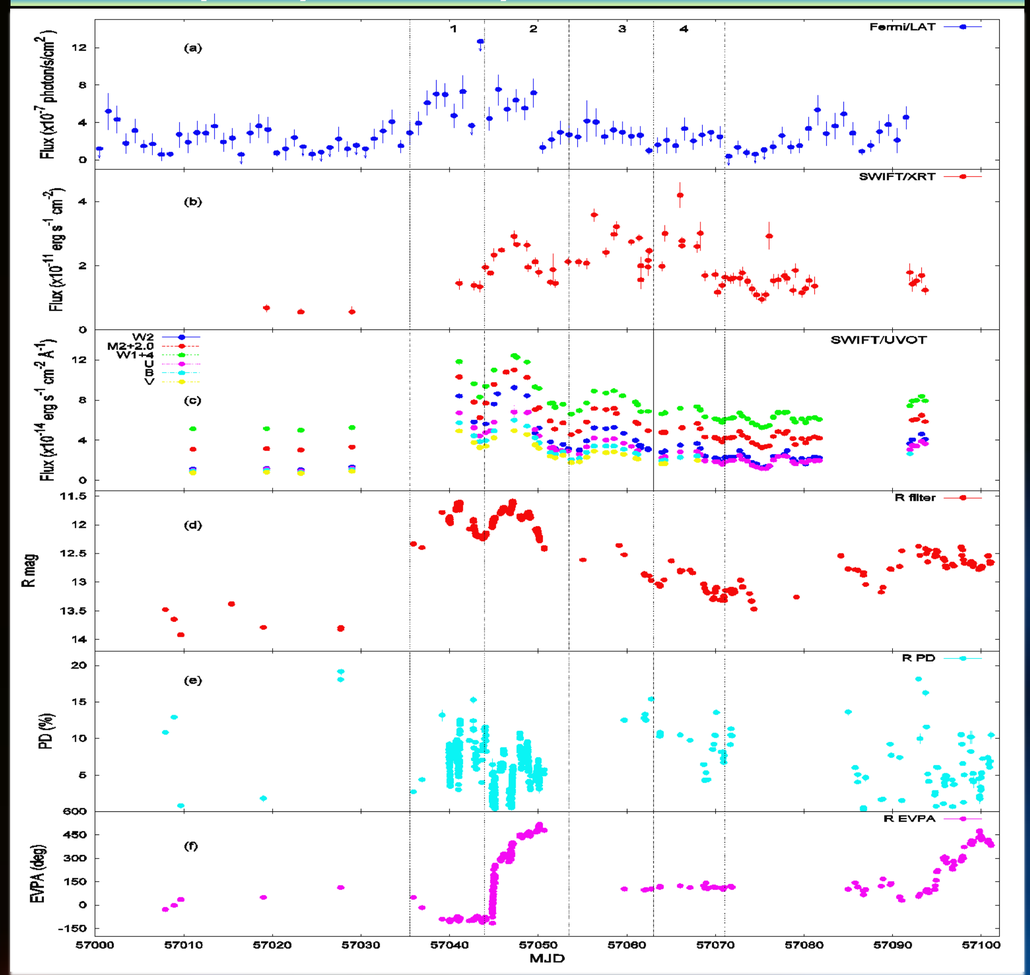
Bhatta G., Ostrowski M., L. Stawarz, F. Krauss, A. Markowitz, A. A. Arkharov, R. Bachev, G. A. Borman, A Cason, V. Doroshenko, D. Jableka , S. A. Klimanov, V. M. Larionov, A. C. Sadun, I. S. Troitsky, O. Vince, J. Webb and S. Zola

Astronomical Observatory of Jagiellonian University, Krakow, Poland

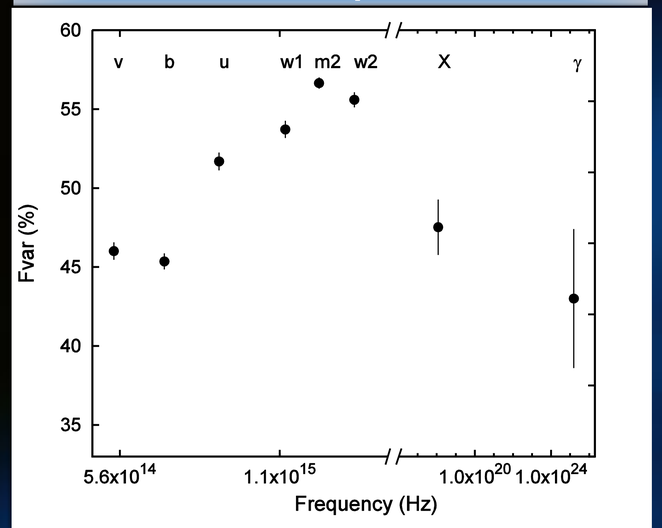
Background

- Blazars are believed to be the most violent radio-galaxies with one of their jets pointed towards us.
- They are widely considered as luminous sources with highly polarized emission variable in all frequencies and timescales ranging from years down to minutes.
- Blazars frequently go through sudden outbursts releasing a tremendous amount of energy in the form of multi-frequency emission.
- The nature of the events leading to such violent episodes along with the other dynamic and kinematic processes involved e.g. emission and particle mechanisms are still under debate.
- A multi-frequency study of the flare in blazar 0716+714, unprecedented in magnitude and scale, is carried out with the aid of observations in optical, UV, X-ray and gamma ray observations lasting about 90 days.
- Such a muli-frequency look into the event provides with an insights placing important constraints on the various parameters such geometry, magnetic field, particle acceleration and emission mechanism etc.

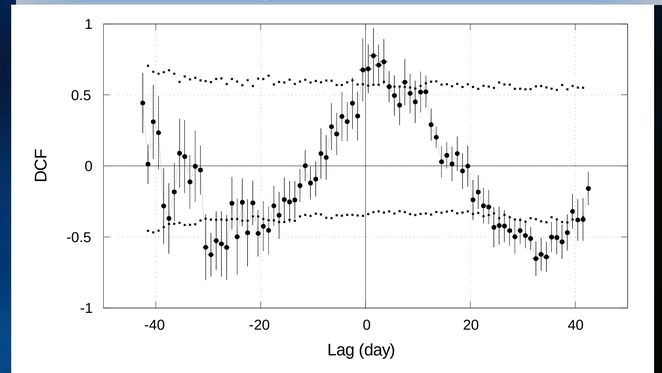
Muliti-frequency Variability of the blazar S5 0716+714



Fractional Variability



DCF between gamma ray and U flux



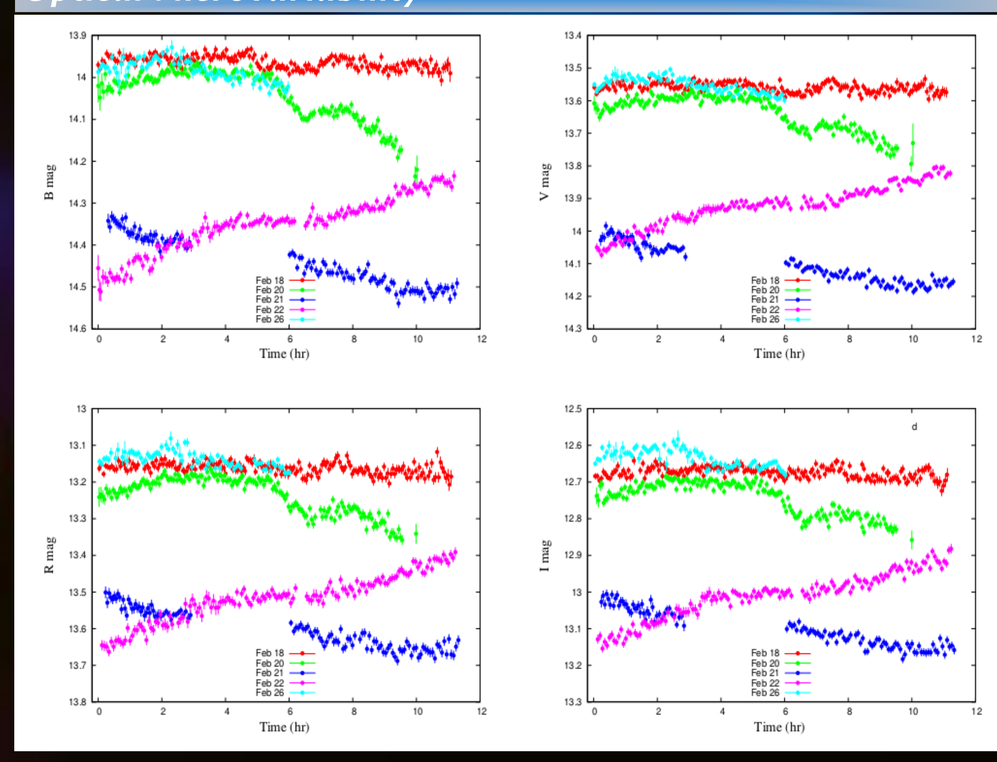
Observation Summary

Table 1: Observation Summary

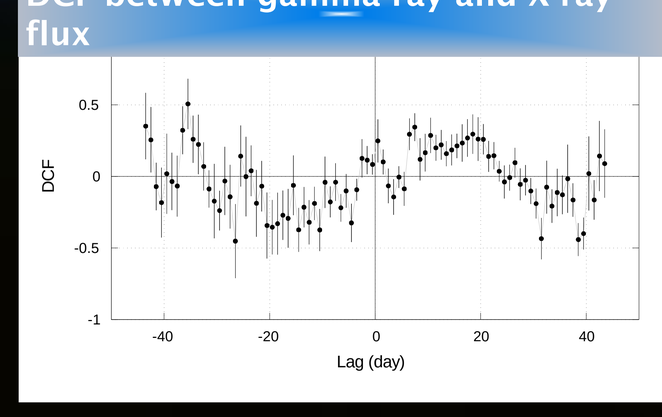
Instrument	Bandpass or Filter Center	N_{pts}	Mean Flux or Flux Density	F_{var} (%)
Fermi LAT	0.1–300 GeV	46	2.92×10^{-7} ph cm^{-2} s^{-1}	53.1 ± 4.5
Swift XRT	0.5–10 keV	70	1.91×10^{-11} erg cm^{-2} s^{-1}	35.6 ± 1.3
Swift UVOT W2	1928 Å	64	3.44×10^{-14} erg cm^{-2} s^{-1} Å^{-1}	55.0 ± 0.5
Swift UVOT M2	2246 Å	63	3.40×10^{-14} erg cm^{-2} s^{-1} Å^{-1}	56.1 ± 0.3
Swift UVOT W1	2600 Å	65	3.30×10^{-14} erg cm^{-2} s^{-1} Å^{-1}	53.1 ± 0.5
Swift UVOT U	3465 Å	63	2.89×10^{-14} erg cm^{-2} s^{-1} Å^{-1}	49.8 ± 0.4
Swift UVOT B	4392 Å	30	3.05×10^{-14} erg cm^{-2} s^{-1} Å^{-1}	44.8 ± 0.5
Swift UVOT V	5468 Å	28	2.61×10^{-14} erg cm^{-2} s^{-1} Å^{-1}	45.8 ± 0.5

N_{pts} is the number of data points. F_{var} is the fractional variability amplitude.

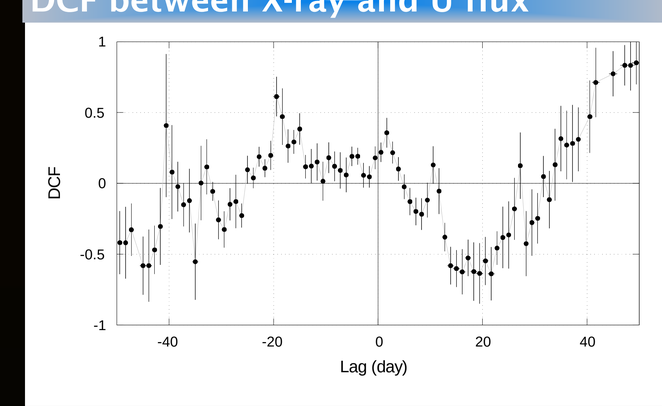
Optical Microvariability



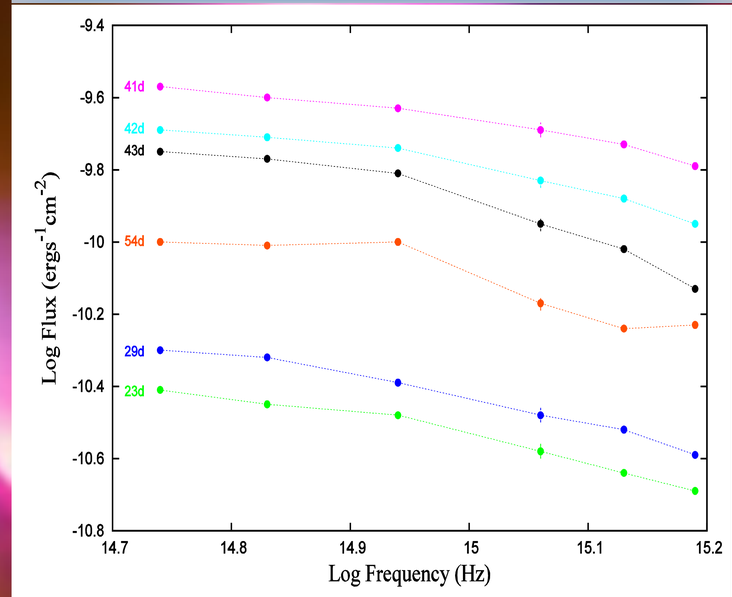
DCF between gamma ray and X-ray flux



DCF between X-ray and U flux



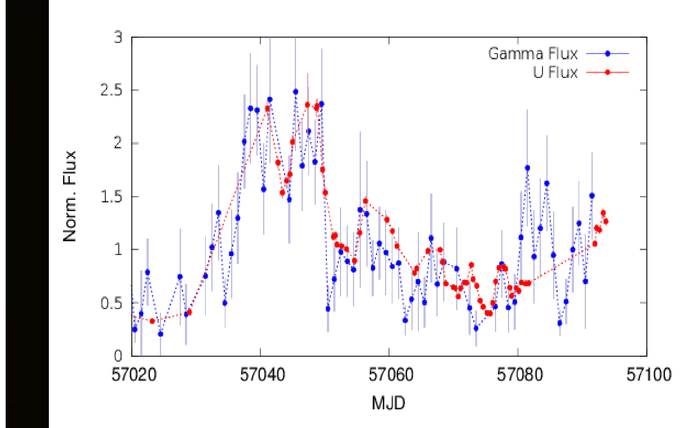
Swift UVOT Spectrum



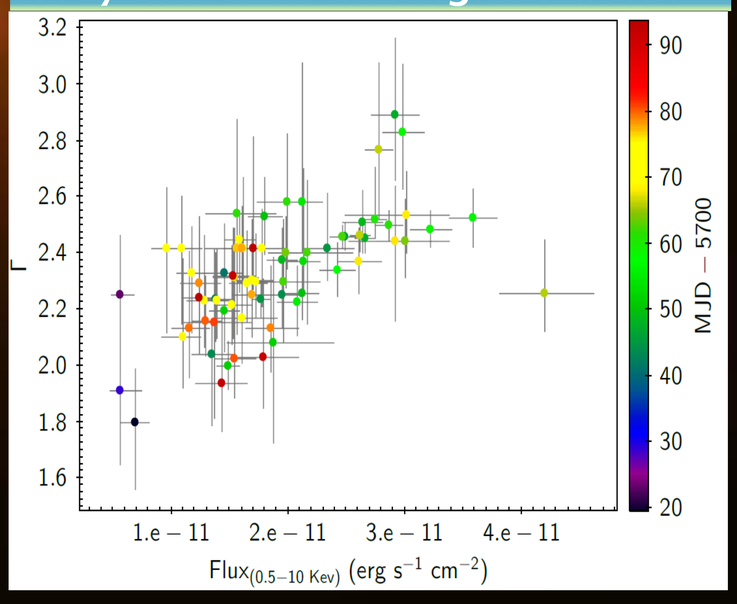
Results

- The source went through a large surge in gamma-ray emission correlated with optical emission lasting about 30 days.
- The accompanying X-ray flares during the violent episode found to behave *quasi-independently*.
- A huge positive swing in optical polarization angle (PA) was observe to coincidence with the gamma ray emission flaring up nearly **7 times**
- The rate of change in PA is found to be *the fastest* one – **550 deg in merely 5 days**.
- The observed rise in PA began at rather low polarization degree.
- A softer-when-brighter trend was observed in X-ray emission.
- The UVOT spectra were found to be almost *power-law type*.
- Surprisingly, the optical intranight variability was found to be devoid of *sub-hour-like oscillations* usually observed with high duty cycle.

UV –gamma ray flux Correlation



X-ray softer-when-brighter trend



Acknowledgement

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Thank You !!