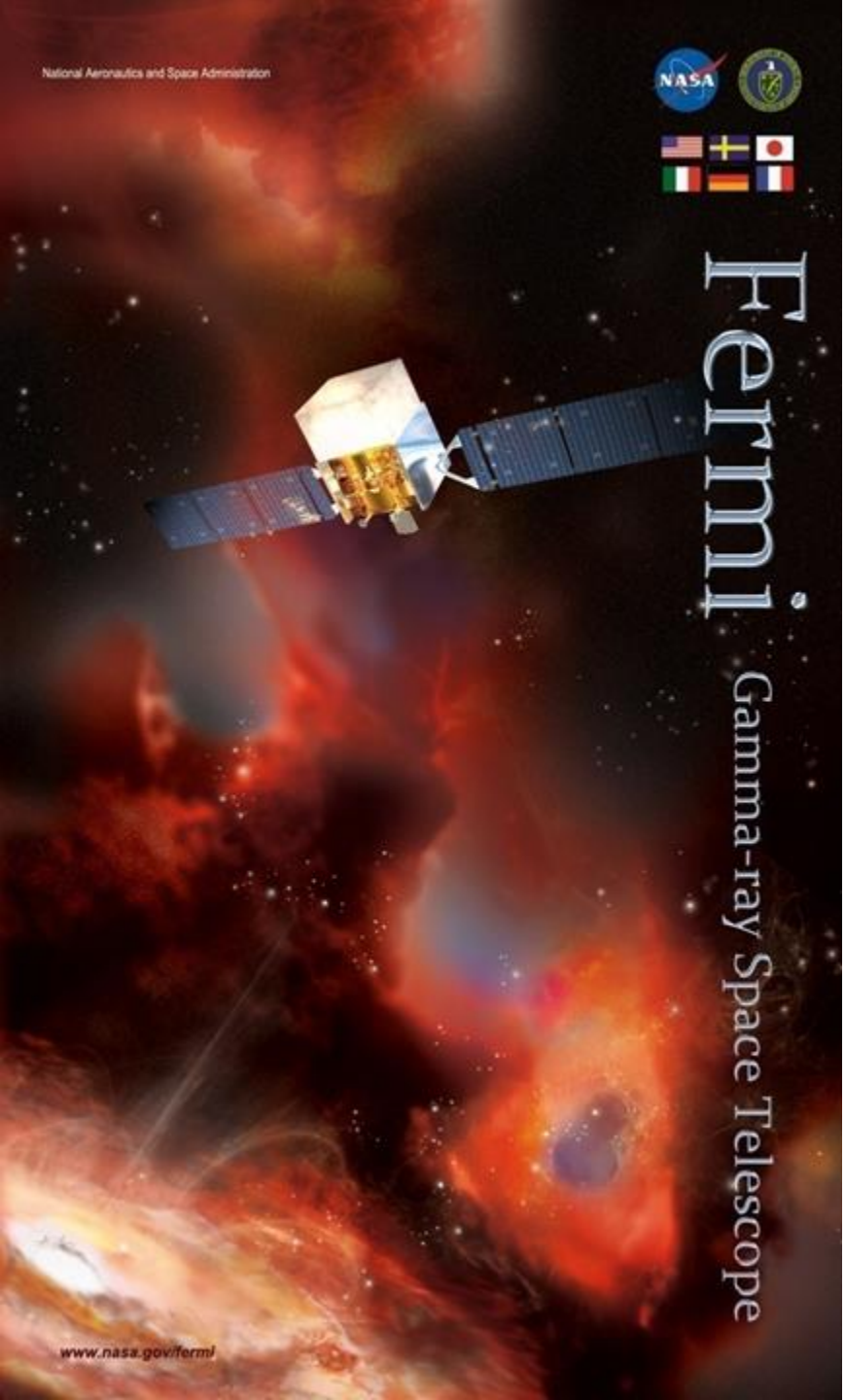

Blazar variability in gamma-ray and optical polarization with Fermi and Kanata telescope

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Yasushi Fukazawa, Y. T. Tanaka,

M. Uemura (Hiroshima University)

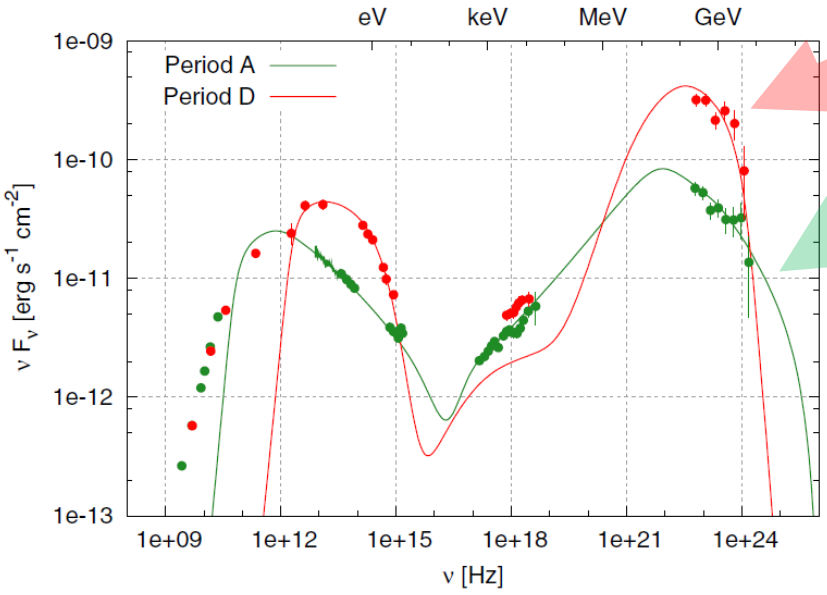
for the Fermi-LAT collaboration, Kanata team

2015-11-09

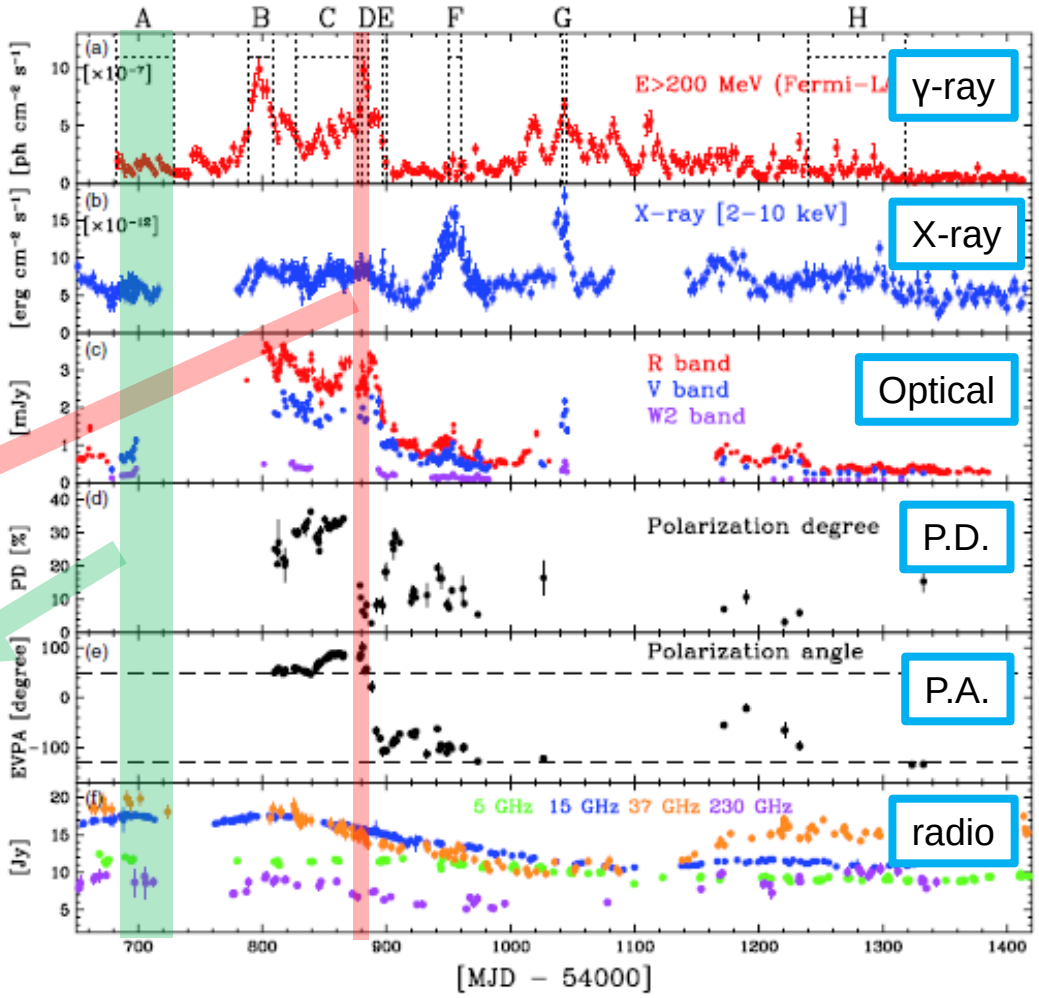
6th Fermi Symposium

MW-Obs. of blazar in Fermi era

Owing to improvement of instruments, we now can observe the daily change of SED.
It provides us with a lot of information about the jets



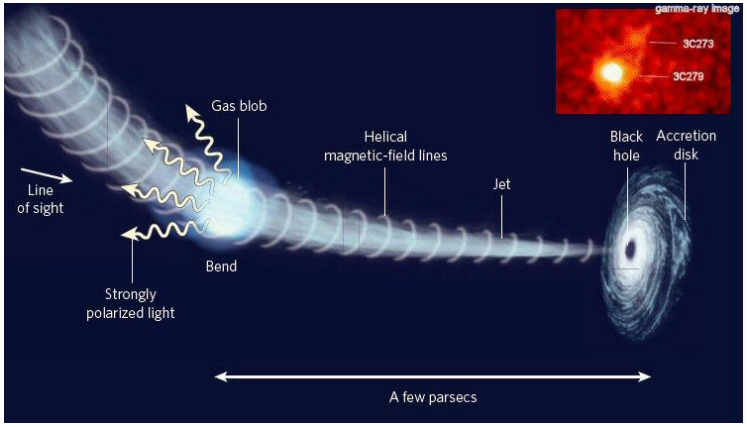
Light curve for 3C 279, Hayashida+12



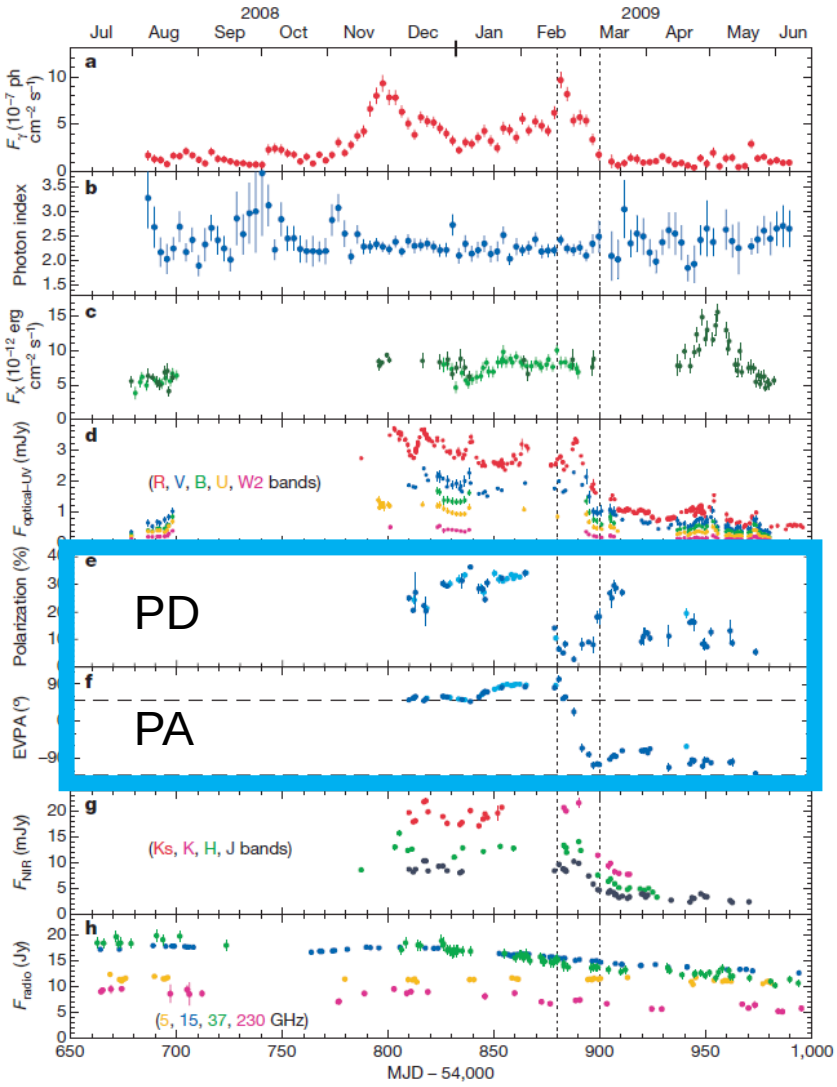
Polarization in blazar

- **Polarization** information plays an important role in studying the environment in the jet

- Many MW-polarimetric observations were performed, but "**common**" properties in the jets are still unclear



FSRQ 3C 279, Abdo+10



Our team performed a number of monitoring observations with optical polarization with Fermi

Kanata Telescope

Kanata Telescope

1.5m diameter telescope designed for optical and near infrared band located at Higashi-Hiroshima Observatory in **Japan**.

Target object; Any type of transients (AGN, GRB, etc…)

Performed a lot of **campaign/ ToO/follow-up** observations with Fermi/LAT and other telescopes

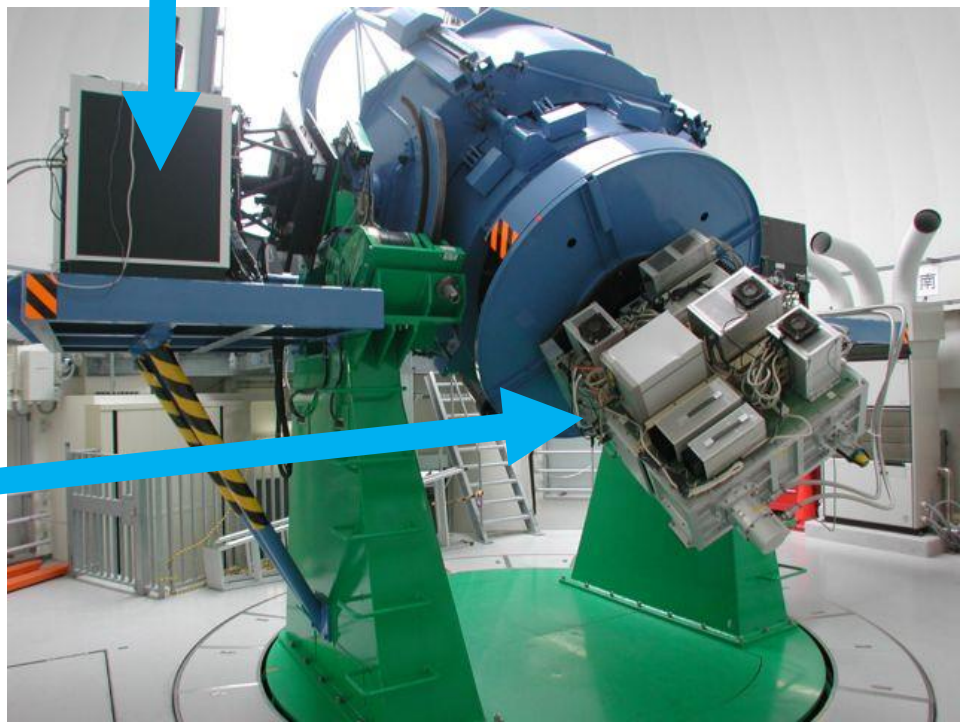
HOWPol (1st Nasmyth)

Optical polarimeter

Have a capability of one-shot polarimetry
It enable us to get polarization with time scale of **< 1 minute** for R=15 mag object.

TRISPEC (Cassegrain)

Optical and NIR polarimeter.
Have a capability of **simultaneous** polarimetry in **optical & NIR** band



Target List

Red; GeV bright source

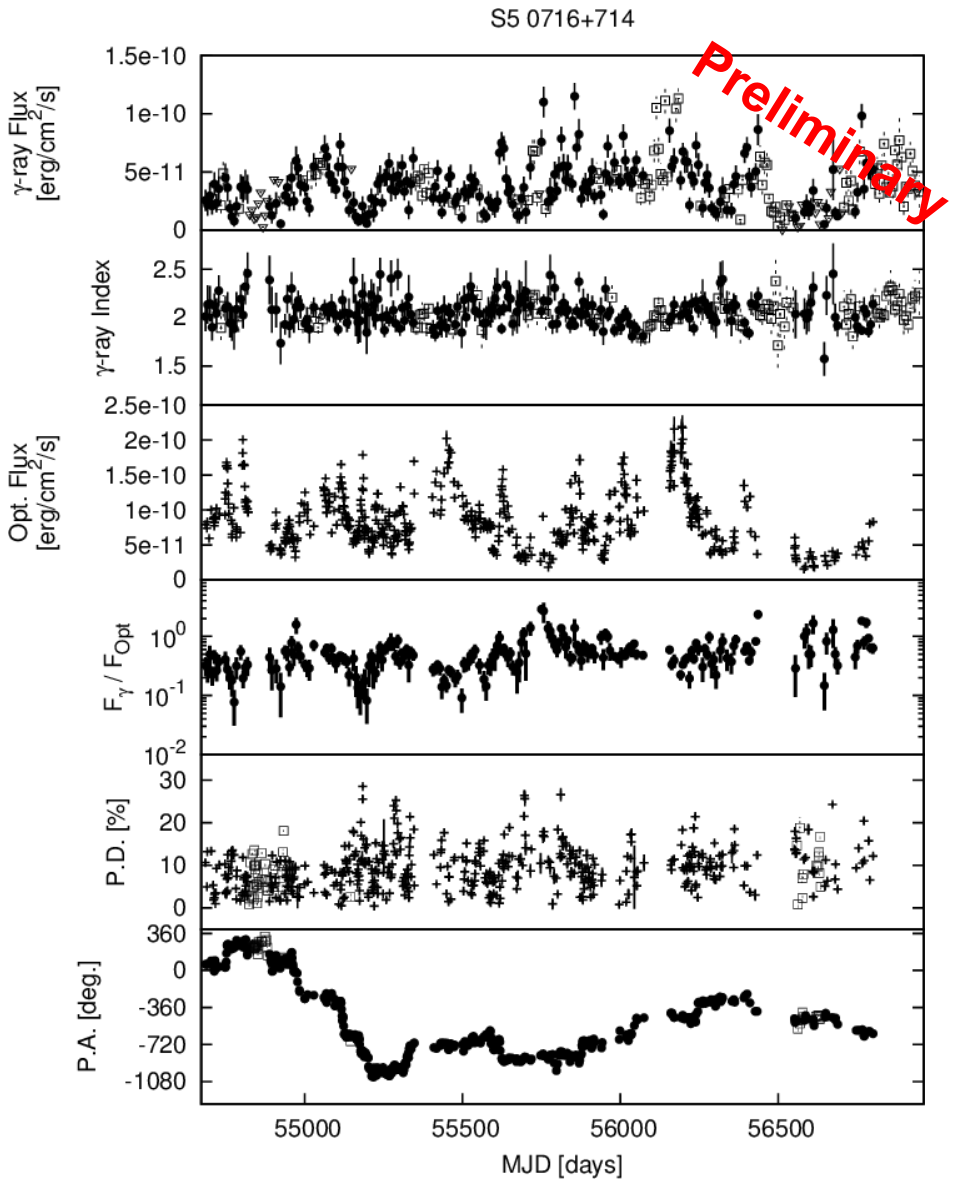
FSRQ	LSP	ISP	HSP	RL-NLSy1
3C 454.3 (498)	BL Lac (539)	S5 0716+714 (628)	Mrk 501 (244)	1H 0323+342
3C 273 (332)	OJ 287 (413)	3C 66A (487)	PG 1553+113 (225)	PMN J0948+0022
3C 279 (177)	AO 0235+164 (93)	1ES 1959+650 (202)	PKS 2155-304 (161)	
PKS 1749+096 (163)	OJ 49 (70)	S2 0109+22 (102)	Mrk 421 (74)	
3C 371 (124)	S4 0954+658 (5)	PKS 0048-097 (63)	ON 325 (56)	
RX J1542.8+612 (113)	1ES 1218+304 (3)	ON 231 (48)	1ES 0806+524 (54)	
PKS 1510-089 (110)		OQ 530 (19)	H 1722+119 (66)	
Mis V1436 (106)			PKS 0422+004 (42)	
CTA 102 (92)			1ES 2344+514 (33)	
PKS 1502+106 (76)			1ES 0647+250 (24)	
QSO 0454-234 (28)			1ES 0323+022 (21)	
S5 1803+784 (35)				
PKS 0754+100 (28)				
PKS 0215+015 (5)				
GB6 J1239+0443 (5)				

- Bright GeV & Opt. source
- Shows large flare

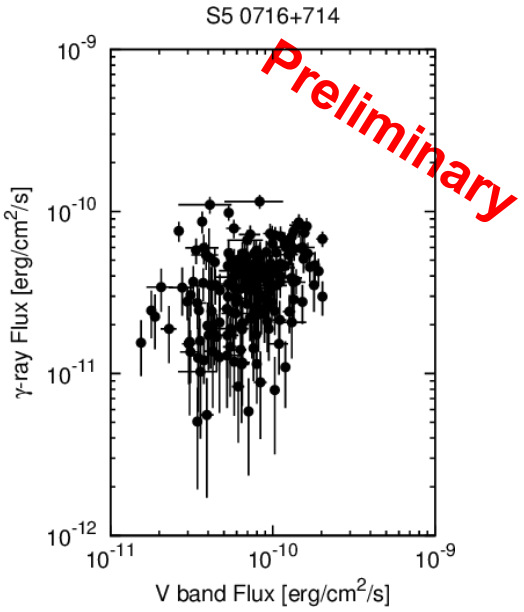
Aug. 2008 – Nov. 2014
(6.5 years data)

Pass 8 Fermi/LAT data with standard analysis
(100MeV to 300 GeV, bin=7days)

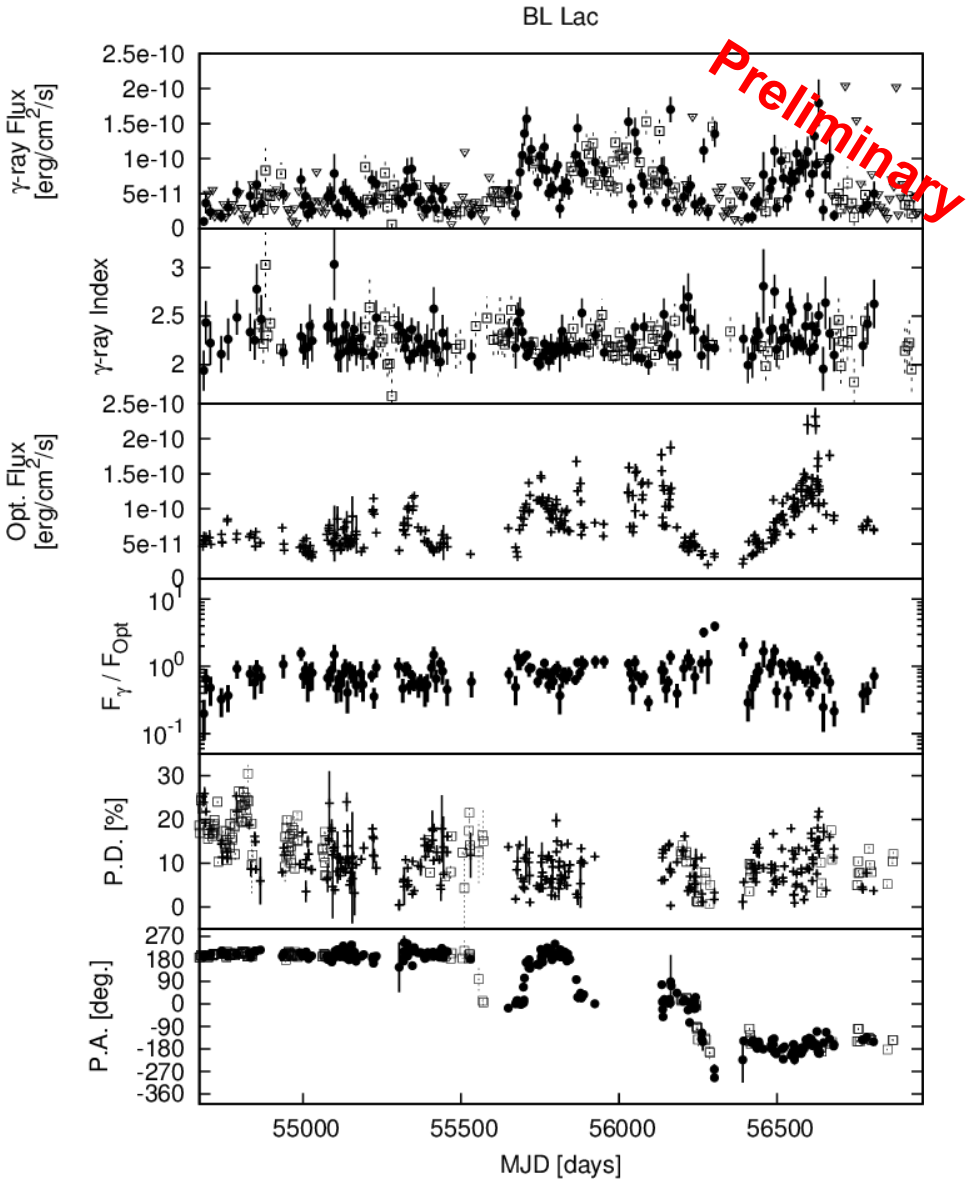
Ind. Object; S5 0716+714



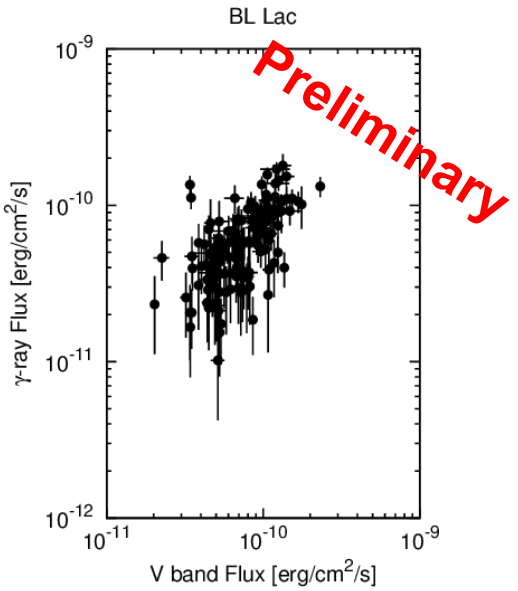
- Average cadence ~ 3 days
- Showed large variability of gamma-ray flux, optical flux, PD and PA
- Sometime, PA shows large variation



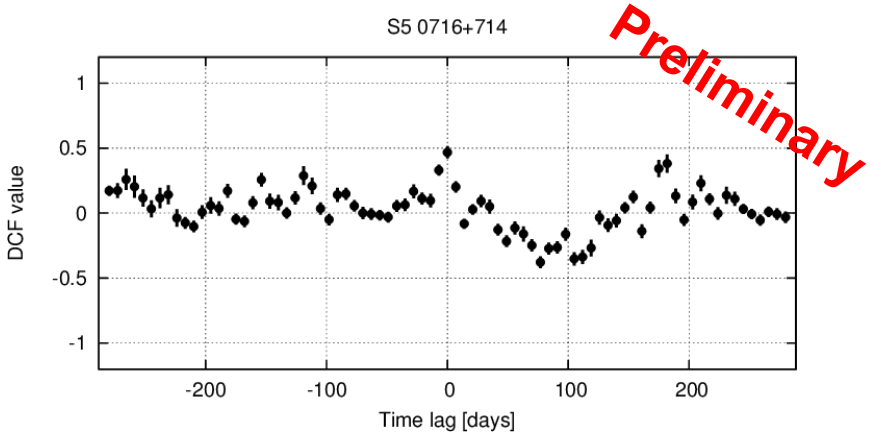
Individual Object; BL Lac

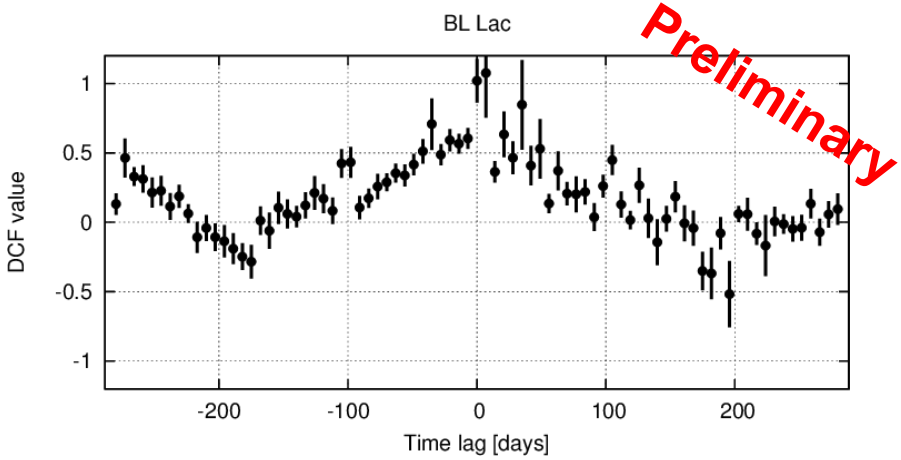


- BL Lac also shows large variability in GeV, Optical flux and PD
- But variability in PA is smaller than that in S5 0715+714



Difference between blazars





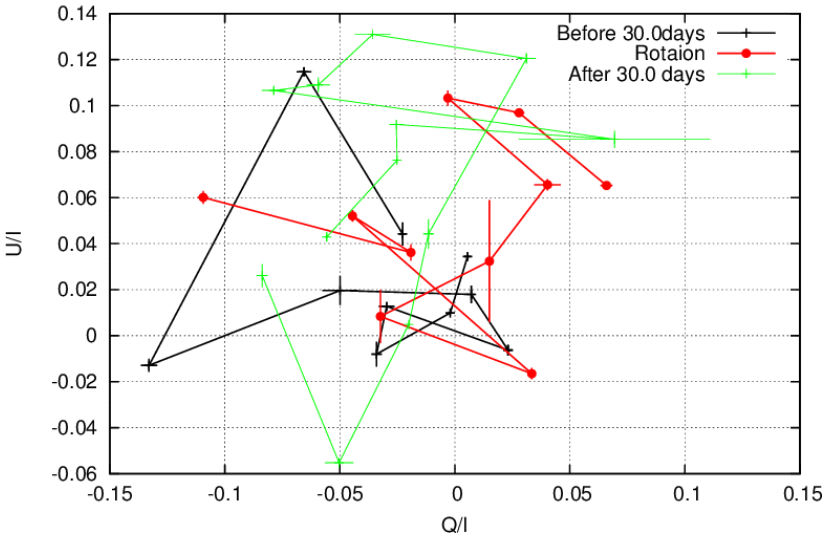
	S5 0716+714	BL Lac
Synchrotron peak [Hz]	$10^{14.6}$	$10^{13.6}$
Red shift	0.3	0.068
Corr. betw. gamma-ray & opt. flux	~0.5	~1.0
Variability of P.A.	Large	Small

Similar blazar shows different properties

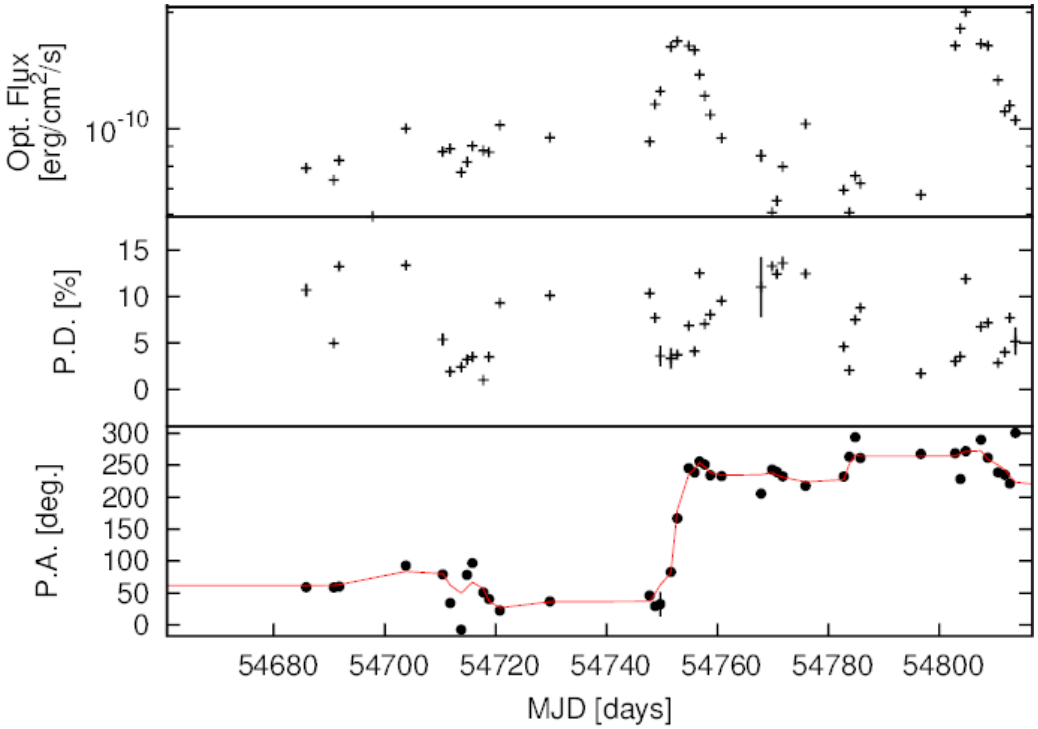
- What is the major parameter for blazar?
  Synchrotron peak? Redshift? BH mass? Luminosity? etc…

PA Rotation/Swing

Polarization variability on the Stokes QU plane for S5 0716+714

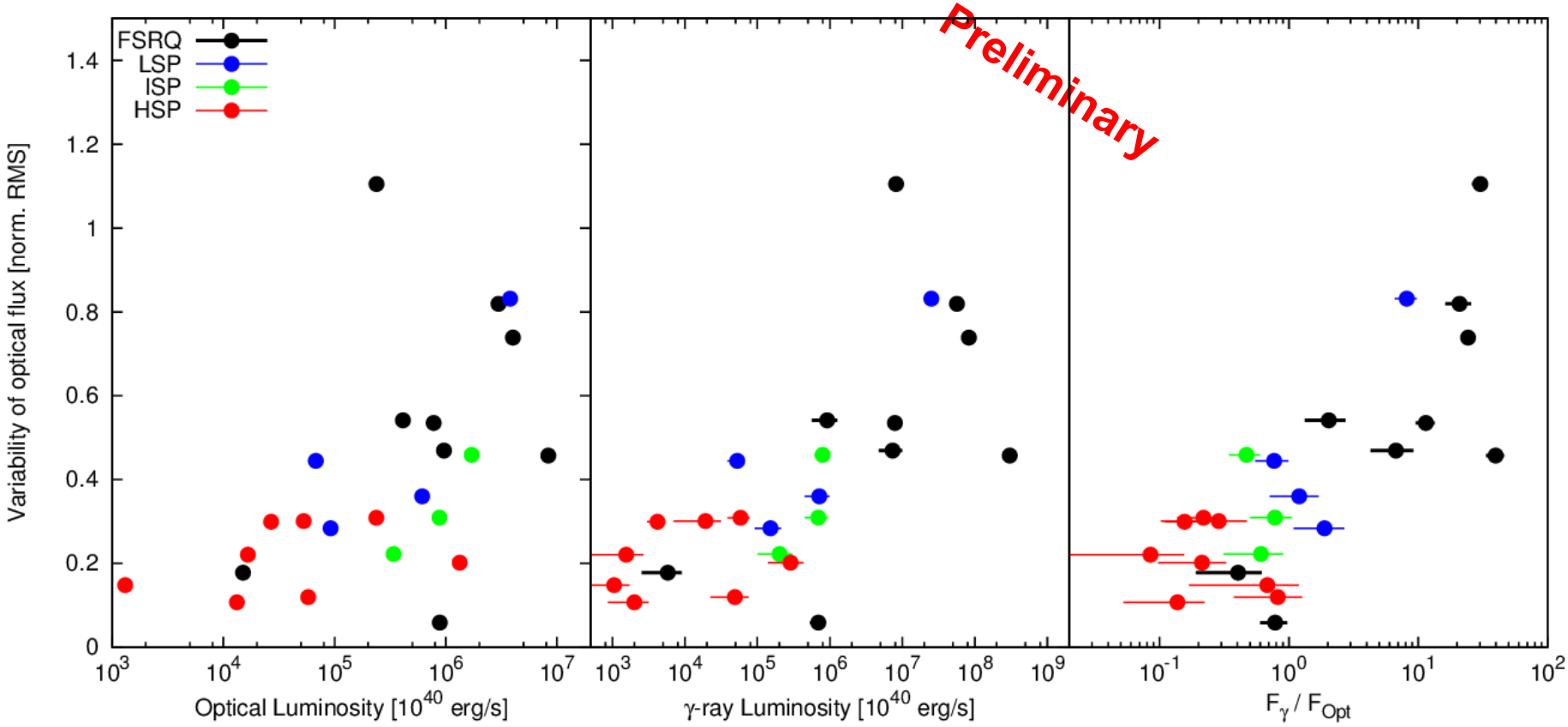


Light curve of S5 0716+714



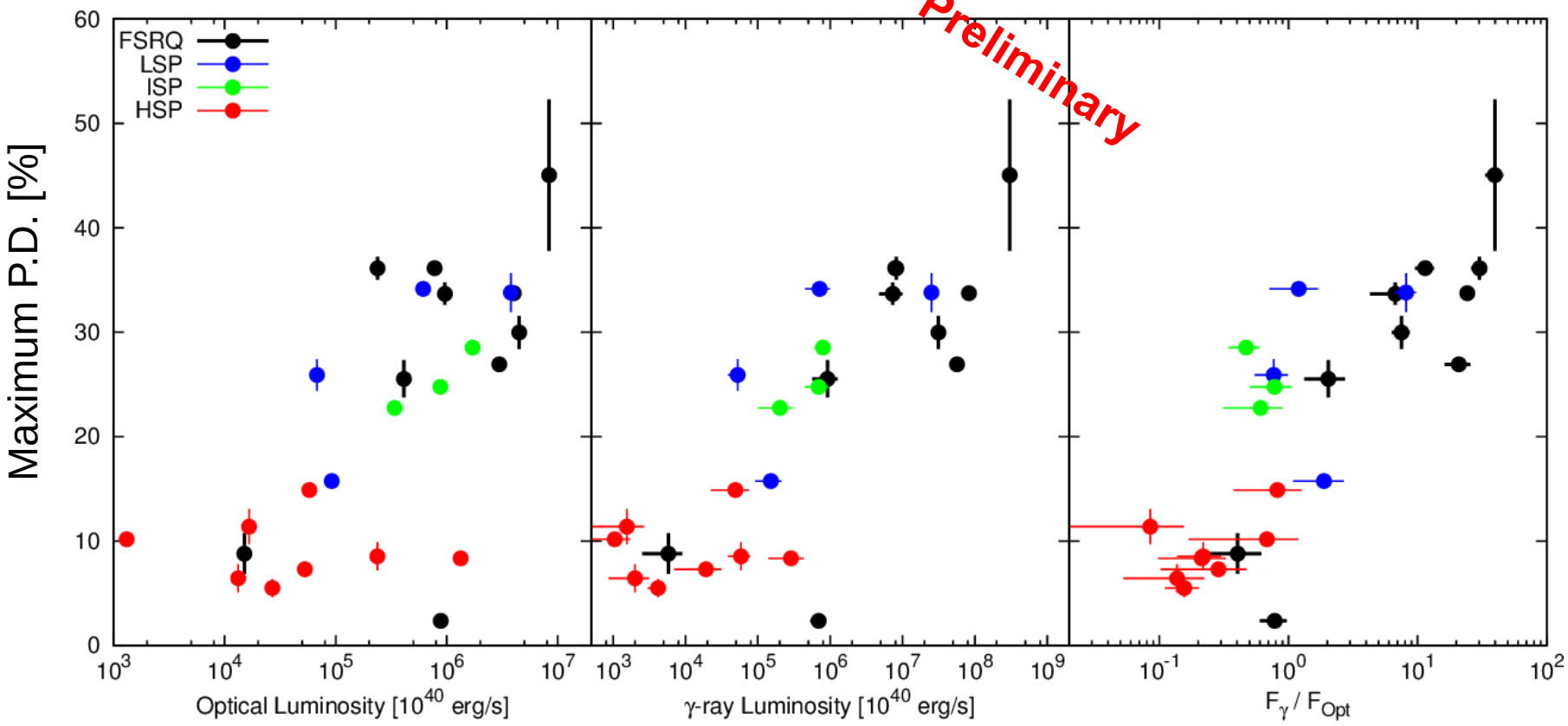
We found 33 PA rotation events from 15 objects,
But there are no clear relation between PA rotation and GeV/Optical flare

Correlation between Lum. & Variability of optical flux



Gamma-ray luminous (Not optical) blazars show large variability in the optical band

Correlation between Lum. & Maximum PD

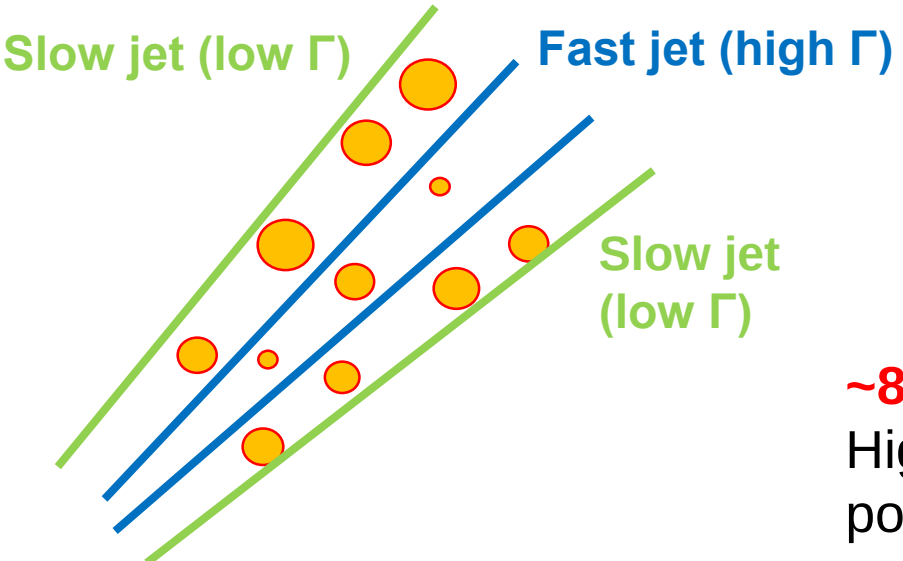


Maximum PD shows good correlation with gamma-ray Luminosity or ratio of gamma-ray flux and optical flux (not optical luminosity)

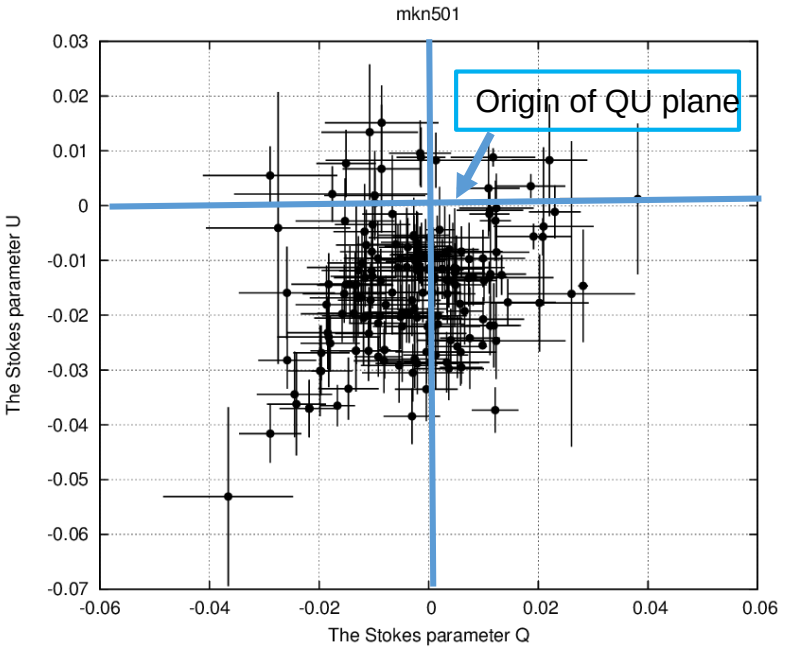
Discussion; Multi-emission regions

	High PD	Low PD
Bulk Lorentz factor	High	Low
Number of emission region	Few	Many
Compton dominance	High	Low

Superposition of several emission regions with various magnetic field directions will result in low degree of total polarization.



Mrk 501; polarization on QU plane



~80% of Low-PD objects and **~30** of High-PD objects show such systematic polarization on the Stokes QU plane.

Summary

- We performed long-term optical polarimetric observation of 39 blazars with Kanata and *Fermi/LAT*. And we found
  1. 33 “PA rotation” events but there is no clear relation between it and GeV/Optical flare
  2. Variability in the optical might be related with γ-ray luminosity
  3. Maximum PD related with γ-ray luminosity or ratio of γ-ray flux and optical flux (~ Compton dominance).
- These results indicated that low γ-ray luminous blazars possess “multi-emission region”.
- A measurement of “Flare cadence” will be helpful to test the assumption of “multi-emission region” model.

Study for extracting method of flare and relation between GeV/optical flare and polarization angle is presented in poster session (M. Uemura, Y. kanda)

We are planning to open all the polarization data as database in a few month

Kanata team welcomes collaborative observations of any transient objects (Blazar, AGN, SN, X-ray binary, and any transients). Please contact us if you are interested in working with our team.