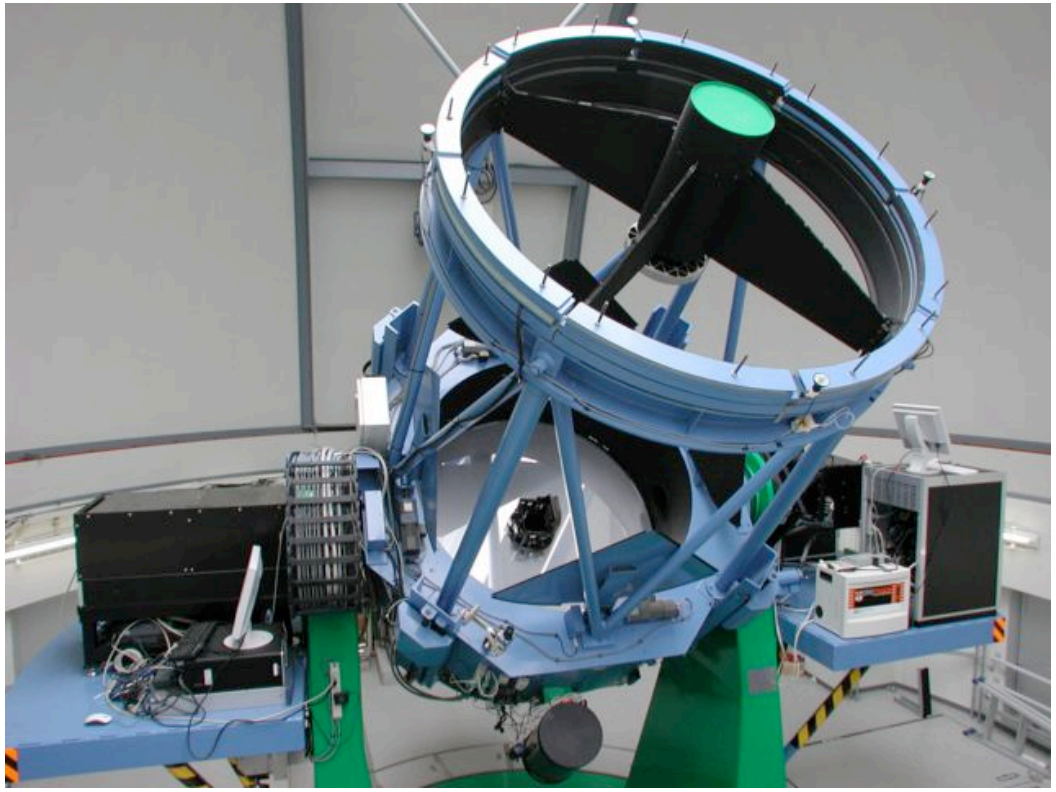
2009.11.4 fermi symposium

Photopolarimetric monitoring of 41 blazars in optical and near-infrared bands with KANATA telescope

(Flux, Color, Polarization)



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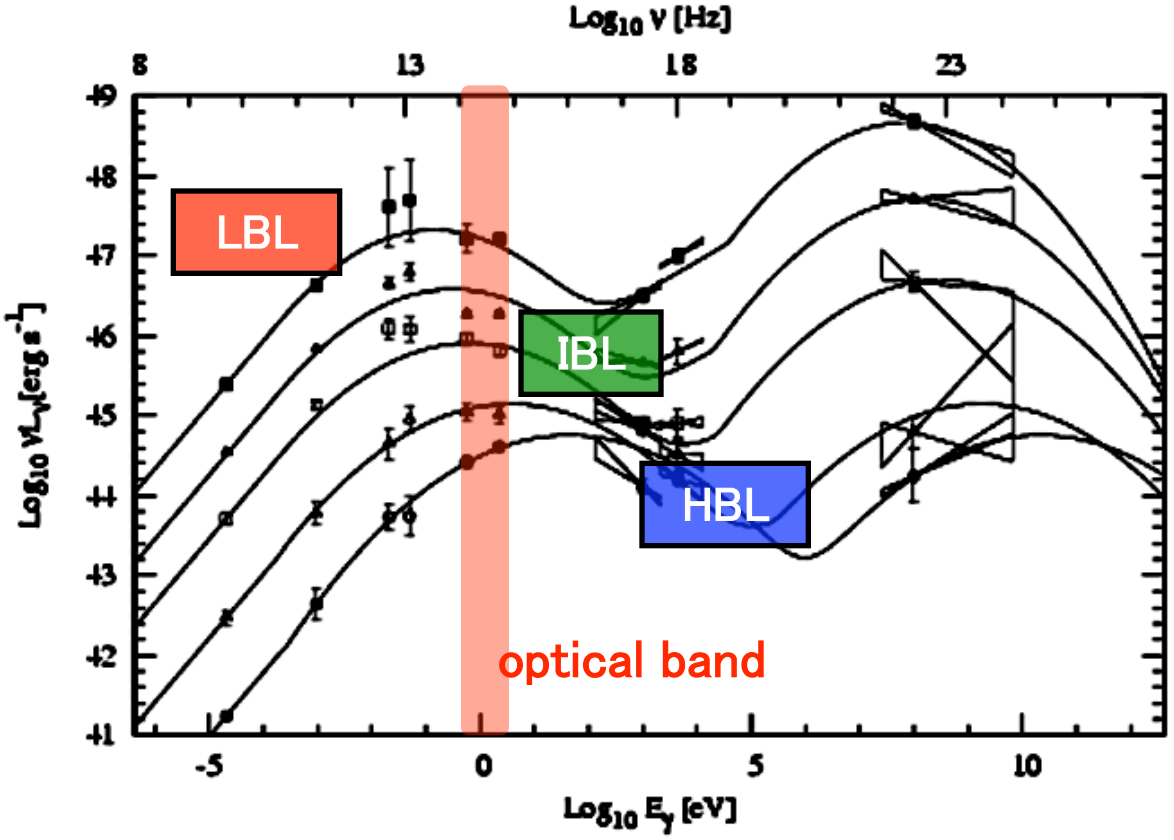
Class of Blazars



Inoue et al. 2009

The peak energy of synchrotron emission :

Lower than optical region	⇒ LBL (Low-energy peaked BL Lac object)
Optical region	⇒ IBL (Intermediate-energy peaked BL Lac object)
Higher than optical region	⇒ HBL (High-energy peaked BL Lac object)

We discuss the characteristics of each class.

Previous works about color and polarization

Relationship between flux & color

Some of blazars tend to be bluer-when-brighter.

The Flux varies

by injection of high energy electron?

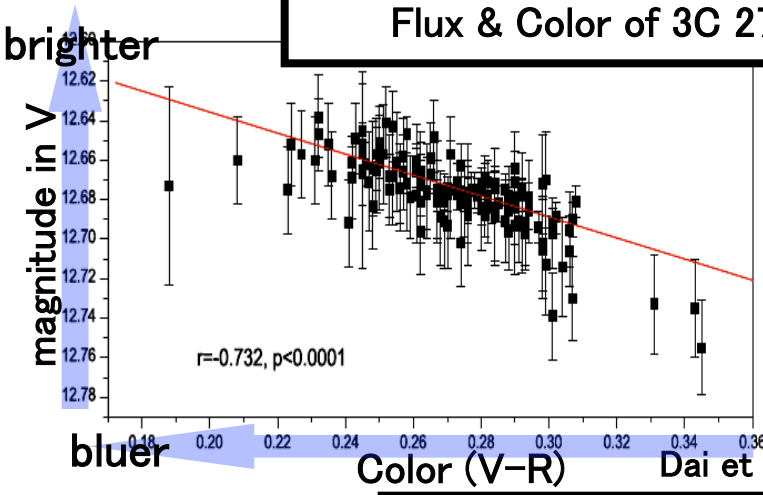
⇒Common feature in ALL blazars???

Relationship between flux & Polarization Degree (P.D.)

Erratic or Systematic???

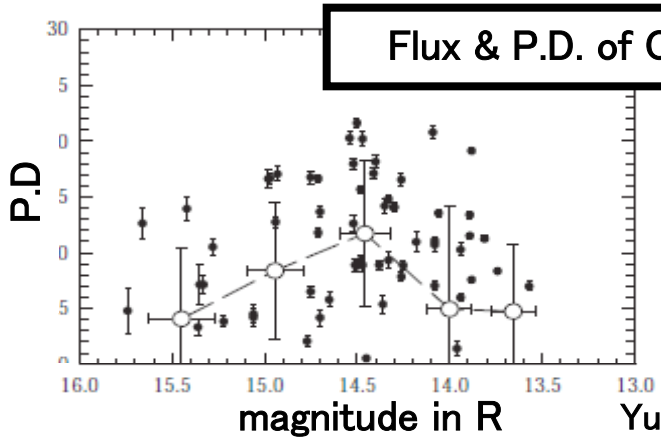
⇒Poorly studied in optical

Flux & Color of 3C 273



Dai et al. 2009

Flux & P.D. of OJ 287

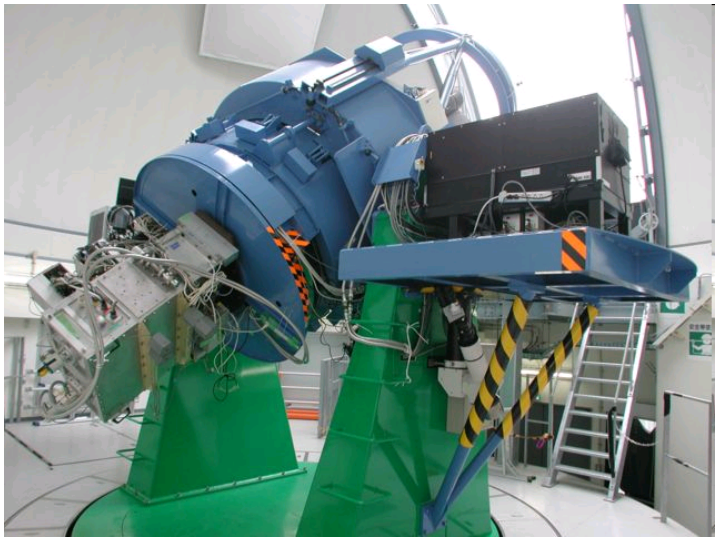


Yu et al. 2002

We investigated the correlation of Flux, Color and Polarization, using the KANATA telescope.

KANATA telescope

KANATA 1.5m
Optical and near-infrared telescope
in Higashi-Hiroshima Observatory



·KANATA of Hiroshima-Univ.
⇒We can perform observations Flexibly, Frequently and for a Long period.

Detector: TRISPEC

·TRISPEC can do simultaneous photopolarimetory in the Optical (V) and near-infrared (J) bands.

KANATA and TRISPEC are good tools for the observation of blazars.

We performed follow up observation with Fermi!!

Monitoring list

Total : 41

Monitoring observations
started on May 2008.

Detected by Fermi

Some results : Sasada+08, Sasada+09

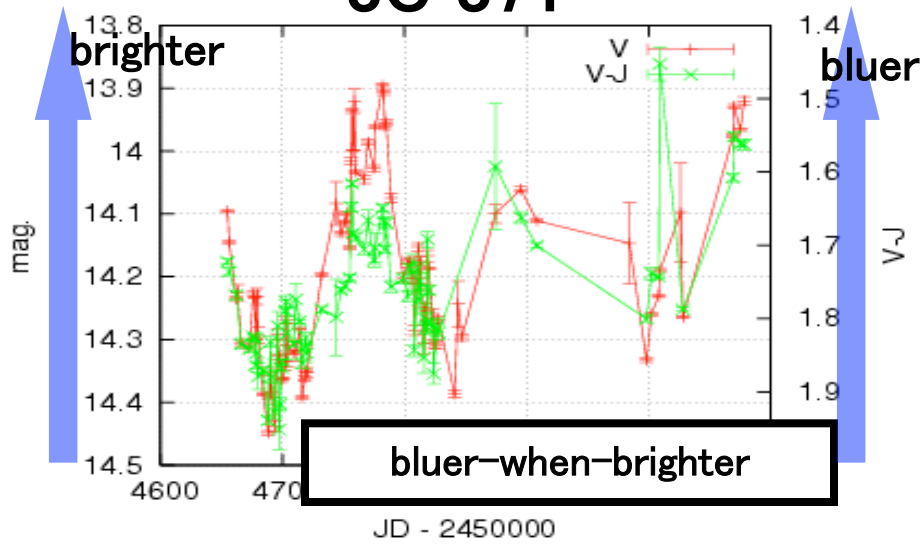
1ES 0323+022	MisV 1436	PKS 1222+216
1ES 0647+250	Mrk 421	PKS 1502+106
1ES 0806+524	Mrk 501	PKS 1510−089
1ES 1959+650	OJ 287	PKS 1749+096
1ES 2344+514	OJ 49	PKS 2155−304
3C 371	ON 231	QSO 0454−234
3C 454.3	ON 325	QSO 0948+002
3C 66A	OQ 530	QSO 1239+044
3C 273	PG 1553+113	RX J1542.8+612
3C 279	PKS 0048−097	S2 0109+22
AO 0235+164	PKS 0215+015	S4 0954+65
BL Lac	PKS 0422+004	S5 0716+7143
H 1722+119	PKS 0754+100	S5 1803+78

3EG 1052+571
QSO 0324+341

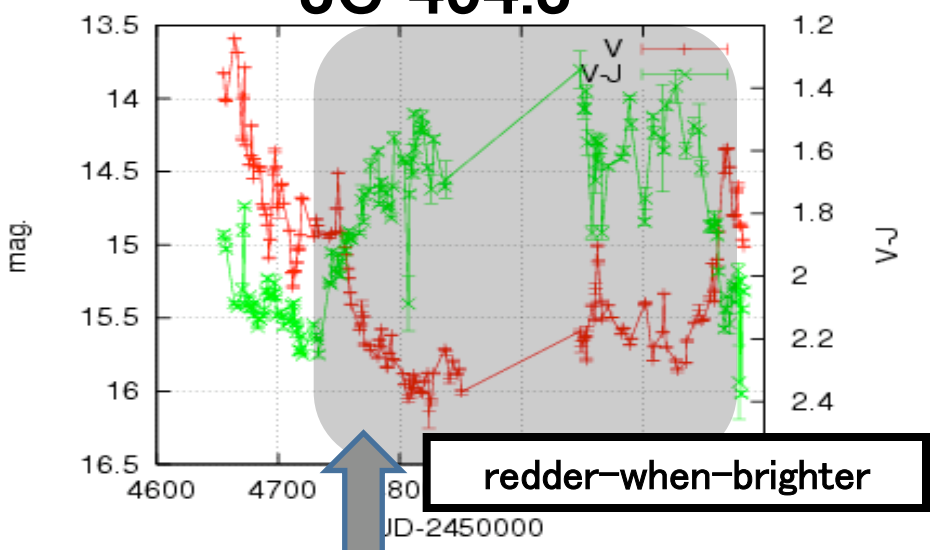
Correlation of Flux and Color (V−J)

Examples of light curves

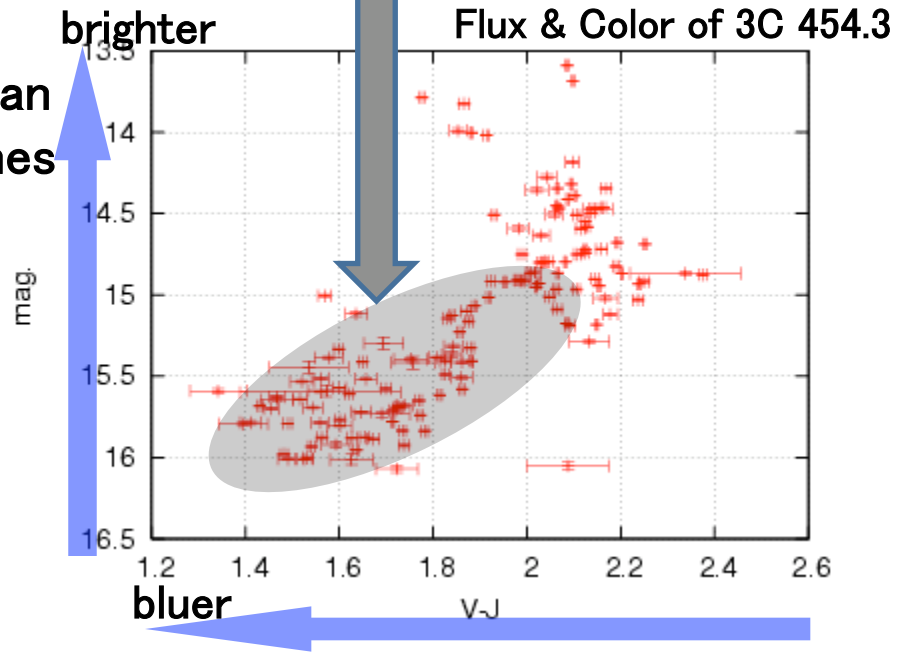
3C 371



3C 454.3



The thermal emission of an accretion disk can be seen when the emission of the jet becomes weak.



The objects showing a redder-when-brighter trend.

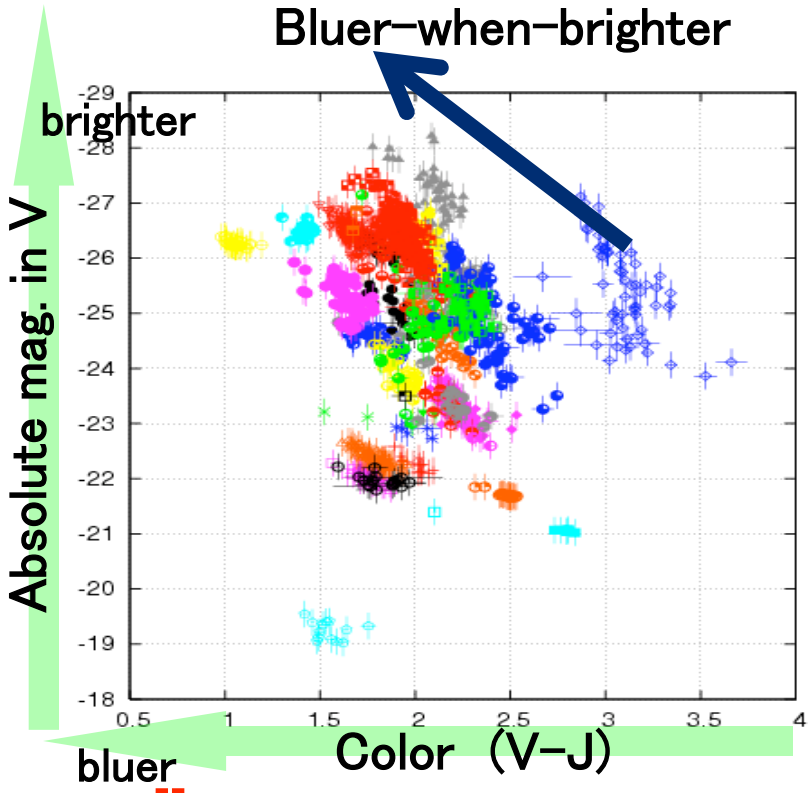
- 3C 454.3
- PKS 1510-089
- QSO 0454-234

Correlation of Flux & Color

Objects observed in more than 10 nights: $N_{obs} > 10 \Rightarrow 29/41$

The number of objects which have ・・・

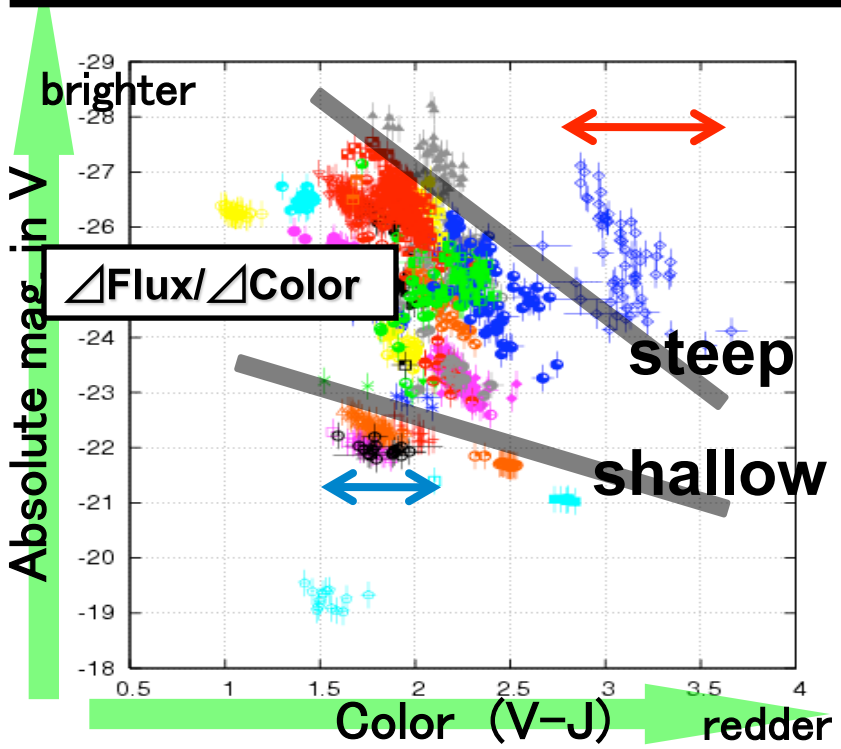
- significant correlation : 24 (83%).
  - –bluer–when–brighter 21
  - –(redder+bluer)–when–brighter 3
- no correlation : 5 (17%).



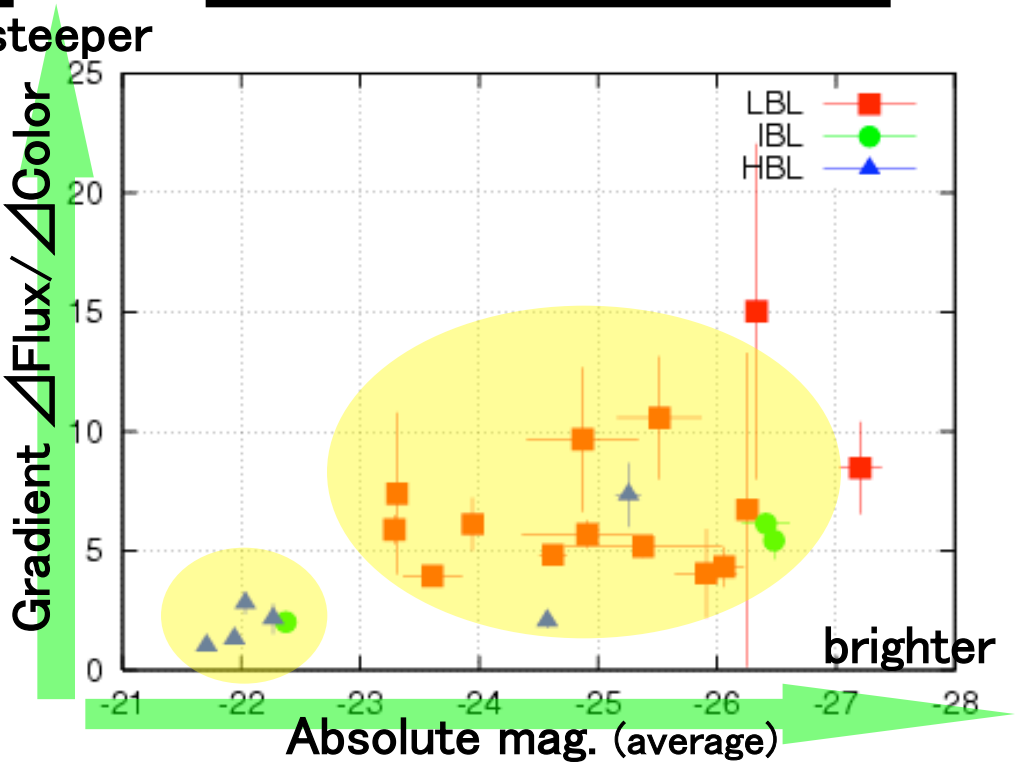
The “bluer–when–brighter” feature is common observed in 83% blazars.

Luminosity & Color(V−J)

Absolute magnitudes and Color of all objects



"bluer−when−brighter" objects



- HBLs tend to be faint and have small gradient.
- The variation amplitudes of color are also small in HBLs, too.

The faint blazars (=HBLs) show less variability than LBLs.

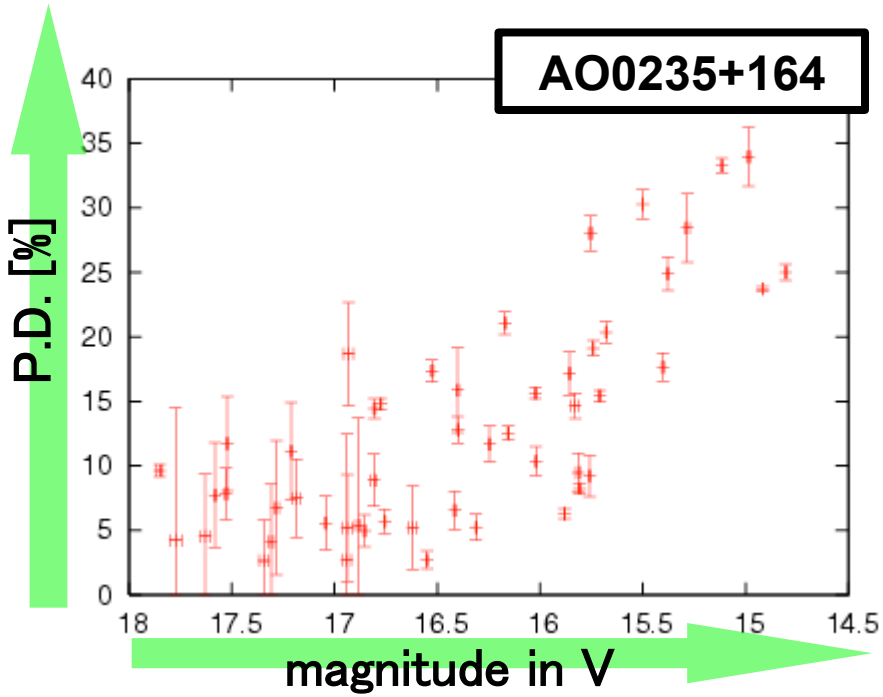
Correlation of Flux and Polarization Degree (P.D.)

Correlation of Flux & P.D.

Objects observed for more than 10 nights: $N_{obs} > 10 \Rightarrow 29/41$

The number of objects which have ・・・

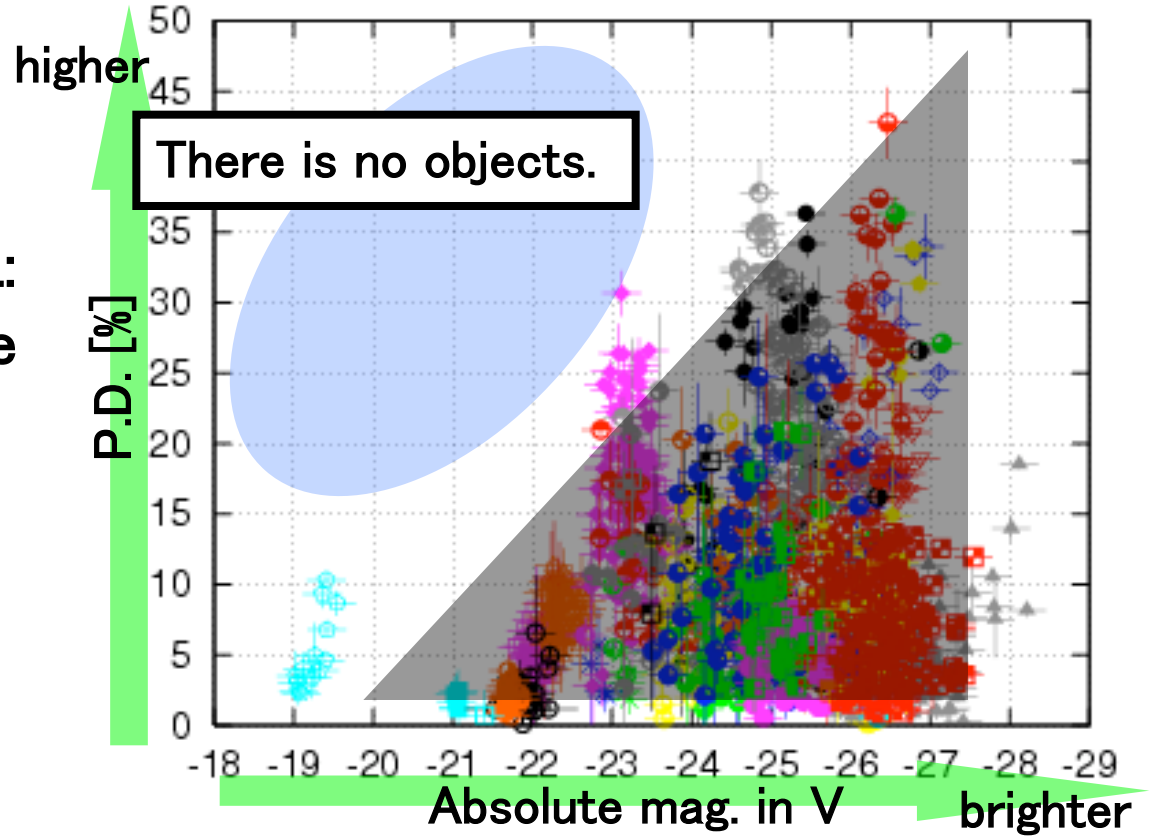
- significant correlation: 14 (48%).
  (4 objects show negative correlation.)
- no correlation: 15 (52%).



Poor correlation of Flux & P.D., compared with that of Flux & Color

Luminosity & P.D.

absolute magnitudes and P.D. about all blazars



- There are two type of LBL:
  - large variation amplitude
  - small variaion amplitude

- The P.D. of faint blazars (=HBLs) are always low.

The faint blazars (=HBLs) have low P.D. and show small amplitudes of P.D..

Implication of the observations

The results of the observations

- "Bluer-when-brighter" : common feature in blazars
- The faint blazars (=HBLs) have the small variation amplitudes of Flux, Color and P.D..

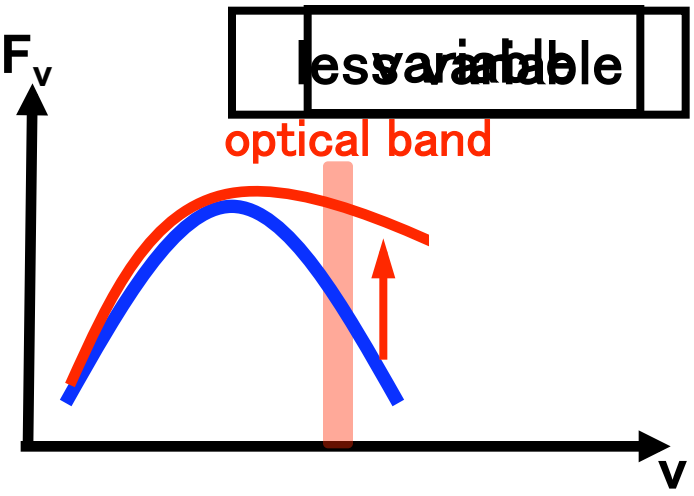
LBL: observed	above cut off of synchrotron emission
HBL:	below

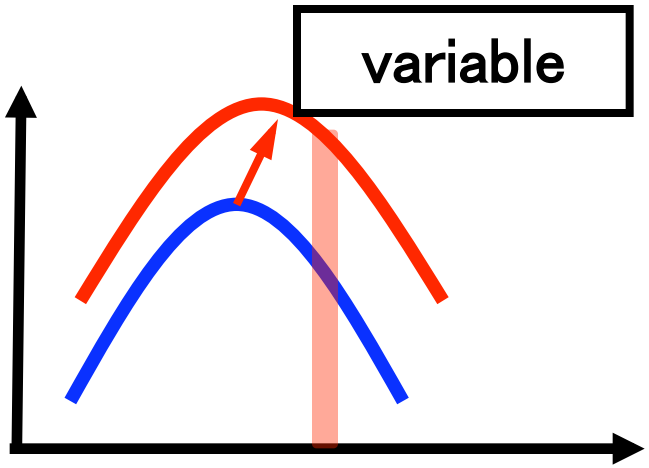
Injection of high energy electrons

Variation of beaming factor

In the case of

HBL





In blazars, most of flare is caused by the injection of high energy electrons.

Summary

●Correlation

- The correlation of the Flux and the Color
  ⇒ 24/29 (83%)
- The correlation of the Flux and the P.D.
  ⇒ 14/29 (48%)

  (positive correlation: 10 (34%), negative correlation: 4 (14%))

●Variability in each class

- The faint blazars (=HBLs) have the small amplitudes of Flux, Color and P.D..

Future works

- More detailed analysis of Polarization
- The correlation of the gamma and the optical ⇒ under investigation

Latest observations can been in "KANATA Obslog"
http://kanatatmp.q.atena.ne.jp/kanataobslog/