HIROSHIMA UNIVERSITY

Optical and NIR follow-up observations for transient objects with Hirosima 1.5-m telescope and tutorial `how to read the data'

広島大における突発天体の可視近赤外追跡観測とそのデータの「読み方」

Koji S. Kawabata (Hiroshima Univ)

川端 弘治 （広島大学）

Kanata

広島大学 極限宇宙研究拠点

CORE-U

Core of Research for the Energetic Universe

HIROSHIMA UNIVERSITY

HIROSHIMA UNIVERSITY

Index

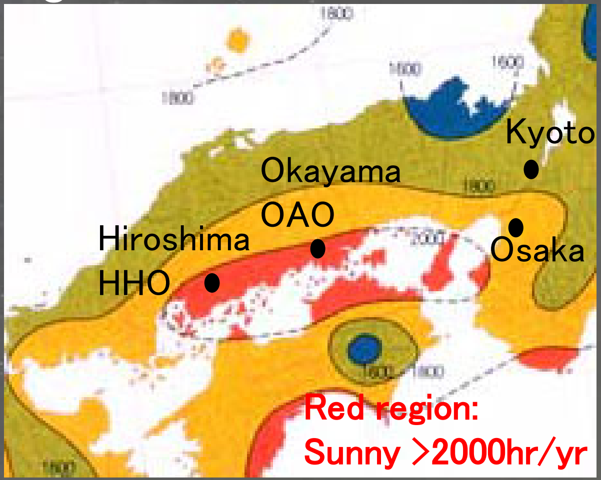
- `Kanata' 1.5-m Optical Telescope
- Strategy of Kanata Telescope
  - Multi-wavelength, Multi-mode
- Representative Results
    - Blazars and related objects
    - Microquasars
    - GRBs
    - IceCube events
- New HinOTORI 0.5-m telescope
- Summary

`Kanata' 1.5-m Optical Telescope

Higashi-Hiroshima Observatory

HIROSHIMA UNIVERSITY

- Found in 2006; operated by Hiroshima University
- Only 25 min by car from campus (503m above sea level)
- ~40% observable nights
- Better seeing condition (median FWHM ~1.2 arcsec)
- Sky brightness R=19-20 mag/arcsec^2 in dark nights



Higashi-Hiroshima Observatory: Aim

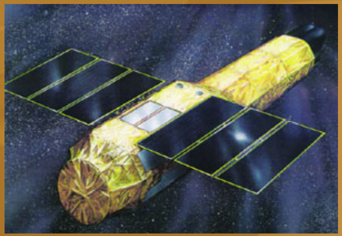
Multi-wavelength and/or Multi-band study for variable, transient objects

Gamma-ray, X-ray and
Optical/NIR Observations

GRB, XRB, AGN, etc

1.5m Optical/NIR telescope, Kanata (2006-)
Gamma-ray satellite (Fermi 2008-)
X-ray satellite (Suzaku 2005-, Hitomi 2016)

© NASA



© JAXA

© JAXA

5

HE & Opt/NIR Obs. Astronomy group

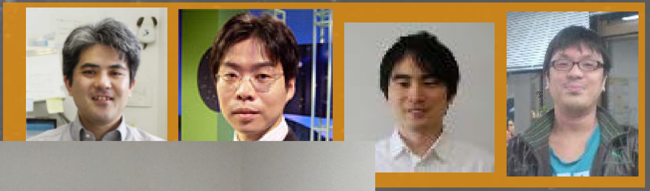
HIROSHIMA UNIVERSITY

HE (X-ray and gamma-ray) Astronomy Group

- Fukazawa, Yasushi (Prof)
- Mizuno, Tsunefumi (Assoc. Prof)
- Takahashi, Hiromitsu (Assist. Prof)
- Ohno, Masatoshi (Assist. Prof)

Optical and Near-Infrared Astronomy Group

- Kawabata, Koji (Assoc. Prof)



chi Ohsugi

Moved out recent 12 months…

Telescope and Instruments

Nasmyth focus#2

High Speed-readout spectrograph
FoV: 2.3’×2.3′
Wavelength res.: R = λ/Δλ =
9-70（400-800nm）、
150（430-690nm）
~30 frames/sec

Cassegrain focus

Nasmyth focus#1

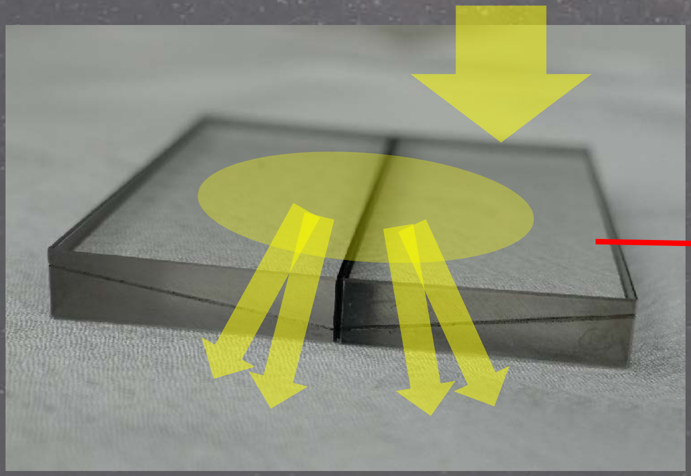
HOWPol 2009- (KSK+ 2008)
Opt Imaging：FoV 15′Φ
Opt ImagPol：One-shot type
Spec：R~400(400-1050nm)
We-Do-Wo type Wollaston
\`One-shot polarimetry’ is available --- Unique potential for quickly-variable object like GRB afterglows

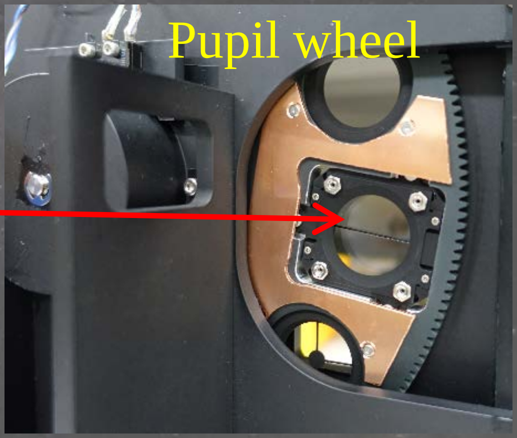
\`Kanata’ Telescope

- Successor of IR simulator of Subaru telescope
- 1.5mΦ main mirror
- Azimuth rotation speed : 5° /sec, 2-4 times faster than normal 1-m size telescopes. (merit in high-response observation (e.g. GRBs)

HONIR： 2012- （Akitaya+ 2014 SPIE）
1 Optical band + 1（future 2) NIR band (simultaneous)
Opt+NIR Imaging：FoV 10′×10′
Opt+NIR Spec：R~400-500
Opt+NIR ImagPol/SpecPol
Maximizing information by single observation
One-shot polarimetry now available

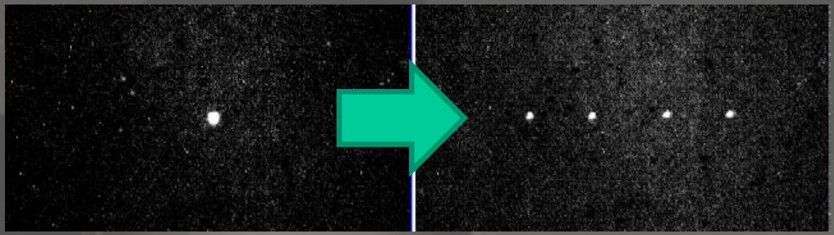
Double Wollaston prism for HONIR (2016.7-)



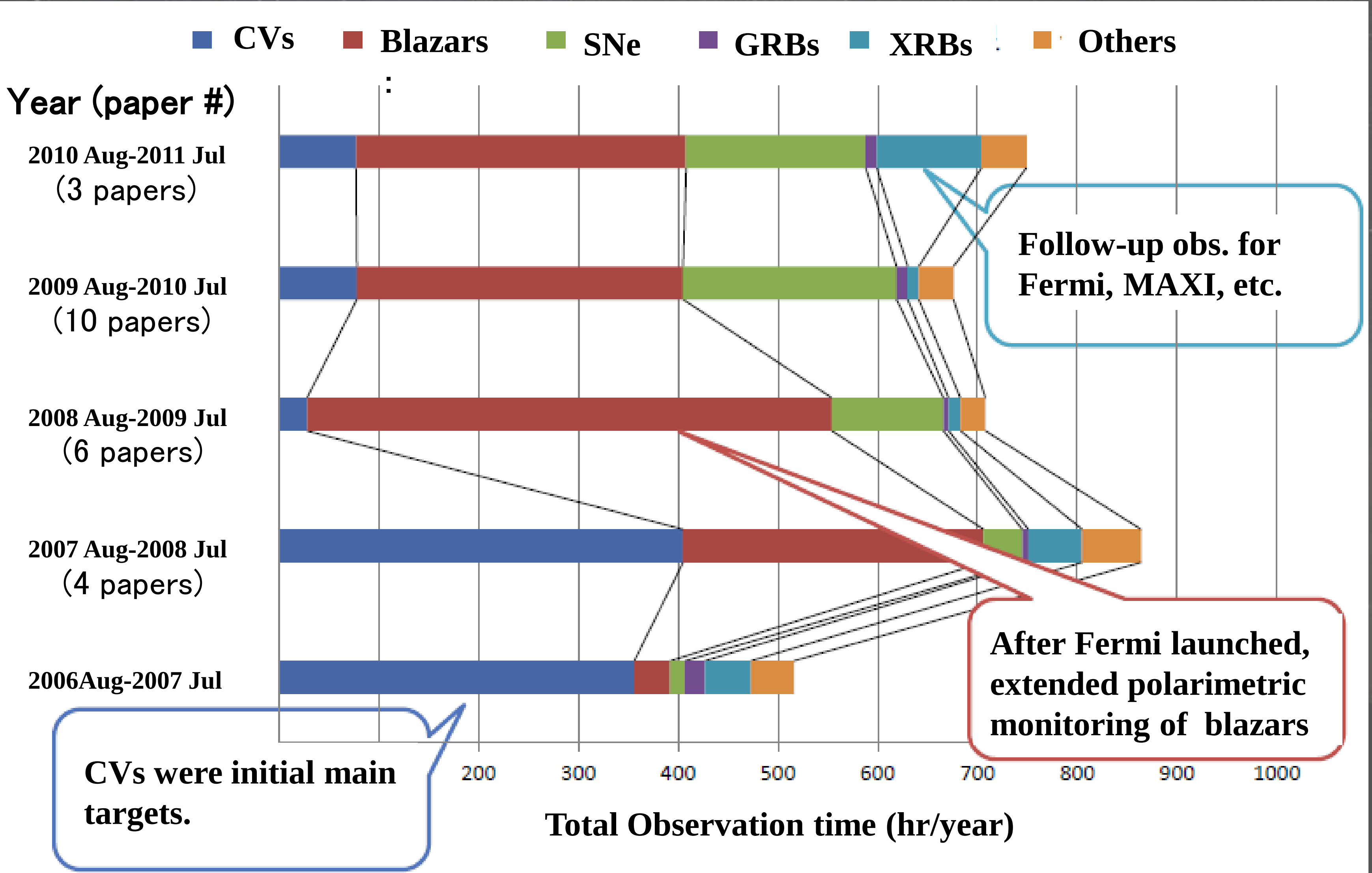


- LiYF$_4$ crystal, covering 0.45–2.3 μm
- Four polarization images are divided

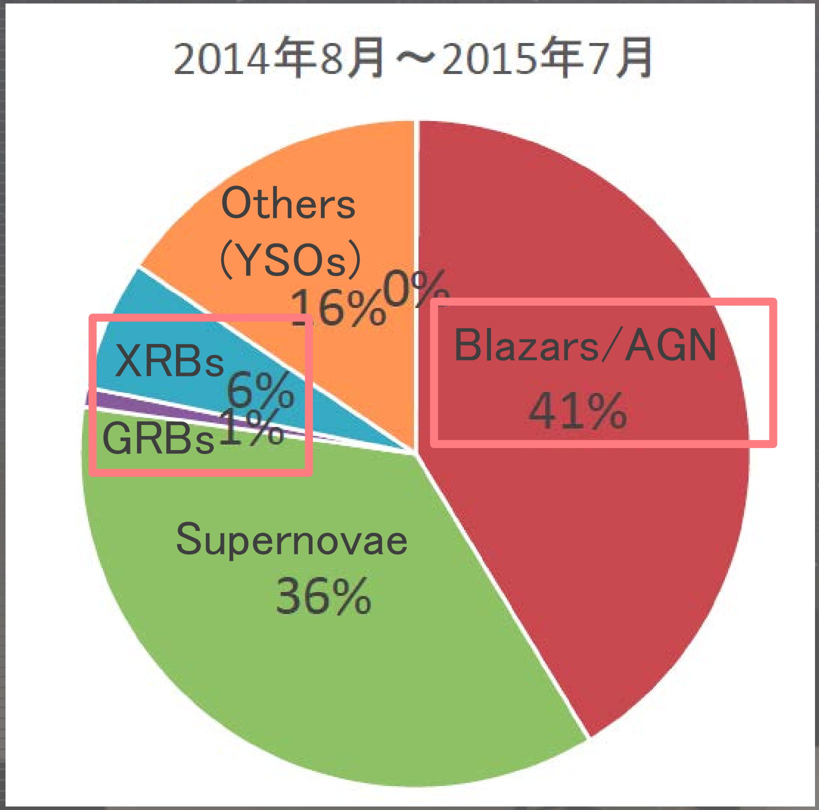
→ One-shot Polarimetry avairable for both Opt/NIR chan.

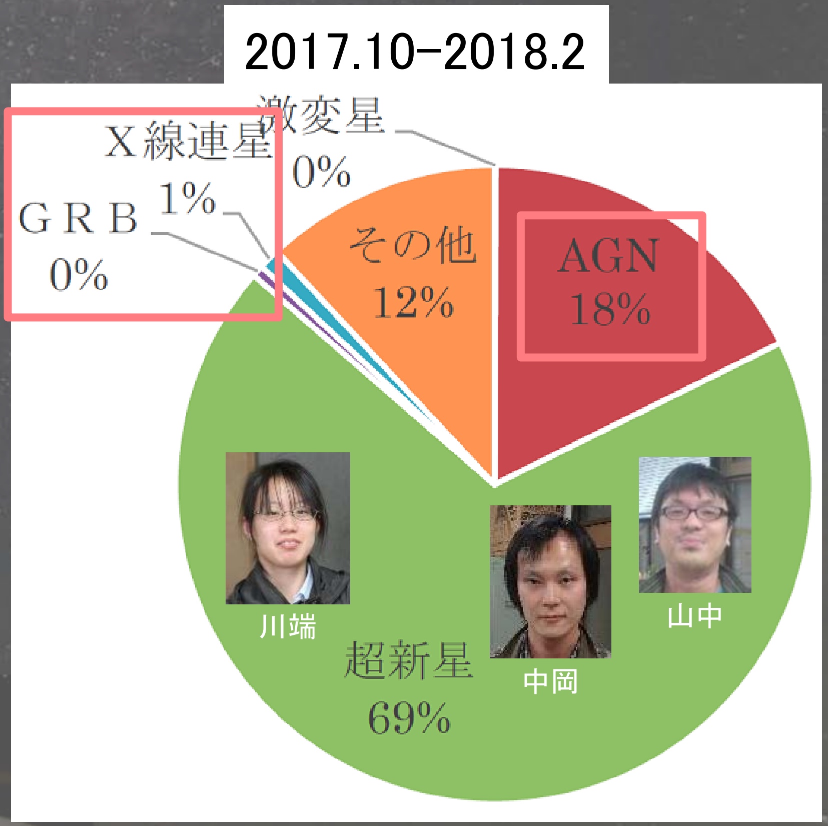


Observational Targets with Kanata telescope 1



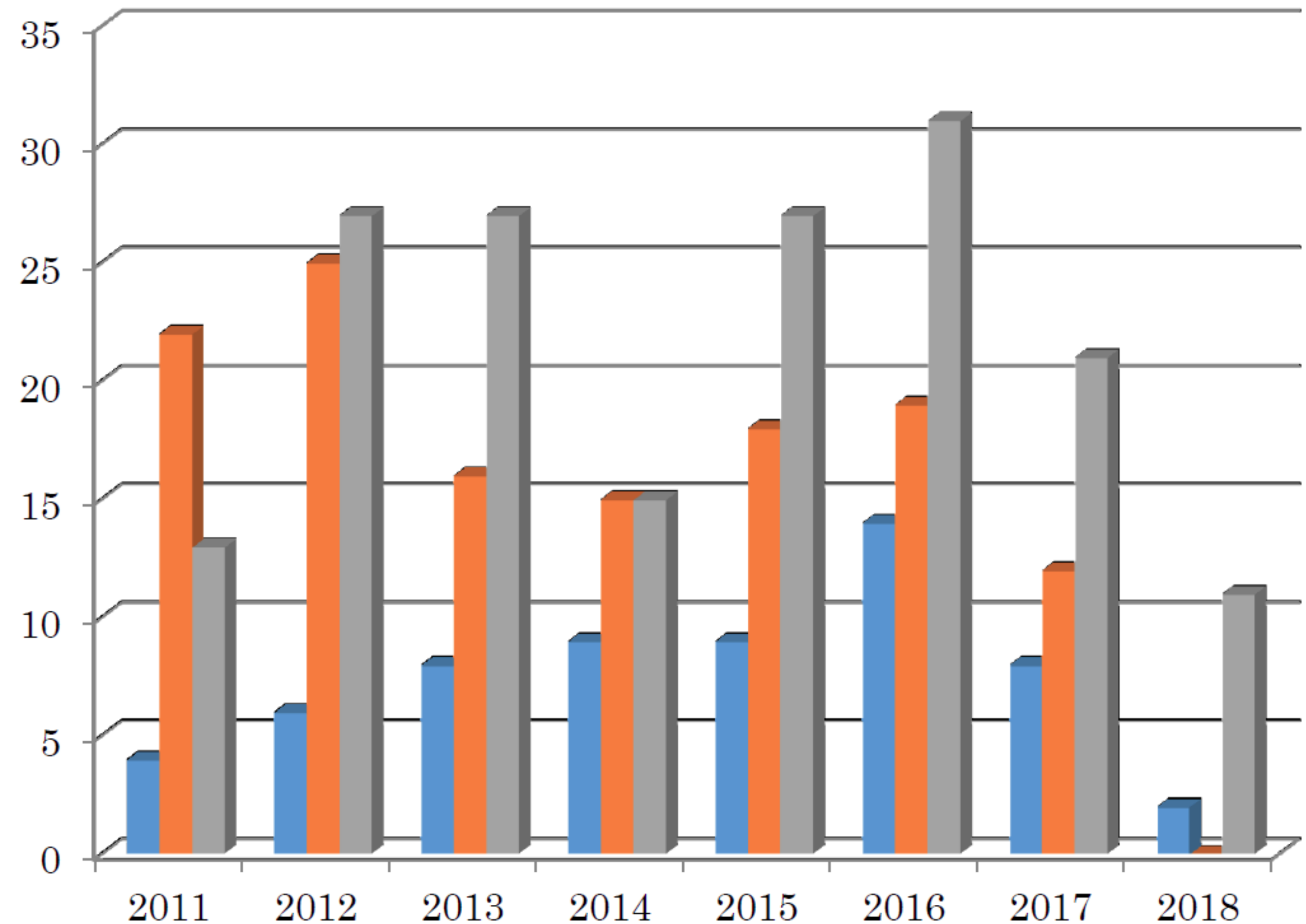
Observational Targets with Kanata telescope 2





Number of published papers

~80 papers with Kanata observation since 2007



Collaborating studies with Kanata telescope

FY 2006-2015: 105 studies (204 persons) in total

2014年度　共同研究 28件、35名

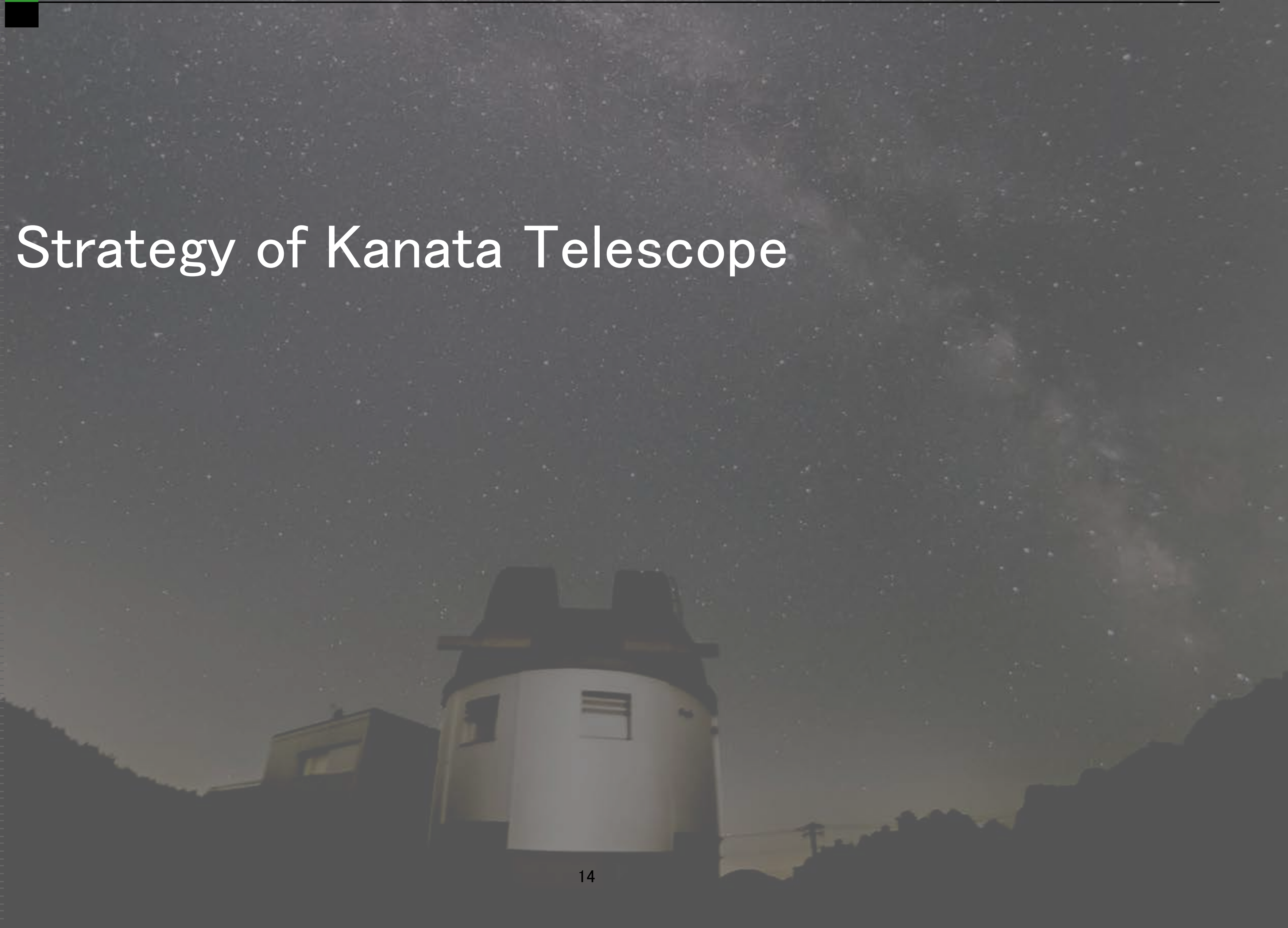
- 名古屋大1件1名（X線連星フレア）、米国UCSD1件1名（X線連星多波長観測）、東京大4件4名（AGN多波長観測、近傍セイファート銀河観測、AGN分光モニター）、大阪大1件1名（TeVガンマ線フレア）、ドイツMPI 2件2名（AGN多波長観測）、米国USRA 1件1名（X線連星多波長）、英国サウサンプトン大1件1名、東工大1件2名（X線増光天体追跡観測）、韓国ソウル大1件2名（彗星偏光観測）、埼玉大1件1名（YSO多波長観測）、ブラジル・サンパウロ大1件1名（Be星偏光分光）、香川大 1件2名（星間雲偏光）、【継続分】東京大1件2名（木曽超新星サーベイ追跡観測）、大学間連携キャンペーン観測8件8名、ポーランド ジャギーロニアン大1件1名（AGN偏光）、東京大1件2名（大質量星形成領域）、茨城大1件3名（Fermi未同定天体）

2015年度　共同研究 18件、33名

- 重力波対応天体捜索1件10名、韓国KASI 1件1名（活動銀河分光）、理研 1件1名（クエーサー多バンド偏光）、東北大 2件4名（木星衛星食、惑星雲赤外閃光モニター）、兵庫県立大 1件1名（皆既月食偏光）、JAXA 1件2名（金星の赤外偏光分光）、鹿児島大1件1名（ミラ型候補星分光）、【継続分】東京大4件6名（木曽超新星サーベイ追跡観測、AGN多波長観測、AGN分光モニター、大質量星形成領域）、大学間連携キャンペーン観測4件4名、韓国ソウル大1件2名（彗星偏光観測）、ブラジル・サンパウロ大1件1名（Be星偏光分光）

OISTER 光赤外大学間連携 (2011-; 2017-)

(Japan)	(Chile)	(South Africa)
16 tels.	1 tel.	1 tel.
0.5-2m	1m	1.4m



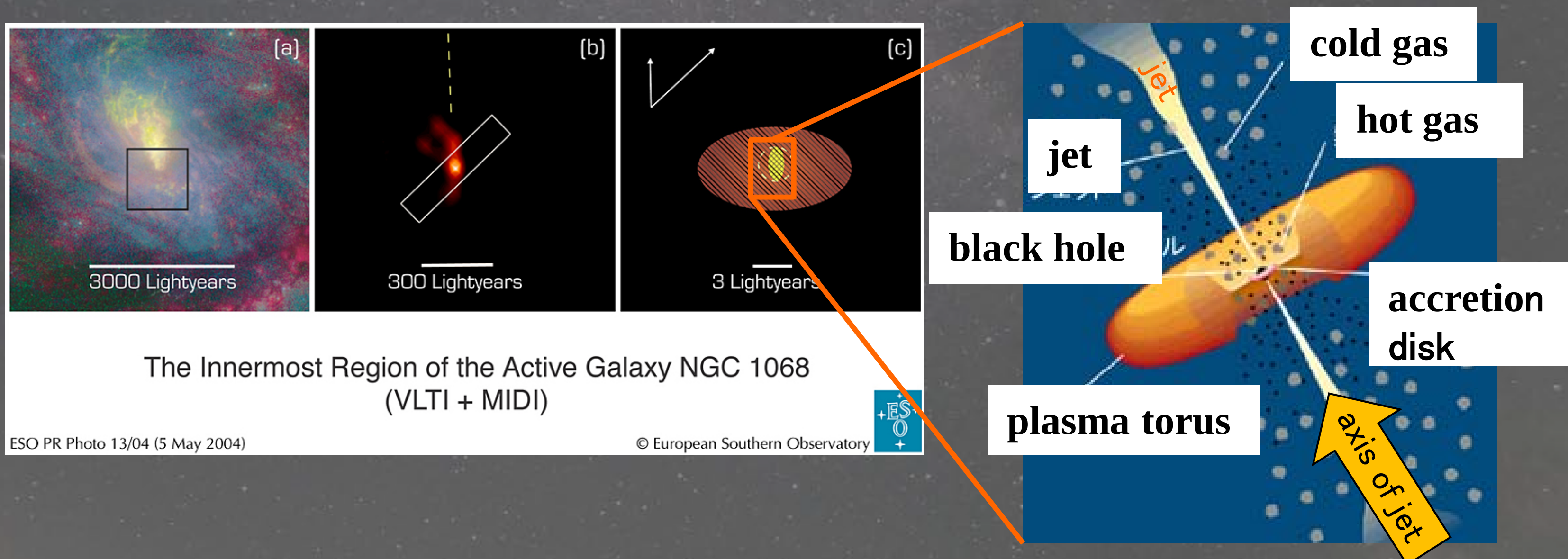
Strategy of Kanata Telescope

Discrimination from other telescopes

- Transient phenomena
  - Requiring high response system and/or extended observations (being hard for large telescopes)
- Multi-wavelength
  - Coordinated with X/Gamma-ray observations supported by high-energy (and theoretical) people.
- Multi-mode
  - Simultaneous Opt/NIR observation including polarimetry and spectroscopy, maximizing information gaining from a single observation.

Multi-wavelength Observation Sample 1: Blazars and related objects

Blazars and related objects



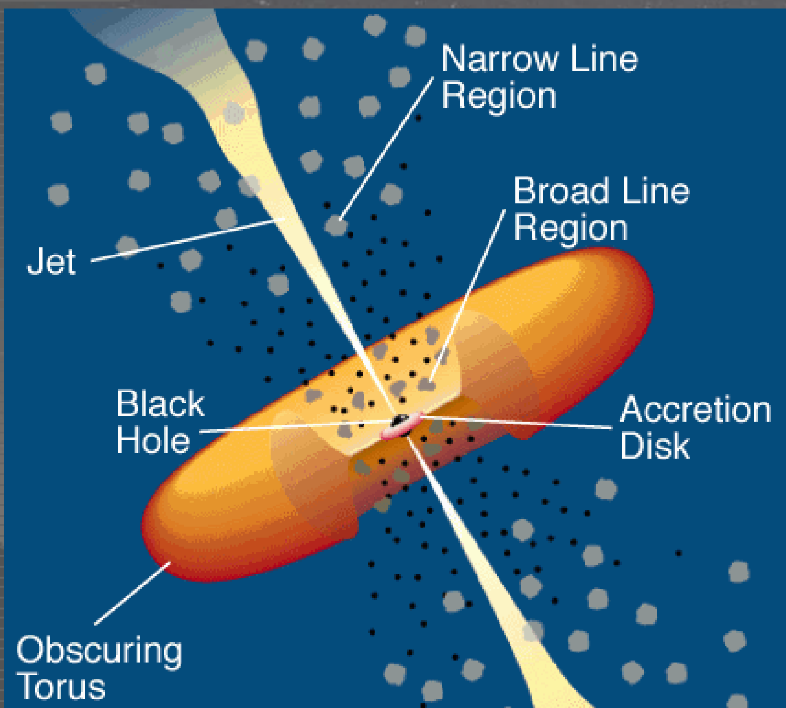
Blazars： AGN seen from jet axis

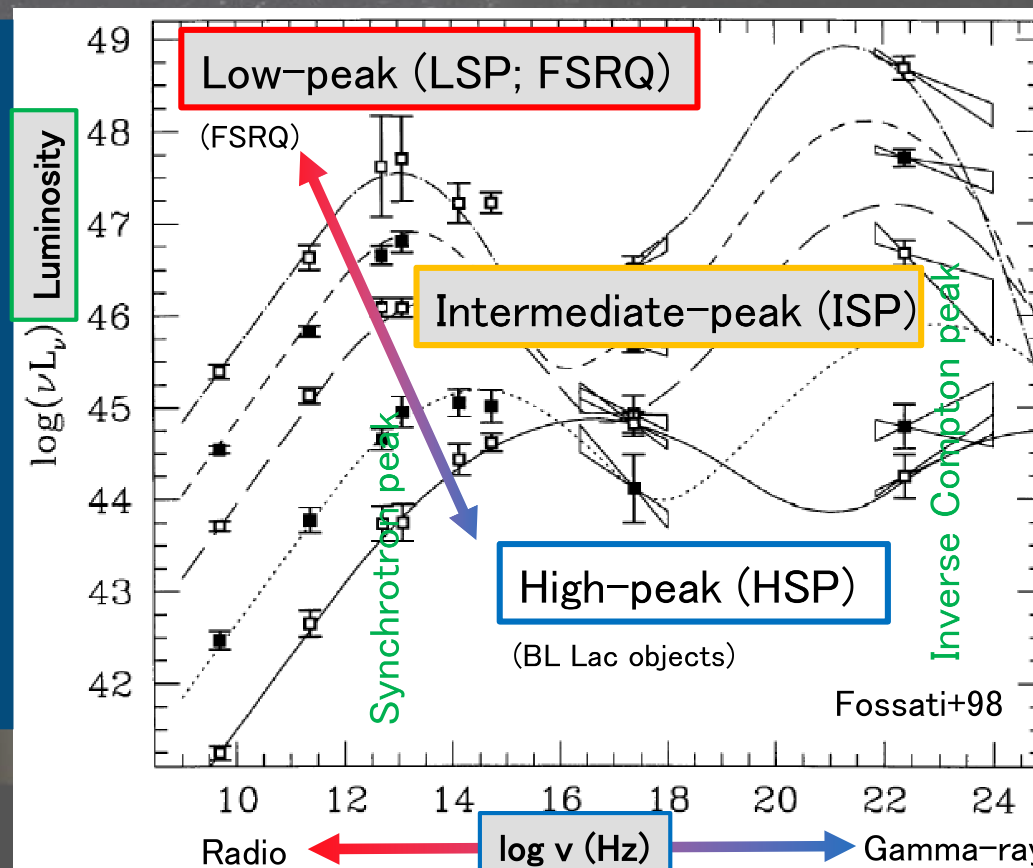
Beamed synchrotron radiation from jet dominates (thus bright)

SED of Blazars

Relativistic beaming; brightened by δ^4 ~ 10,000 times

Emission from the jet dominates from radio through gamma-ray; rapid and large amplitude variability and strongly polarized light

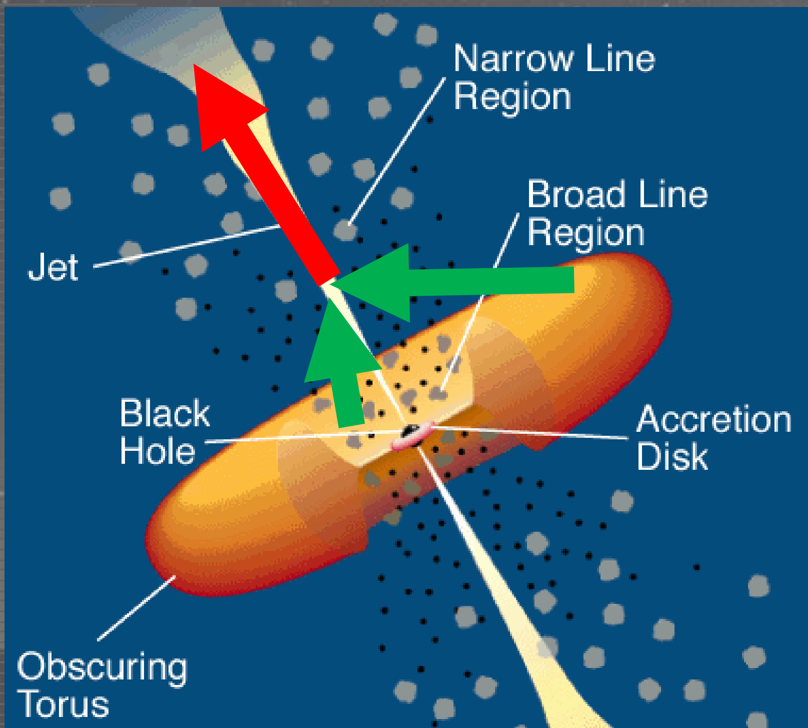


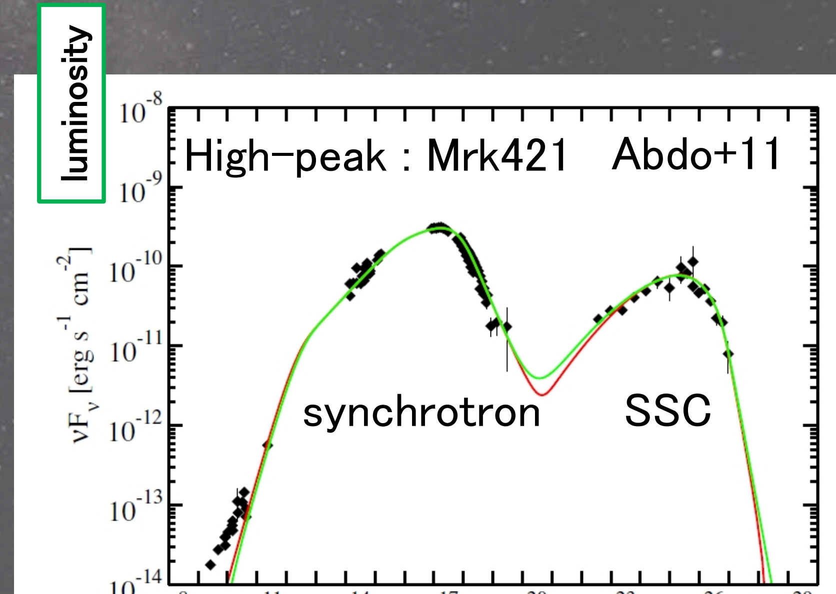


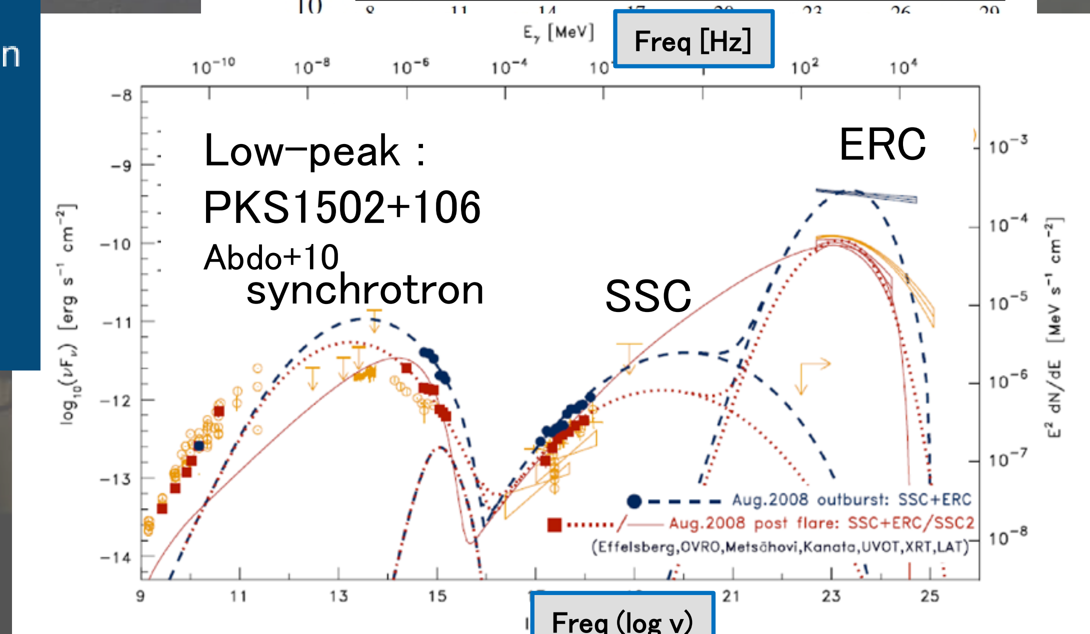
HIROSHIMA UNIVERSITY

Emission model of high energy part

Synchrotron –Self Compton (SSC)
External Radiation Compton (ERC)







Emission at GeV regime
High-peak : SSC
Low-peak : ERC

HIROSHIMA UNIVERSITY

Kanata Blazar Photo-Polarimetry Campaign

2008-2014: 42 (13 FSRQs, 8 LSPs, 9 ISPs, and 12 HSPs) +3 blazars have been monitored

Compared with gamma-ray with Fermi observation

Itoh et al. 2016; Ikejiri et al. 2011

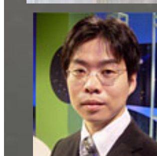
Target Blazars

PKS 0048	PKS 0754	3C279
S2 0109	1ES 0806	OQ 530
MisV1436	OJ 49	PKS 1502
PKS 0215	OJ 287	PKS 1510
3C66A	S4 0954	PG 1553
AO 0235	3EG 1052	Mrk 501
SO 0324	Mrk 421	H1722+11 9
1ES 0323	RGB 1136	PKS 1749
PKS 0422	ON 325	S5 1803
QSO 0454Q	ON 231	3C371
1ES 0647	3C 273	1ES 1959
S5 0716	QSO1239	PKS 2155
BL Lac	1ES 2344	3C454.3

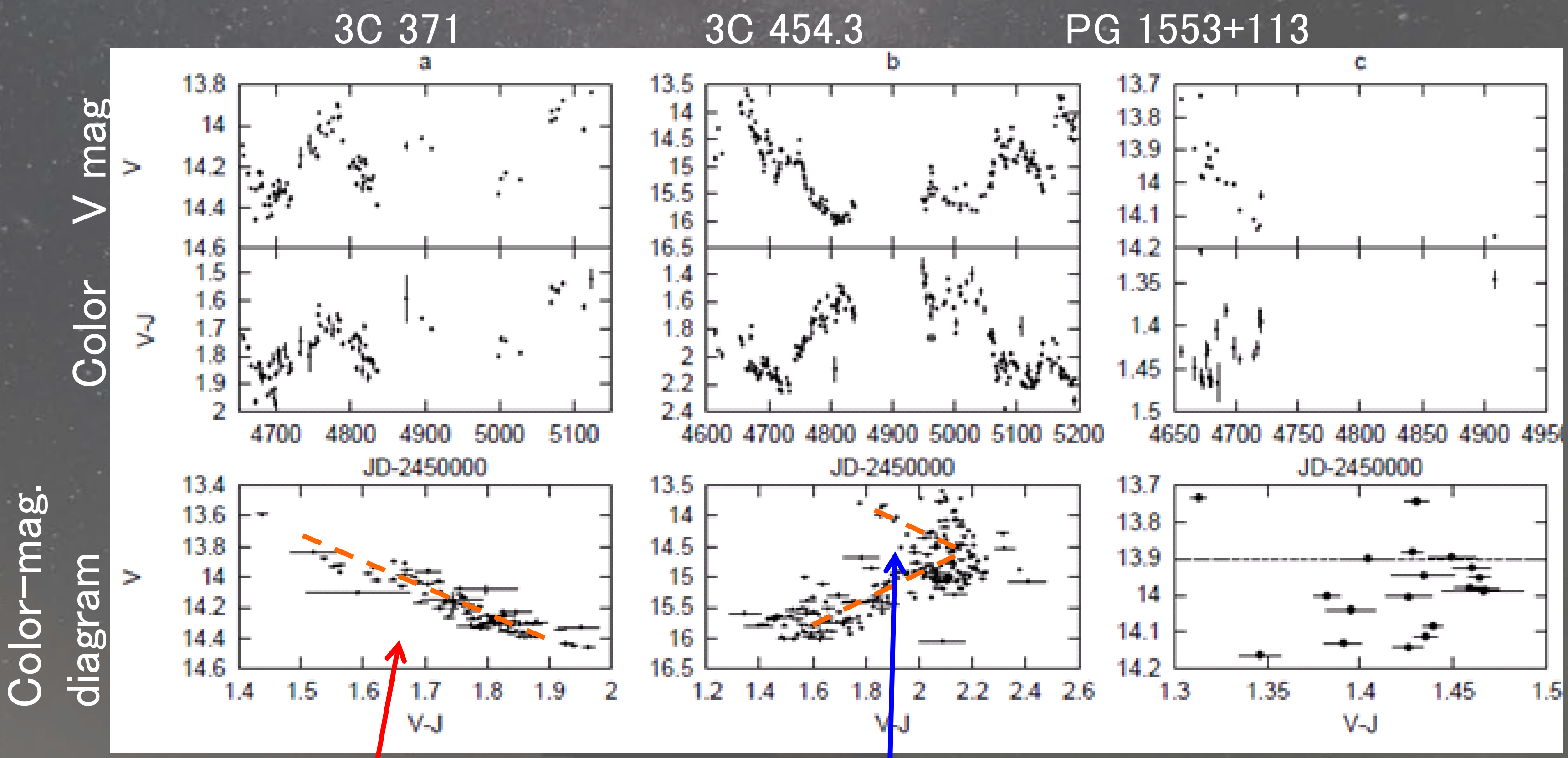
TABLE 2
LIST OF OUR TARGETS WITH MORE THAN 10 DATA POINTS.

Object Name (1)	3FGL name (2)	log(ν_{peak}) (3)	Type (4)	z (5)	$N_{opt.}$ (6)	N_{γ} (7)
S2 0109+22	3FGL J0112.1+2245	14.6	ISP	0.265	44	24
Mis V1436	3FGL J0136.9+4751	13.6	LSP (FSRQ)	0.859	52	18
3C 66A	3FGL J0222.6+4302	15.1	ISP	0.444	462	164
AO 0235+164	3FGL J0238.7+1637	13.5	LSP	0.94	72	26
PKS 0454-234	3FGL J0457.0-2325	13.1	LSP (FSRQ)	1.003	27	20
S5 0716+714	3FGL J0721.9+7120	14.6	ISP	0.3	556	198
OJ 49	3FGL J0831.9+0429	13.5	LSP	0.1737	27	16
OJ 287	3FGL J0854.8+2005	13.4	LSP	0.306	174	75
Mrk 421	3FGL J1104.4+3812	16.6	HSP	0.031	85	46
ON 325	3FGL J1217.8+3006	15.5	HSP	0.13	38	17
3C 273	3FGL J1229.1+0202	13.5	LSP (FSRQ)	0.15834	224	91
3C 279	3FGL J1256.1-0547	12.6	LSP (FSRQ)	0.5362	140	72
PKS 1502+106	3FGL J1504.3+1029	13.6	LSP (FSRQ)	1.839	71	27
PKS 1510-089	3FGL J1512.8-0906	13.1	LSP (FSRQ)	0.36	108	51
RX J1542.8+612	3FGL J1542.9+6129	14.1	LSP (FSRQ)	0.117	69	38
PG 1553+113	3FGL J1555.7+1111	15.4	HSP	0.36	196	90
Mrk 501	3FGL J1653.9+3945	17.1	HSP	0.033663	170	80
PKS 1749+096	3FGL J1751.5+0938	13.1	LSP (FSRQ)	0.322	47	16
3C 371	3FGL J1806.7+6948	14.7	ISP (FSRQ)	0.051	21	16
1ES 1959+650	3FGL J2000.0+6509	16.6	ISP	0.047	82	42
PKS 2155-304	3FGL J2158.8-3013	16.0	HSP	0.116	146	60
BL Lac	3FGL J2202.8+4216	13.6	LSP	0.0686	340	137
CTA 102	3FGL J2232.4+1143	13.6	LSP (FSRQ)	1.07	76	33
3C 454.3	3FGL J2253.9+1609	13.6	LSP (FSRQ)	0.859	442	143






Flux-color correlation



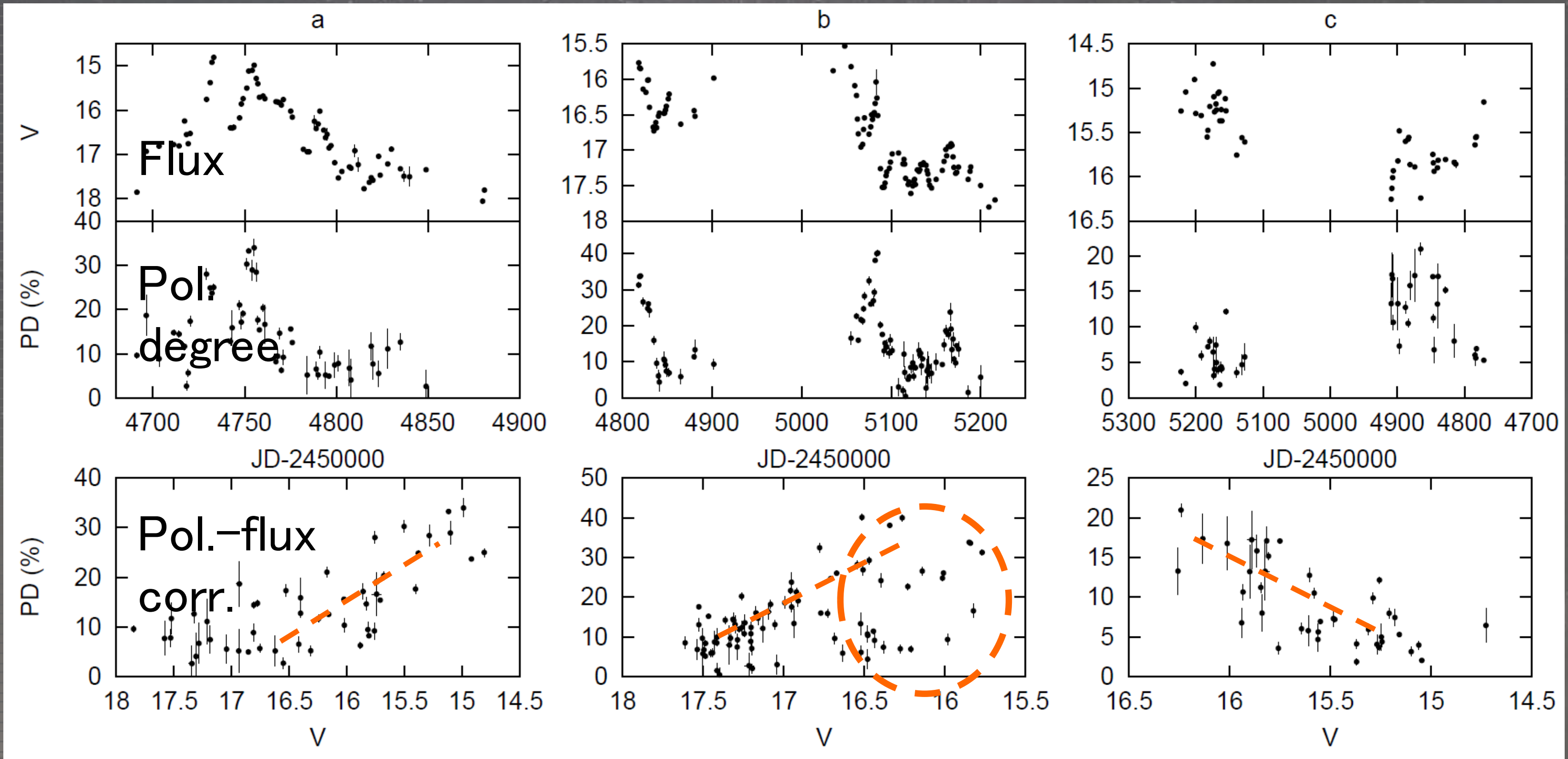
Ikejiri et al. 2011

`Bluer when brighter' trend in the whole data (72%)

`Bluer when brighter' in brighter phase (16%)
(In faint phase, hot disk component is dominant)

Flux–polarization correlation

AO 0235+164 MisV1436 OJ 49



positive corr. positive corr. + other negative corr.

45%

Ikejiri et al. 2011

Rotation of Linear Polarization Angle

HIROSHIMA UNIVERSITY

PKS 1510-089

3C 66A

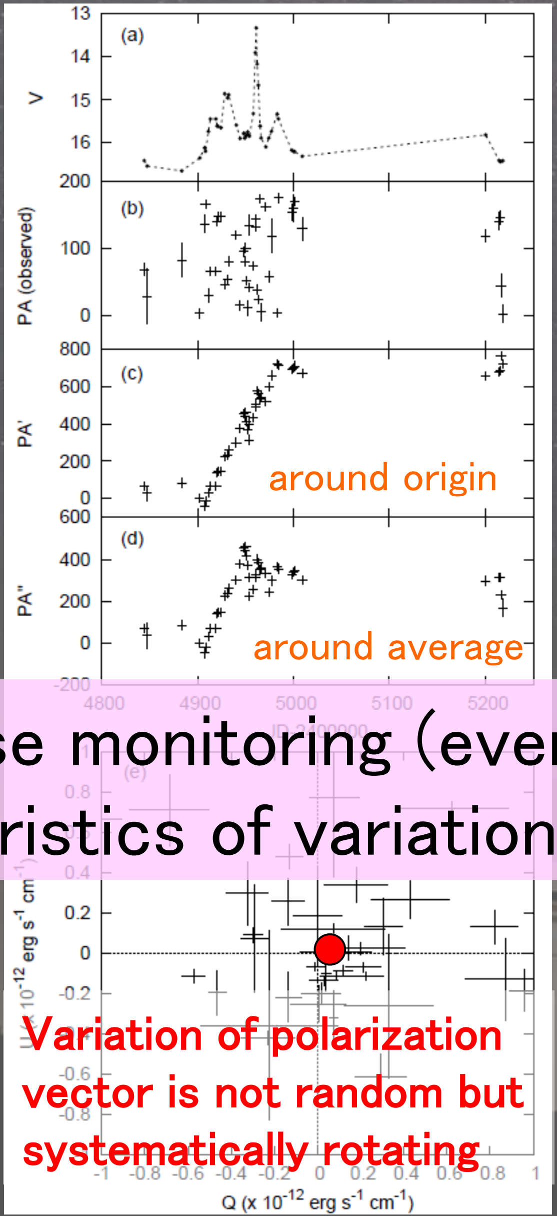
V mag

PAobs

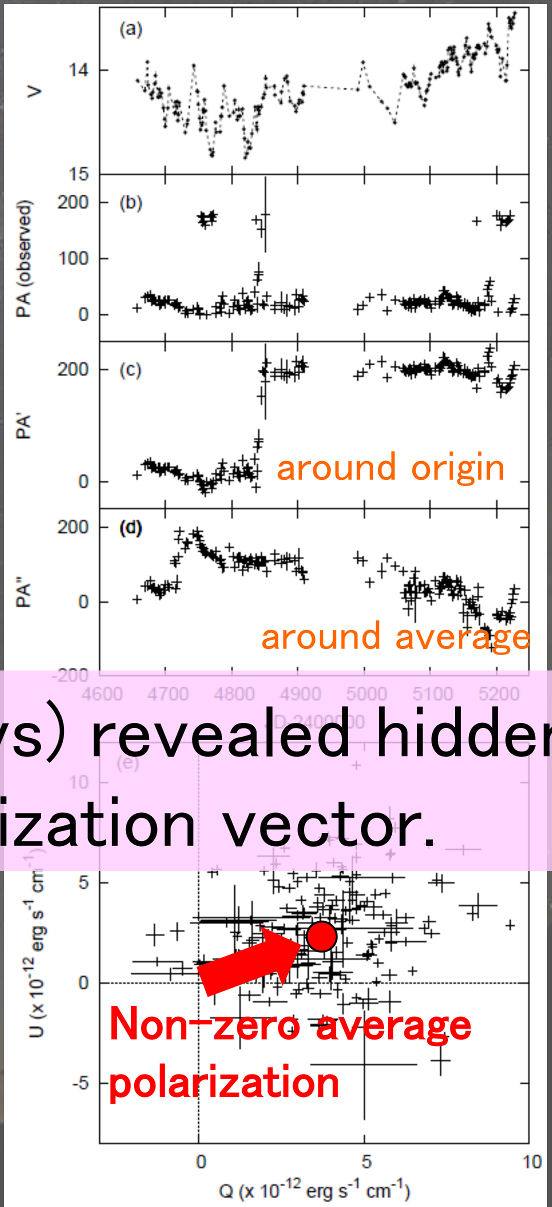
PA180

PAshift

QU-diagram



Typically, 10-20° /day



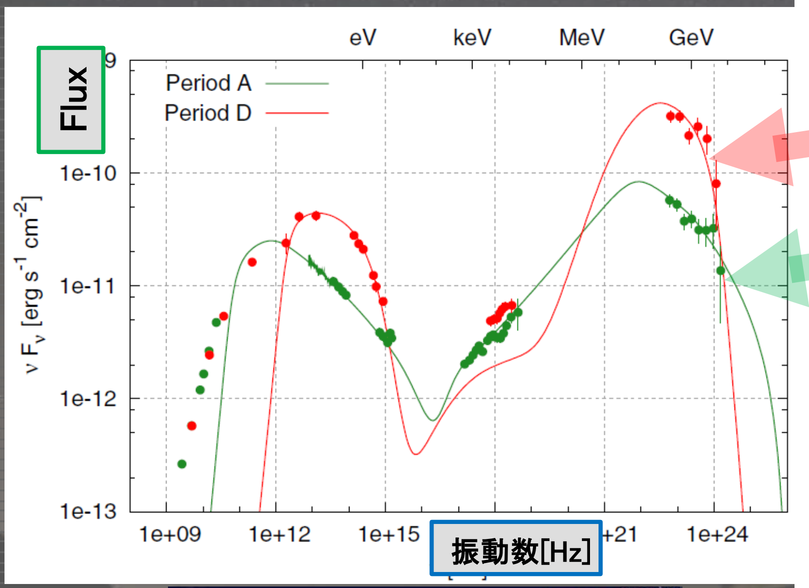
Our dense monitoring (every ~3 days) revealed hidden characteristics of variation of polarization vector.

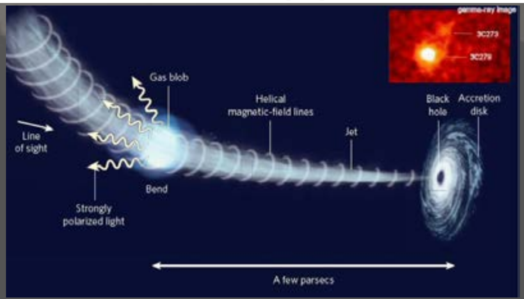
Ikejiri+ 2011

Multi-wavelength study in 3C 279

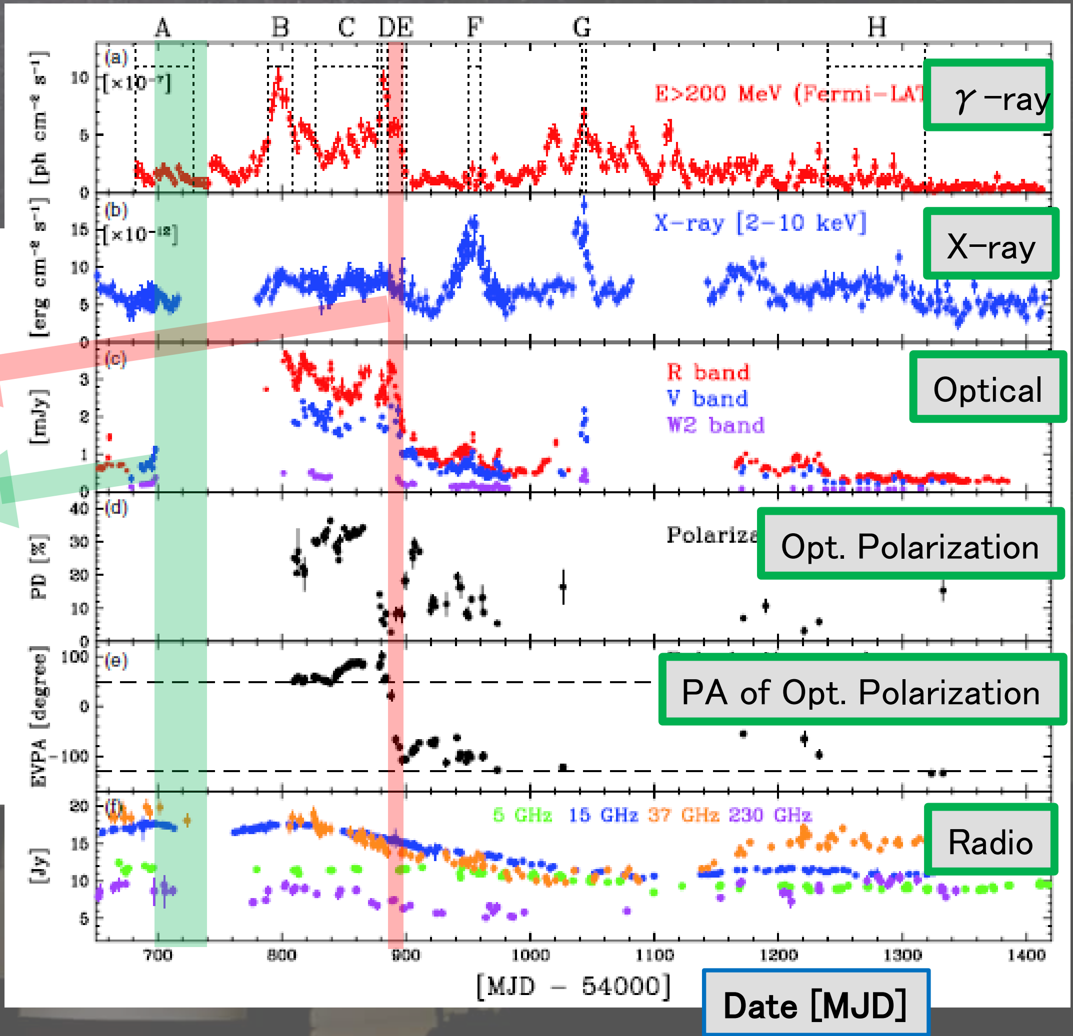
HIROSHIMA UNIVERSITY

SED





MW Light Curve and Opt. Polarization



Abdo+10, Hayashida+12; Itoh private comm.

Correlation between gamma-ray and optical light

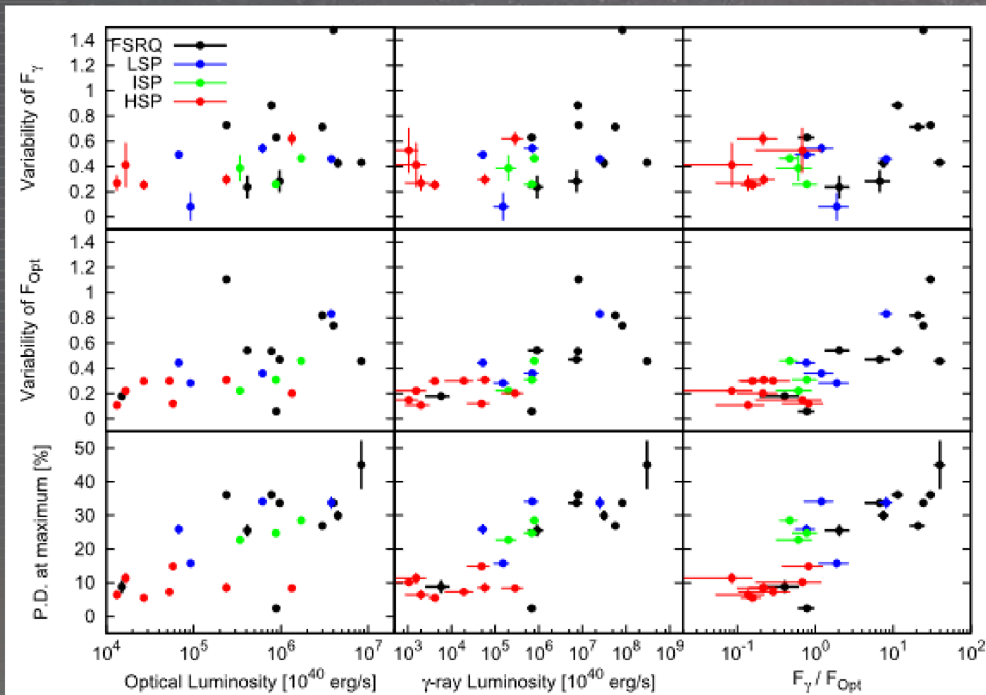


TABLE 4
SUMMARY OF CORRELATION TIME LAGS BETWEEN GAMMA-RAY FLUX AND OPTICAL FLUX

Source Name	time lag (days)	DCF peak value
AO 0235+164	0^{+4}_{-14}	0.67 ± 0.08
S5 0716+714	0 ± 7	0.47 ± 0.05
OJ 287	-134^{+4}_{-28}	1.0 ± 0.5
3C 273	-145^{+7}_{-21}	-0.97 ± 0.18
3C 279	-28 ± 14	0.67 ± 0.15
3C 279	77^{+7}_{-14}	-0.6 ± 0.1
PG 1553+113	21^{+14}_{-28}	0.4 ± 0.1
PKS 2155-304	-28^{+28}_{-7}	0.9 ± 0.2
BL Lac	0^{+28}_{-77}	1.0 ± 0.1
CTA 102	0 ± 7	0.8 ± 0.2
3C 454.3	0^{+49}_{-49}	0.84 ± 0.13

Itoh et al. 2016

Alignment of magnetic field depends on blazar type

Active phase monitoring in CTA 102

HIROSHIMA UNIVERSITY

FSRQ (z = 1.037)

Flare observed on

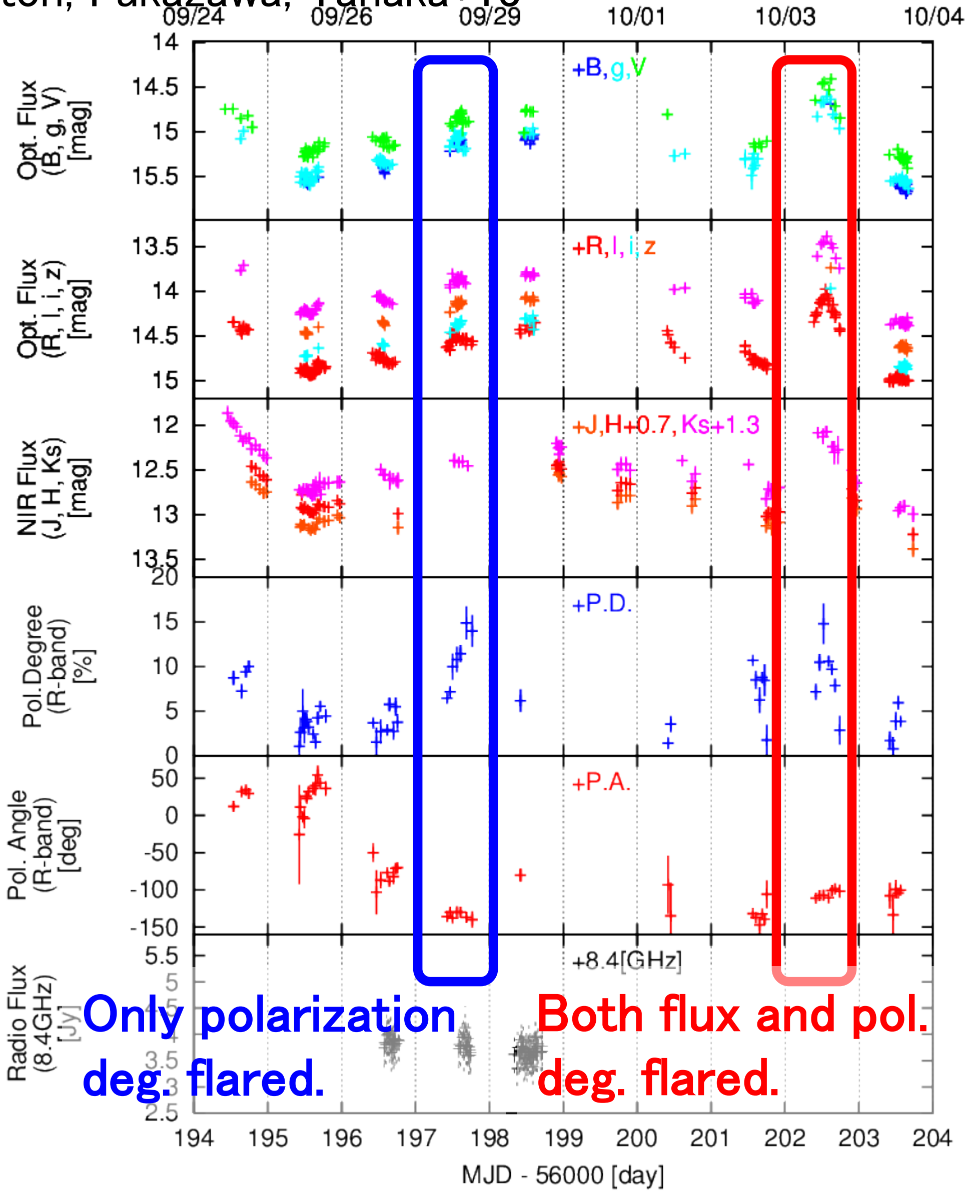
19 Sep 2012 Optical report (ATel #4397)

21 Sep 2012 GeV report (ATel #4409)

Started dense monitoring with Kanata + OISTER

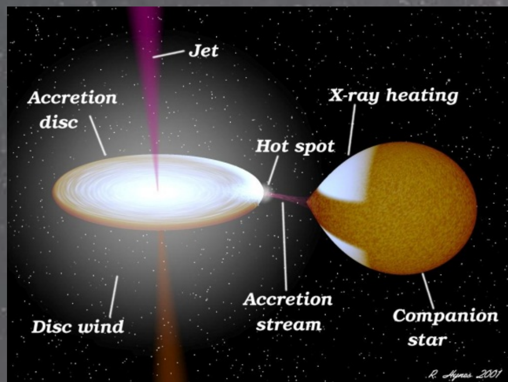
Two types of violent variation in optical polarization observed.

Itoh, Fukazawa, Tanaka+13

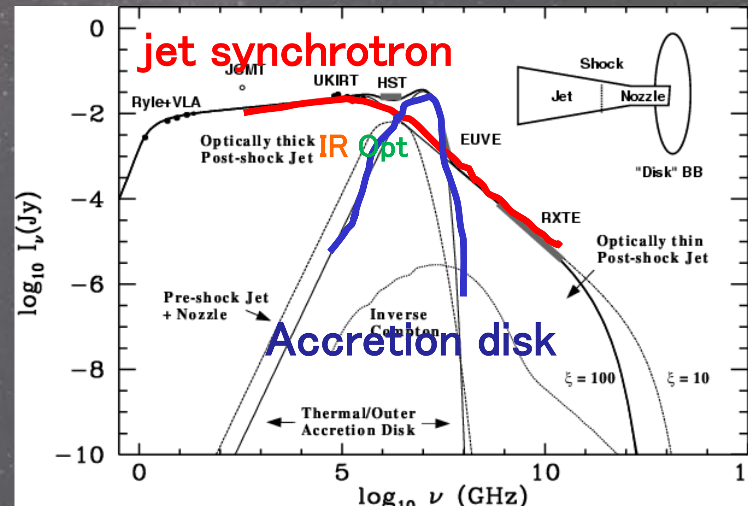


Multi-wavelength Observation Sample 2: X-ray binary/microquasar

X-ray binary



Binary including BH or NS

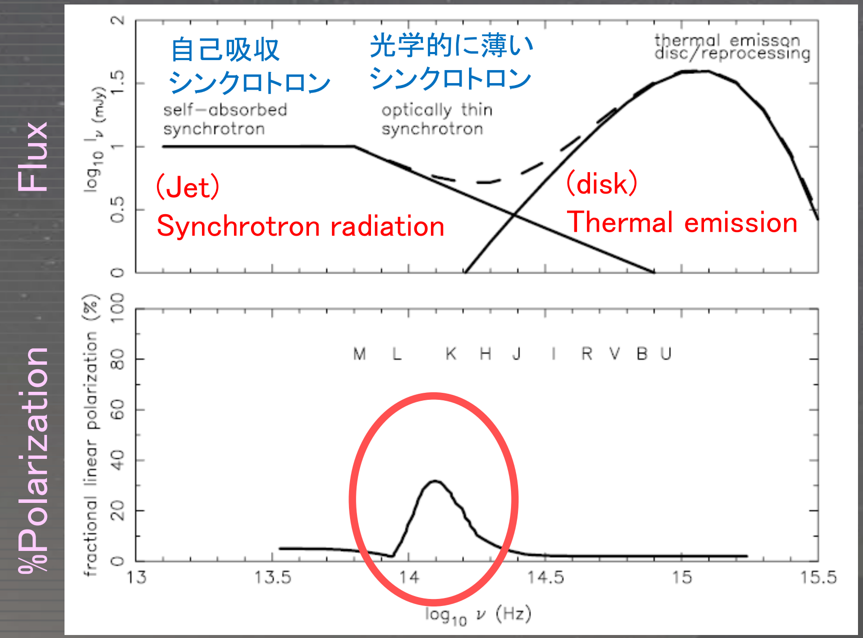


XTE J1118+480; Markoff et al (2001)

- It has been claimed that NIR light is produced by jet. (Most X-ray binaries locate near the milky way, and the optical light is heavily absorbed, but NIR light is much less absorbed.)
- Thus, jet can be probed by NIR observation (as well as X-ray and radio observations)

Outburst of blackhole binary V404 Cyg

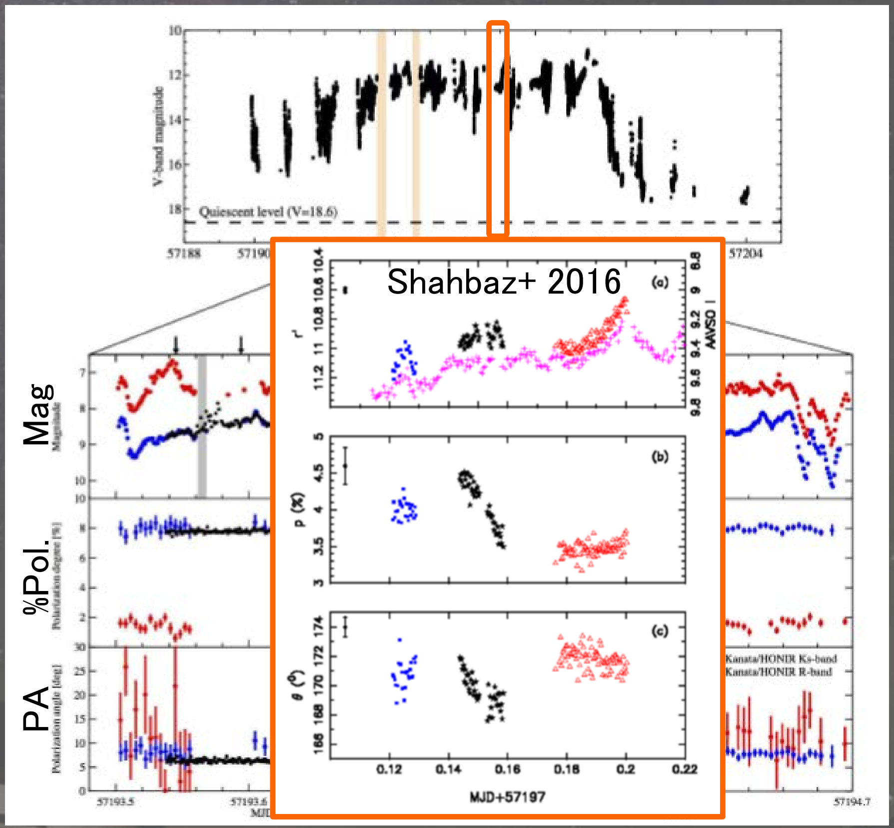
Conceptual SED and polarization vs frequency for X-ray binary in active phase



Shahbaz+ (2008)

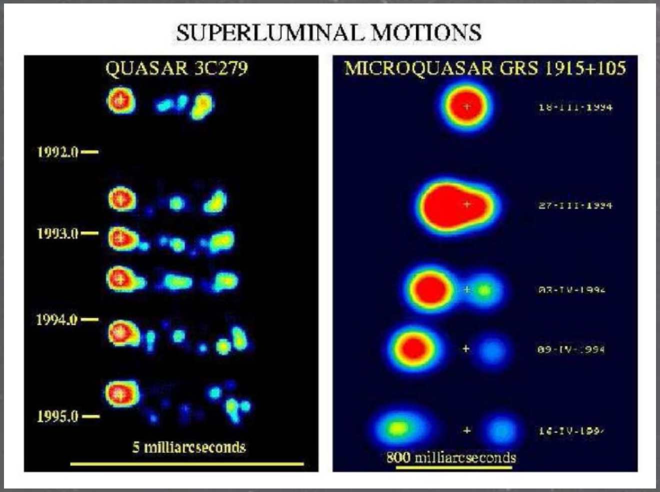
Kバンド付近で数十%もの大きな偏光が期待される(かも)

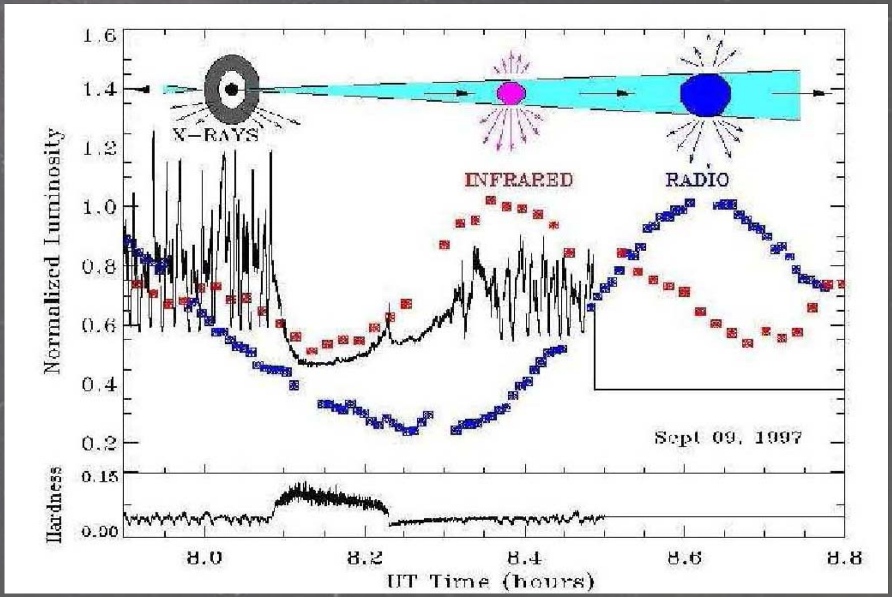
V404 Cyg in outburst phase
(Kanata/HONIR, Pirka; Tanaka+ 2016)



しばらくしてから可視シンクロトロンフレア活動性が現れる場合もある

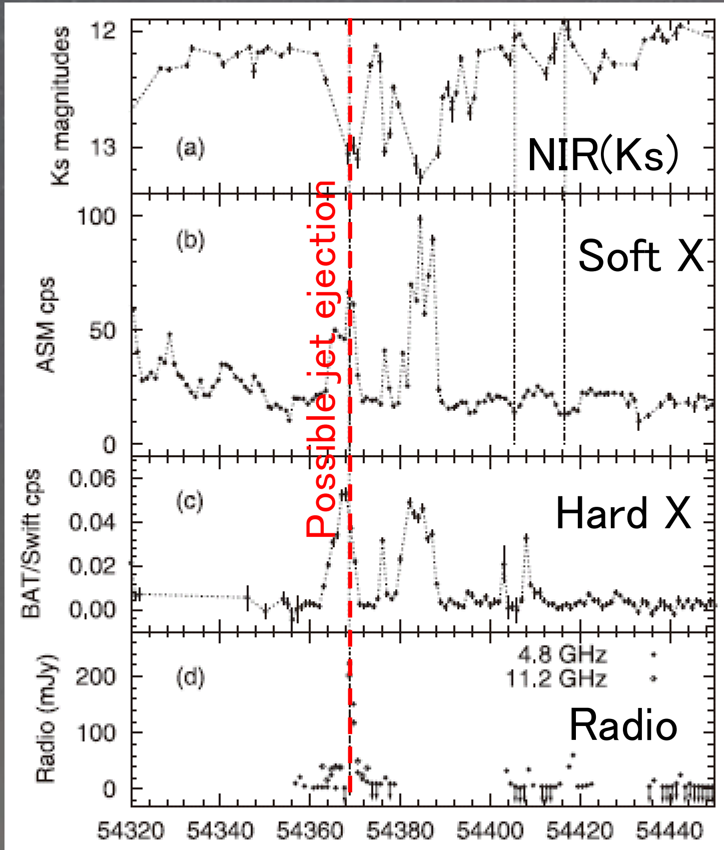
Microquasar GRS 1915+015





- Superluminal motion in radio (VLBI)
  → High-velocity jet → Called as microquasar
- BH mass 14±4 $M_{\odot}$ from NIR spectroscopic period (Greiner et al. 2001)
- A time-sequential flare among X-ray, NIR and radio wavelengths is found, explained by disk-jet model (Mirabel et al. 1998)
- But, the observational material for accretion and jet physics is still poor.

GRS 1915+015: NIR and X-ray monitoring

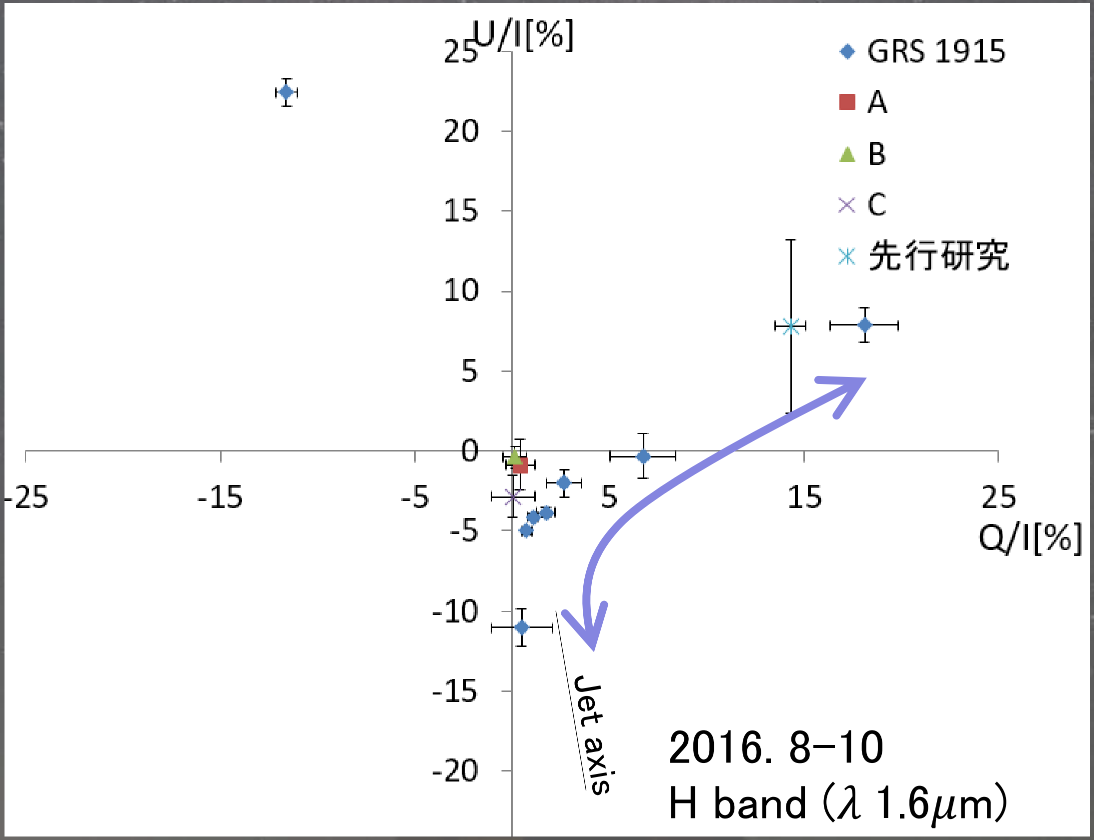


Arai et al (2009)

NIR photometric monitoring.
X-ray hardness ratio suggests this binary is in soft state at MJD 54320–54570.
Around MJD 54370, X-ray and radio flare appeared
→ jet ejection
In contrast, NIR flux decreased.
(Time lag < 1d)

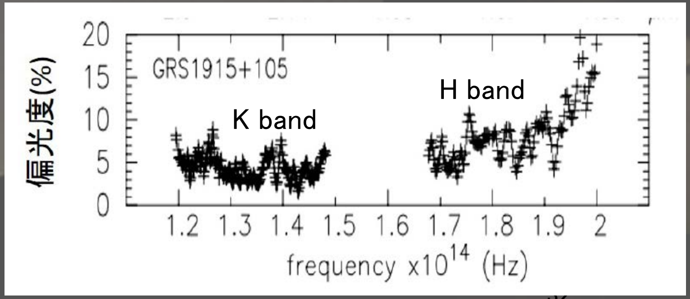
This NIR – X/radio anti-correlation continued during its soft state (~250 d).


GRS 1915+015: NIR polarimetry



Strong, variable polarization
→ Synchrotron radiation from jet?

廣地(2018)
広島大修論



Shahbaz , et al . (2008)

Bias (fake) polarization?
Too strong as interstellar pol.
Synchrotron is unlikely because of lowerpol. at longer wavenength

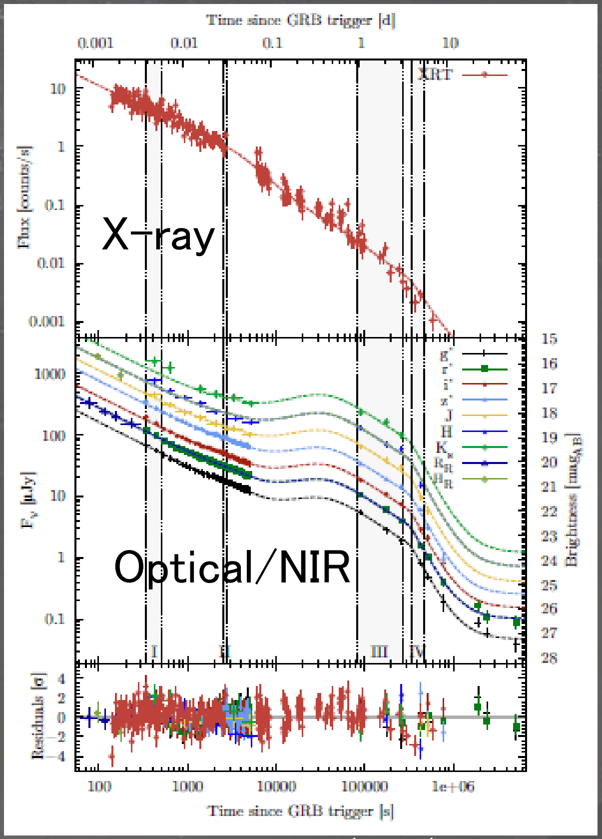
Multi-wavelength Observation Sample 3:
Gamma-ray bursts and their afterglows,
Optical counterpart of GW events

Afterglow of GRBs

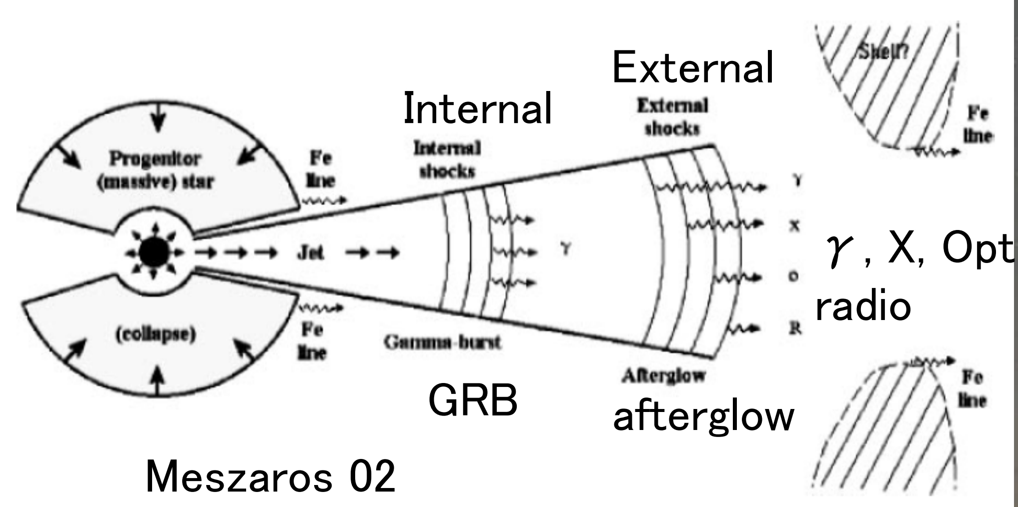
A considerable fraction of GRBs (~30%) show afterglows in optical wavelengths.

They are explained by synchrotron radiation originated in an external shock region where the relativistic jet interacts with circumstellar matter.

080413B Filgas+ 2011



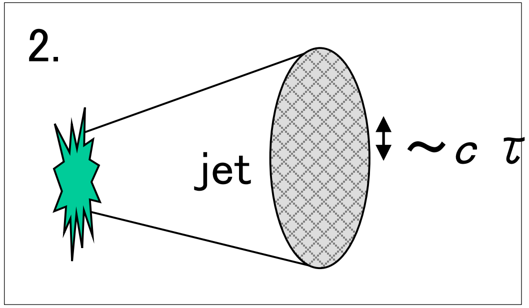
Time since (sec)

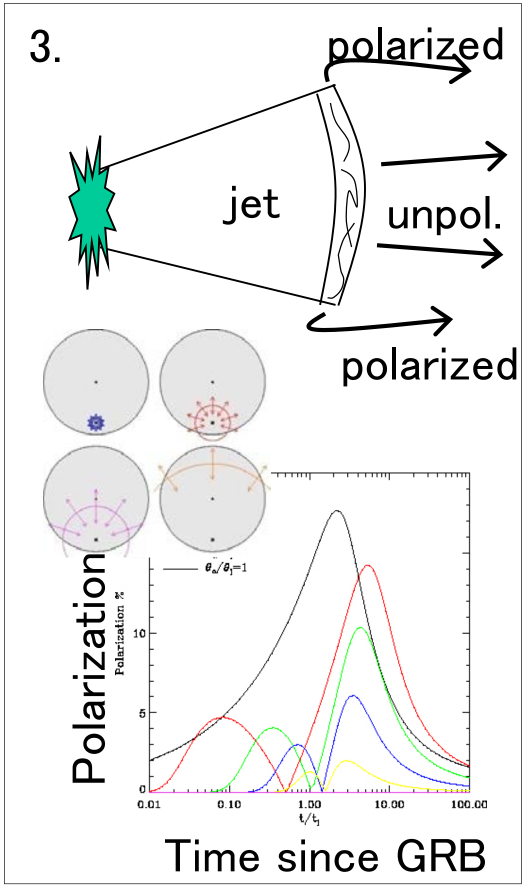


Meszaros 02

Expected geometry of magnetism and polarization

1. **Totally random orientation of magnetism.**
   → Null polarization
2. **Combination of coherent patches (scale length ~ $c\tau$). Within each patch, the magnetic field is ordered. Normal jet may have ~50 patches.**
   → Constant polarization of ~10% (=70%/$\sqrt{N}$)
   (e.g., Gruzinov & Waxman 1999)
3. **Axi-symmetric polarization pattern due to compressed, tangled magnetic field, coupled with relativistic `beaming' and `occultation' of emitting region.**
   → Variable polarization of p=0-10% from oblique line of sight (e.g, Sari+ 1999; Rossi+ 2004)
4. **Large scale ordered-magnetic field in (not hydrodynamic jet, but) Poynting-flux dominated jet** (e.g, Lyutikov+ 2003)
   → Large polarization (up to ~50%)





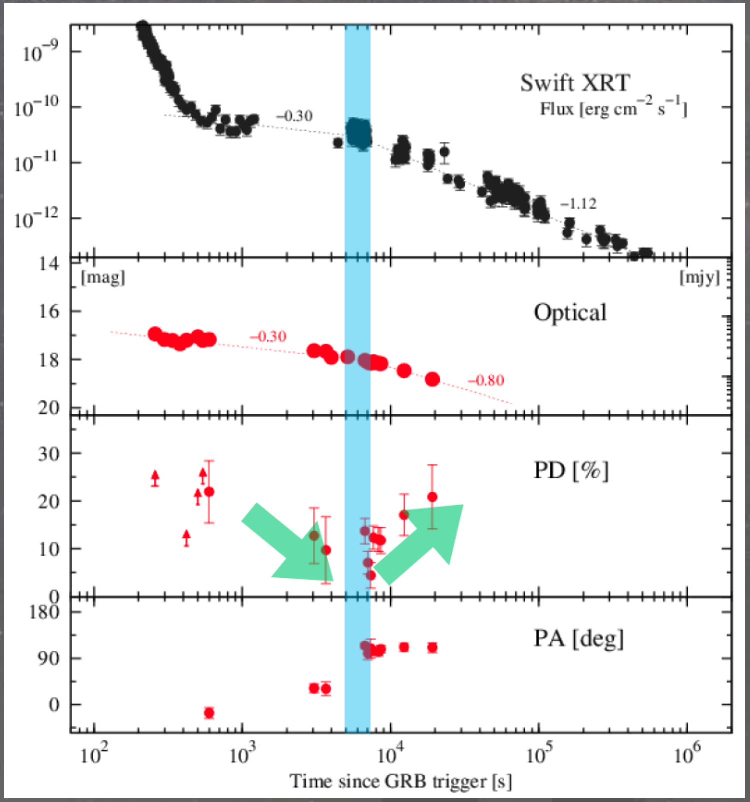
Rossi+ 04

List of Kanata optical polarimetry for GRBs

	GRB trigger t1	GCN receive t2	Expos. start t3	t3−t1 (s)	t3−t2 (s)	Polarized?
GRB 091208B	9:49:58	9:50:24	9:52:27	149	123	Yes
GRB 111228A	15:44:43	15:45:33	15:47:25	162	112	Yes
GRB 121011A	11:15:30	11:16:09	11:17:02	92	53	No
GRB 130427A	7:47:57	7:49:15	11:40:26	14027	13949	No
GRB 130505A	8:22:28	8:22:51	10:46:08	8643	8620	No
GRB 140629A	14:17:30	14:17:46	14:18:43	73	57	No

We have the record of earliest observation (<~100s after gamma-ray trigger) for GRB afterglow in polarimetry (091208B, 121011A, 140629A).

GRB 111228A (z=0.714)



Takaki, Toma, KK+, submitted

Optical afterglow shows significant temporal polarization change.

<u>**GRB 111228A: Strongly polarized**</u>

Katsutoshi Takaki will give a talk on the study of this GRB afterglow on third day of this GRB conference.

HIROSHIMA UNIVERSITY

GRB 140629A (z=2.3)

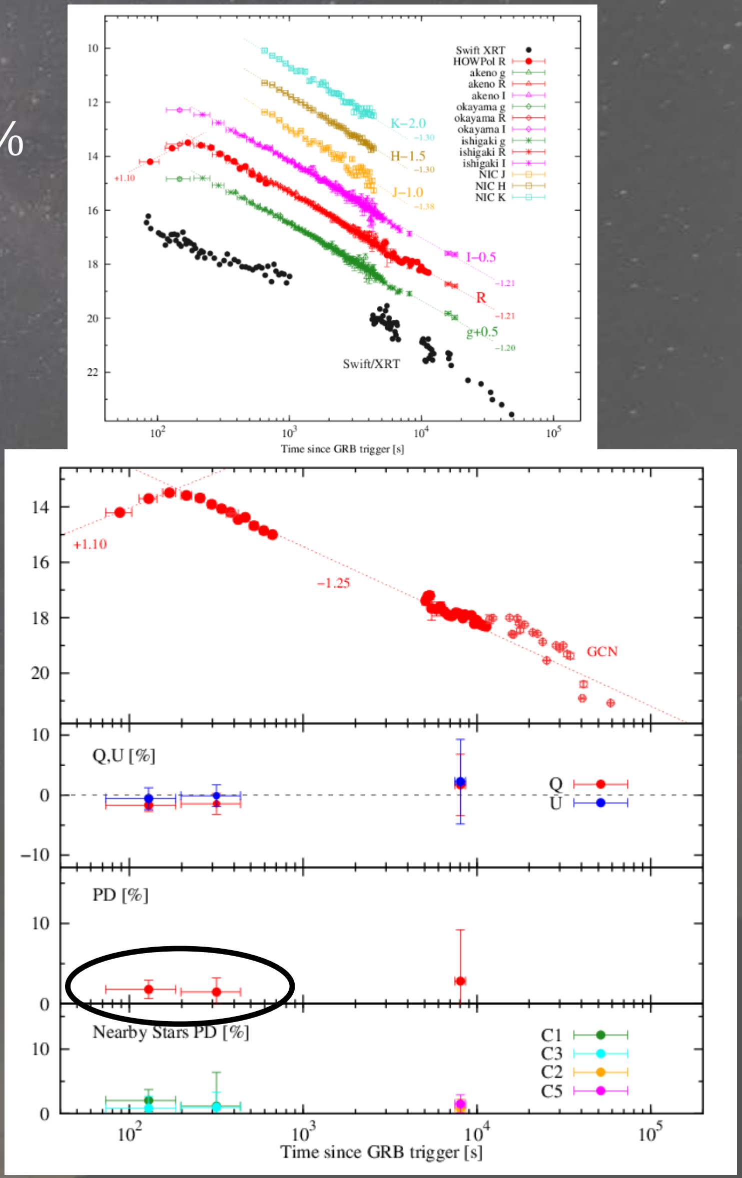
T_{90} (15–350keV) = 75.6±12.7sec
Galactic $A_V = 0.022$; upper-limit p_{MW}~0.07%

Polarimetry began at $T_0 + 73$ s
(22 s in rest frame)

The record of earliest polarimetry ever!

$p = 1.8 \pm 1.1$ % at T_0+73 s to 185 s
$p = 1.5 \pm 1.8$ % at T_0+198 s to 436 s
$p = 2.8 \pm 6.4$ % at T_0+7456 s to 8618 s

GRB 140629A: Unpolarized (or only weakly polarized)

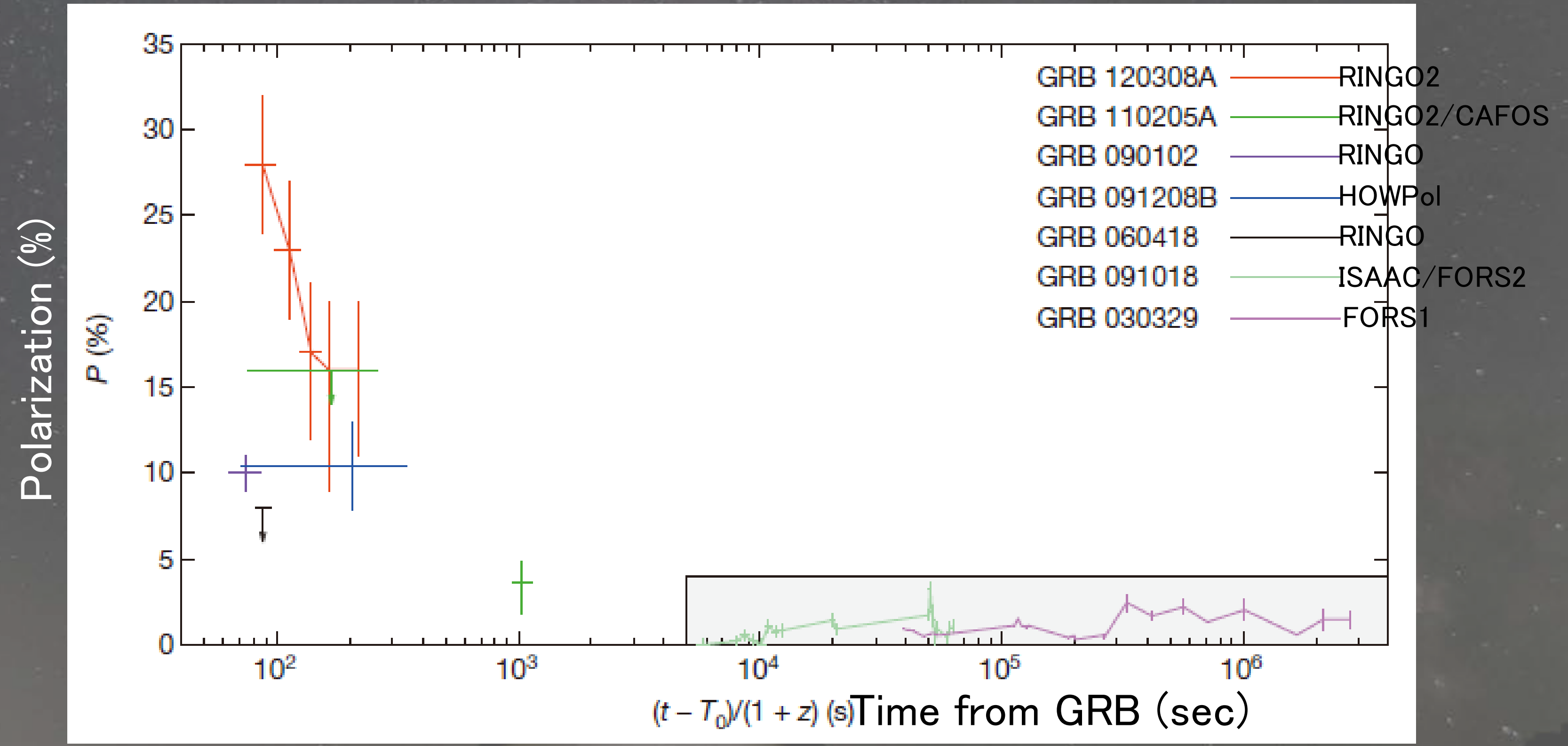


Takaki+, in prep.

HIROSHIMA UNIVERSITY

Other early afterglow polarimetry

Mundell+ (2013), Nature

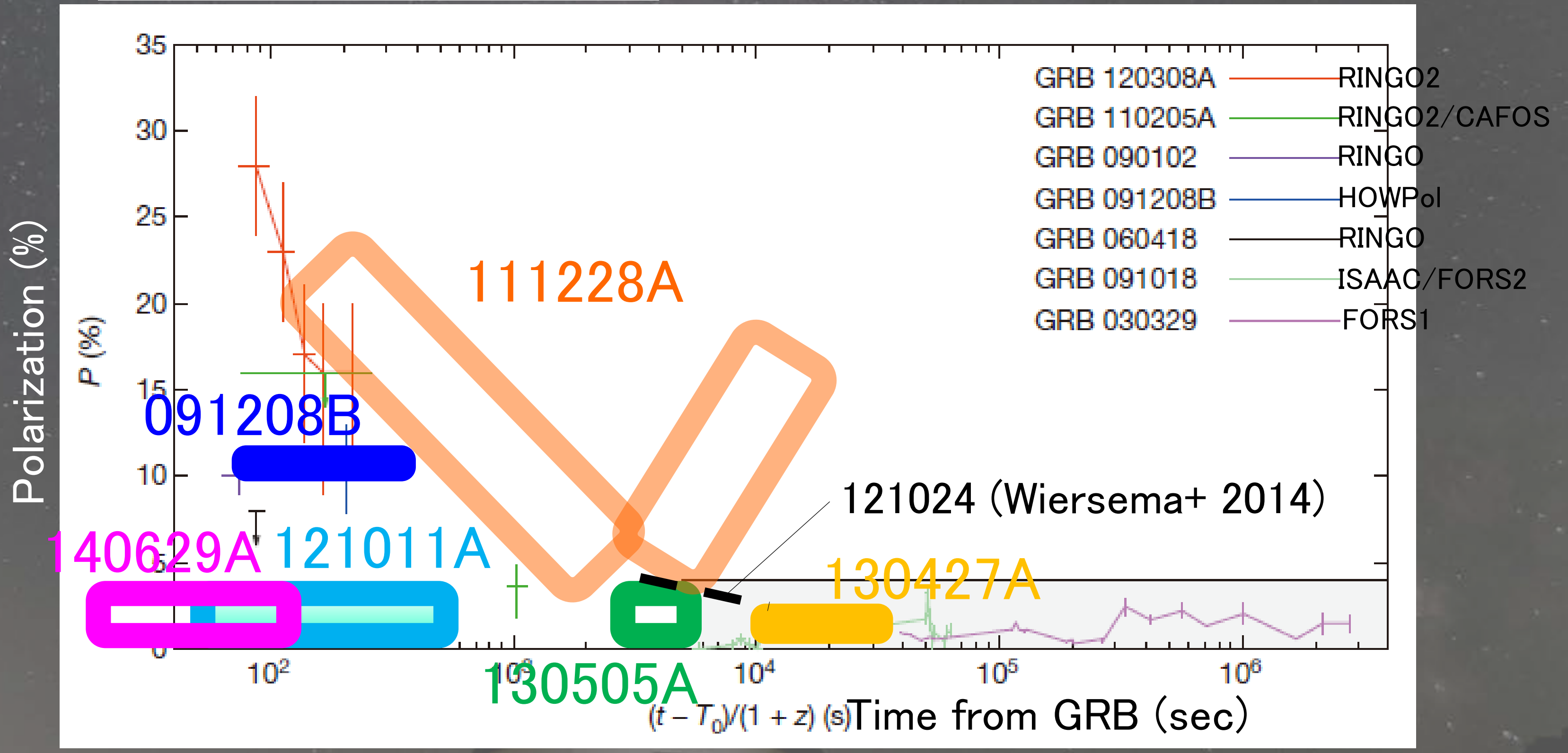


Earliest afterglow is generally strongly polarized?

HIROSHIMA UNIVERSITY

Other early afterglow polarimetry w/ HOWPol data

Mundell+ (2013), Nature



Earliest afterglow is generally strongly polarized?

— No.

Multi-wavelength Observation Sample 4: Neutrino sources

HIROSHIMA UNIVERSITY

Searching counterparts for IceCube events

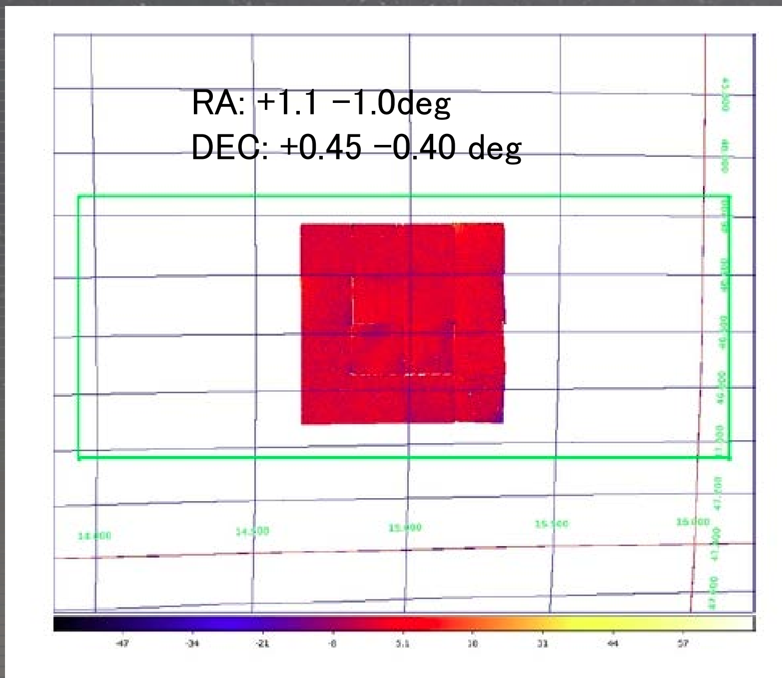
- Tiling observation covering error circle

↓

- Targeted observation for blazars within error circle

IceCube-161210A

Alert: 2016-12-10 20:07(UT)



2016-12-11 9:30-17:30 (UT)
J-band imaging (tiling)

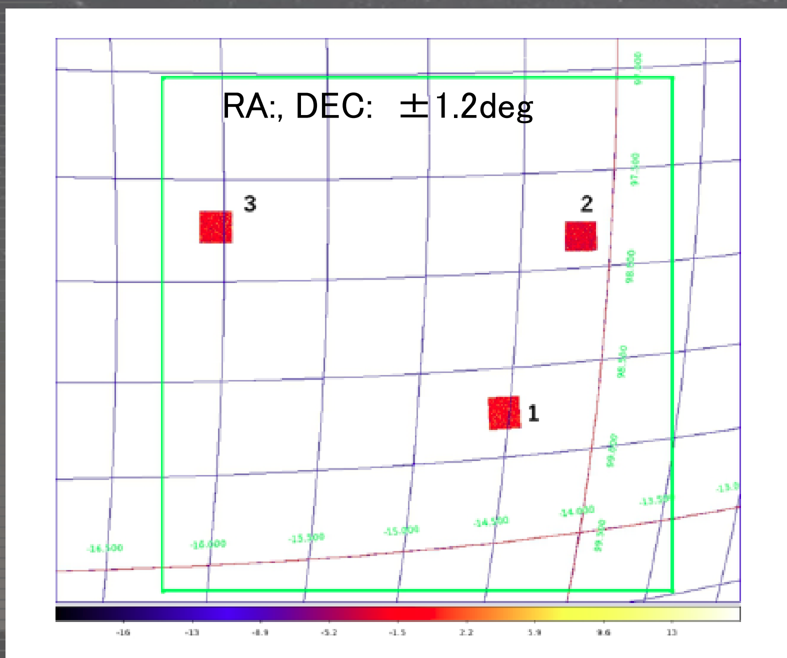
ID	1	2	3	4	5	6	7	8
積分時間 [sec]	300	300	300	300	300	900	1200	300
5sigma 限界等級 [AB mag]	19.29	19.39	19.27	18.64	18.58	18.07	18.50	18.32
変動天体 (目視)	なし	なし	なし	なし	なし	なし	なし	なし
ID	9	10	11	12	13	14	15	16
積分時間 [sec]	300	900	1020	300	300	300	300	300
5sigma 限界等級 [AB mag]	18.97	19.02	18.54	19.21	19.20	18.82	18.77	19.12
変動天体 (目視)	なし	なし	なし	なし	なし	なし	なし	なし

森 修論(2018)

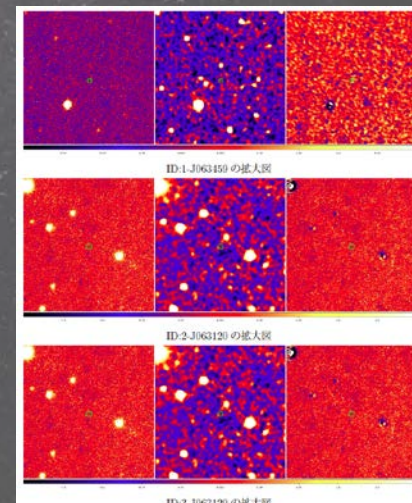
IceCube-170321A

BROS blazar catalog (Tanaka, Itoh, Inoue, et al.)
>5000 from TGSS, PanSTARRS

Alert: 2017-03-21 07:32(UT)



2017-03-22 10:30-11:10 (UT)
J-band imaging



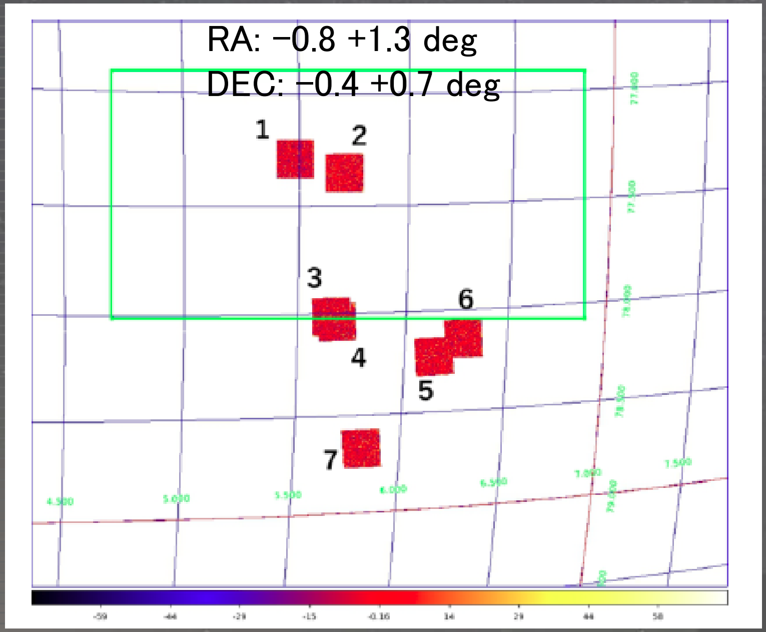
ID-天体名		1-J063459	2-J063120	3-J063120
PanSTARRS,r バンド等級 [AB mag]		20.33	20.01	No data
2MASS,J バンド等級 [AB mag]		No data	No data	No data
RA[deg]		98.7463	97.8343	97.7285
DEC[deg]		-14.5301	-14.1757	-16.0434
HONIR	R バンド積分時間 [sec]	375	375	375
	R バンド限界等級 [AB mag]	19.27	19.17	19.15
	J バンド積分時間 [sec]	300	300	300
	J バンド限界等級 [AB mag]	18.14	17.95	17.91
	観測結果	未検出	未検出	未検出

森 修論(2018)

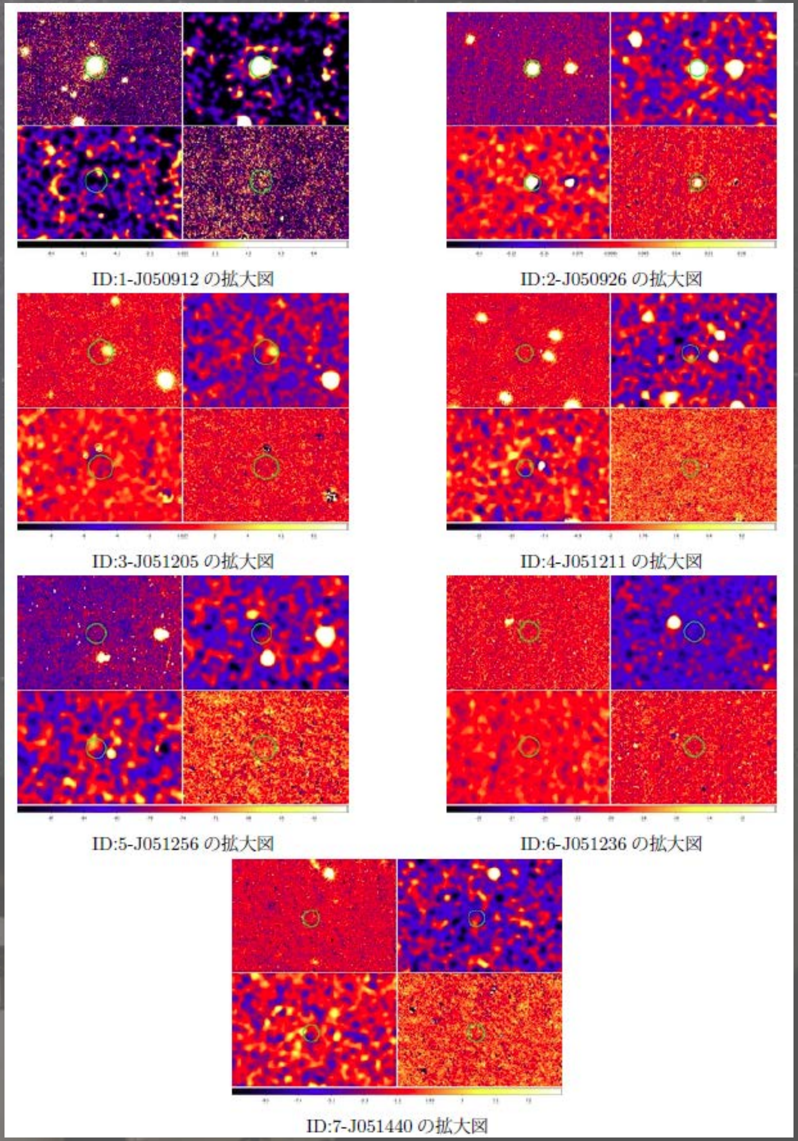
HIROSHIMA UNIVERSITY

IceCube-170922A

Alert: 2017-09-22 20:54(UT)



2017-09-23 16:10-20:20 (UT)
J-band imaging



森 修論(2018)

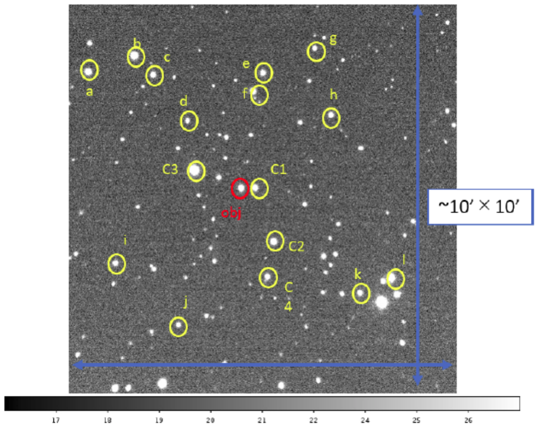
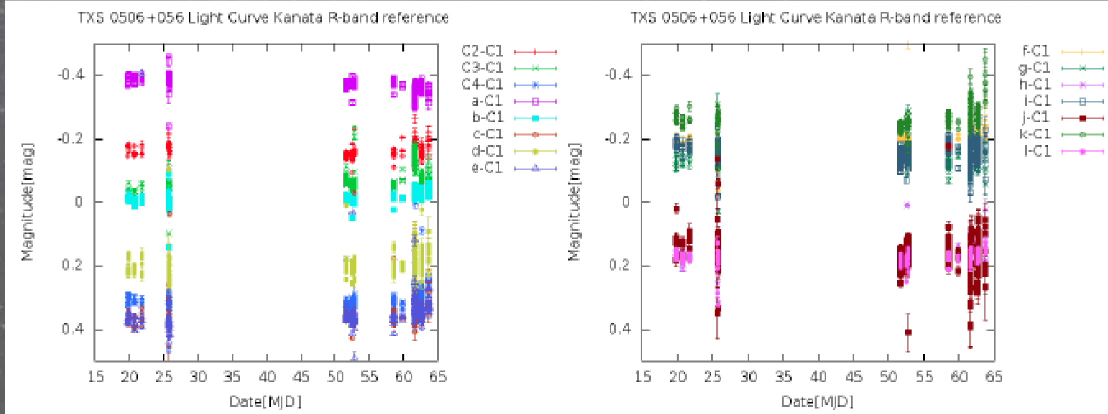
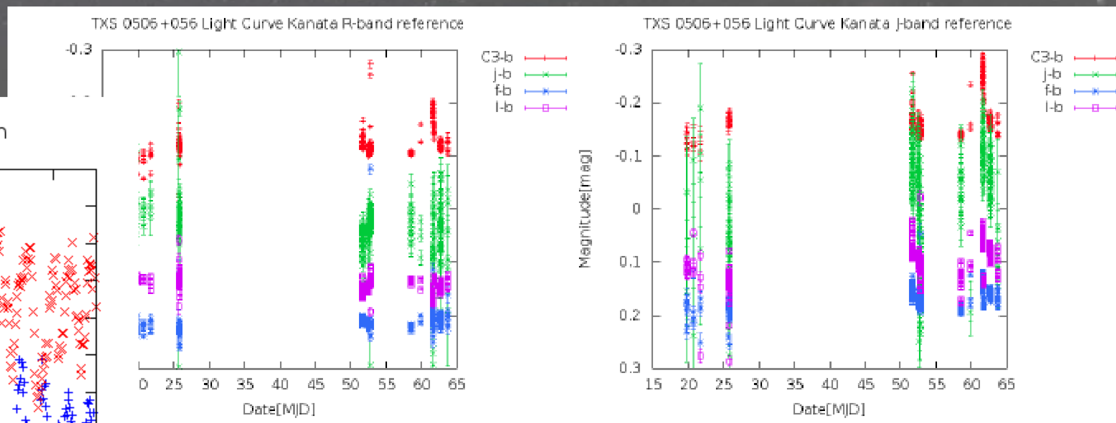


図 4.18: reference 候補天体の ID

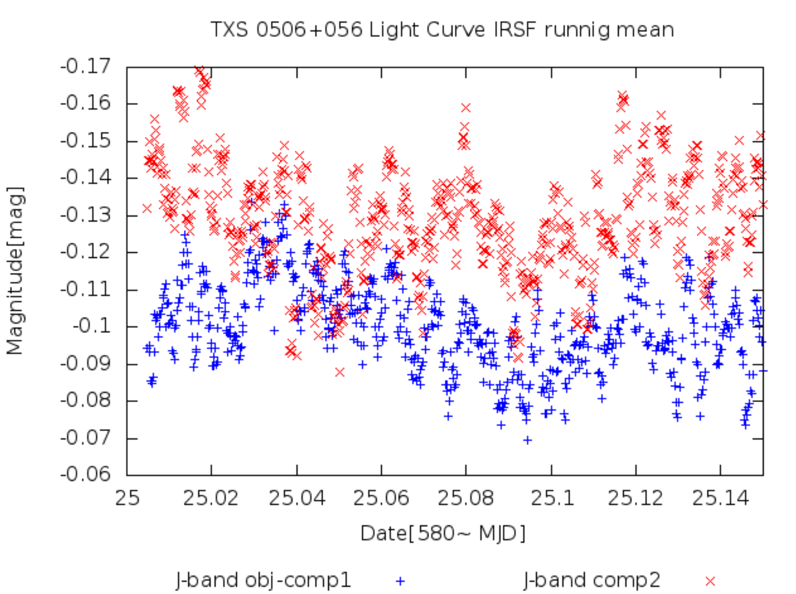
ID	C1	C2	C3	C4	a	b	c	d
AAVOS,R バンド等級 [AB mag]	14.277	14.133	12.278	14.971	13.949	13.291	14.961	15.603



左:R バンドの C2~C4,a~e の相対測光結果　右:R バンドの f~l の相対測光結果



左:R バンド　右:J バンド

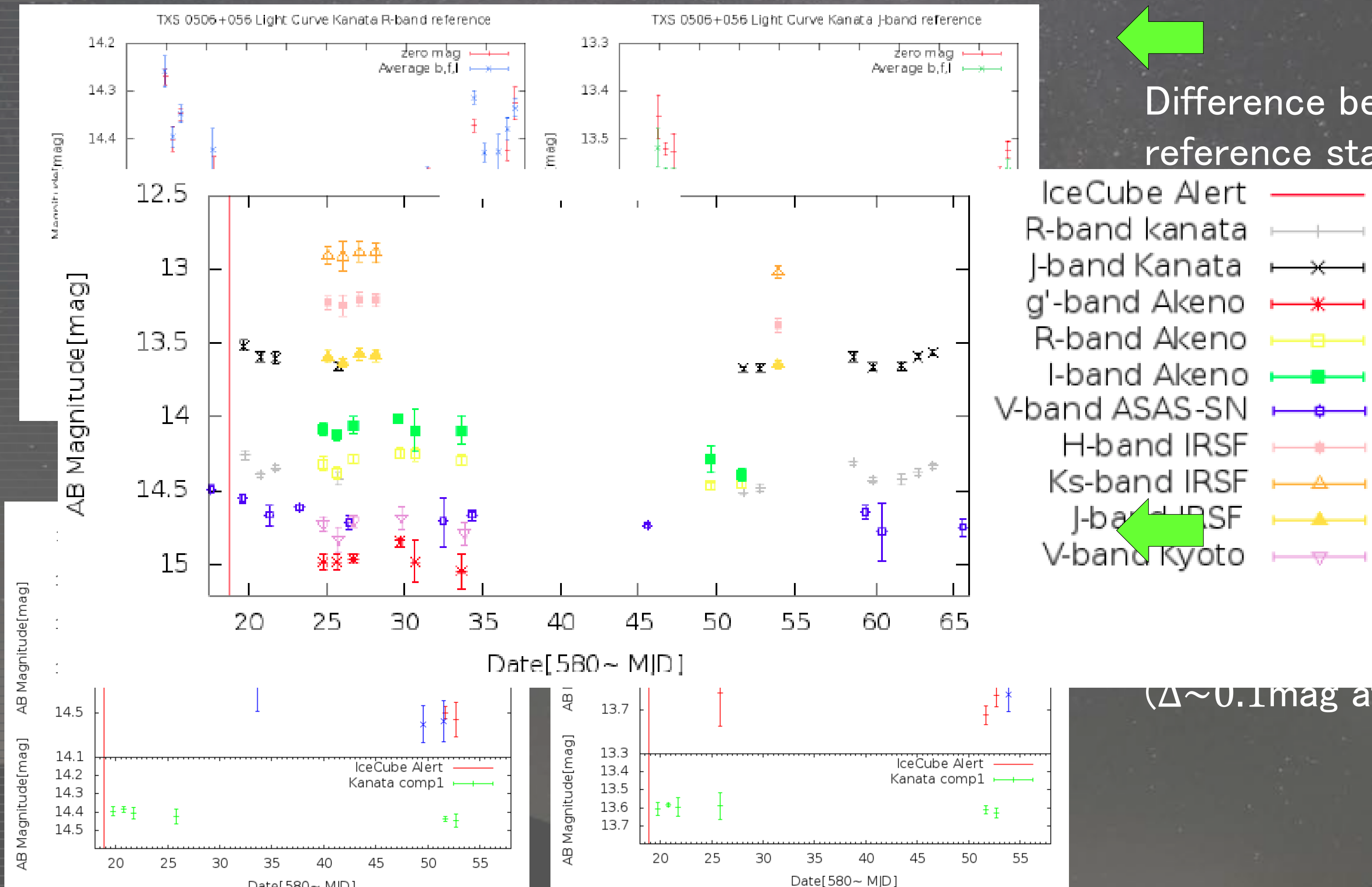


~0.1mag scatters depending on used reference star

森 修論(2018)

IceCube-170922A: Light curve

Difference between
reference star method



ethod
at most)

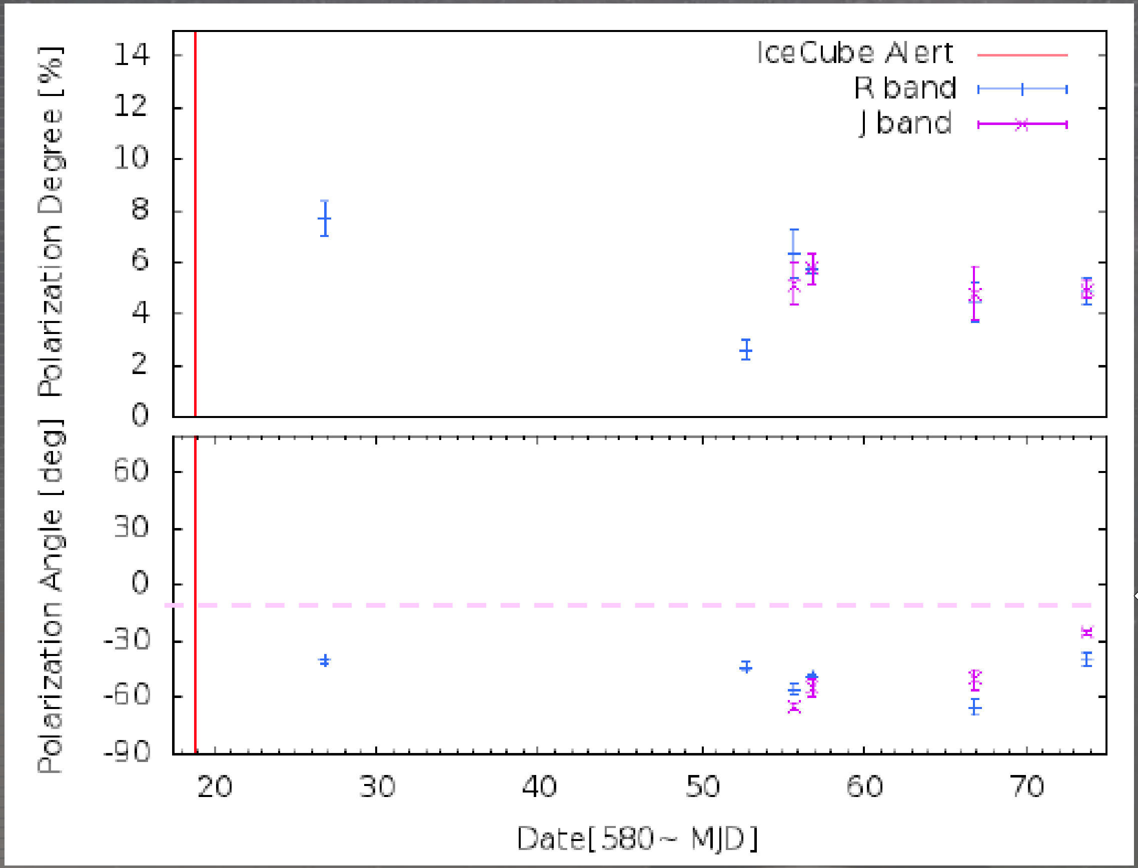
tween

(Δ~0.1mag at most)

Imcomplete flat-fielding, errors in used catalogue, instability due to observing condition, intra-night variability, etc.

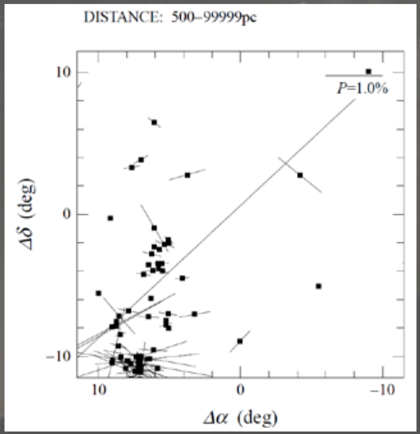
森 修論(2018)

IceCube-170922A: Polarization



Radio jet axis
(cf. Iinuma, Nagai's talk)

Misalignment with jet axis?



Polarization map of nearby stars

HIROSHIMA UNIVERSITY

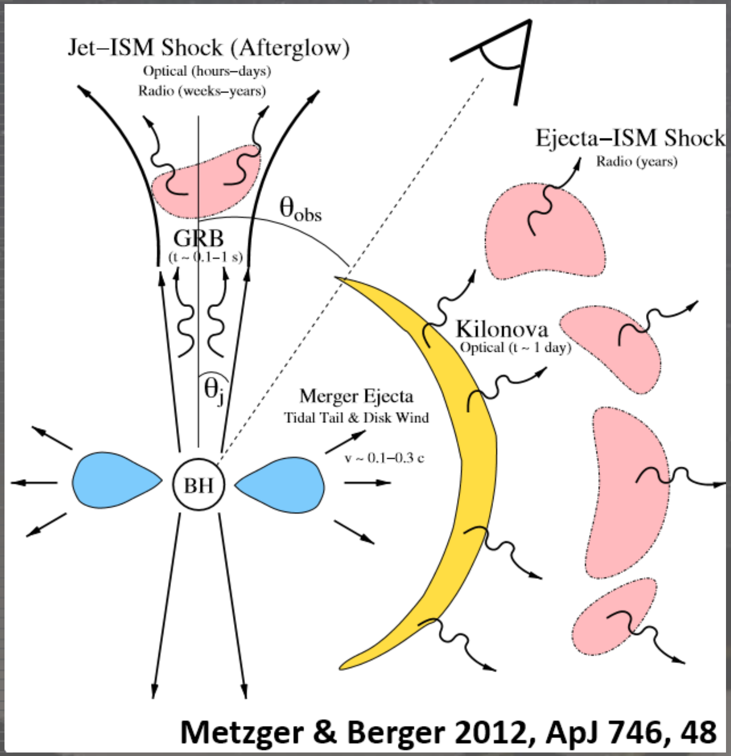
Multi-wavelength Observation Sample 5: GW events

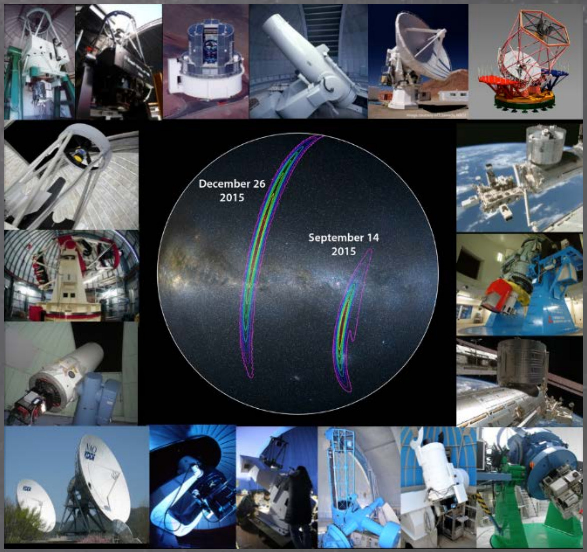
HIROSHIMA UNIVERSITY

重力波天体 同定観測ネットワーク J-GEM

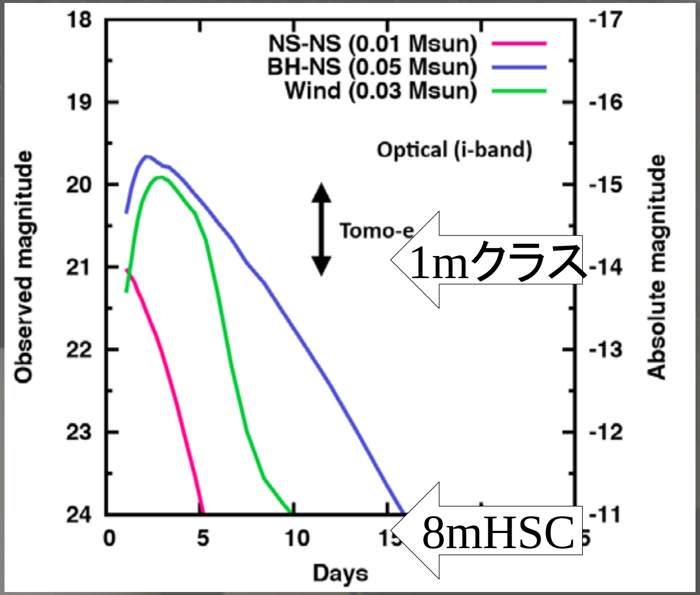
PI 吉田道利（広島大）

NS-NS（BH）合体





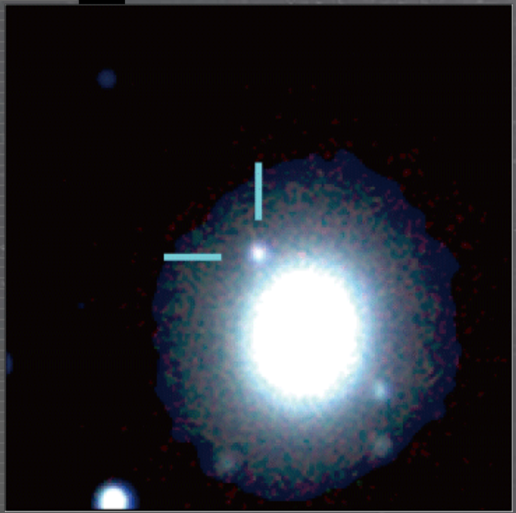
J-GEMに参加している望遠鏡群（諸隈ほか2017）



O2ラン進行中（～2017夏）

距離100MpcでのGWイベントの光度曲線モデル（田中雅臣2017）

2017.08.18-19 2017.08.24-25



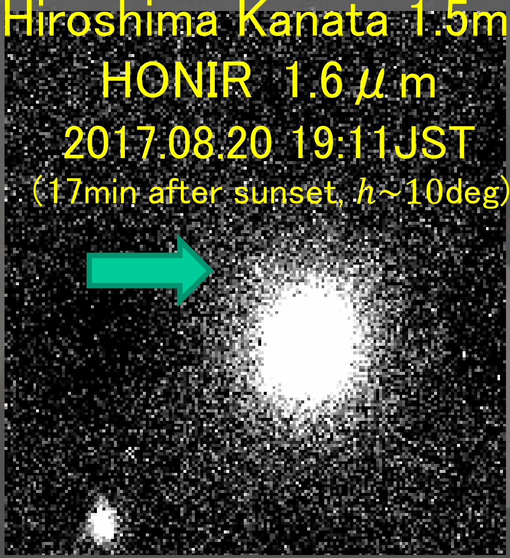
Subaru HSC λ0.9 μm、IRSF1.2 μm, 2.2 μm composite color image

J-GEM obs. of the counterpart of GW 170817: SSS17a

Decayed and reddened quickly

Utsumi et al. 2017;
Tanaka et al. 2017;
Tominaga et al. 2017;

Hiroshima Kanata 1.5m/
HONIR 1.6 μm
2017.08.20 19:11JST
(17min after sunset, h~10deg)



Severe to photometry from Japan

Nakaoka et al. 2017;
Utsumi et al. 2017

HinOTORI 0.5m telescope in Tibet, China




HinOTORI 0.5m tel.@5100m

HIROSHIMA UNIVERSITY

Yomiuri
2017 Nov 12

2017年(平成29年)11月12日(日曜日) 読売新聞 (第3種郵便物認可)

重力波 チベットから迫る

望遠鏡設置完了

標高5000㍍ 広大で来秋にも観測開始

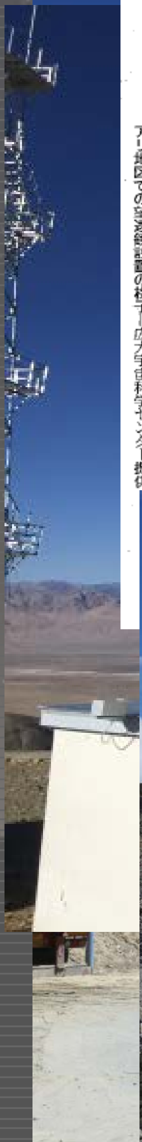
広島大は中国国家天文台と共同で、中国西部・チベッ…
置したと発表した。標高約5000㍍にあるアリ地区で…
ては南米チリに次ぐ高さ。来年秋にも観測を開始すると…
同大学などによって初めて捉えられた時空のさざ波「重…
現象の観測などで活躍が期待される。

プロジェクトは「HinOTORI」と名付けられ、2013年から中国国家天文台と準備を進めてきた。現地のインフラ整備などは中国が担い、望遠鏡の設置や観測システムの構築などは広大が担当した。

観測施設は欧米や南米、日本国内に多いが、中国西部周辺は望遠鏡の設置が進んでいない「空白地帯」だった。アリ地区は高地にあるため、観測の支障となる大気の影響を受けにくいことも建設地に選ばれる理由となった。

広大は15年秋に望遠鏡を現地に発送したが、研究者の渡航許可がなかなか…

アリ地区での望遠鏡設置の様子＝広大宇宙科学センター提供



Close to AliCPT site
(IHEP/CAS)

HIROSHIMA UNIVERSITY

Summary

- Kanata 1.5m telescope
  - Dedicated for transient objects/phenomana
  - Simultaneous optical and NIR observation (imaging, spectroscopy, polarimetry)
  - Supernova, Blazars, GRBs, IceCube events, GW events,..
  - Be careful to reliability for errors (depending on observer/reduction tool, etc.) – easily changing by 0.1-0.2 mag
- HinOTORI 0.5m telescope
  - Construction finished in 2017 Oct
  - Proper observation will begin in late 2018 or 2019

Collaborating study with Kanata is always welcome!

Opt imaging ≦21 mag, NIR imaging ≦17-19 mag

10’x10’(HONIR) low-res. spectroscopy, polarimetry

HinOTORI 0.5m in Tibet will be available soon.