Small telescopes for simultaneous multi-wavelength astronomy

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Outline

Tiny telescopes

- < 1m
- Light curves of short-term variations

Small telescopes

- 1-3 m
- Spectroscopy, Polarimetry, NIR

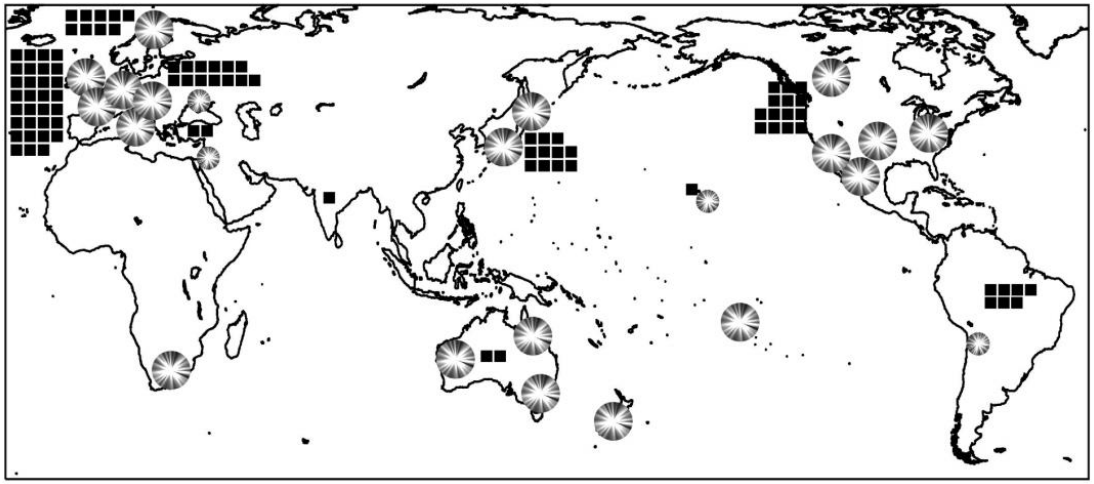
Tiny telescope networks (, including amateurs)

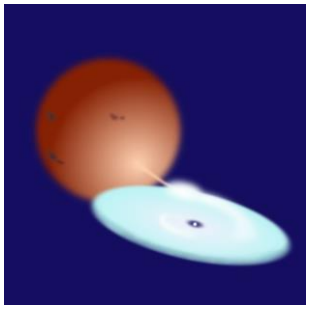
- Groups of observers
  - AAVSO (USA),
    BAAVSS (England),
    VSOLJ (Japan), VSNET, …
- Projects
  - CBA (CV), WEBT (Blazars), ...
- 24-hour light curve coverage
- Non-uniform data-quality

AAVSO Members and Observers Map (2012)

VSNET Collaborators (Kato+04)

CCD users (bursts) and visual observers (squares)





Dwarf novae

HT Cas
VSNET Collaboration (ground-based)

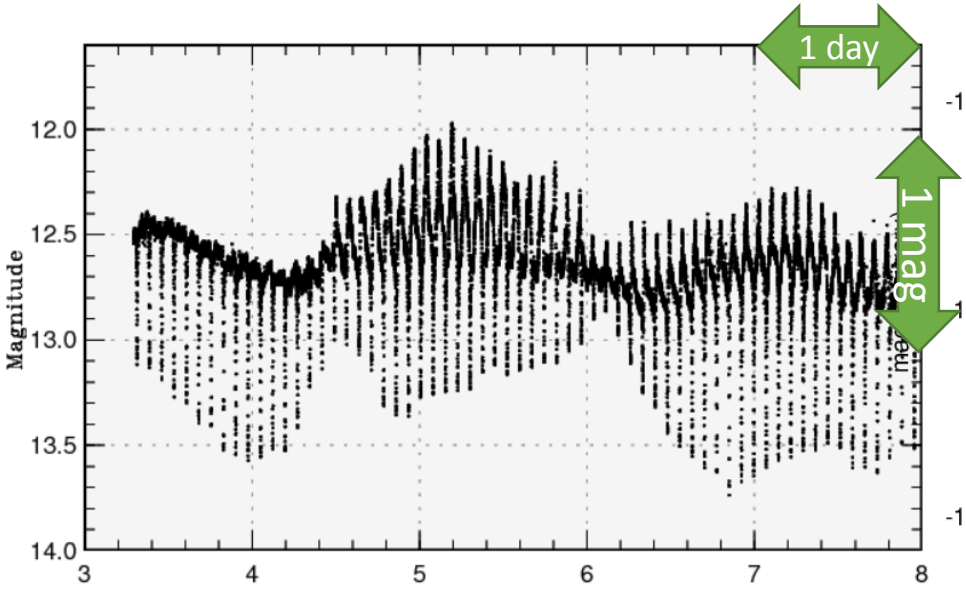
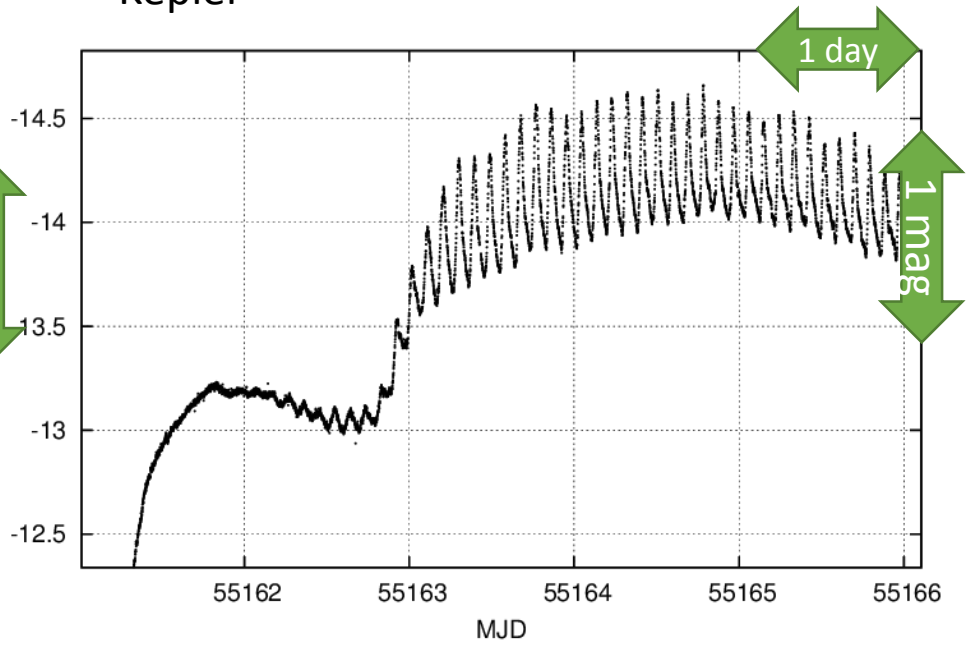
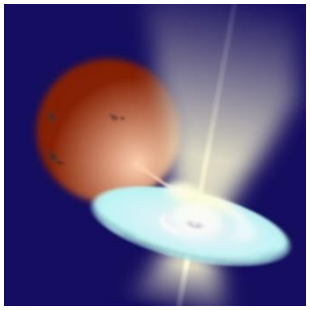


Figure from T. Kato

V344 Lyr
Kepler



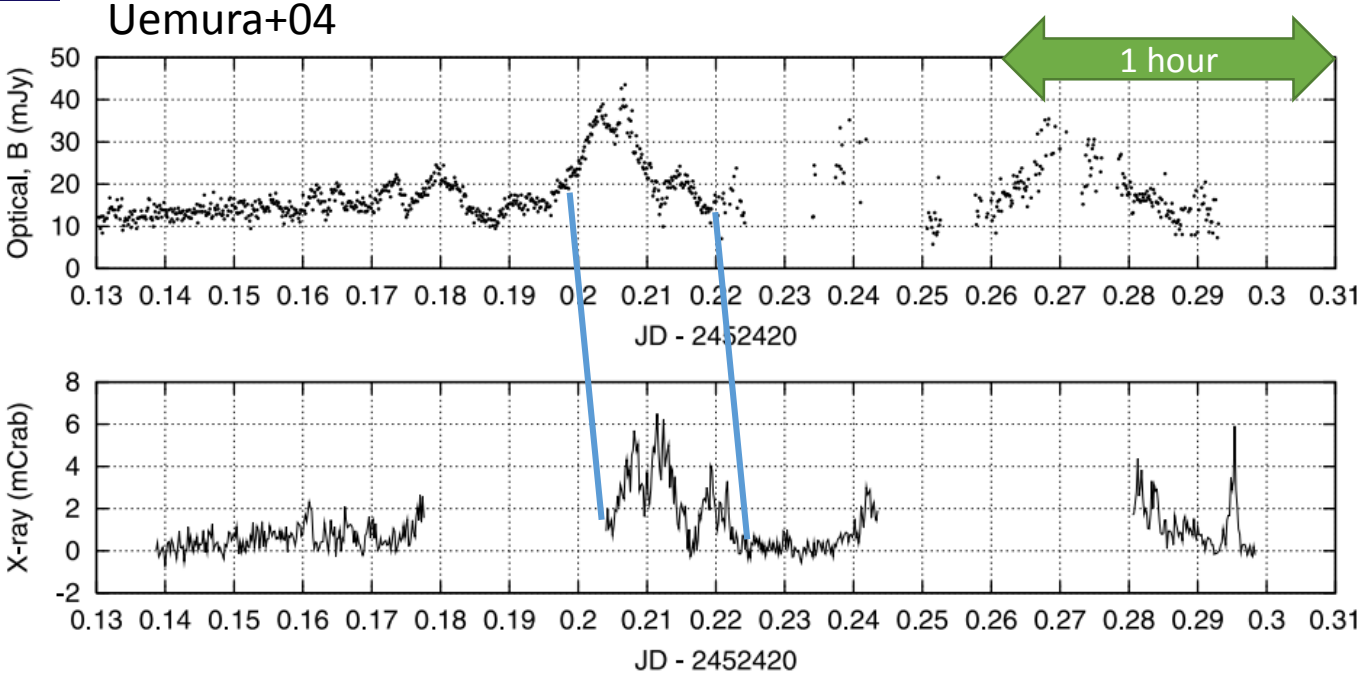


BH X-ray transient (V4641 Sgr)

Uemura+04

Optical (VSNET)

X-ray (RXTE/PCA)



- An optical flare precedes ~7 min to X-ray one.
- Propagation of a heating wave from an outer to inner disk.

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Beyond simple photometry

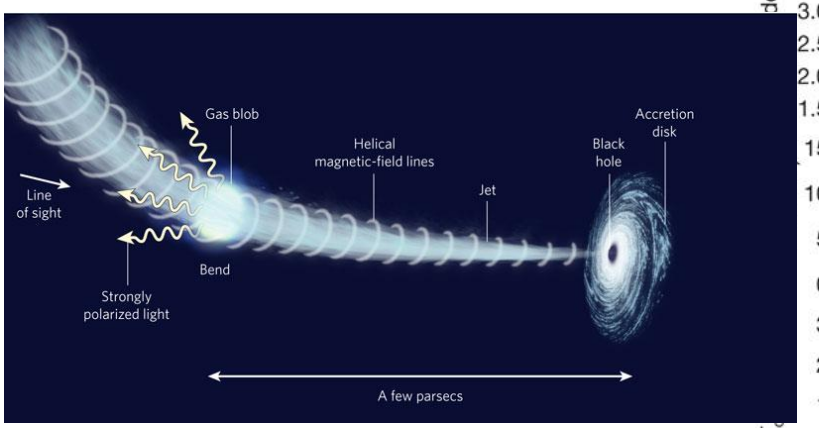
- "Kanata" 1.5-m optical-NIR telescope
  - Hiroshima University, since 2006
  - Follow-up observations of variables and transients

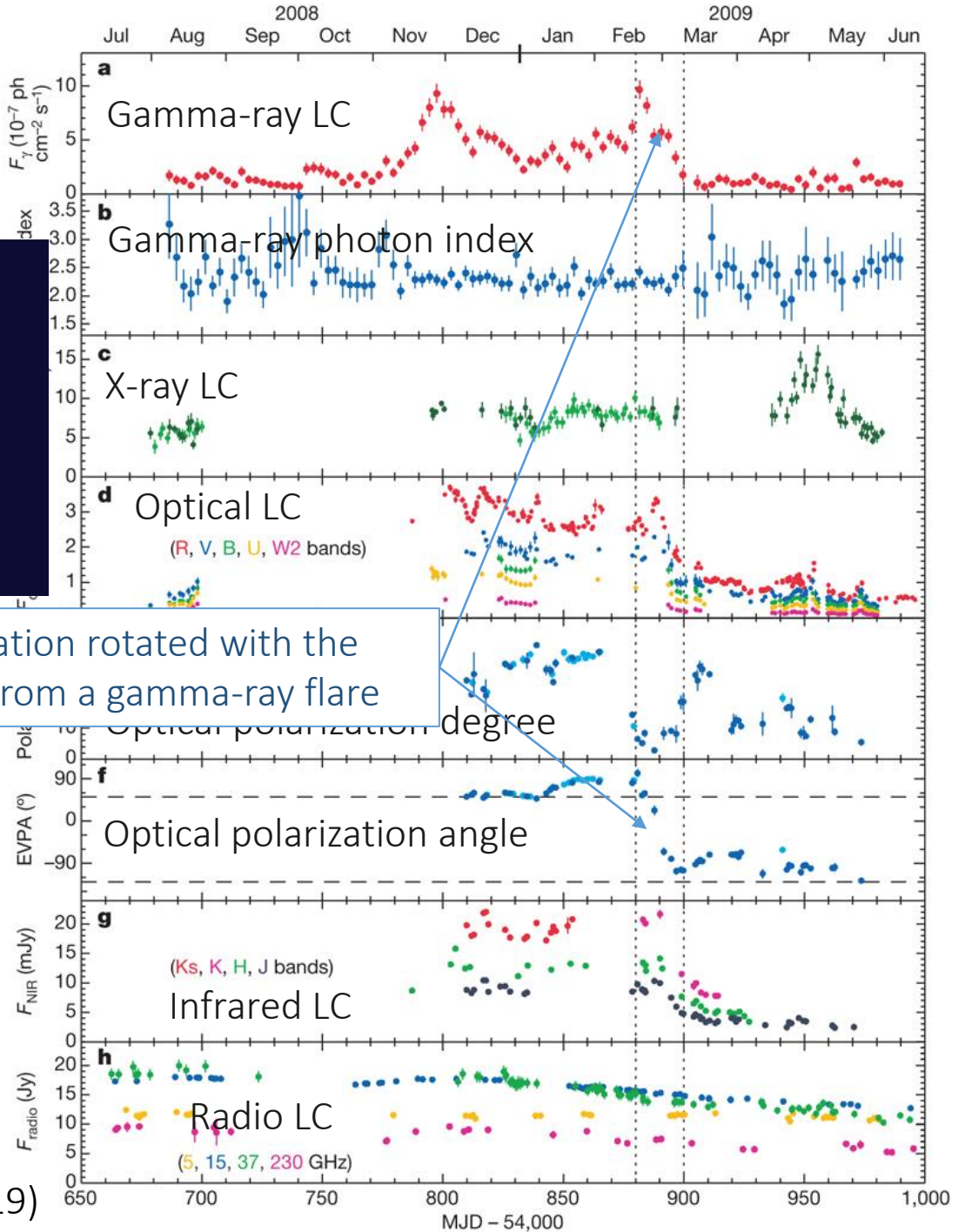
<u>High Speed Camera and Spectrograph</u>
- Optical imaging, spectroscopy
- Maximum rate = 33 Hz

<u>HOWPol</u>
- Optical imaging, spectroscopy, imaging polarimetory, spectro-polarimetry
- Double-Wollaston prism → GRB polarimetry

<u>HONIR</u>
- Simultaneous optical & NIR
- Imaging, spectroscopy, imaging polarimetry, spectro-polarimetry

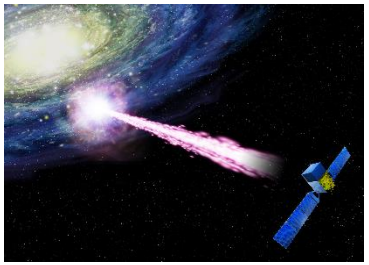
Polarization variations in





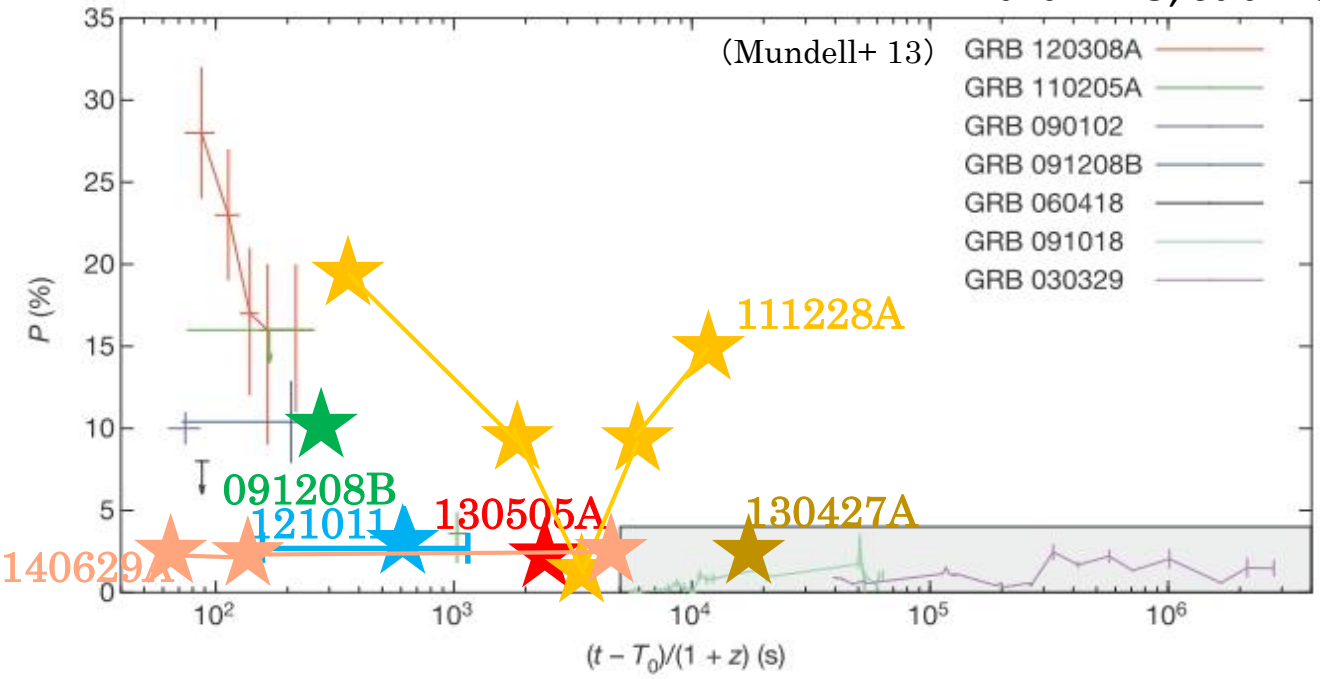
Polarization rotated with the decay from a gamma-ray flare

(Abdo+10, Nature, 463, 919)

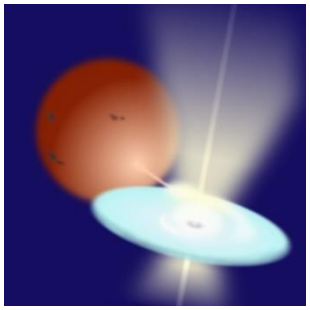


Polarization in GRB

Takaki+15, submitted

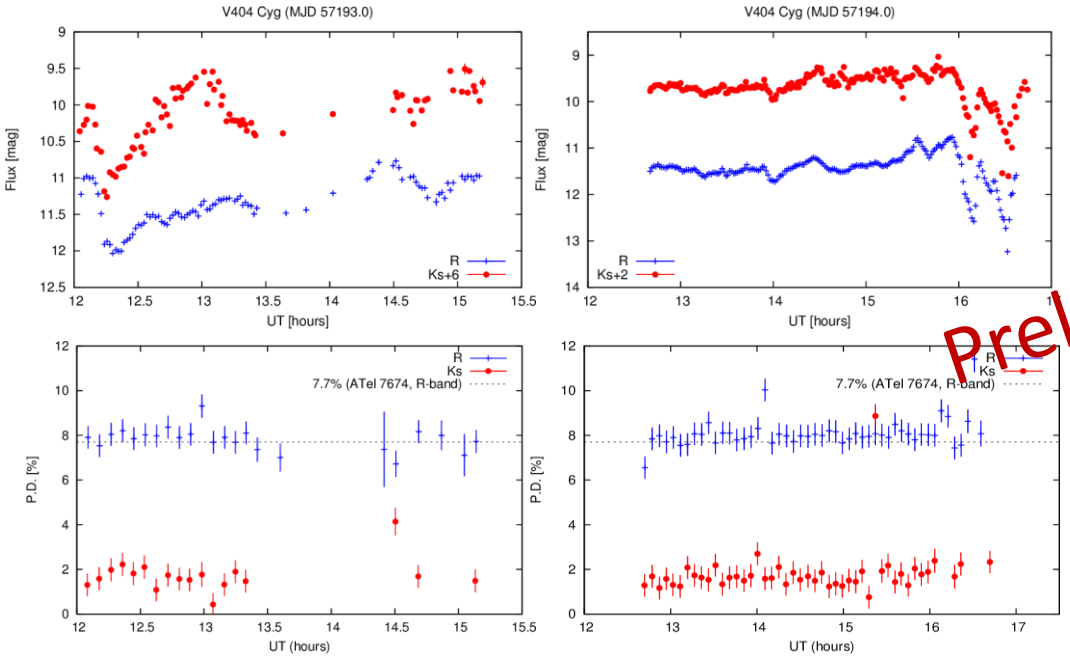


- Our sample (2008-2014): Polarization of 6 GRBs
- 2 systems show large polarization
  - GRB 091208B:10% at T=300s
  - GRB 111228A:major variation in PD and PA rotation
- 4 systems show small polarization
  - Even in very early phase (T<100 s)



BH X-ray transient (V404 Cyg)
Simultaneous opt. & NIR polarimetry

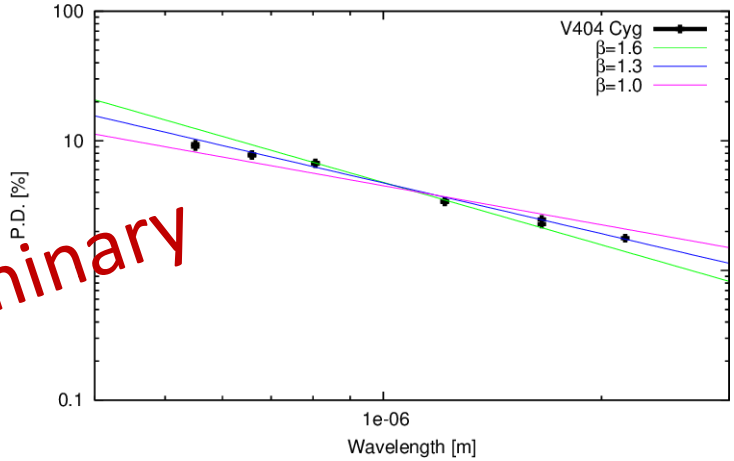
Contact: Y. Tanaka (Hiroshima Univ.)



R- & Ks-band light curve (upper) and PD (lower).

- Observation from 18 – 23 June.
- No PD variation associated with light curves both in R- and Ks-band.

Preliminary



PD spectra

- Power-law; PD∝λ^-1.5
- Similar to interstellar polarization of highly reddened stars (Atel #7709)

Summary & Future

- Tiny telescopes are good in terms of the light-curve coverage.
- Small telescopes can provide multi-band and/or polarization data, which are crucial to multi-wavelength studies.

- But, only for bright sources (in the optical-NIR regime)
  - Further cooperation of small (1-3 m) and middle (4-6 m) telescopes may be required.
- Are they open for everyone?