Optical-infrared and High-energy Astronomy Collaboration at Hiroshima Astrophysical Science Center

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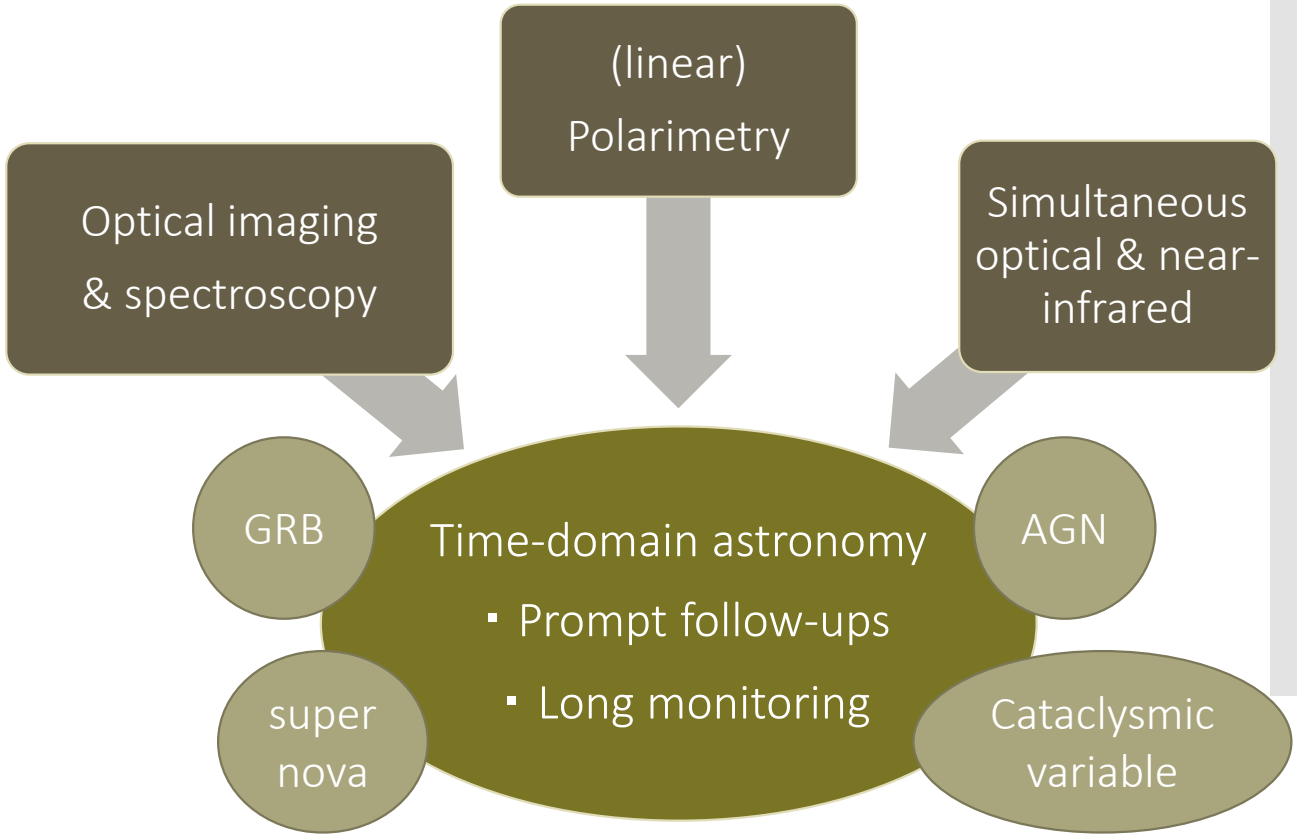
Higashi-Hiroshima Obs.


Kanata

“Kanata”

1.5-m telescope @Hiroshima



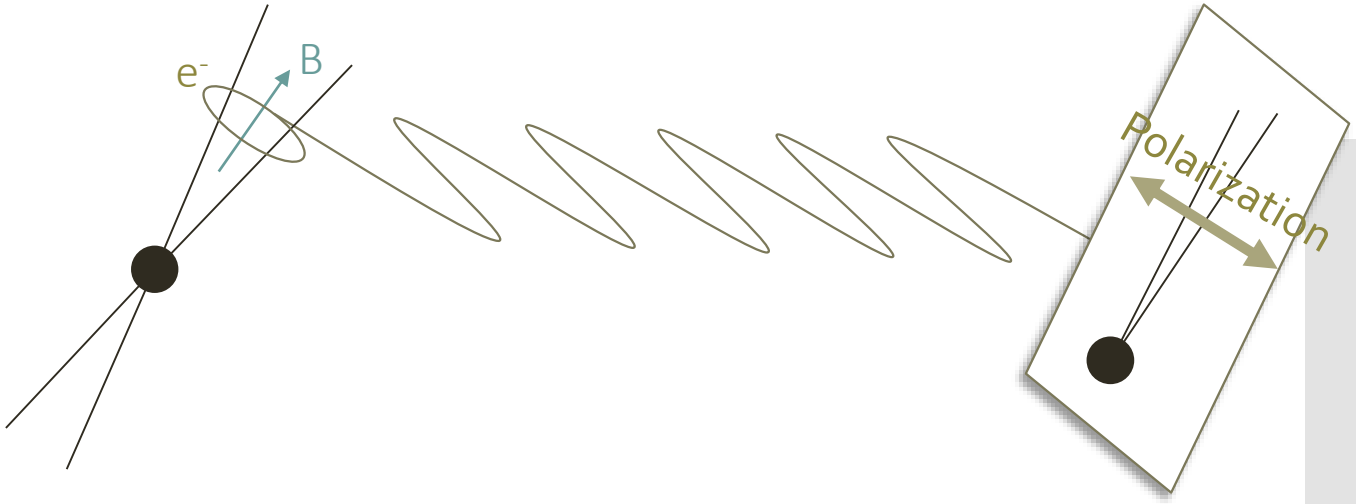
"Kanata"
1.5-m telescope
@Hiroshima

Contents

Time domain astronomy

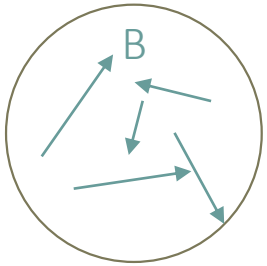
1. Polarimetry
   - Gamma-ray bursts
   - Blazars
2. Simultaneous opt. & NIR
   - Dwarf novae

Polarimetry: Jet & Magnetic field

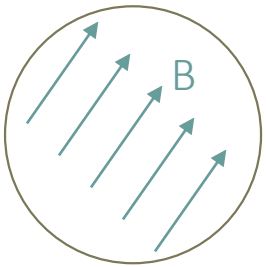


- Synchrotron emission from jets could be highly polarized if the magnetic field is aligned in the emitting region.
- Polarimetric observations can be a unique tool to study the magnetic structure in the jets, ex. In GRBs and AGN.

Low polarization

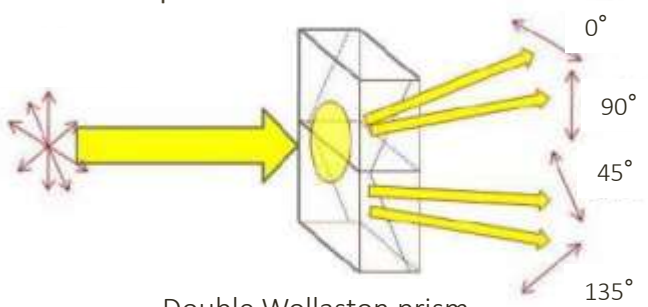


High polarization



Polarimetry: Instrument

- HOWPol
  - Hiroshima One-shot Wide-field Polarimeter
    (PI: Kawabata, K. S.)
  - Polarimetric observation with a high time resolution
    - Using a Double-Wollaston prism

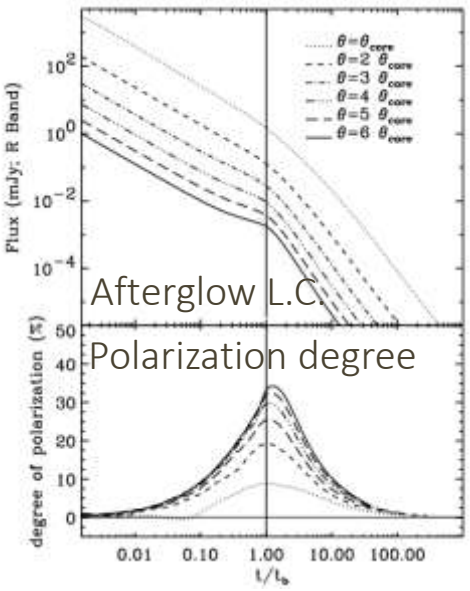


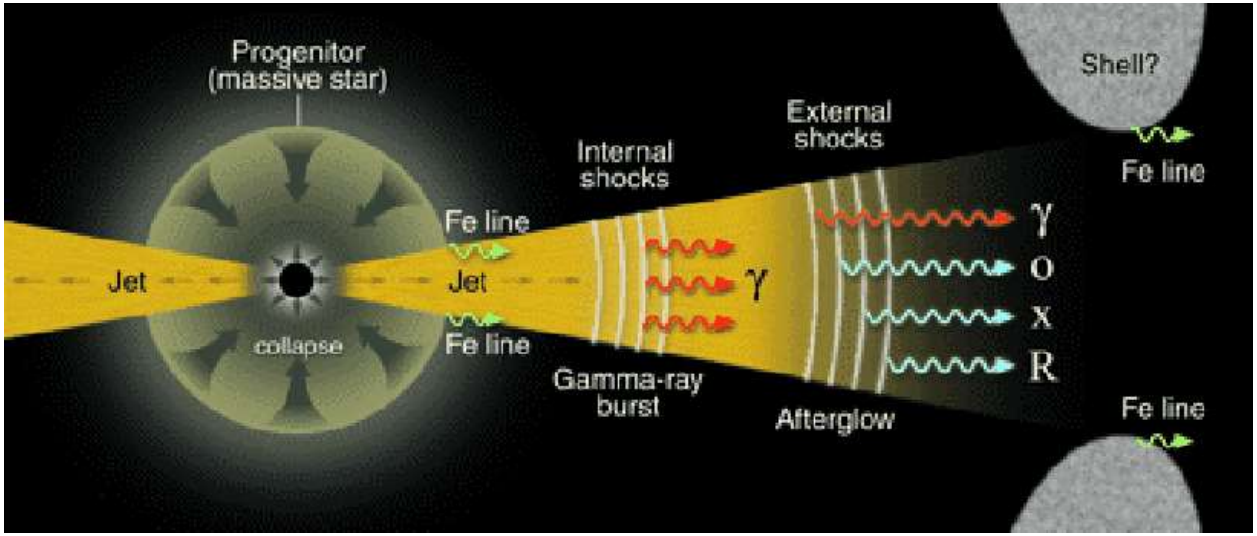
Double Wollaston prism

Polarimetry Results: γ-ray burst

- Relativistic jets directed to us
- Collapse of massive stars (long GRBs)
- Prompt emission: only for ~100 s
- Afterglows: synchrotron emission.
- Polarization from the synchrotron emission of afterglows
- Structure of the magnetic field in the jet

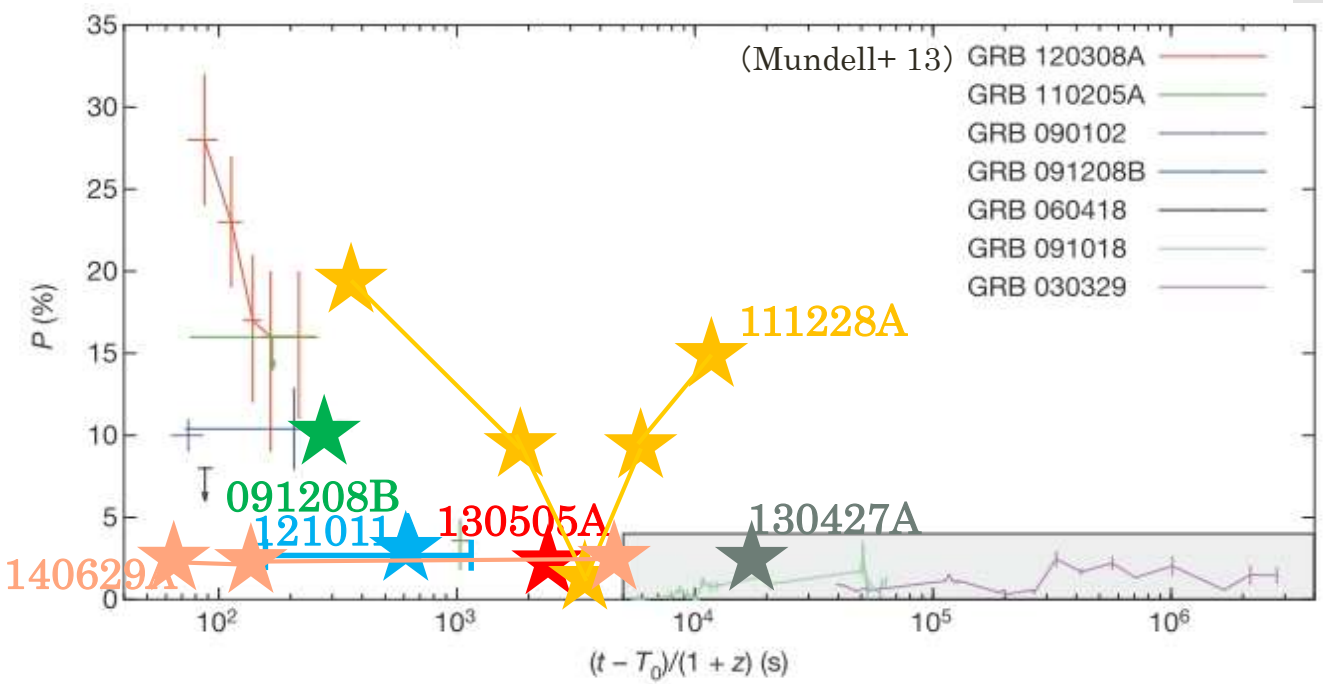
Rossi+04





Polarimetry Results: γ-ray burst

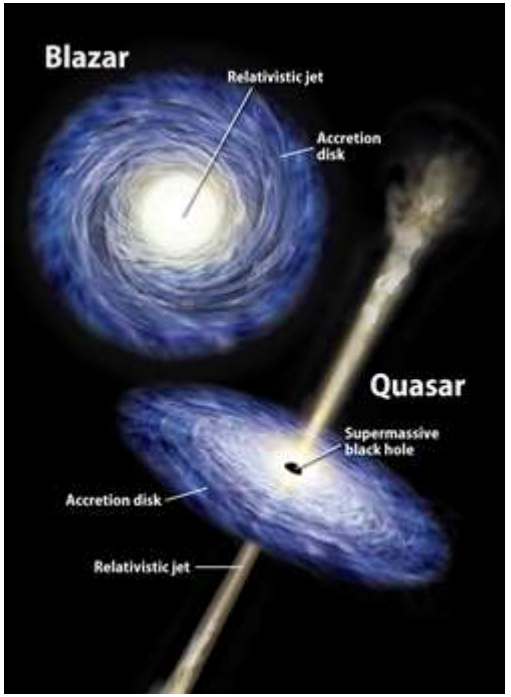
- Our sample (2008-2014): Polarization of 6 GRBs
- 2 systems show large polarization
  - GRB 091208B:10% at T=300s
  - GRB 111228A:major variation in PD and PA rotation
- 4 systems show small polarization
  - Even in very early phase (T<100 s)

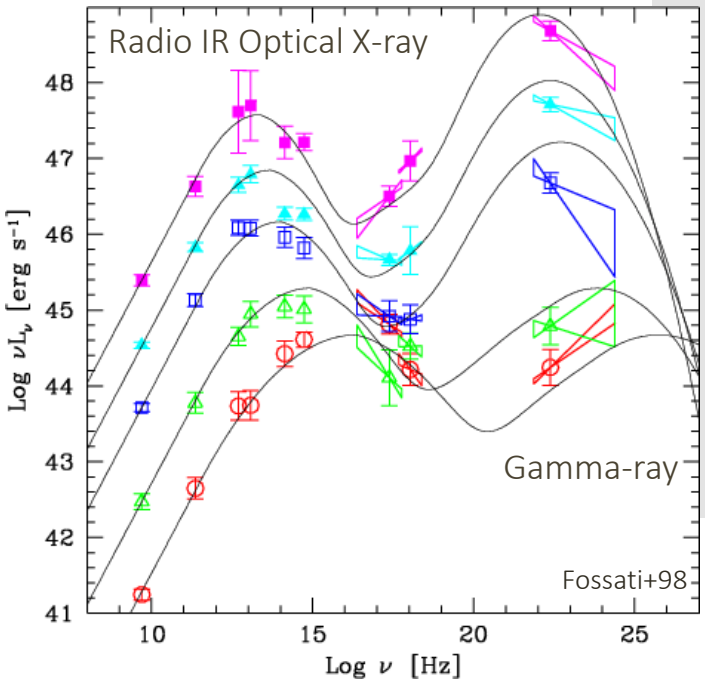


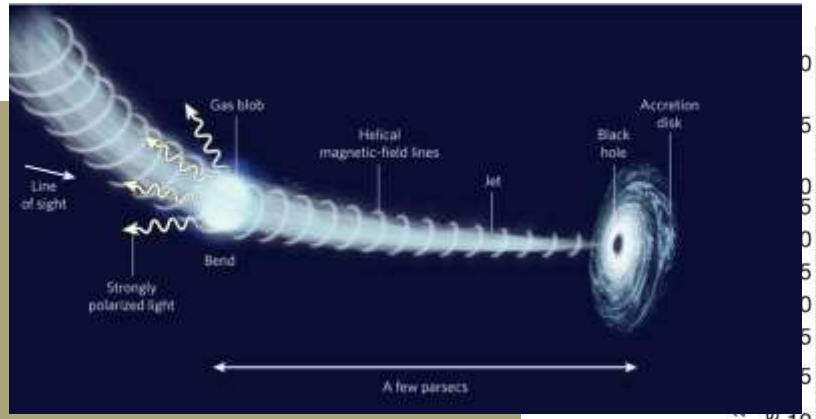
Polarimetry Results:

Blazars

- Blazars
  - A subtype of AGN: the jet axis is along the line of sight.
  - Optical emission is dominated by the polarized synchrotron emission from jets.
- Fermi LAT collaboration
  - “Femi” gamma-ray space telescope
  - A number of gamma-ray sources are identified with blazars.







Polarimetry Results:

Blazar 3C 279

(Abdo+10, Nature, 463, 919)

Polarization rotated with the decay from a gamma-ray flare

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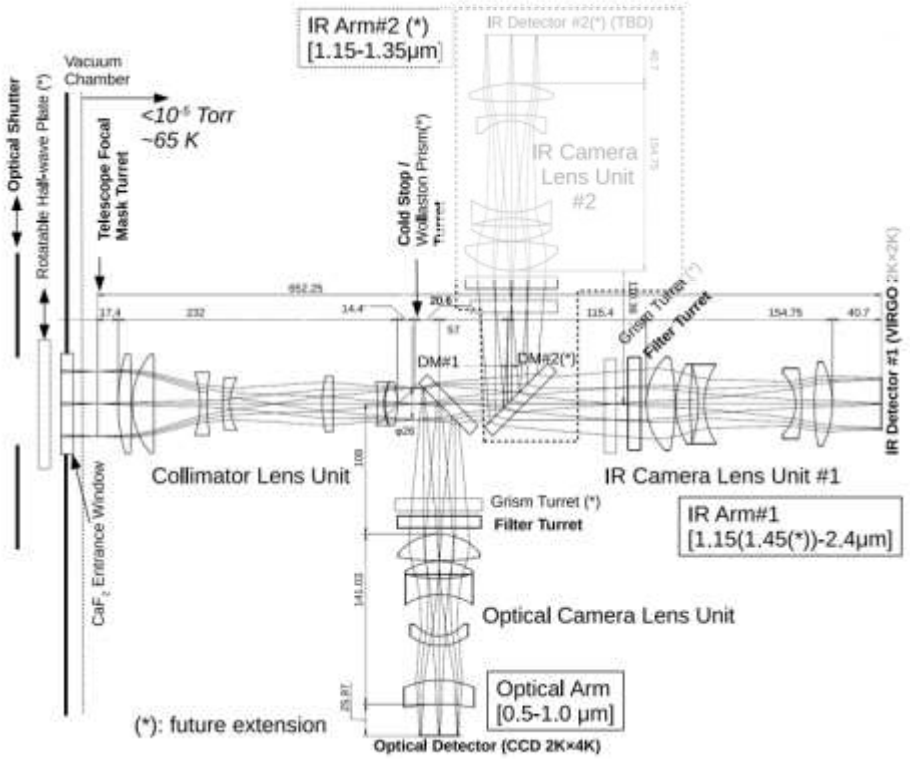
NIR-Opt. Instrument

- HONIR

(development led by Dr. Hiroshi Akitaya)

- One optical CCD
- One NIR Virgo (HgCdTe array)
- Simultaneous obs. in opt. & NIR

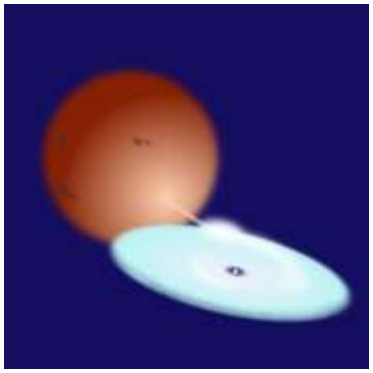


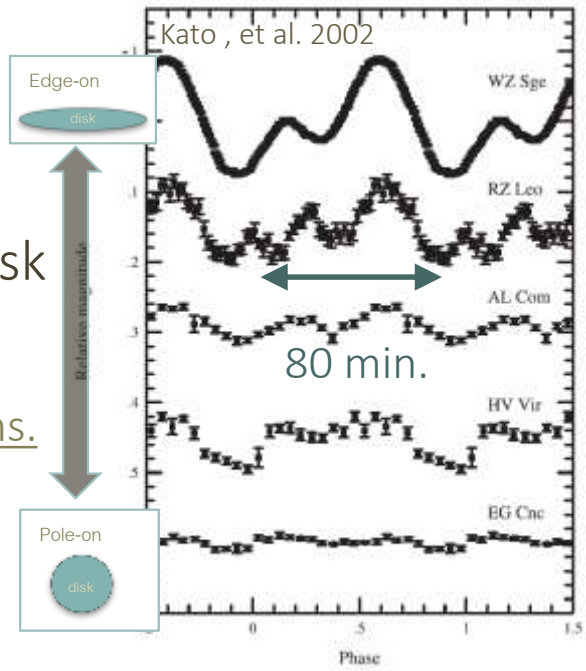
NIR-Opt.
Results:

Dwarf novae

- Dwarf novae
  - White dwarf + Roche-lobe filling late-type star
  - Outburst of the accretion disk
- "Early superhump"

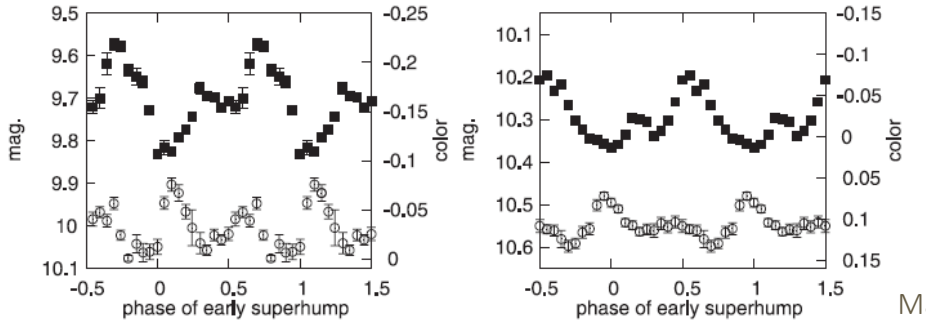
= Vertical structure of the disk





Larger amplitude
in edge-on systems.

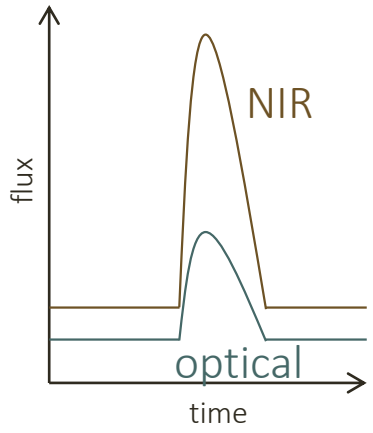
Redder when brighter



Matsui , et al. 2008

Input

Multiband light curves



Model

Bayesian estimation of the height, h(i,j)

$$P(h) \propto L[f_{\nu,obs}(\phi), f_{\nu,model}(\phi)]\pi(h)$$

Posterior　　likelihood　　prior

∗ Likelihood function　(defined by the observed and model LC)

$$L \propto \prod_{i,j} \exp -\frac{[f_{\nu_i,obs}(\phi_j) - f_{\nu_i,model}(\phi_j)]^2}{2\sigma^2}$$

∗ Prior distribution

(locally smoother)

$$\pi_{\rm smooth}(h) \propto \prod_{l,m} [\exp -\frac{(h_{l,m} - 2h_{l-1,m} + h_{l-2,m})^2}{2w^2} \exp -\frac{(h_{l,m} - 2h_{l,m-1} + h_{l,m-2})^2}{2w^2}],$$

(default image to be h=0.1r)

$$\pi_{\rm disk} \propto \begin{cases} \prod_{l,m} \exp -\frac{(h_{l,m} - h_{{\rm disk},l,m})^2}{2h^2_{{\rm disk},l,m}} & (h_{l,m} \geq 0) \\ 0 & (h_{l,m} < 0) \end{cases}$$

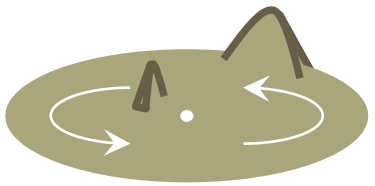
∗ Estimation of "h" is done with Markov-chained montecarlo (MCMC)

∗ The temperature distribution is like an standard disk model, as

$$T = T_{\rm in}(\frac{r}{r_{\rm in}})^{-3/4}$$

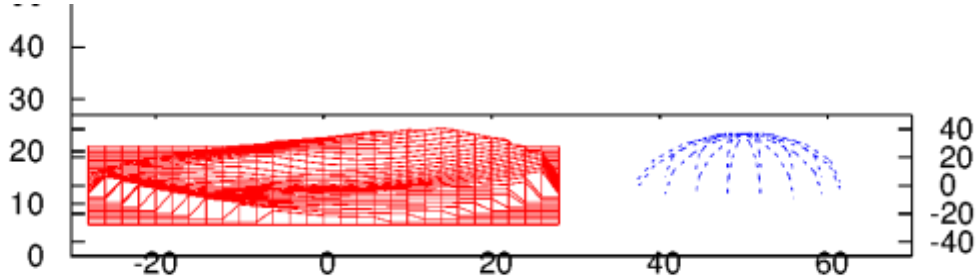
Output

Height map of disk



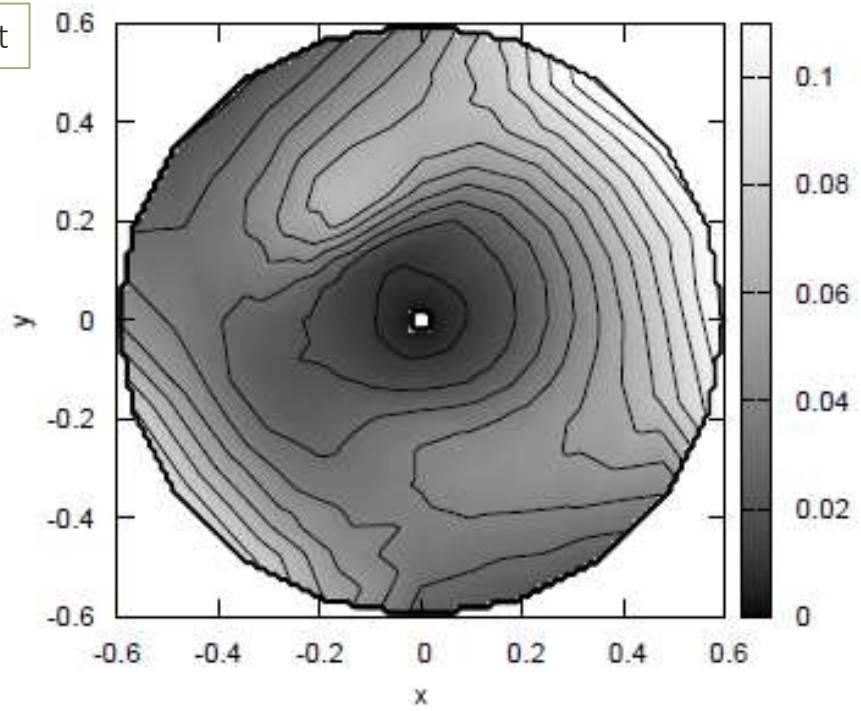
NIR-Opt.
Results:

Dwarf novae



Disk height ~ 0.1 radius
(too high for a standard disk model)

Disk height



Future project

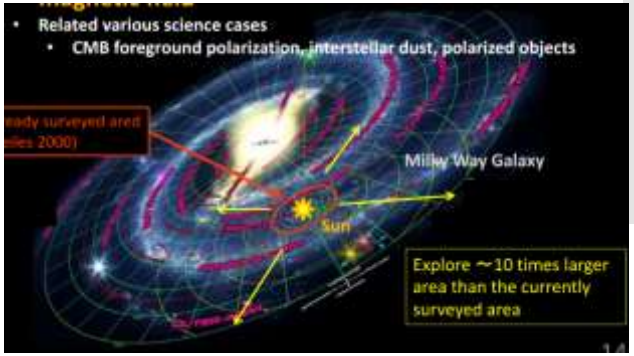
- HinOTORI
  - EM follow-up observation for GW events
  - 50cm telescope at Tibet
- SGMAP
  - Polarization survey
  - 2-m telescope in Hiroshima

Alt. 5100-m. Ali site

50-cm telescope in Hiroshima

New 2-m telescope

Survey area



Introduction of research activity in Hiroshima University

Summary

- Our telescope is small, but instruments are unique
  - Especially for observations of transients
- Polarization
  - High polarization degree of GRB 091208B
  - Rotation of polarization angle in 3C 279
- Near-infrared observations
  - Reconstruction of accretion disks in dwarf novae
- Future plan
  - HinOTORI: EM follow-up of GW events
  - SGMAP: Polarization survey project