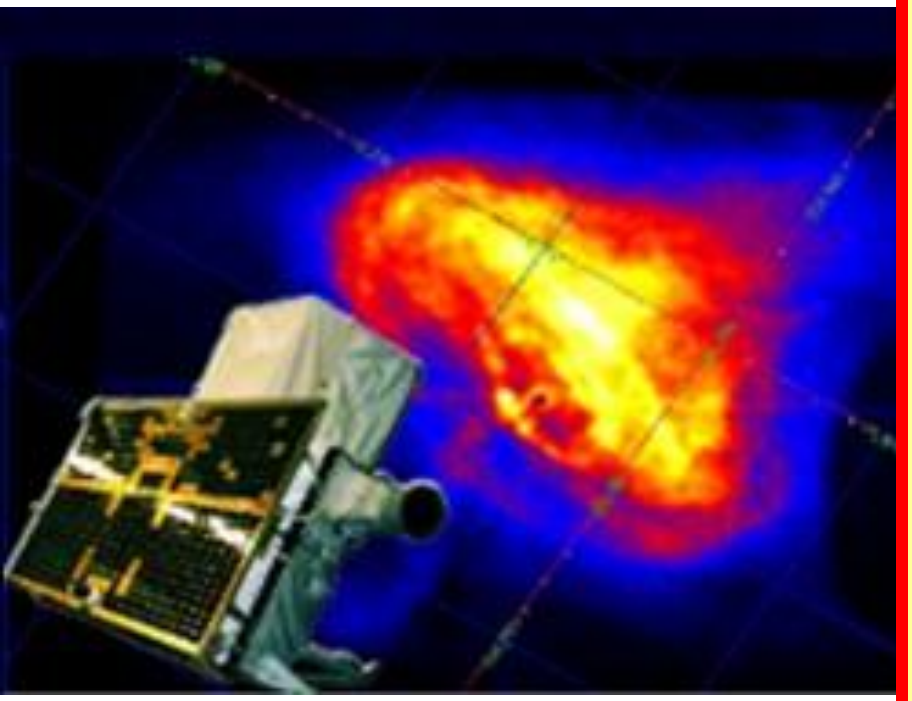
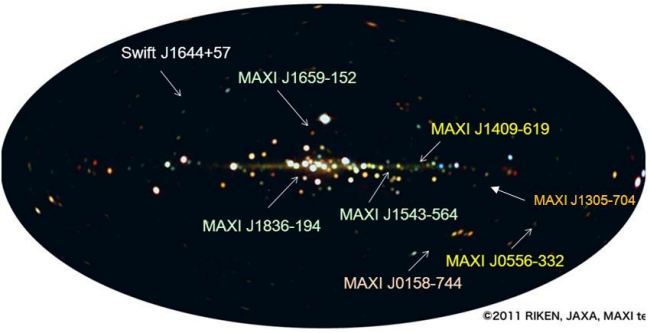
New MAXI Results

Tatehiro Mihara
(RIKEN, Japan)
and
the MAXI team



Congratulations !
upon
the Rossi Prize
to
prof. Marco Tavani
and
the AGILE team

New MAXI Results



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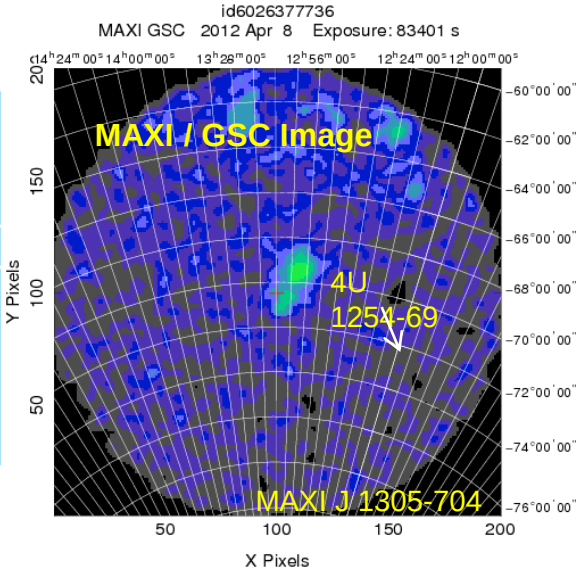
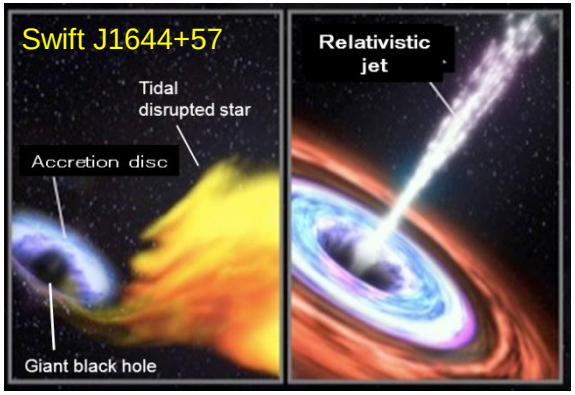
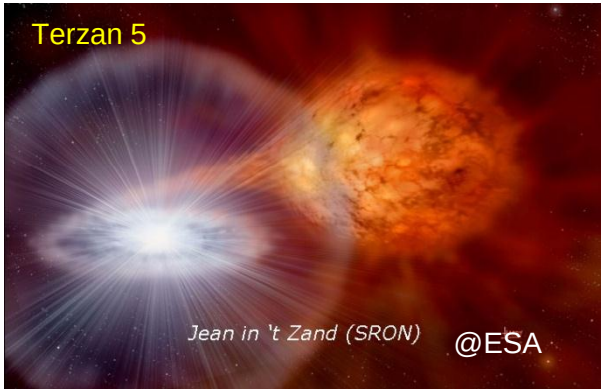
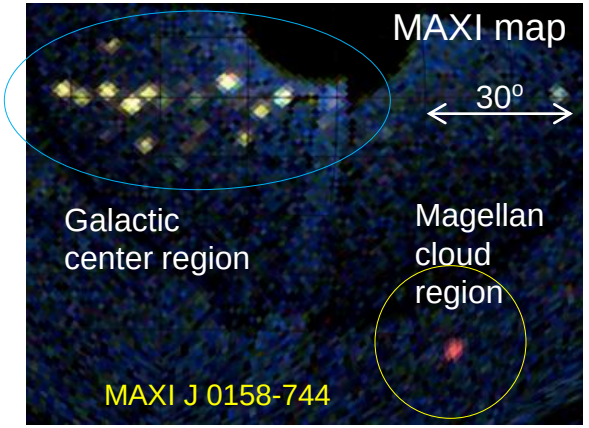
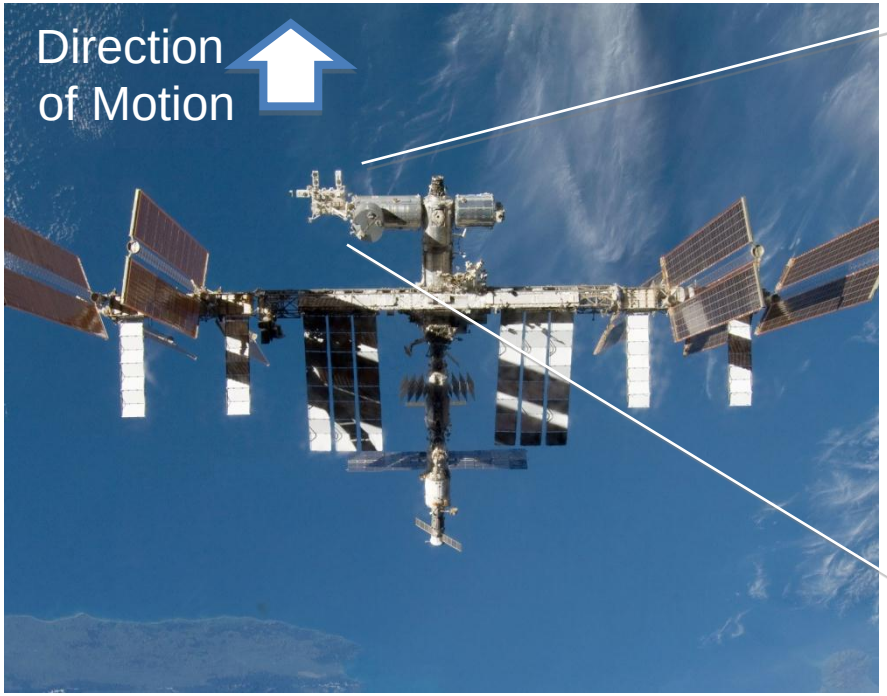


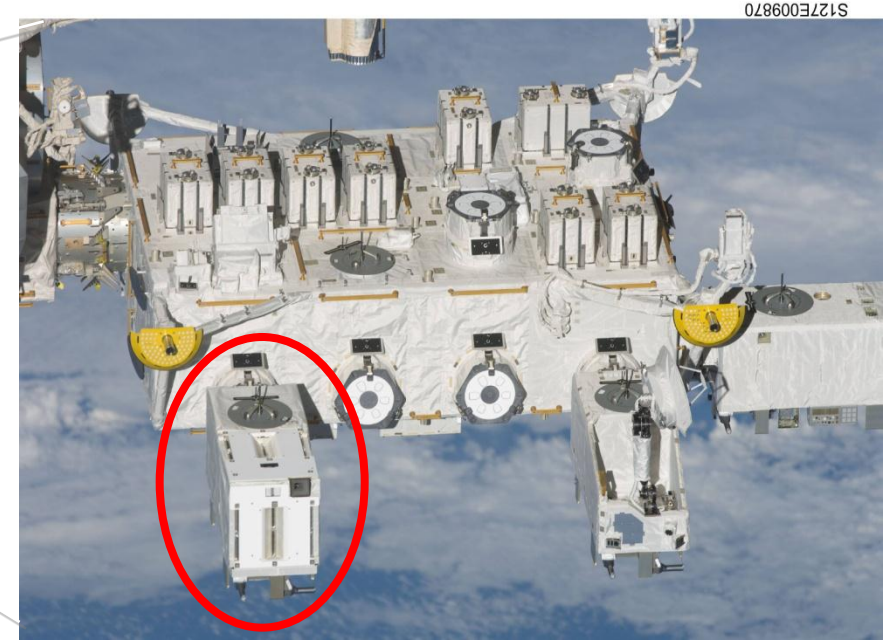






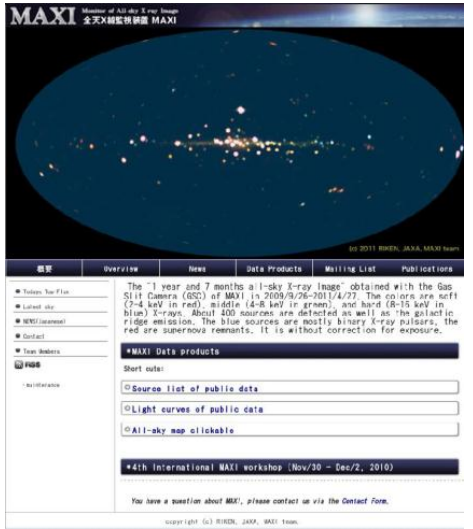
MAXI (Monitor of All-sky X-ray Image) on ISS





MAXI

- The first astronomical mission on ISS
- Attached on ISS experimental module on July 23 2009.
- First Light on August 15 2009.
- The data are open from http://maxi.riken.jp



MAXI Payload

Gas Slit Cameras (GSC)

Xe-filled proportional counter

2—30 keV; 5350 cm^2

FOV of 6 cameras

GPS

Loop Heat Pipe RS

SSC-HZ X-ray CCD 16 chips x 2 cameras

GSC-Z

Visual Star Camera

80cm

107cm

RBM-Z

ATCS

185cm

H

160deg

Ring Laser Gyro

PDAP

DP

MDP

FOV of 6 cameras

RBM-H

ISS motion

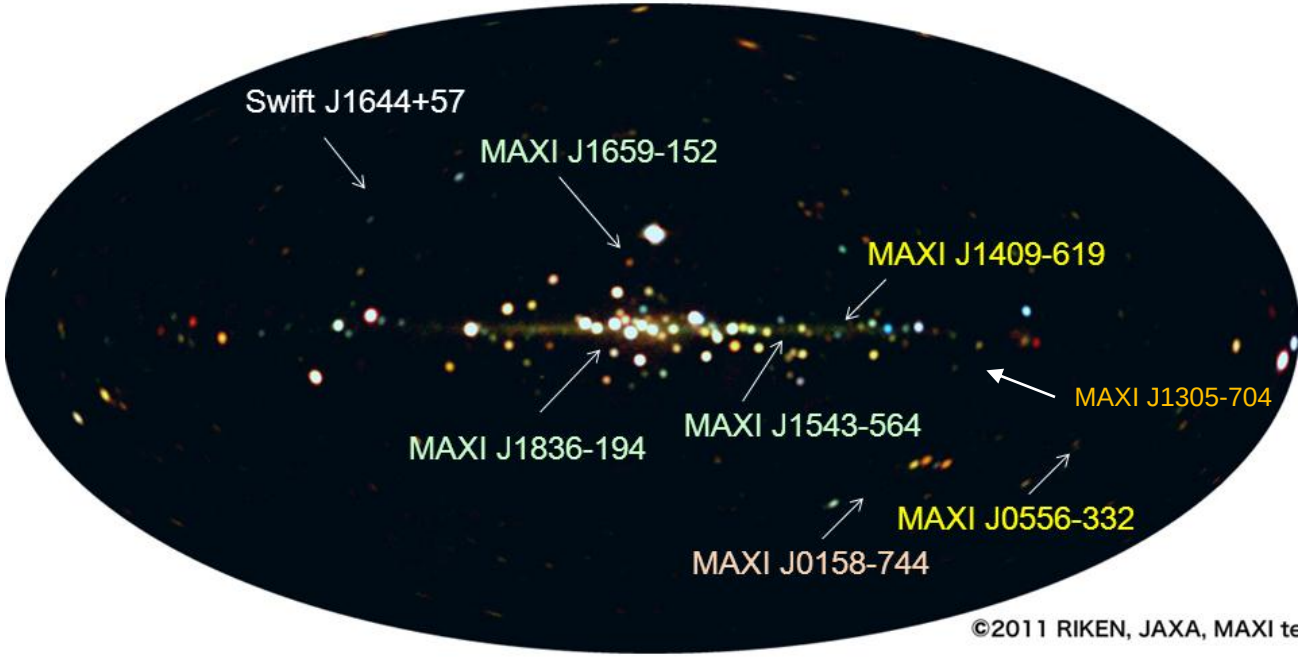
1.5deg (FWHM)

MAXI discovered

22 new sources and 43 stellar flares **in 2 years and 7 months :**

7 MAXI-sources and 15 gamma-ray bursts / X-ray Flashes

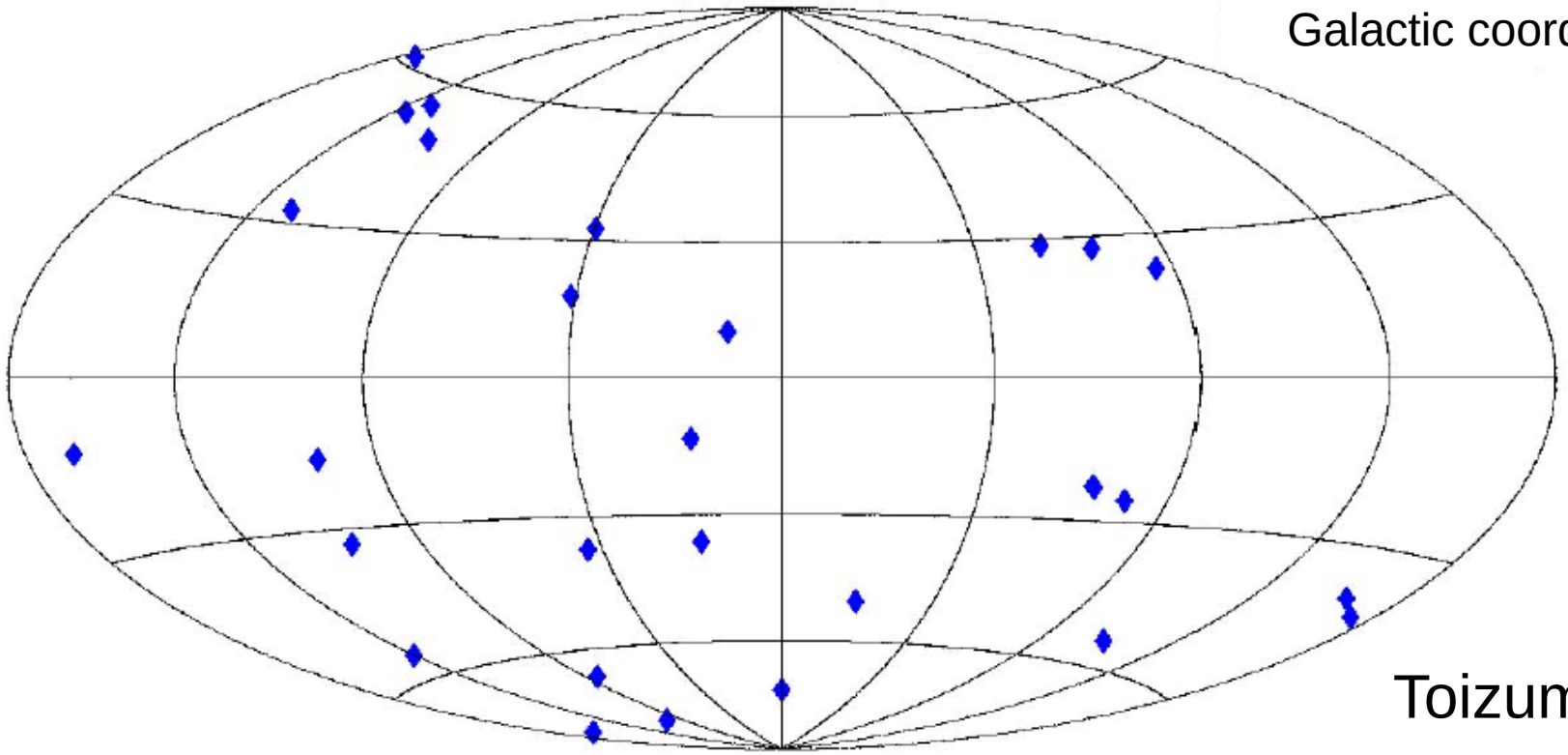
(3 blackholes, 2 neutron stars, 1 nova (SSS), 1 in observing).



All Sky X-ray Map by MAXI/GSC

Unbiased transient search

1 year and 3 months: 2009/10/01 – 2010/12/31, 4-10 keV



Toizumi Ph.D.

29 transients (with significance > 9σ, ～100 mCrab)
(8 GRBs, 3 stellar flares, 2 known sources, 15 unID)

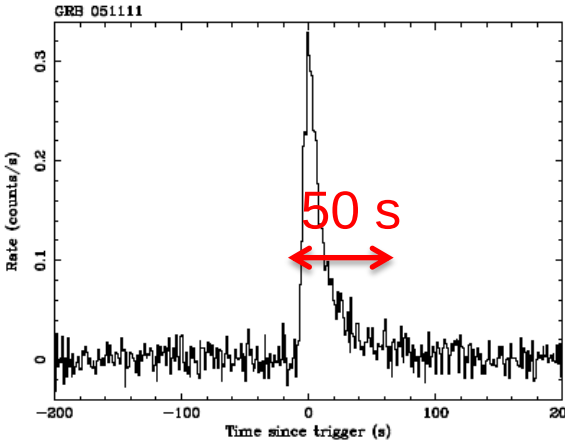
<cosθ> = 0.04 +- 0.17
<V/V$_{max}$> = = 0.52 +- 0.05

uniform
Euclidean space

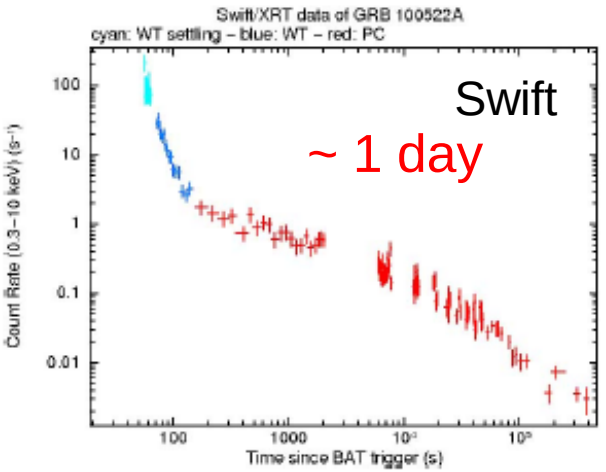
uniformly distributed Short (1～several scans) X-ray Transients

Candidates (popular)

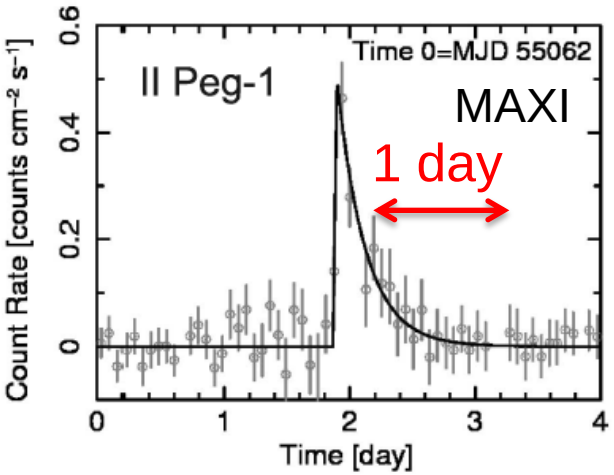
Gamma-ray bursts(GRB)
X-ray Flash(XRF)



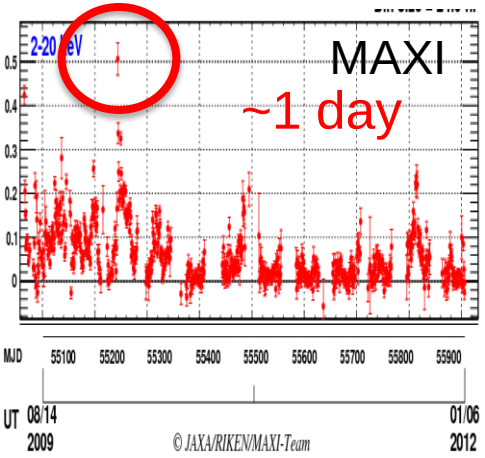
GRB Afterglow



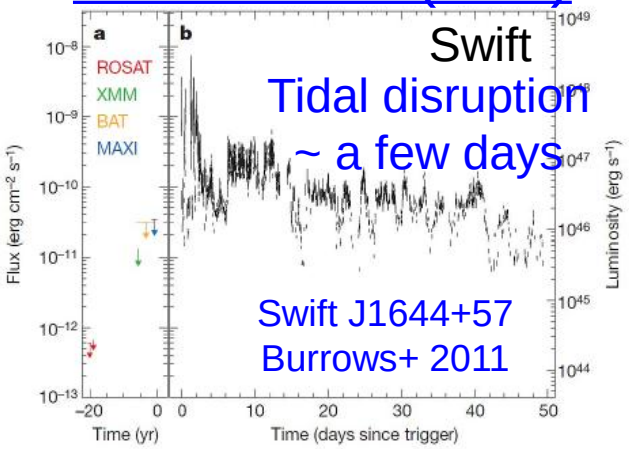
Stellar flares



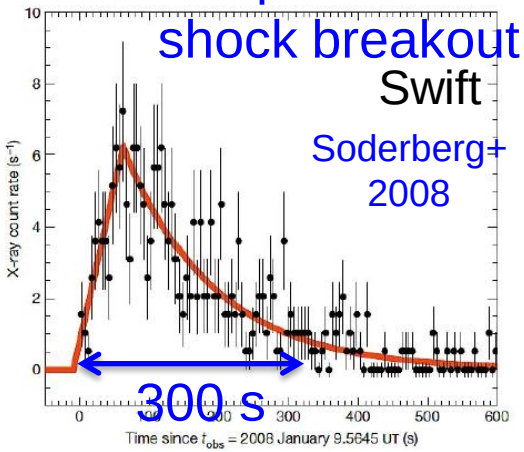
Blazar flares



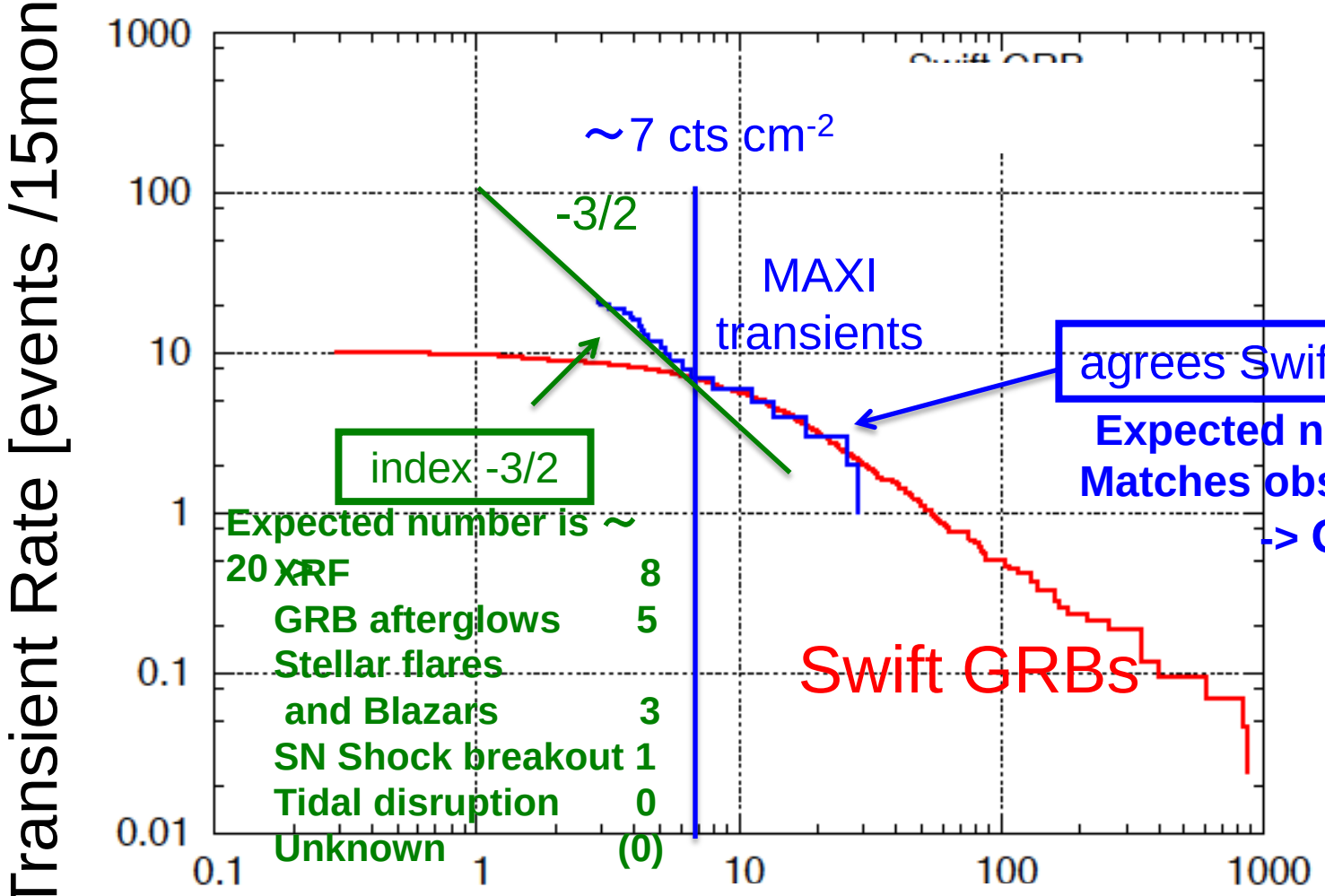
Candidates (rare)



Super Nova shock breakout



Log N - Log S of 29 transients



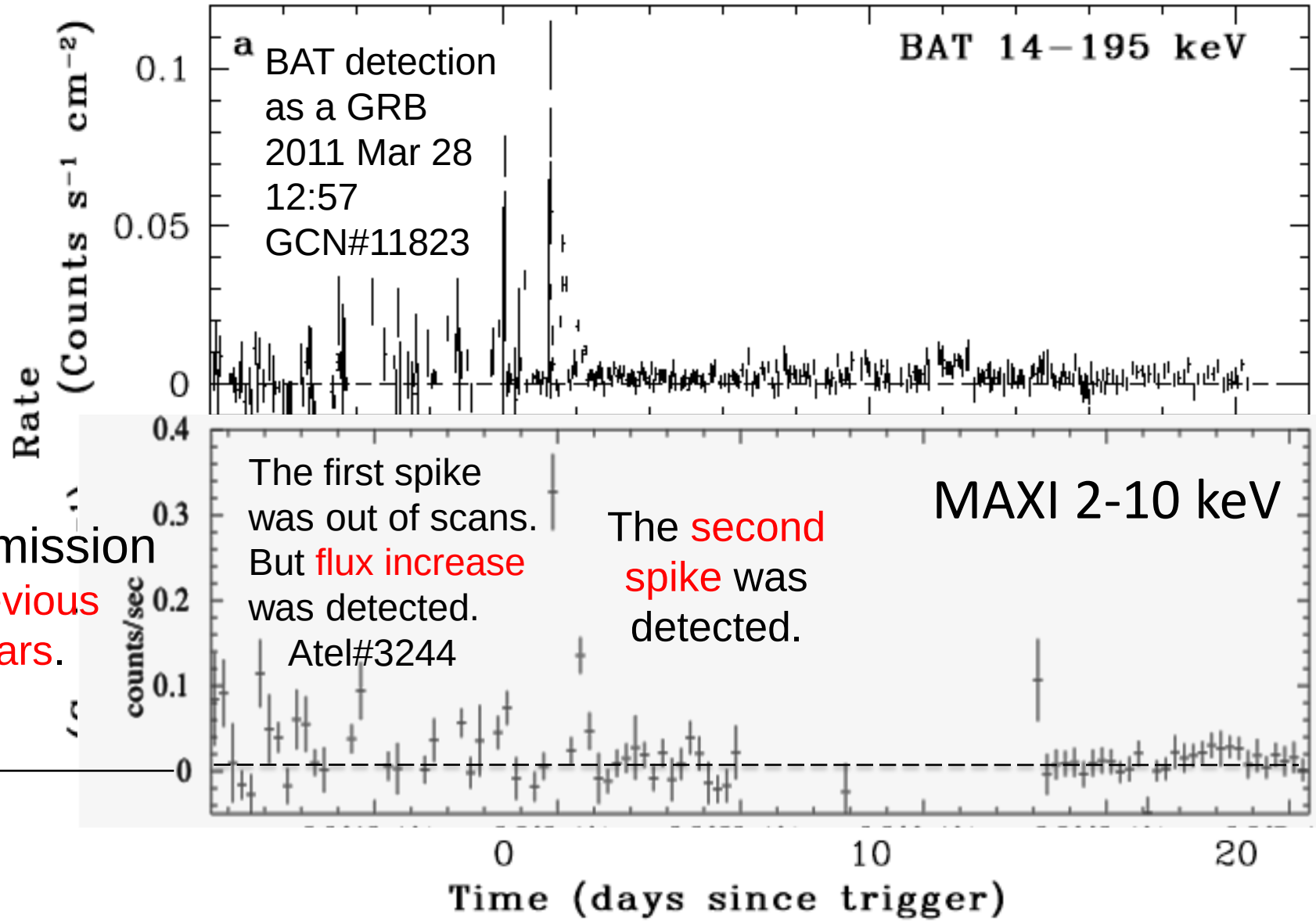
Toizumi Ph.D.

⇒ So far, no need of unknown objects.

MAXI topics this year

- SwJ1644+57 : tidal disruption
- Terzan 5 : super burst and accretion outburst
- MAXI J0158-744 : peculiar type of Nova
- Recent discovery of MAXI J1305-704

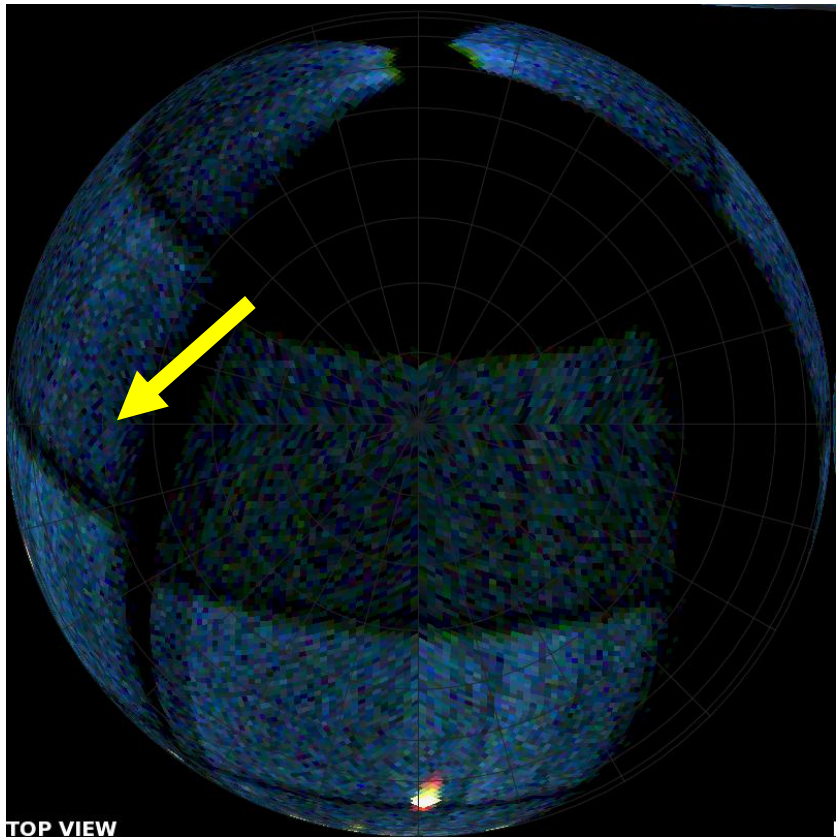
Swift J1644+57 (Nature Burrows+ 2011)
Light curves by Swift/BAT and MAXI

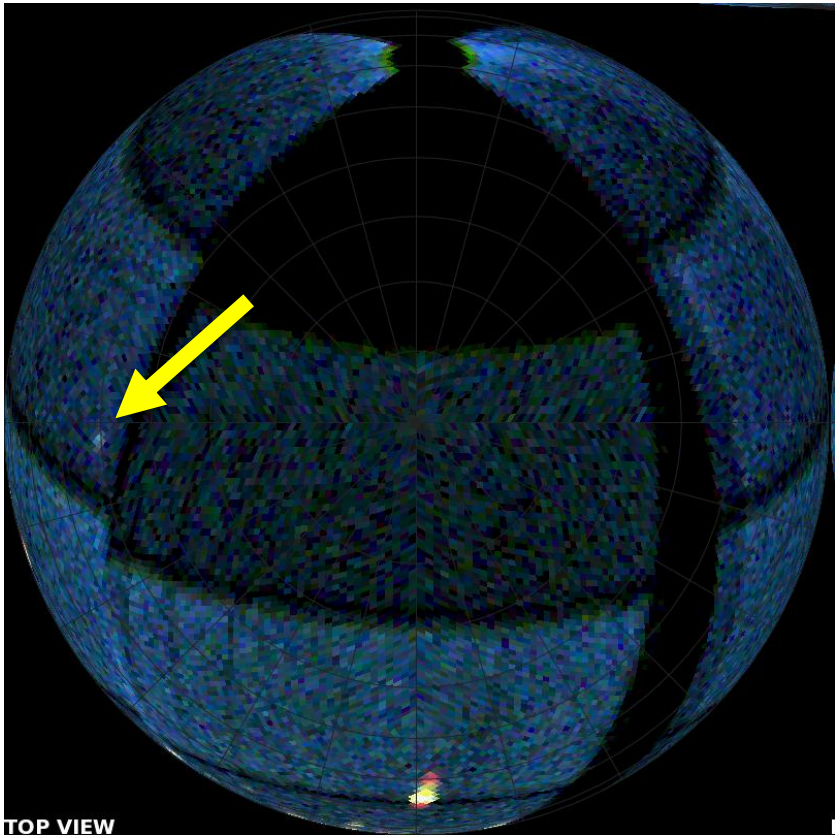


No emission
for previous
1.5 years.

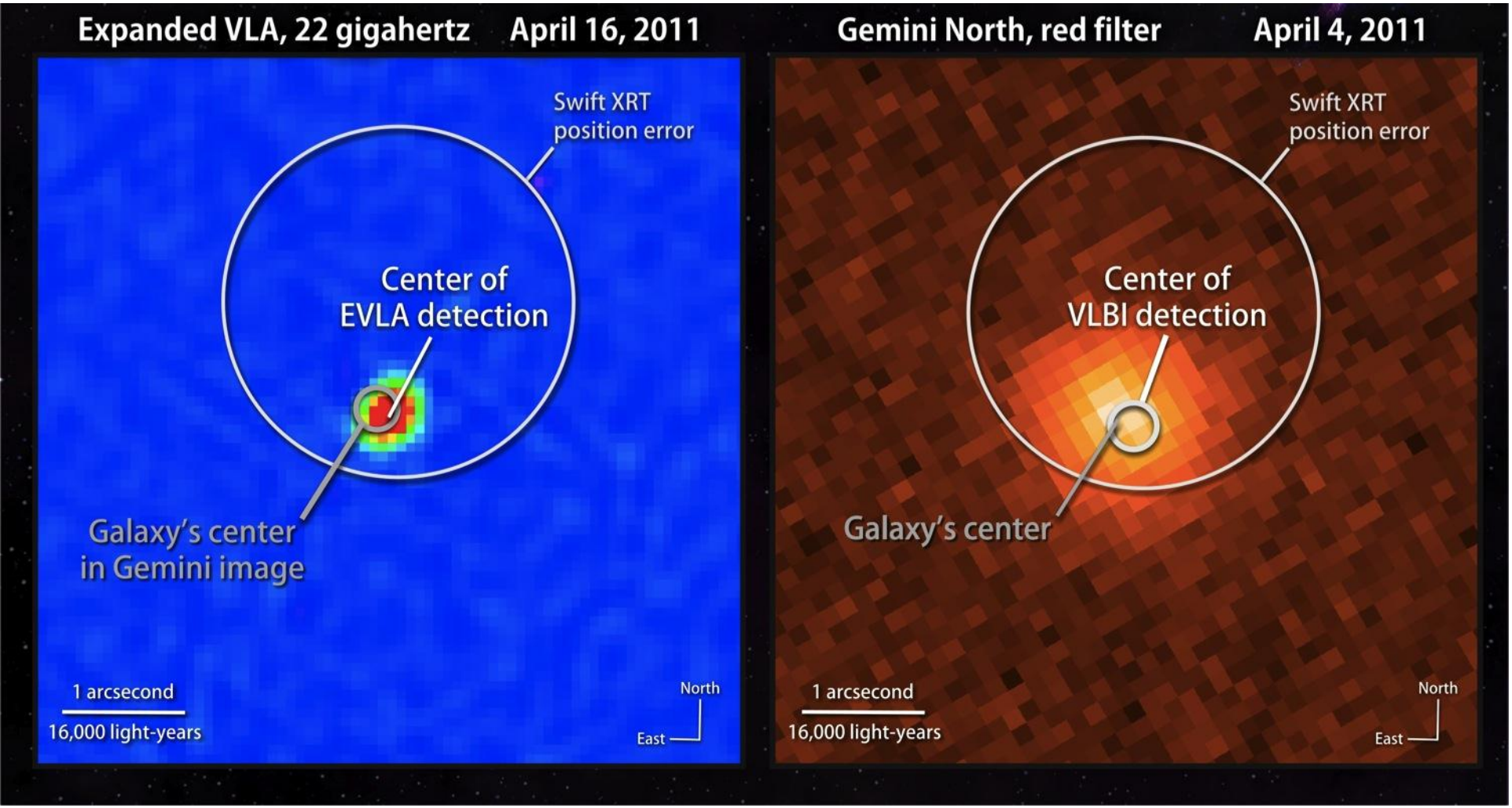
Swift J1644+57

Before and after the break with MAXI





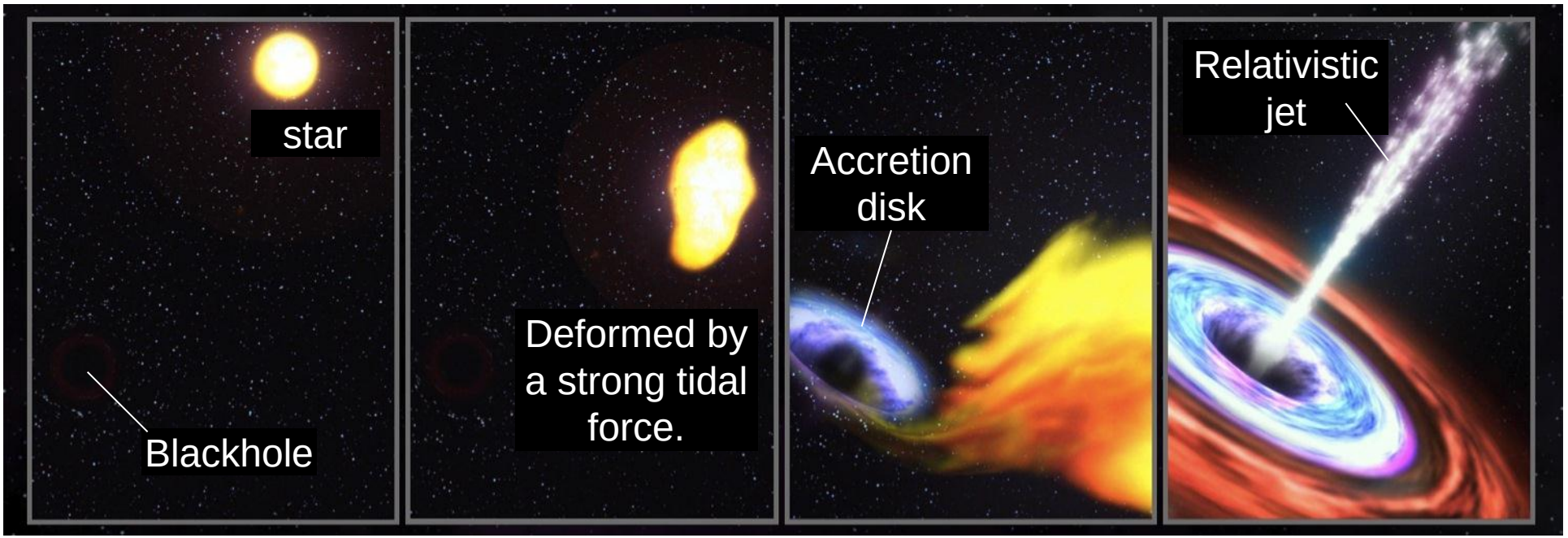
Localizede at the galaxy center by radio observation



Swift J1644+57 : relativistic jet

Huge energy, center of a galaxy, mass accreted, X-ray & radio

⇒ Tidal disruption of a star by a sleeping massive BH



A star approaches a blackhole in the center of a galaxy.

The strong tidal force deforms the star. When the star is too close to the blackhole, it is broken into pieces.

A part of the star falls towards the blackhole and forms an accretion disk. Other parts spread into space.

A narrow jet with almost speed of light is formed near the blackhole by the magnetic field. It appears as a strong X-ray source and a strong radio source when observed from the jet direction.

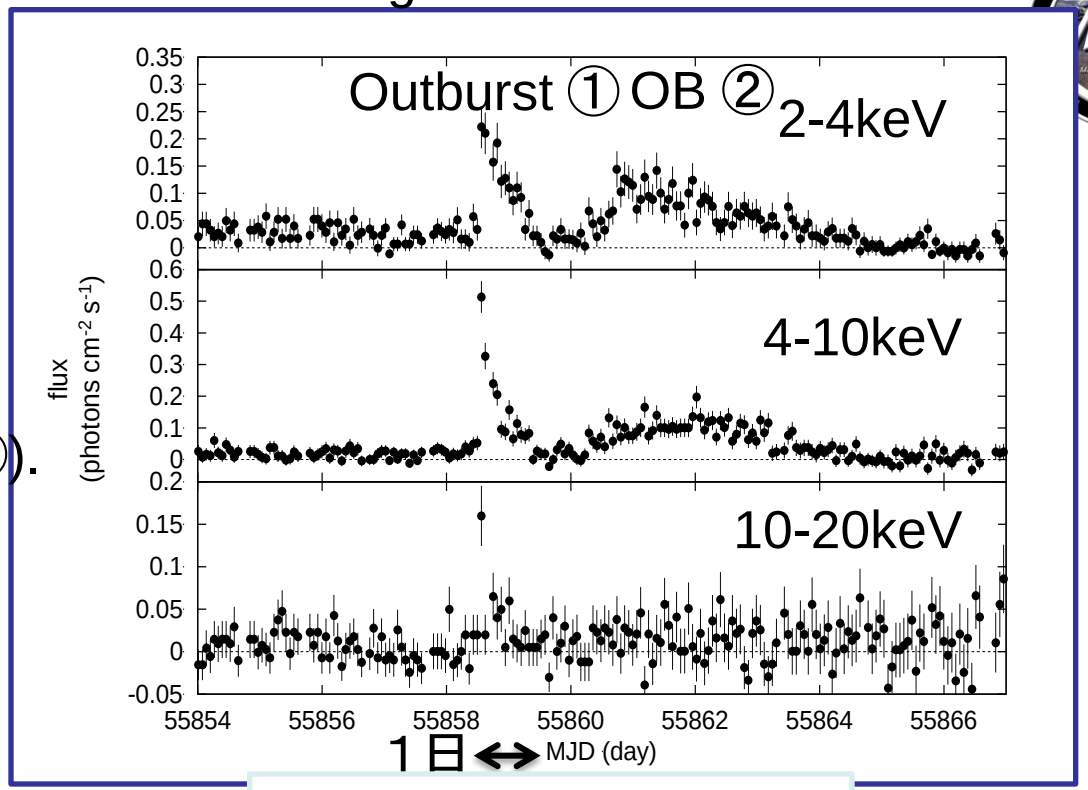
MAXI topics this year

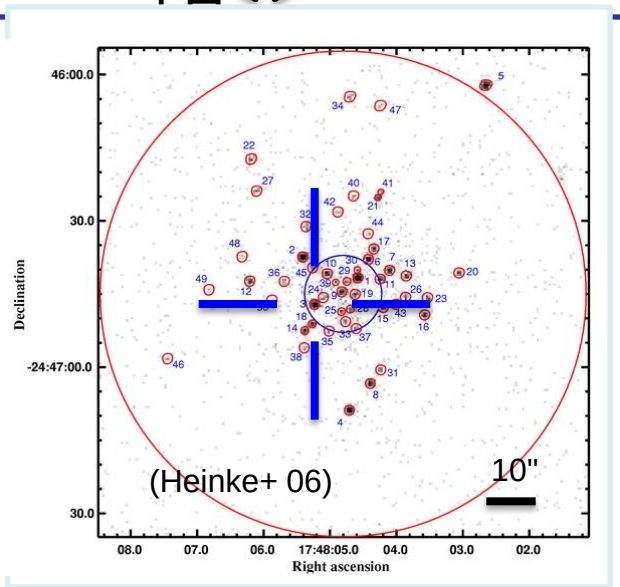
- SwJ1644+57 : tidal disruption
- Terzan 5 : super burst and accretion outburst
- MAXI J0158-744 : peculiar type of Nova
- Recent discovery of MAXI J1305-704

Super burst detection

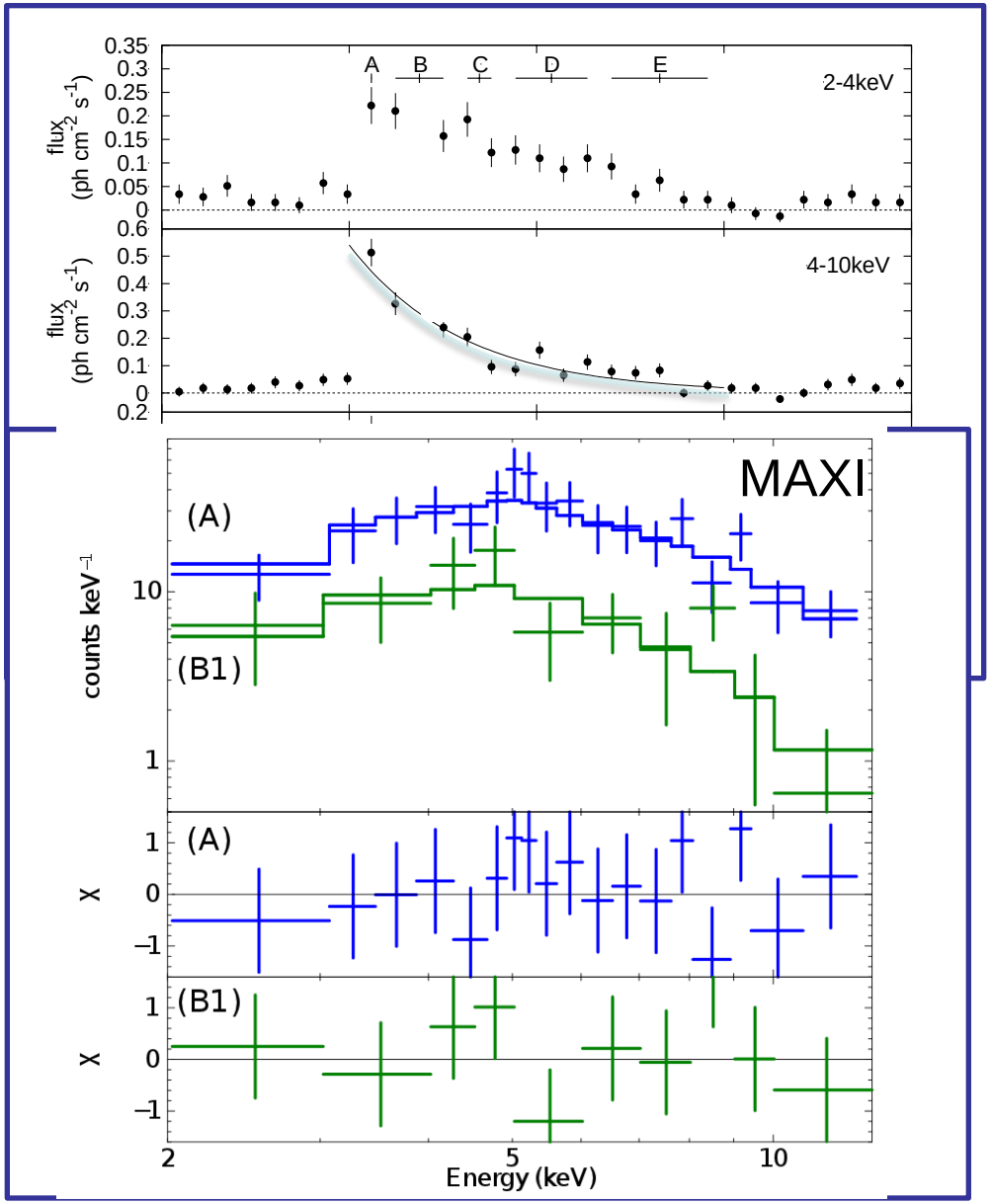
- MAXI detected a 0.4 Crab flare from a globular cluster Terzan 5 at 2011 Oct 24.
- Disappeared in 1 day (OB ①).
- Rebrightened again and lasted for 5 days (OB ②).
- OB① was by MAXI only.
- OB② were by RXTE, Swift, Chandra.
  - identified to EXO 1745-248.
  - Two-component spectrum.
- A series of activity probably indicates both came from the same source.
- OB① is a superburst, OB② is an accretion outburst.

MAXI Light curve 90minutes / bin





Super burst ?



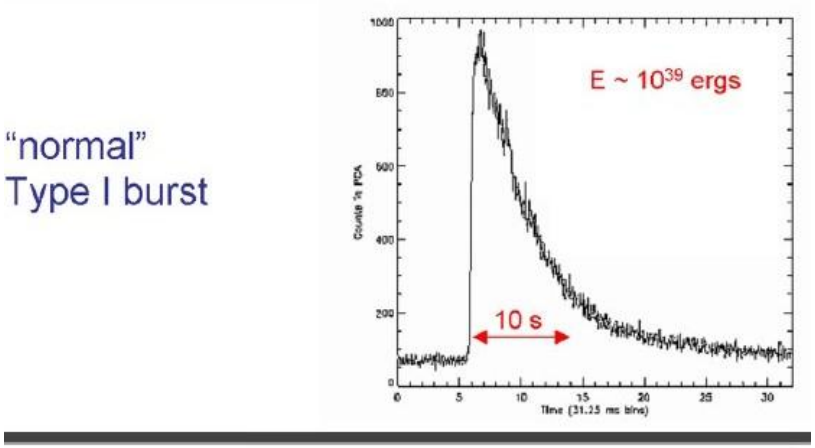
- Rapid rise, exponential decay.
- Decay time scale is 0.3 day.
- Integrated flux is 1.4×10^{42} erg

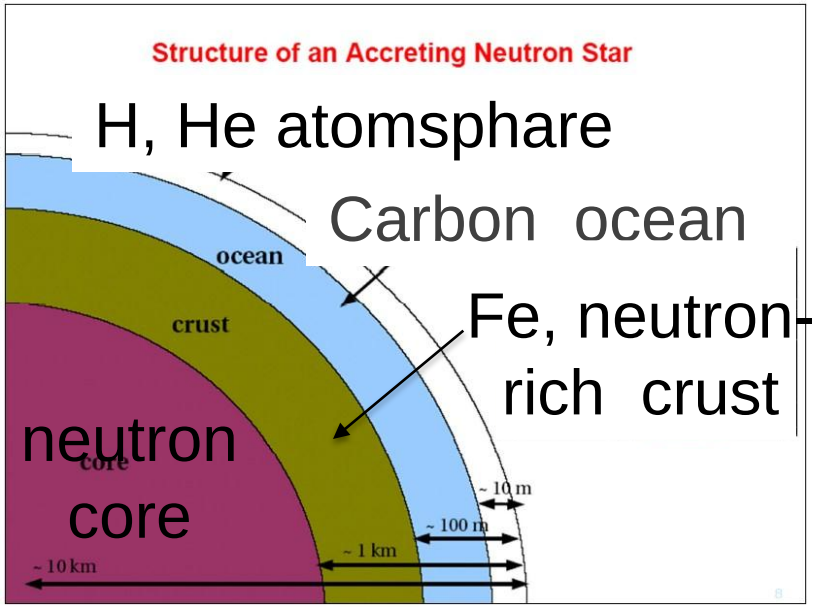
- Black body Spectrum.
- Radius ~ 6 km
- Temperature 2.2 ⇒ 1.2 keV
- Showed cooling.

Super burst is

- Type I X-ray burst, a thermo-nuclear fusion on the NS surface, but lasts for a long time (>30minutes)
  - Long duration
    ⇒ ignition in high density
    ⇒ Carbon ignition
  - Released energy is large compared to the recurrent time.
  - Carbon fraction is small (Xc～0.1). Mainly H and He burnning.
- SB discovered in1996 by BeppoSAX（4U 1735-44 Cornelisse+ 2000)。
- Still a rare phenomenon（20 SB from 10 objects.)

KS 1731-260 (Kuulkers+ 2002)





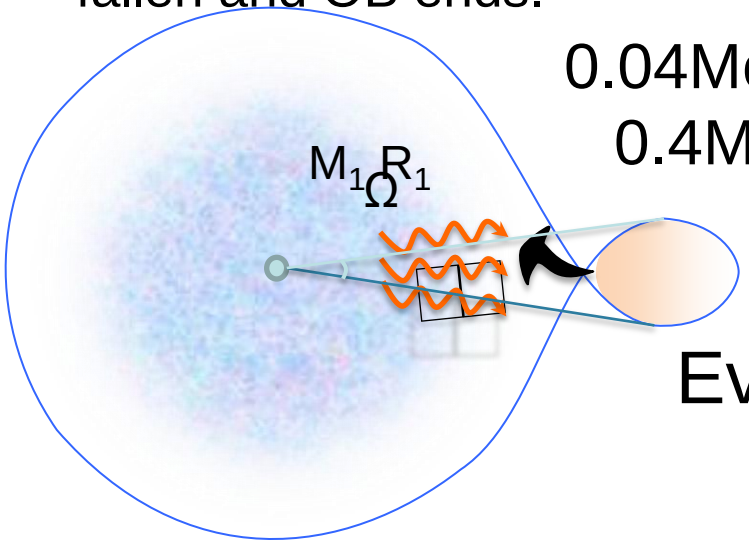
Super burst and accretion outburst

	duration	Total energy
Super burst	τ= 0.3 day	1.4×10^{42} erg
Outburst	5 day	4.3×10^{42} erg

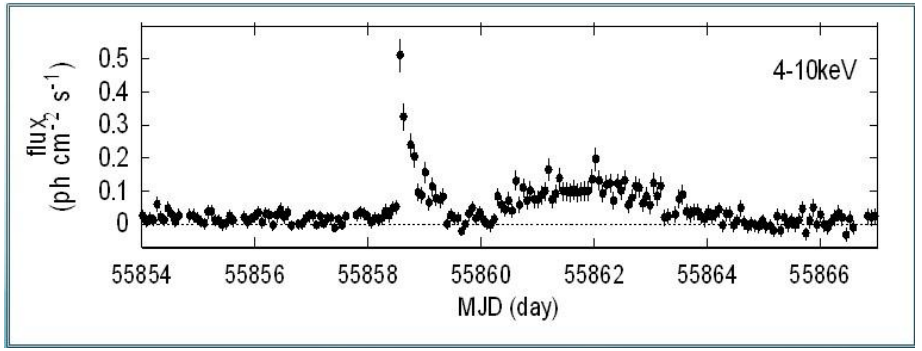
Very short outburst（normally lasting for 100 days.）

↓

1. Superburst excites a disk instability. The disk gas has fallen and OB ends.
2. Superburst heats up the surface of the companion. The evaporated gas has fallen and OB ends.



0.04Mo～
0.4Mo



Evaporating 4～400g cm^{-2}
from the surface ?

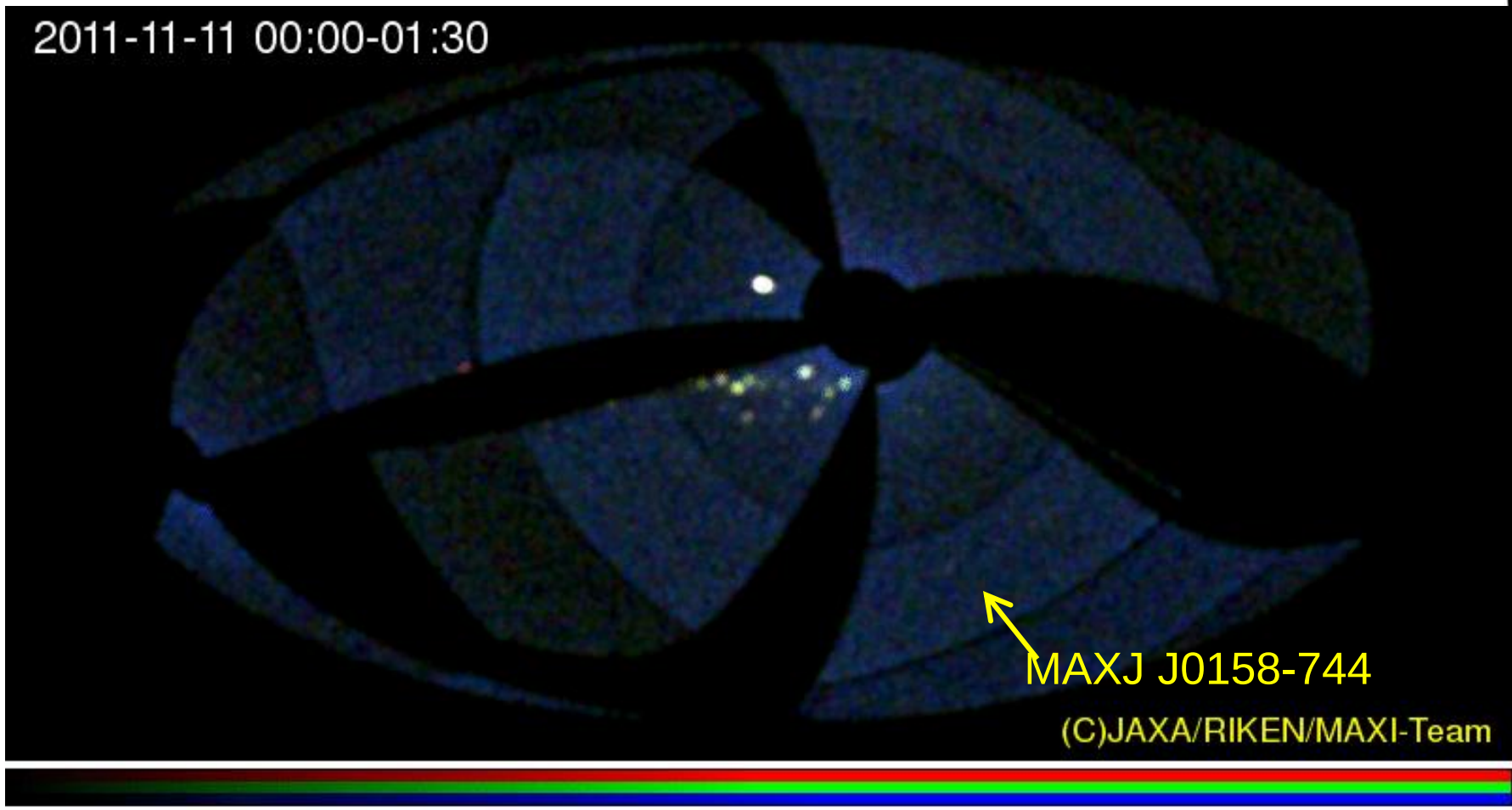
Super burst from Terzan 5

- A super burst from EXO 1745-248.
  It was 4th detection with MAXI.
  - e-folding time (0.3 day)、fluence (1.2×10^{42} erg)、radius(6km)、Tempetrature (2.2-1.2keV) are typical for SB.
- Accretion outburst started 1-day after the SB, and lasted for only 5 days. - First example
- Accreted matter can be of accretion disk, or of evaporated surface of the low-mass companion.
- Serino et al.(2012) PASJ 64, No.5 (**astro-ph:1203.1141**)

MAXI topics this year

- SwJ1644+57 : tidal disruption
- Terzan 5 : super burst and accretion outburst
- MAXI J0158-744 : peculiar type of Nova
- Recent discovery of MAXI J1305-704

MAXI J0158-744 discovery

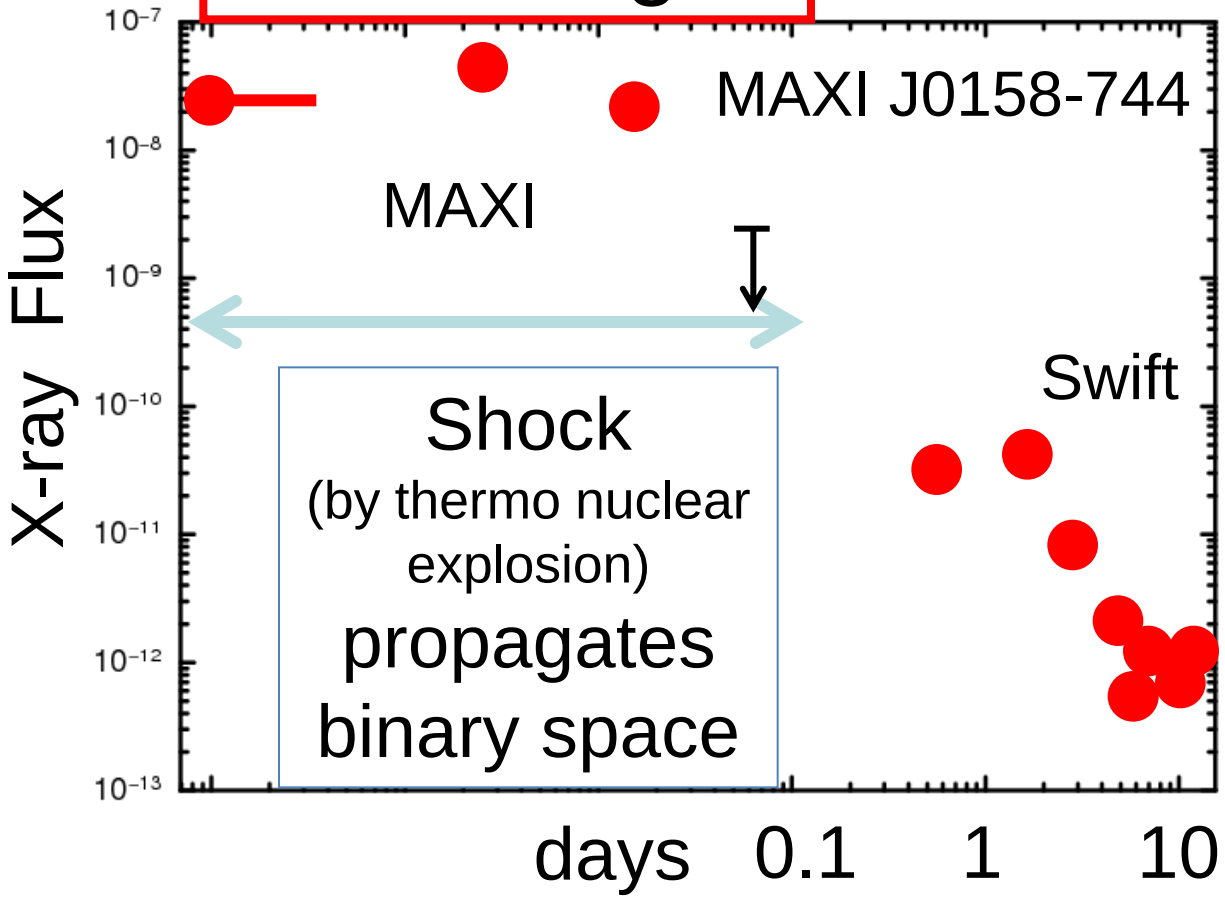


- MAXI GSC **2-4 keV** **4-10 keV** **10-20 keV**
- All-sky scan image
- Galactic coordinate
- every 90 minutes

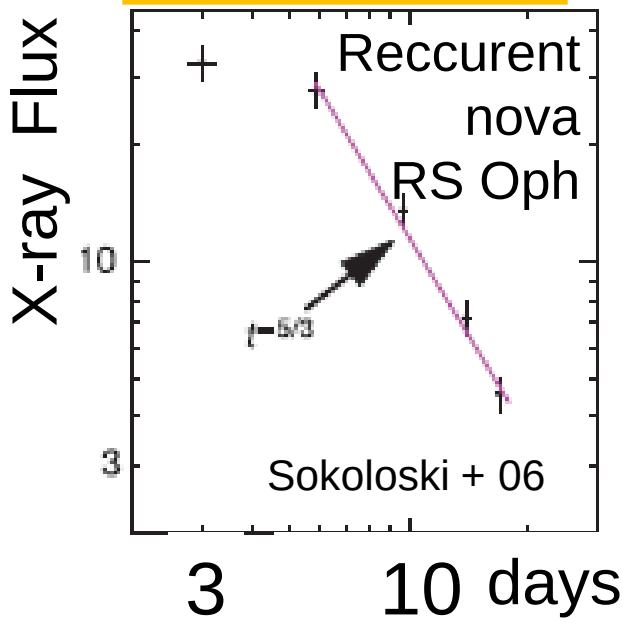
- 2011. 11. 11 05:05:59
- Near SMC (61 kpc) (very luminous)
- Only 1 scan. Very soft (mostly 2-4 keV)

1. Very luminous, quick decline

6×10^{38} erg /s

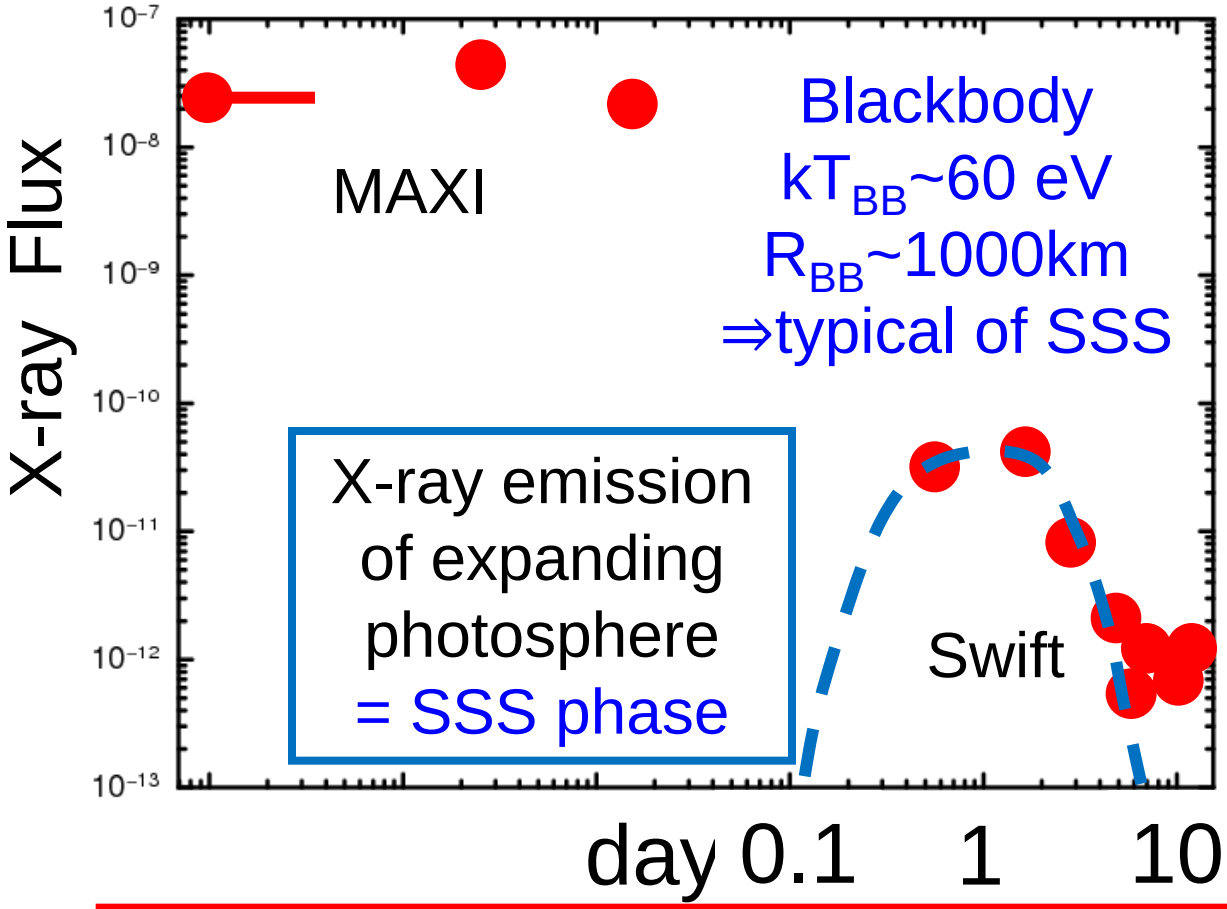


10^{36} erg /s

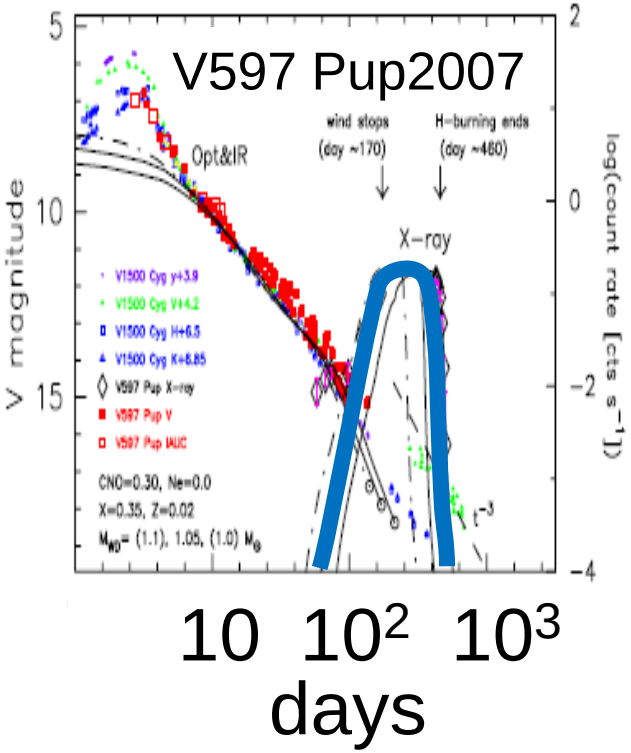


Peak Luminosity : x 100 brighter
Decline : x 10-100 faster

2. Short SSS phase, no optical Nova



Hachisu & Kato 2010

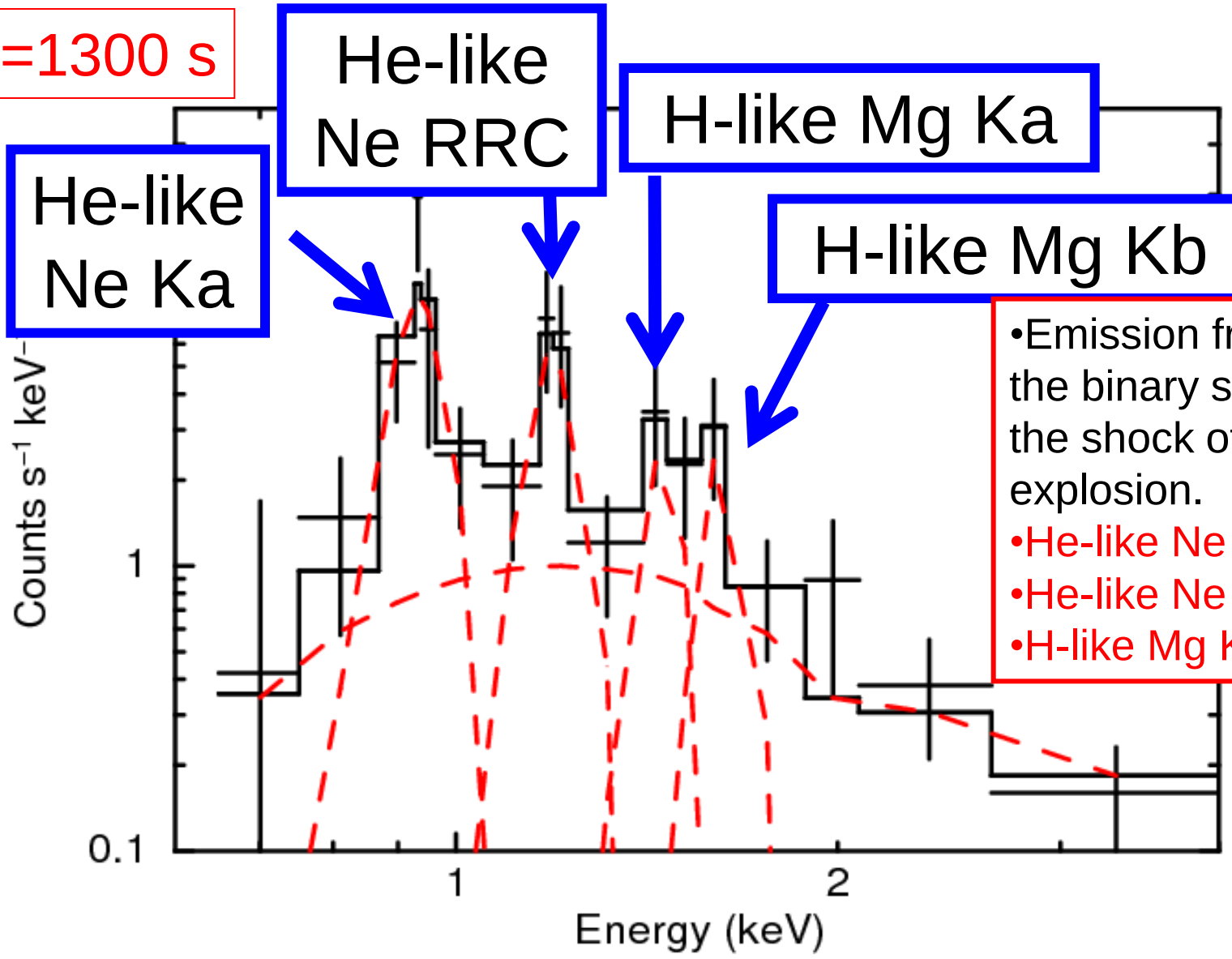


SSS phase: 0.5 - 5 days << 100 days

Optical Nova phase : ended before 0.5 day ?

3. Emission lines by MAXI/SSC

T =1300 s

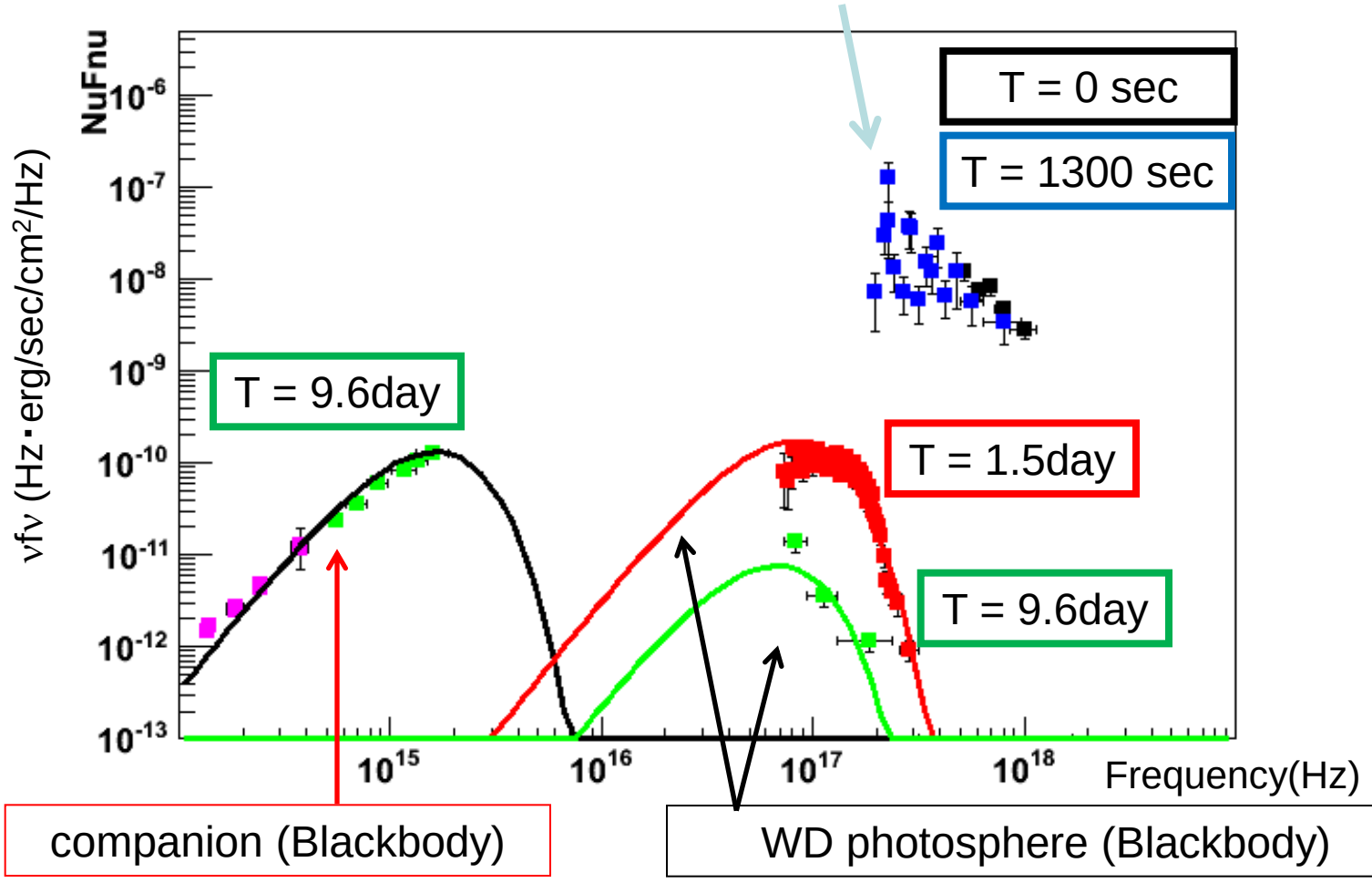


- Emission from the plasma in the binary space heated by the shock of the nova explosion.
- He-like Ne Ka (95% C.L.)
- He-like Ne RRC (90% C.L.)
- H-like Mg Kb (90% C.L.)

4. Hot and luminous companion

Optical - X ray spectrum

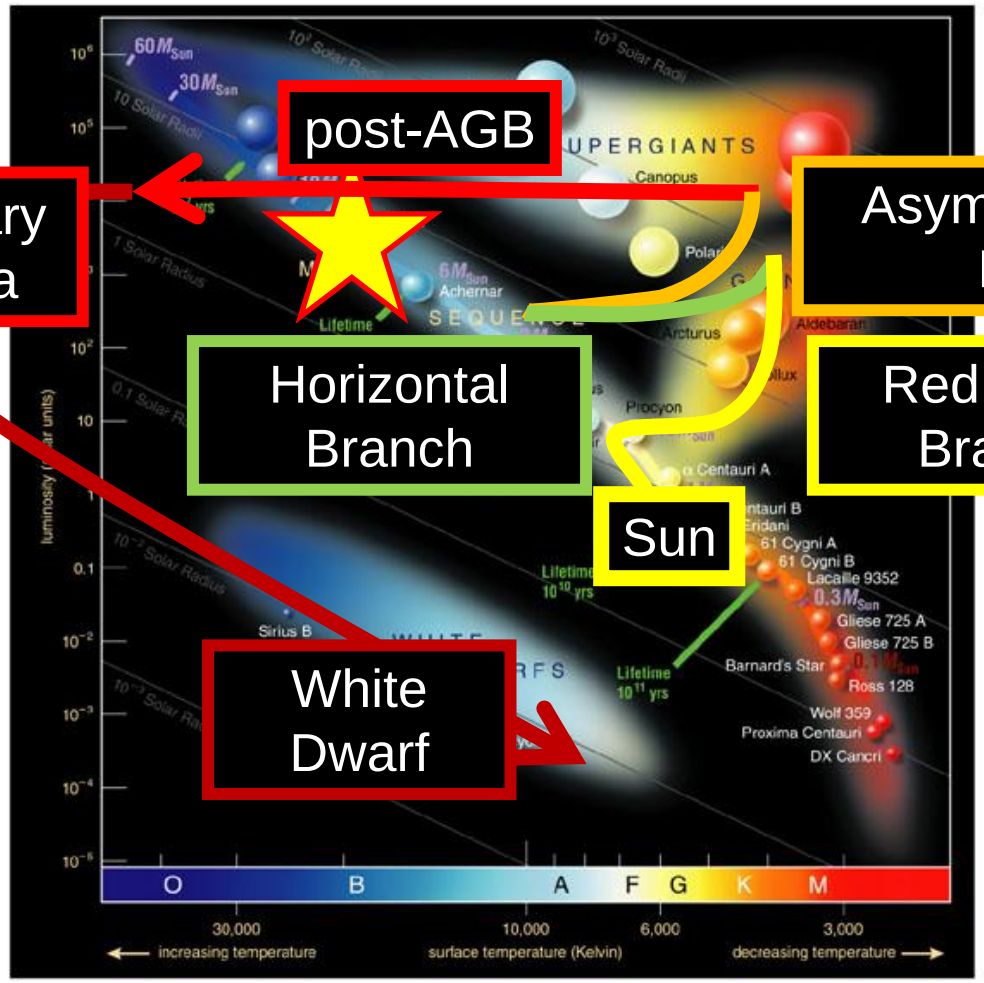
Nova Shock Breakout (Thin thermal)



Temperature : 2 x 10^4 K, Luminosity : 1.4 x 10^4 Lsolar

Companion star of MAXI J0158-744

HR diagram



B-Type star
~ 8 Solar mass

Binary of WD and B-type star

post-AGB star

MAXI J0158-744 is

- A binary of WD and post AGB star
  - Post AGB star had a large mass-loss
  - making a dense ambient matter
  - Heavy shock
  - Very luminous, cools down quickly
- Short SSS phase
  - Close to Chandrasekhar limit (Hachisu et al.)
  - A progenitor of a supernova (type Ia, IIn)

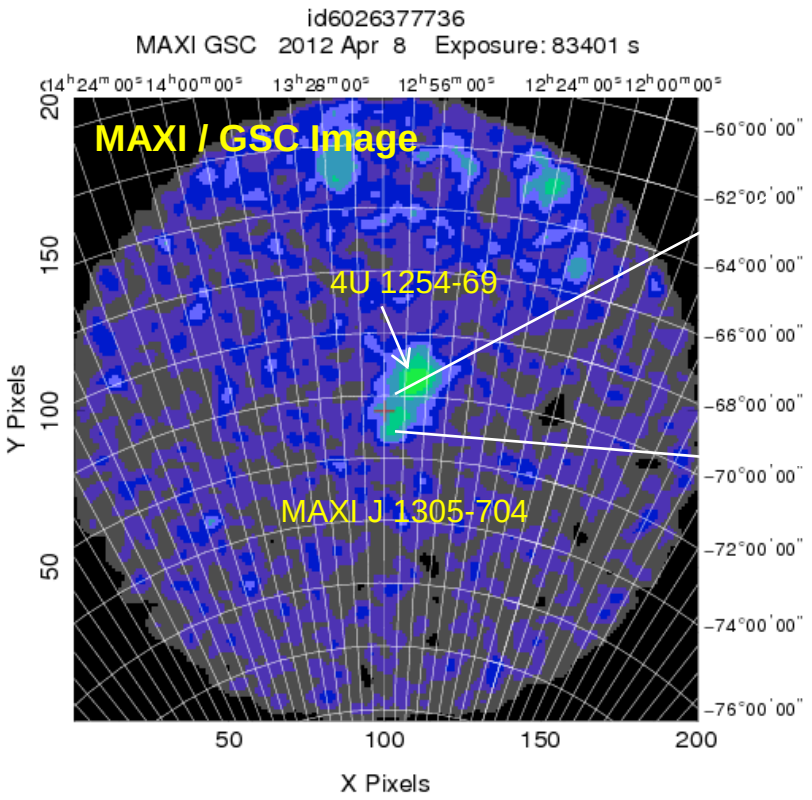
Morii in preparation

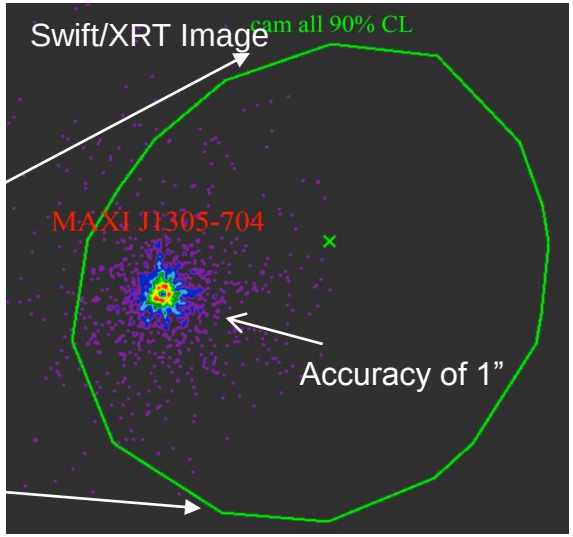
MAXI topics this year

- SwJ1644+57 : tidal disruption
- Terzan 5 : super burst and accretion outburst
- MAXI J0158-744 : peculiar type of Nova
- Recent discovery of MAXI J1305-704

BH or NS ? still unknown

MAXI J1305-704 discovered last week



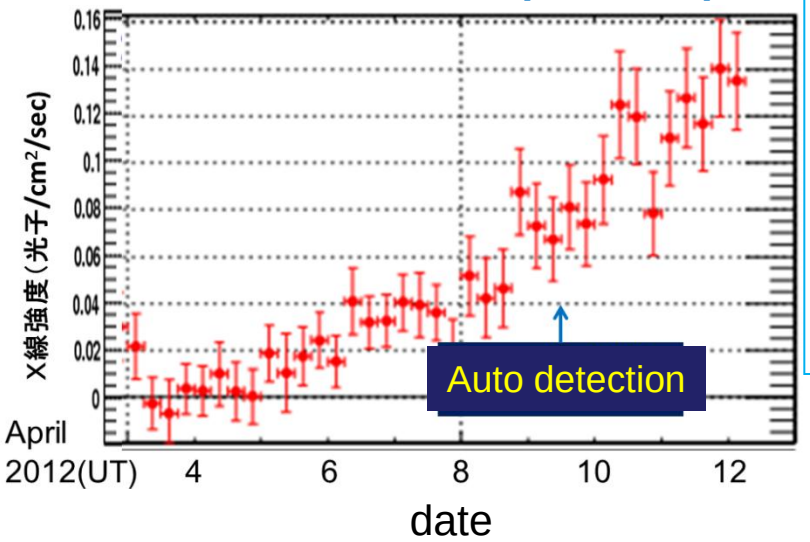


By the TOO request by MAXI team, Swift/XRT found a bright source (Atel#4030):

Dips may have 1.5h period. Shortest orbit ever, if it is a BH (Atel#4044)

2012 Apr 9 11:24
MAXI found a new source at 1.3 degree from a known LMXB 4U 1254-69 (50mCrab). (Atel#4024).

MAXI J1305-704 (2-20 keV)

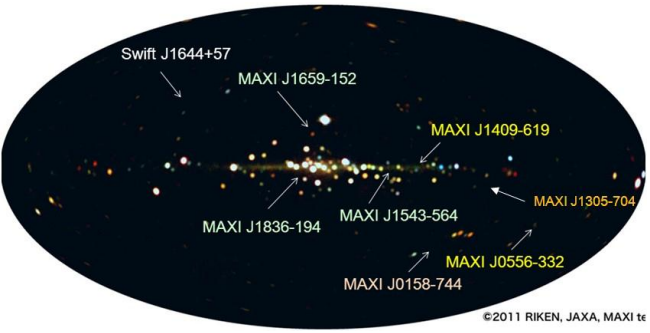


Flux is increasing. MAXI reported hard-to-soft transition from intermediate state (Atel#4035)

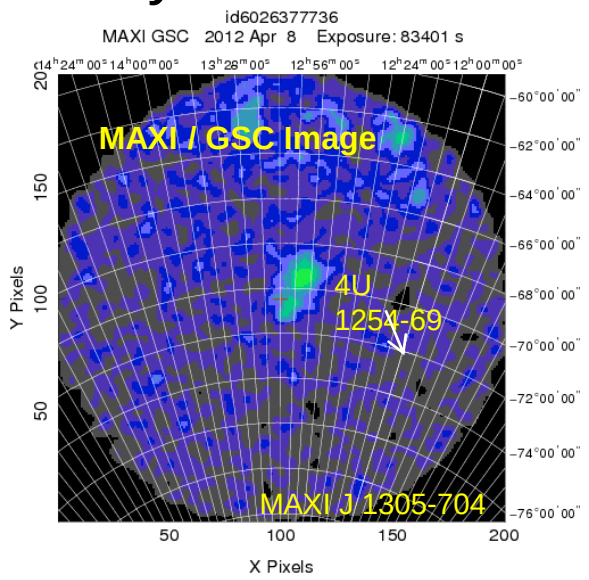
Summary

- MAXI continuously since Aug. 15, 2009.
- Unbiased all sky observations.
- More than 30 publications.
- Extended for three more years.
- a unique all-sky X-ray monitor for international high-energy astrophysics community.

22 new srcs, 7 MAXI srcs

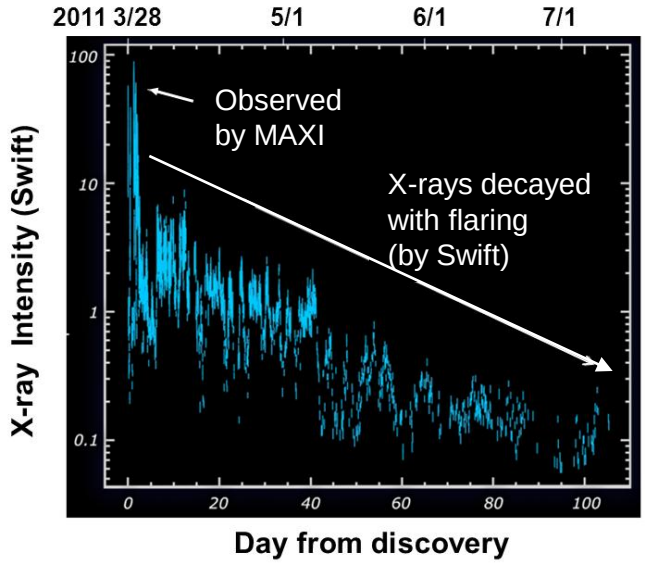


Newly discovered

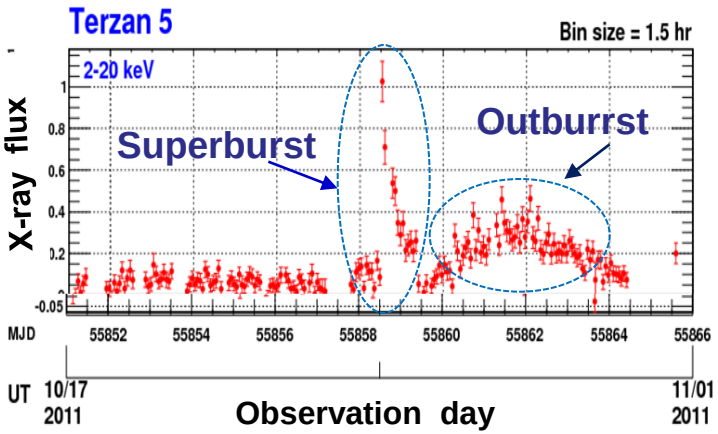


Tidal disruption

Swift J1644+57



Super burst and outburst



Peculiar nova in SMC