

Team Meeting

«Multiwavelength investigations of
X / gamma ray sources.
Support of INTEGRAL Observations»

1 – 9 December 2003
Bern, Switzerland

Members of the team

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- M.Gilfanov (MPA, Garching)
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- M.Chernyakova (ISDC, Versoix)
- P.Kretschmar (MPE/ISDC, Versoix)

Members of the team



25.03.2004

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The INTEGRAL Satellite

The INTEGRAL satellite was launched on October 17, 2002 by a Russian PROTON launcher



1.5 meter optical Russian Turkish Telescope RTT150



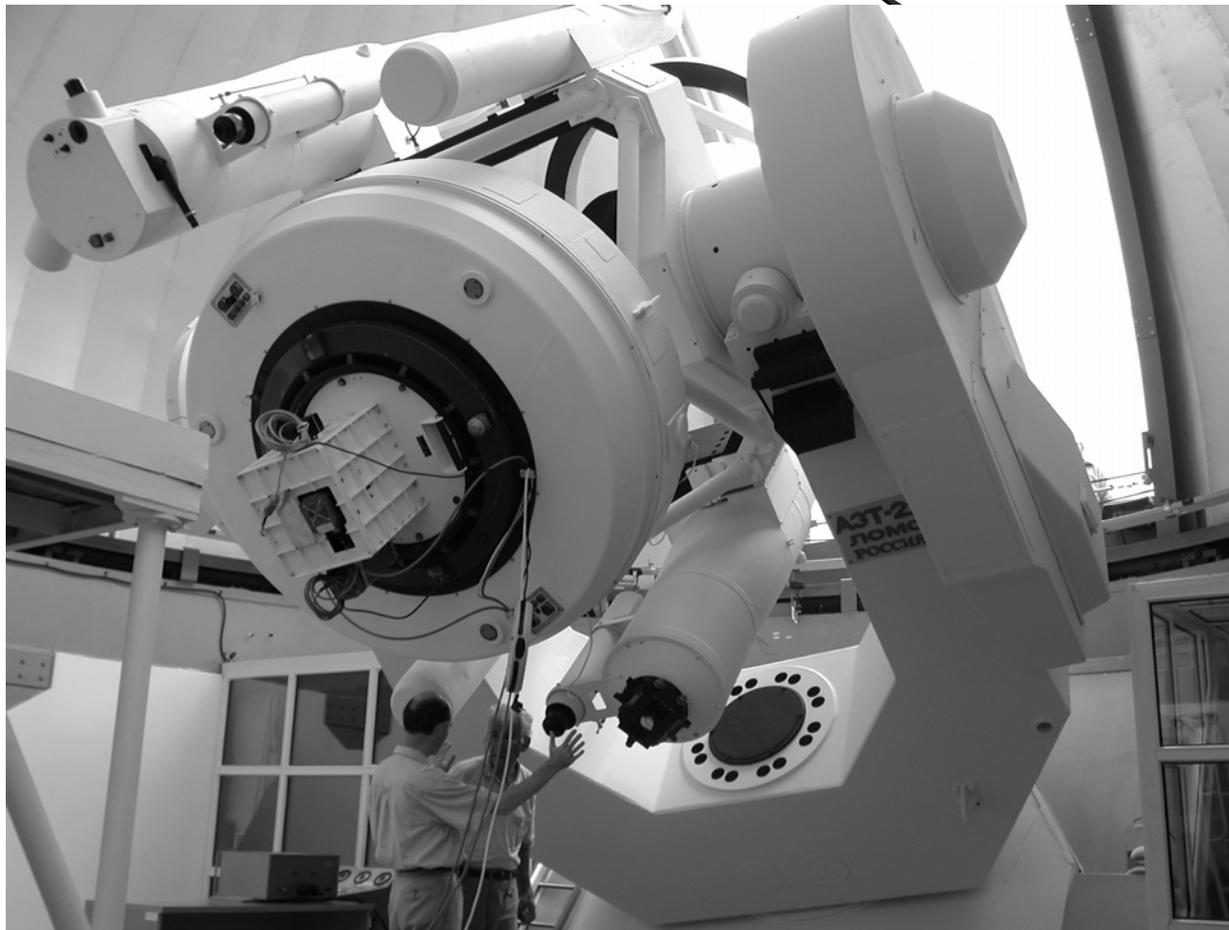
- hea.iki.rssi.ru/AZT22/ENG
- www.tug.tubitak.gov.tr

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1.5 meter optical Russian Turkish Telescope RTT150



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Discussed scientific topics

- Burster GS1826-246
- X-ray pulsars:
 - X Per
 - SAX J2103.5+4545
 - MX0656-07
- New X-ray source IGR17544-2619

The X-ray bursts of GS1826-246 are
very regular and occur with
~3 hours quasiperiod

The goals of GS1826-246 study (1)

- compare the shapes of the time profile of the X-ray bursts in the optical and X-ray bands;
- construct the model of the transfer function between the optical emission and the X-ray emission of the burst;
- determine the model parameters, in particular the size of the accretion disk.

The goals of GS1826-246 study (2)

- If the optical emission during the X-ray bursts is mostly due to illumination of the accretion disk, one can determine the disk parameters independently from (1), based on the observed increase of the optical emission during the burst

The goals of GS1826-246 study (3)

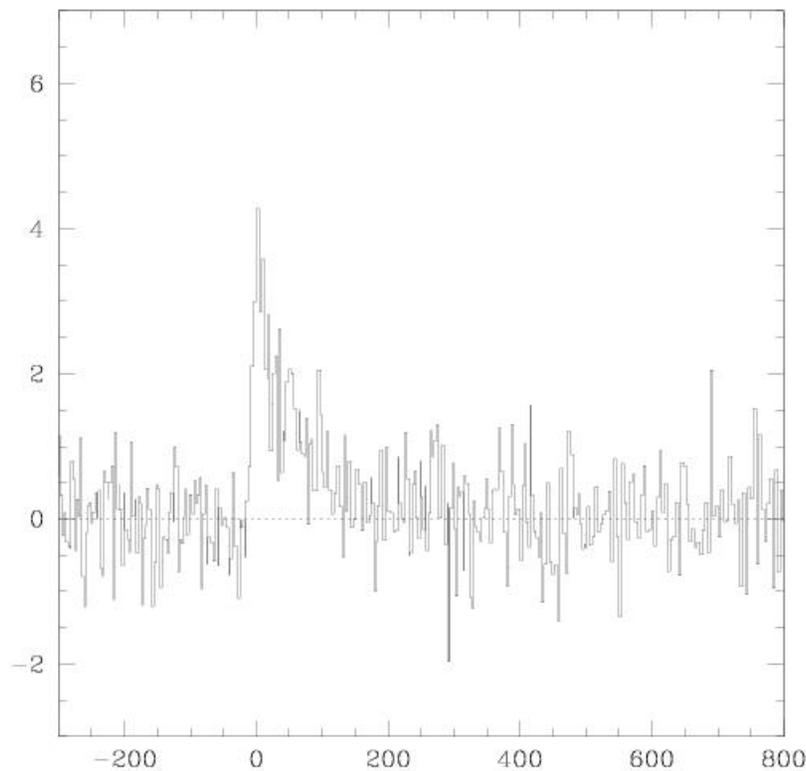
- Check the orbital period at ~ 2.1 hours, tentatively inferred from the previous observations, using the optical photometric data.
- If the orbital period is confirmed, to calculate the orbital parameters of the system, in particular the Roche lobe sizes.
- Compare the size of the disk, determined from (1) and (2) with the NS Roche lobe size. Compare the measured ratio $R_{\text{disk}}/R_{\text{RL}}$ with the theoretical models of the disk formation in LMXBs.

GS1826-246 observations

- GS1826-246 was observed in September 2003 by RTT150, INTEGRAL and RXTE.
- RTT150 telescope was not able to observe simultaneously with RXTE and INTEGRAL. Time gap between RXTE and RTT150 observations is about 3 hours.
- Only hard X-ray INTEGRAL telescopes data are available. These data are useless for X-ray bursts studies.

GS1826-246 observations

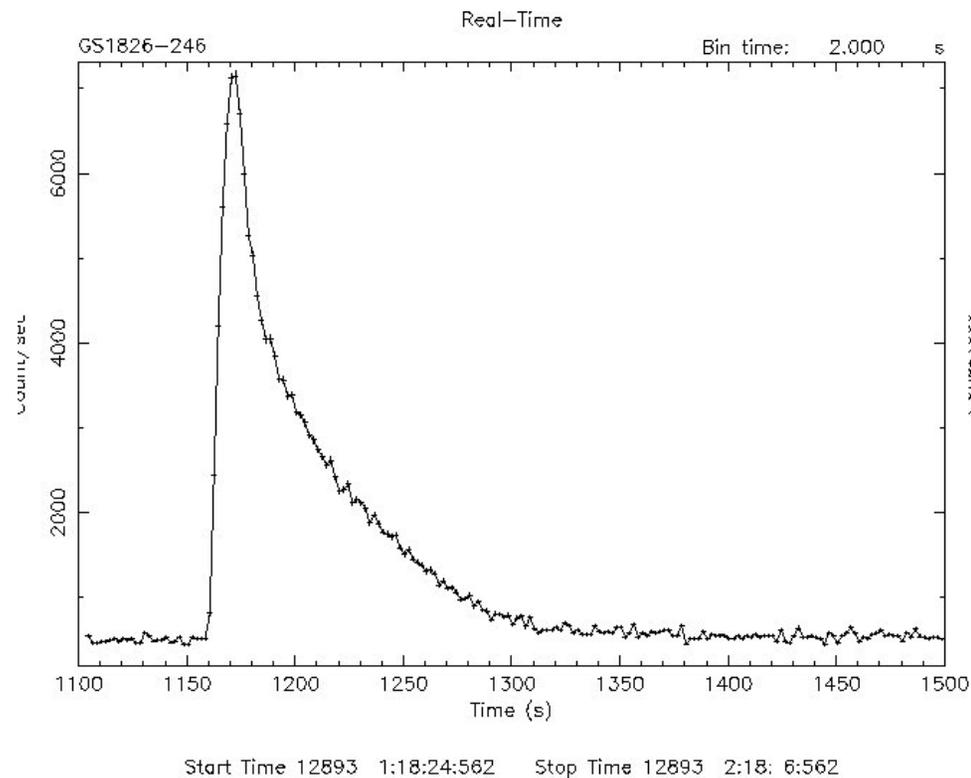
- Optical observations for 5 nights from 6 till 10 September revealed 4 bursts



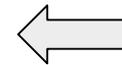
← averaged burst profile

GS1826-246 observations

- Only one burst is available from RXTE data

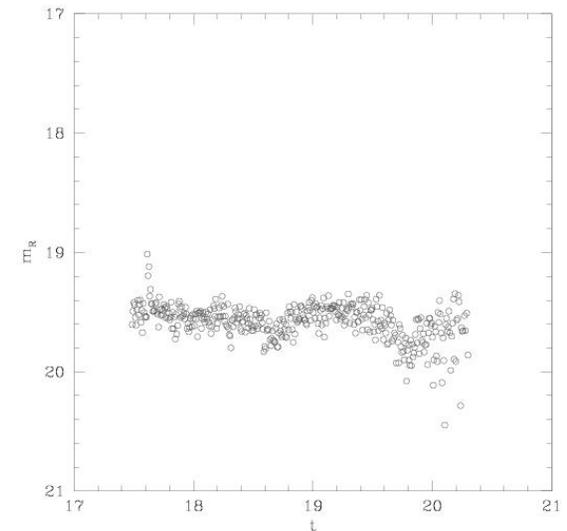
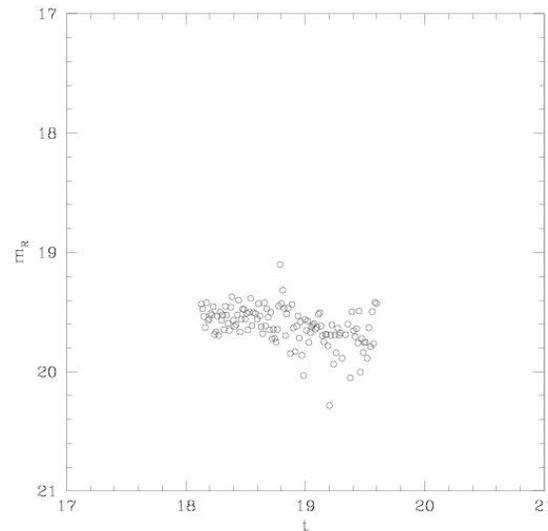
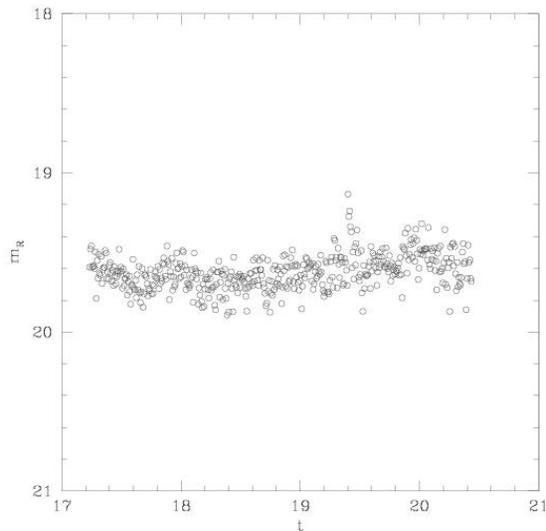


burst profile



GS1826-246 observations

- Search of ~ 2.1 hours orbital period is going on. On the panel - 3 sequential nights (8 – 10 September, 2003) are given as an example



X Per

- a Be/X-ray binary system, a subclass of high mass X-ray binaries (HMXB) consisting of an early-type non-supergiant Be star and a collapsed object, usually a neutron star.
- Be stars are characterized by the presence of emission lines of H I, He I in the spectra, originating in a gaseous, equatorially concentrated circumstellar disc around the Be star. The strength of these lines (e.g. H α) is often variable and is thought to characterize the strength of the stellar wind from the Be star.
- In X-rays these systems reveal themselves as X-ray pulsars and often exhibit a transient or strongly variable behavior. The circumstellar disc acts as a reservoir of material for the compact object to accrete from.

The goals of X Per study

- The goal is to increase our understanding of such systems combining X / gamma ray and optical observations, in particular the high spectral resolution observations performed with the Coude Echelle spectrometer on RTT150 telescope.

X Per observations

- INTEGRAL has observed X Per during the Crab calibration phase in August 2003.
- X Per was regularly observed by ASM/RXTE
- X Per was observed on Nov.13, 2003 during three hours by the short focus camera of RTT150 Coude Echelle Spectrometer (1 minute time resolution).
- X Per was observed on Nov.14, 2003 by RTT150 Andor CCD in H α filter.

X Per observations

- Crab field offset image with 4U 0352+30 pulsar by IBIS/INTEGRAL



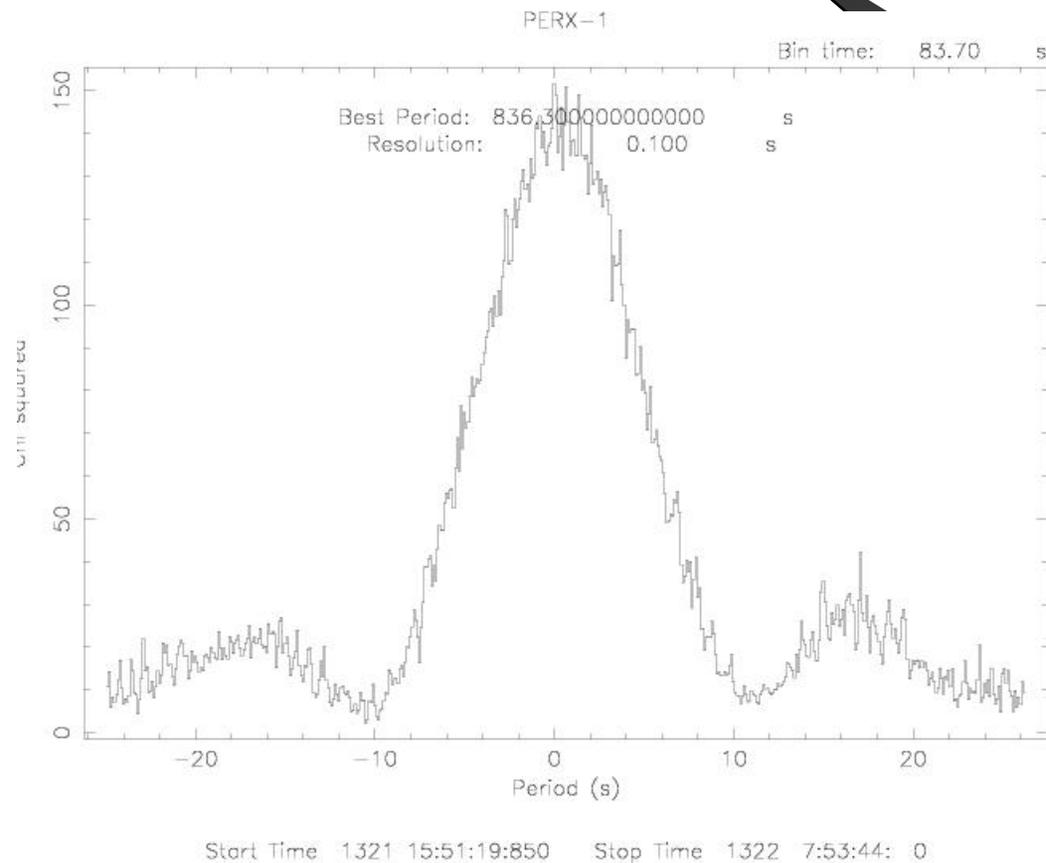
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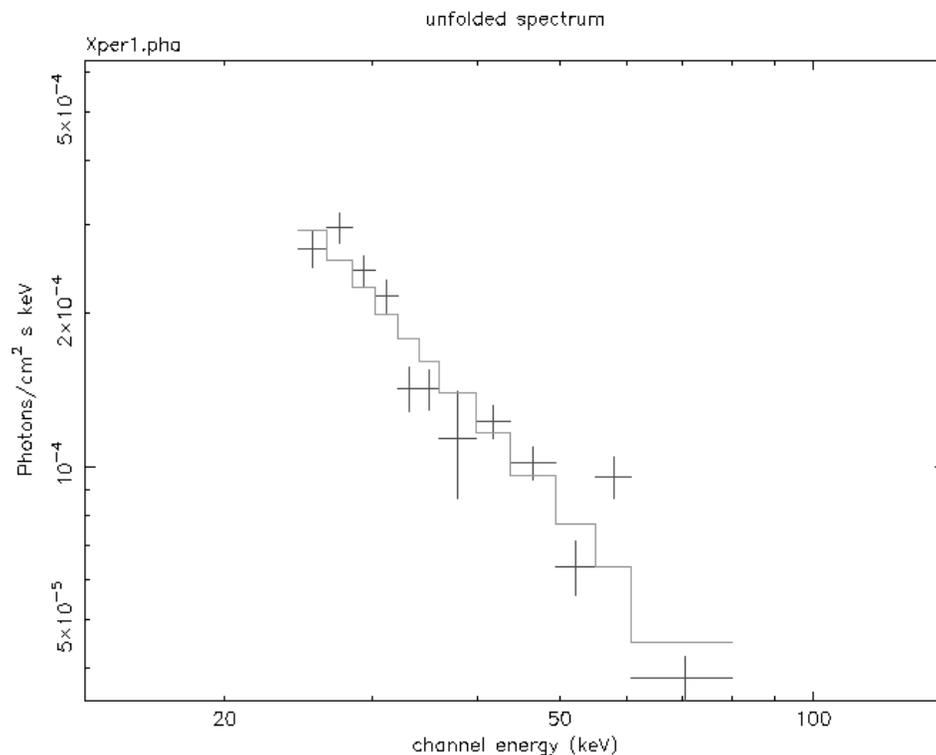
X Per observations

- ~837 s period of X-ray pulsar 4U 0352+30 by IBIS/INTEGRAL



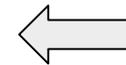
X Per observations

- Energy spectrum of X-ray pulsar 4U 0352+30 by IBIS/INTEGRAL.



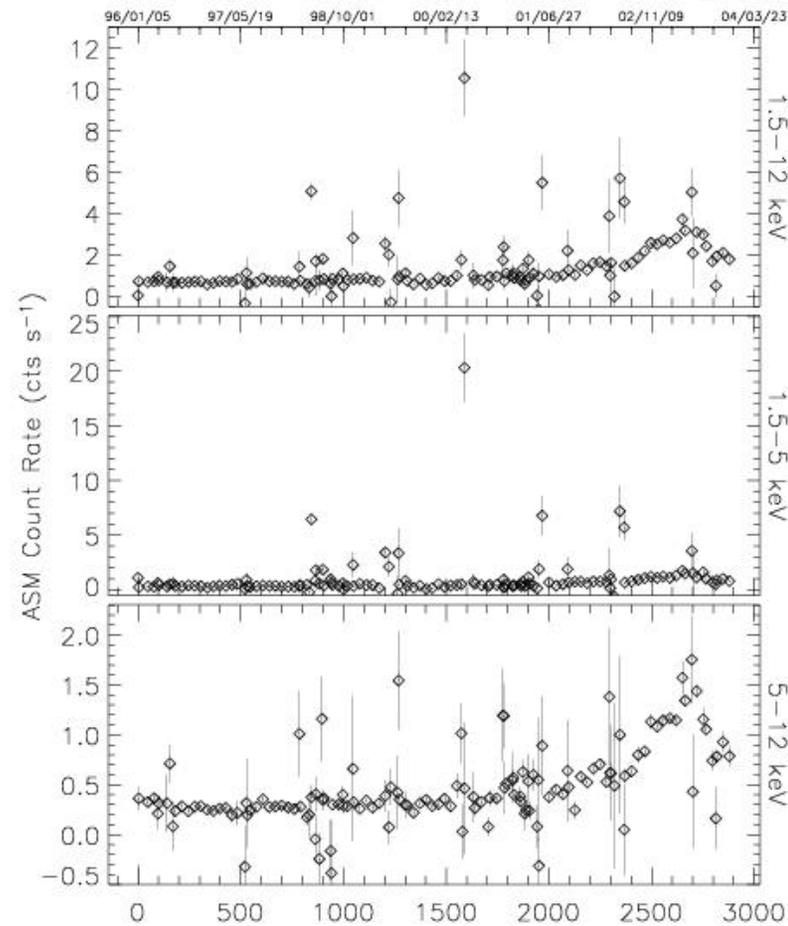
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Spectrum is well described by a simple power law with a photon index ~ 2.5

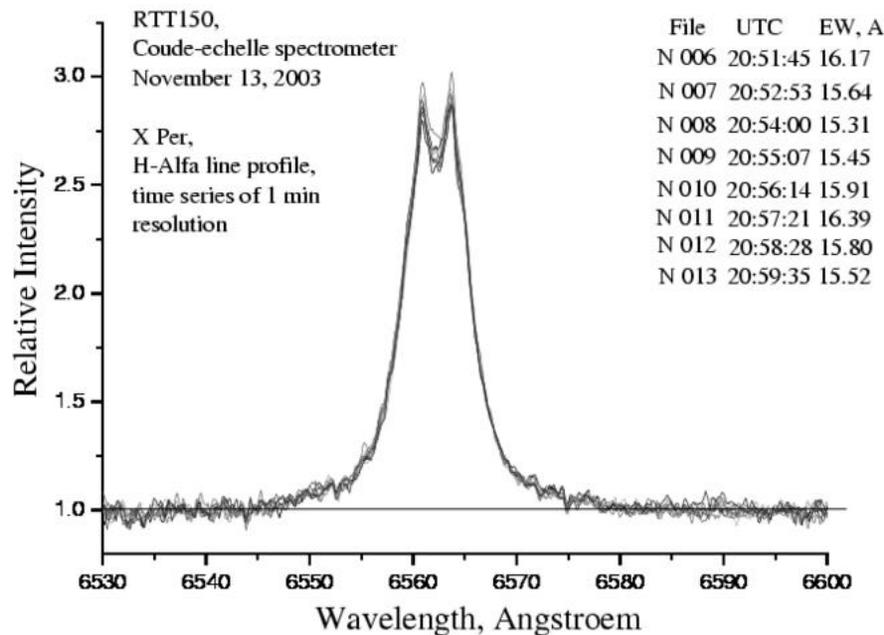


X Per observations

- Long term variability of X-ray pulsar 4U 0352+30 (RXTE)



X Per observations



An example of 8 H α profiles within of 10 minutes interval. These profiles, EW values of 15-16 Å, and $R \sim 6.05$ mag. indicate that X Per system is in the high state now. These optical data can be used along with the INTEGRAL data obtained 2 months earlier (taking into account 250d orbital period of this system).

SAX J2103.5+4545

- From X-ray data we know that this is a HMXB system with pulse period 358.61 s.
- The distance, 3.2 kpc, was determined (Swank et. al., 2001) from correlation of dP/dt with the X-ray flux.
- The X-ray observations also identified an orbital period $P_{\text{orb}} \sim 12.68$ days (Baykal et. al., 2000).

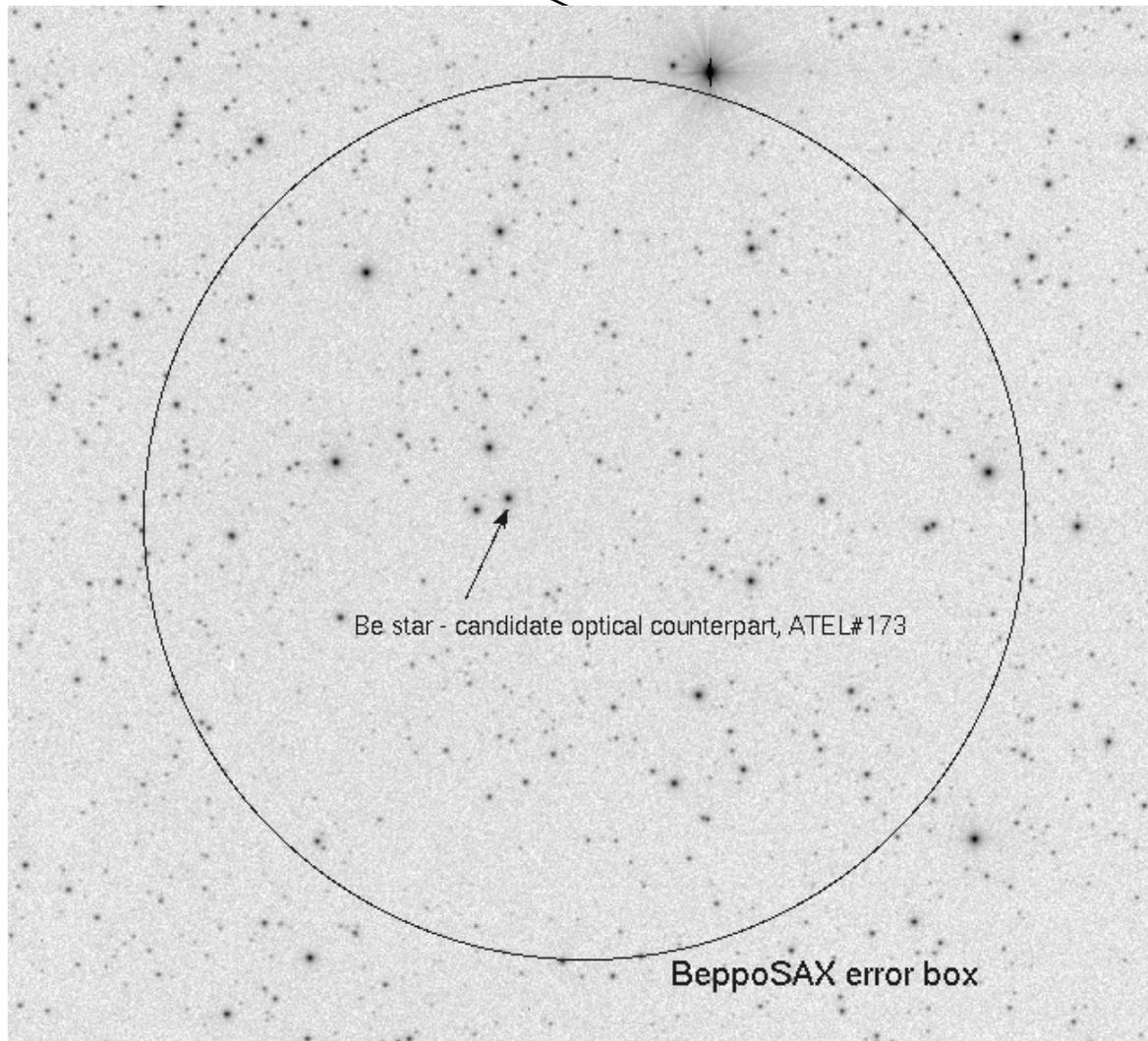
The goals of SAX J2103.5+4545 study

- The main goal is to find the optical counterpart of this system.
- The available X-ray error box is rather big $\sim 1'$ in radius and contains a large number of stars.
- The optical extinction to the source is about $A_V \sim 4$. This allows us to constrain the visual magnitude of the optical counterpart, $m_V \sim 10-14$ and its optical colors.
- With these constraints, the number of possible candidates for the optical counterpart can be significantly reduced.

SAX J2103.5+4545 observations

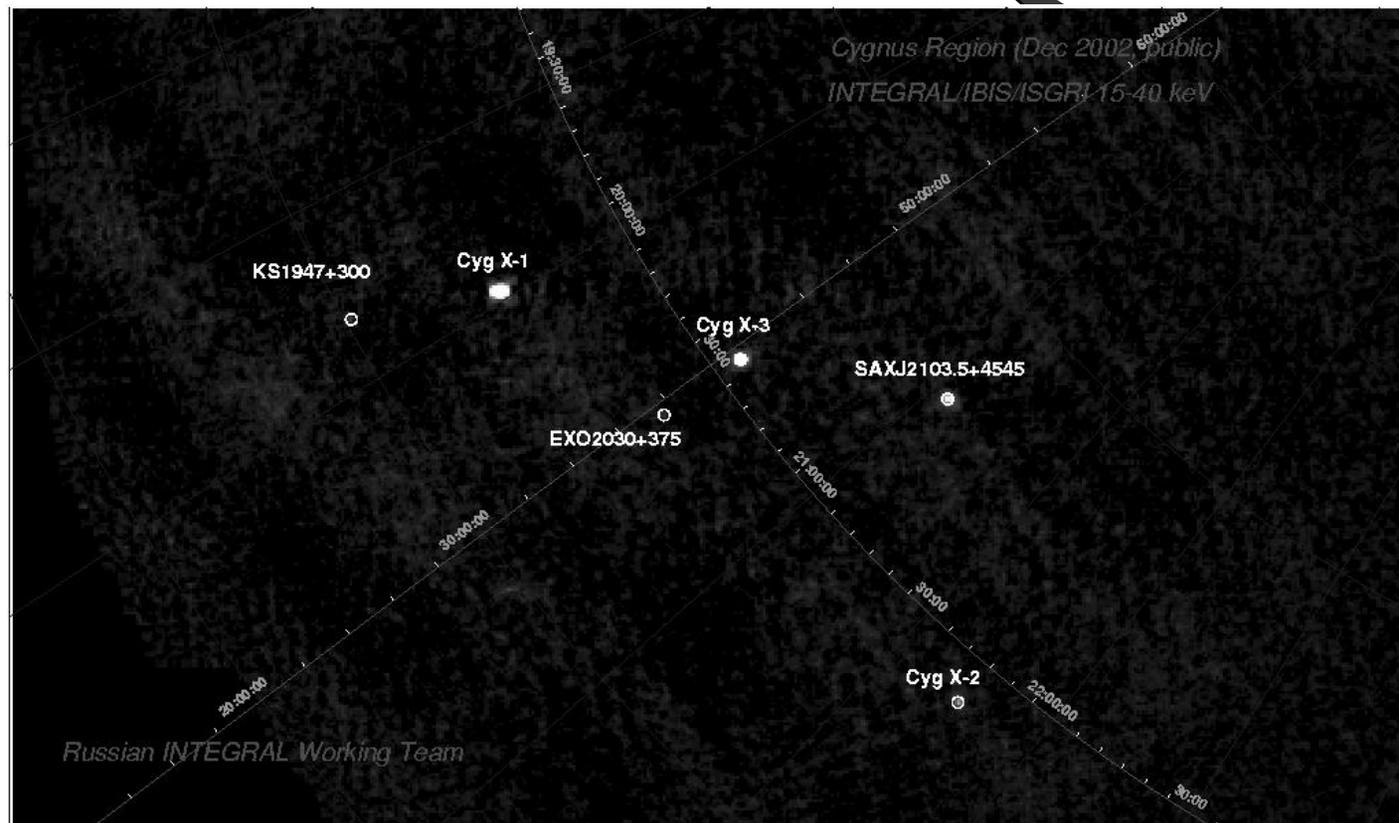
- Observations were performed with RTT150 in R-filter during 14 nights in Oct. and 10 nights in Nov.2003
- Source was observed with INTEGRAL observatory in December 2002 during public observations of Cyg X-1 field

RTT150 observations



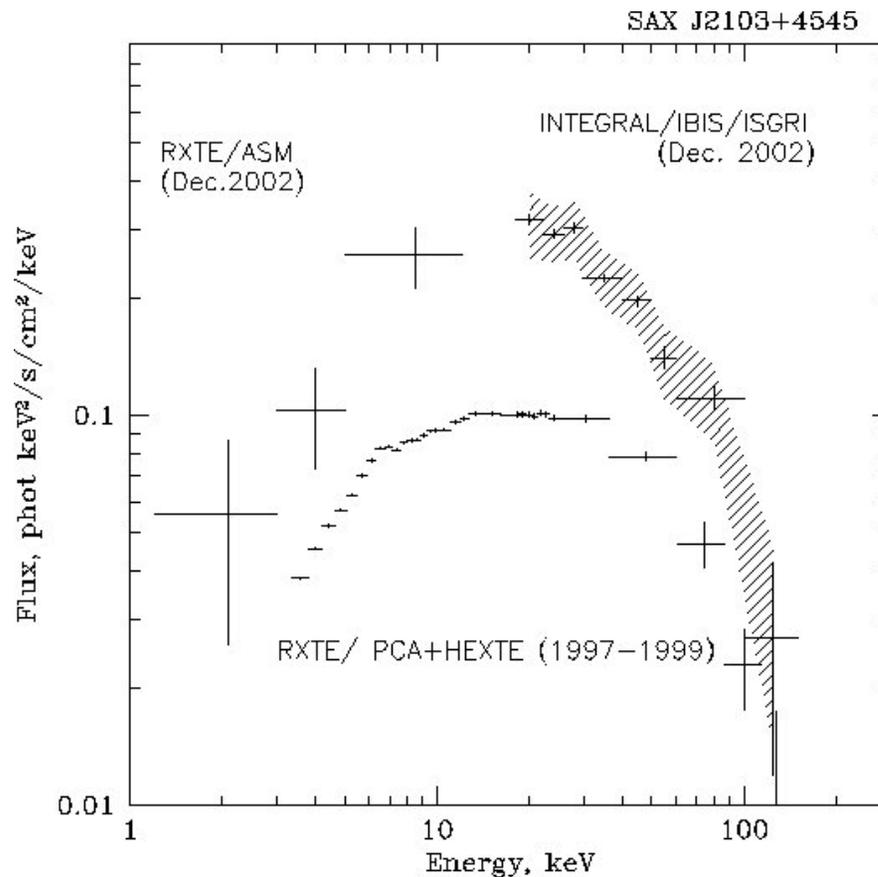
SAX J2103.5+4545

- Cyg X-1 field image with SAX J2103.5+4545 pulsar by IBIS/INTEGRAL

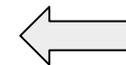


SAX J2103.5+4545

- Energy spectrum of X-ray pulsar SAX J2103.5+4545 by IBIS/INTEGRAL

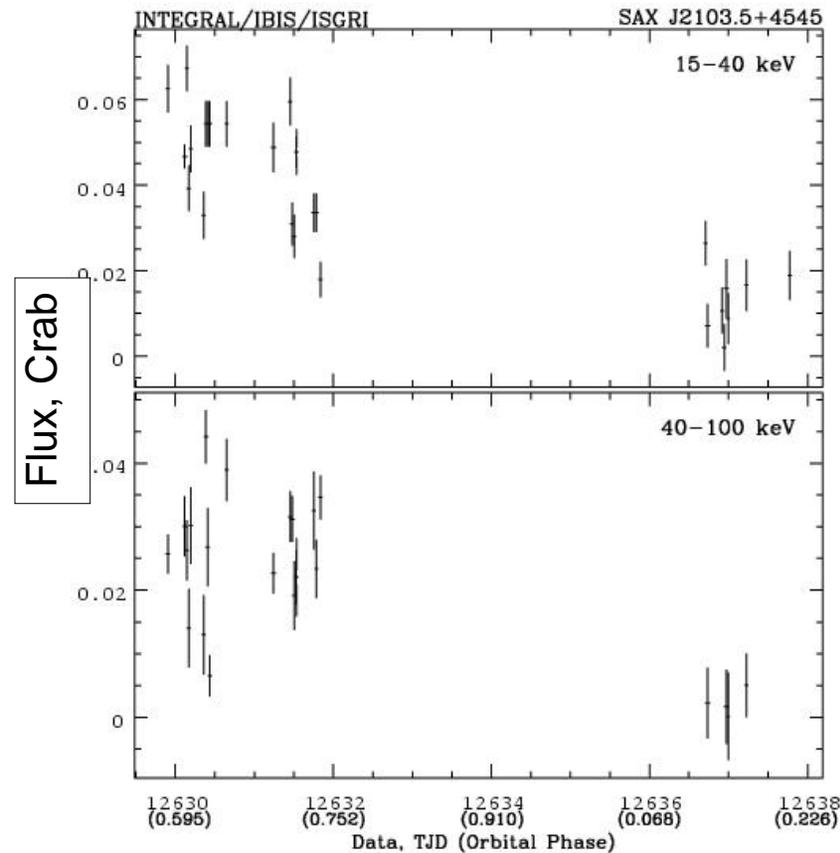


The source has typical pulsar spectrum - power law with high energy cutoff



SAX J2103.5+4545

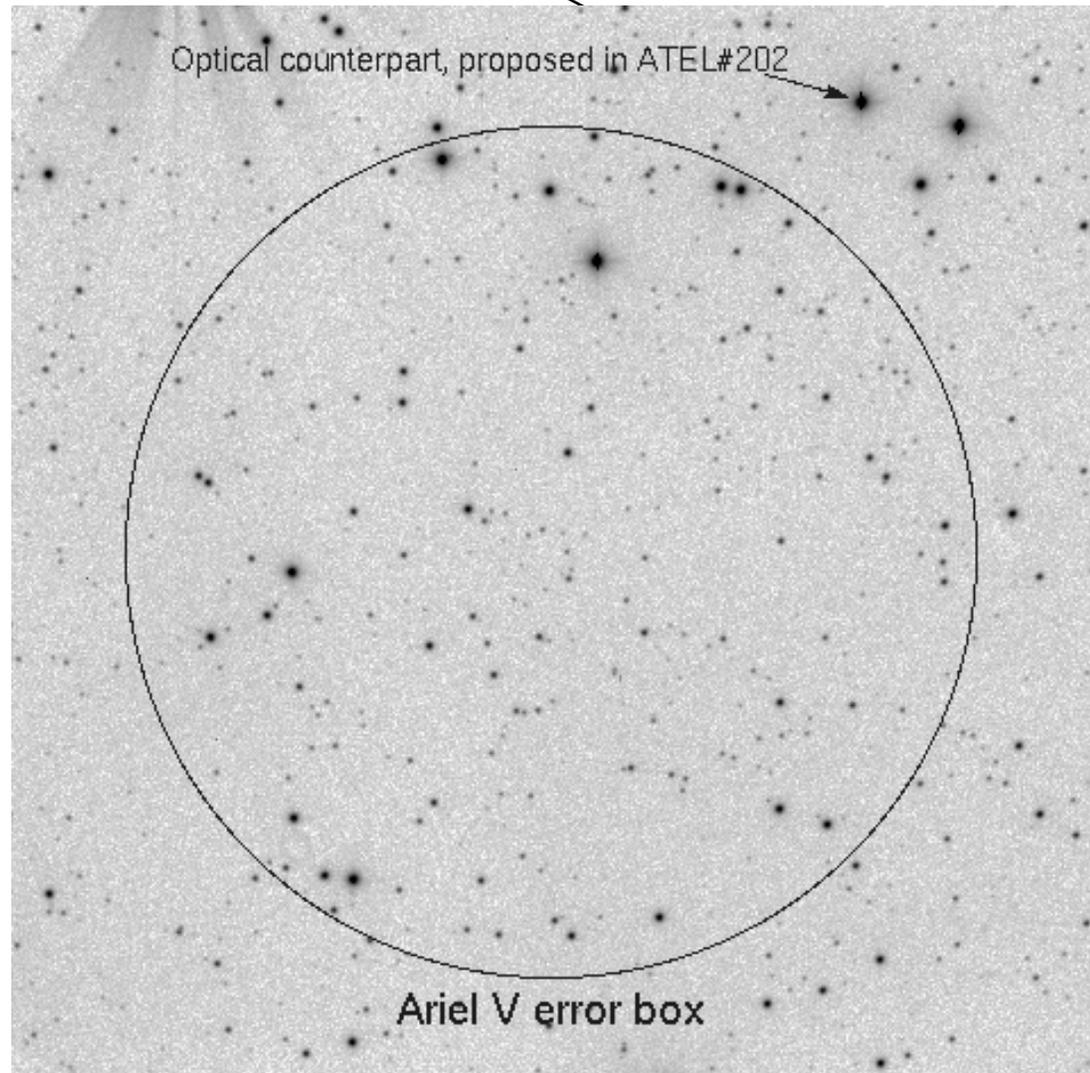
- The IBIS/INTEGRAL light curves of the pulsar SAX J2103.5+4545 in the energy bands 15-40 and 40-100 keV.



MX0656-07

- HMXB system with the pulse period 160.7 s (ATEL #199).
- The main goal is to find the optical counterpart of this system (similar to SAX J2103.5+4545).

RTT150 observations



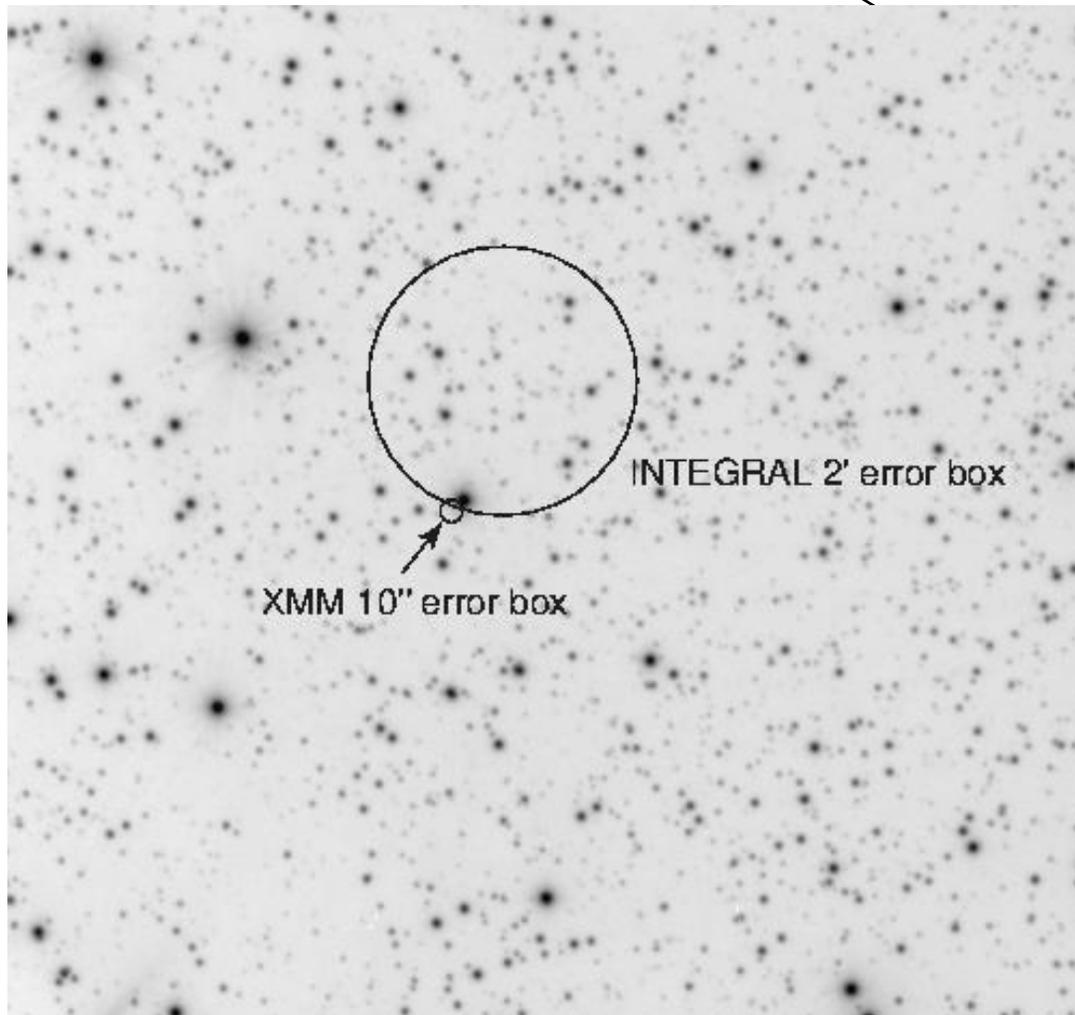
IGR J17544-2619

- New transient X-ray source was discovered by IBIS/INTEGRAL on September 17, 2003 (ATEL # 190)
- The source position is RA=17h54.4m, DEC=-26d19' (equinox 2000, position uncertainty around 2').
- The main goal is to find the optical counterpart of the source

RTT150 observations

- Observations in B, V, R filters have been performed during September 18-28, 2003.
- Processing of these data show no any variable source in the indicated field of view with accuracy of 1-3% for bright ($R \sim 10-13$ magnitude) stars.
- There are many of faint stars in the field with $R = 19-22$ magnitudes which are not existed on DSS. Many of them are situated within of $2'$ of INTEGRAL error box.

RTT150 observations



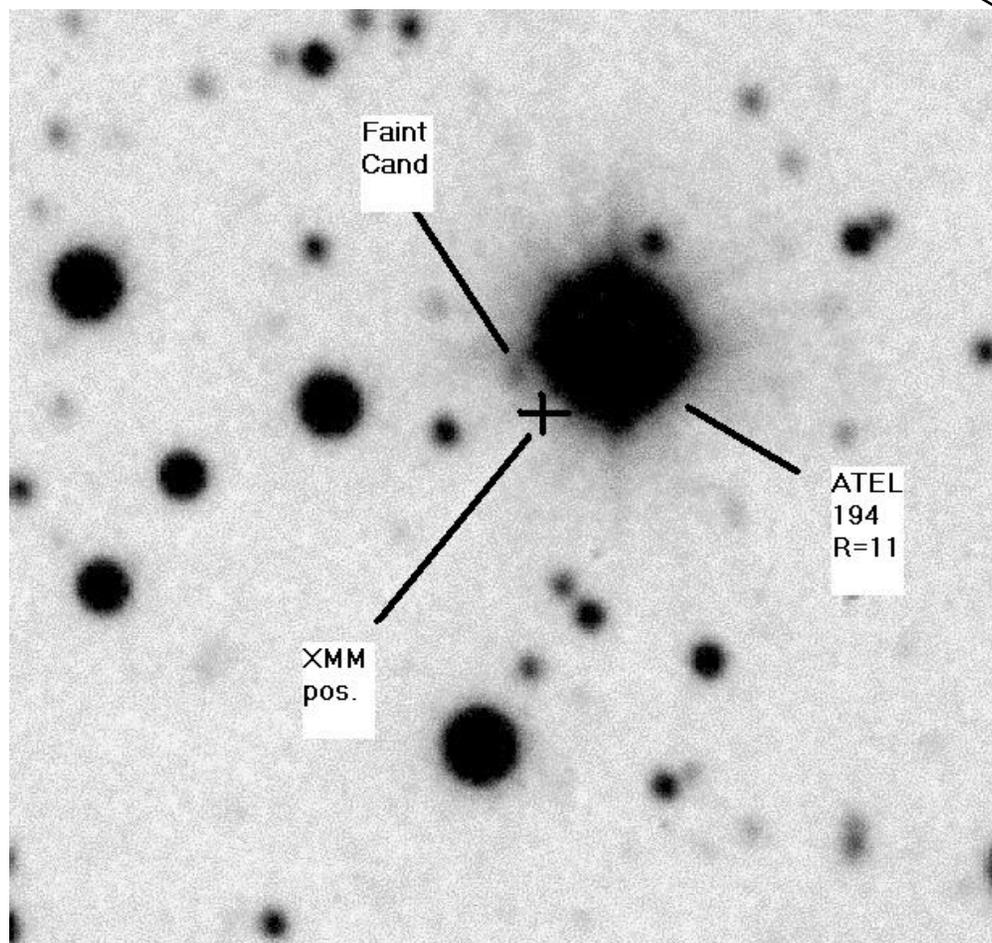
full field of
view 8'×8'



IGR J17544-2619

- This field was observed by XMM 5 days before INTEGRAL (IAUC 8202).
- The source coordinates are R.A. = 17h54m25s.7, Decl.= $26^{\circ}19'58''$ (equinox 2000, uncertainty $\sim 10''$)
- Within $10''$ of XMM error box there is bright enough ($R \sim 11$ mag) star which has been suggested as a possible optical counterpart in ATEL # 194
- Multicolor RTT150 photometric data shows that this star is probably F-G supergiant (assuming 8 kpc distance). No variability at the level of 1% was found for this star during 10 days interval.

RTT150 observations



More careful data analysis shows that there is also a faint $R \sim 20$ mag star just near the bright star within the XMM error bar. We proposed this faint star (probably K-dwarf star) as an alternative candidate for the optical counterpart of this INTEGRAL source.

Additional scientific topics for the next team meeting

- Burster Aql X-1
 - soft X-ray transient which demonstrate transitions from low to high flux states approximately once a year
- V4641 Sgr = SAX J1819.3-2525
 - the binary system consists of A0 star (“Goranskij star”) of $V \sim 14$ mag and high mass relativistic component (likely black hole)