# Team Meeting

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

25 March – 4 April 2004
Bern, Switzerland

# Members of the team

- M.Pavlinsky (IKI, Moscow)
- A.Lutovinov (IKI, Moscow)
- R.Burenin (IKI, Moscow)
- S.Molkov (IKI, Moscow)
- S.Grebenev (IKI, Moscow)
- M.Gilfanov (MPA, Garching)
- M.Revnivtsev (MPA, Garching)
- I.Bikmaev (KSU, Kazan)
- E.Gogus (Istanbul Sabanchi University)
- P.Kretschmar (MPE/ISDC, Versoix)

# Discussed scientific topics

- Burster GS1826-238 and Aql X-1
- X-ray pulsar X Per
- X-ray source IGR17544-2619
- Galactic microquasars BHC SS433 and XTEJ1550-564
- Intermediate polar V1223 Sgr
- Seyfert 2 Galaxy 3C 111

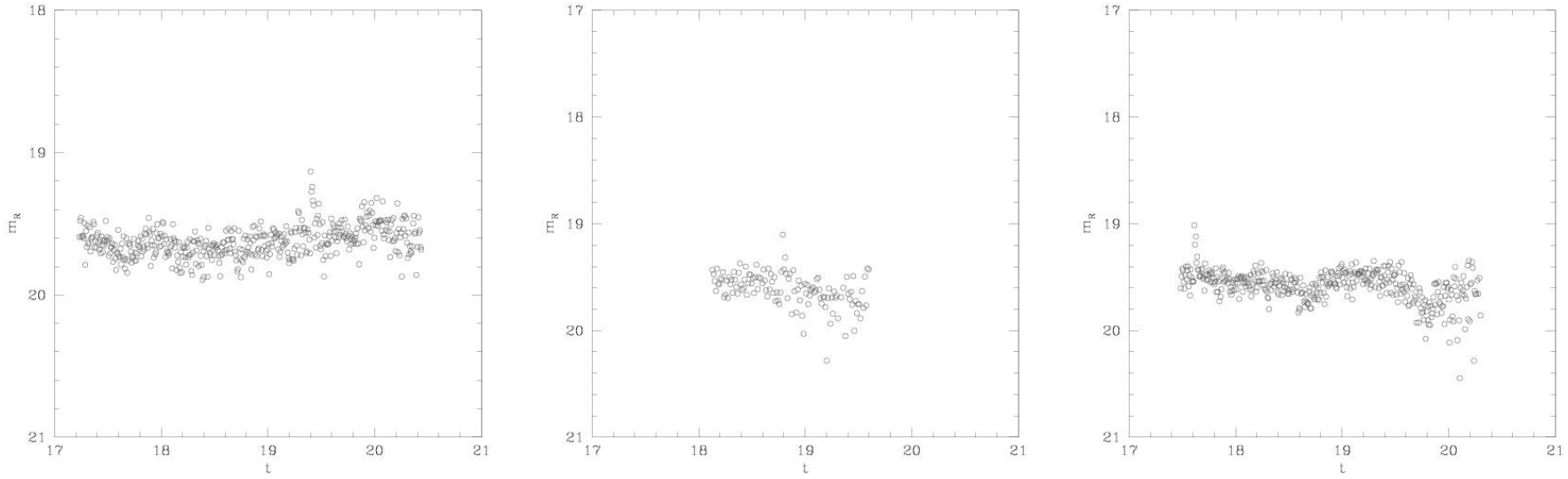
# The X-ray burster GS1826-238

# GS1826-238 observations

- GS1826-238 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 were not used for X-ray bursts studies.

# GS1826-238 optical photometry

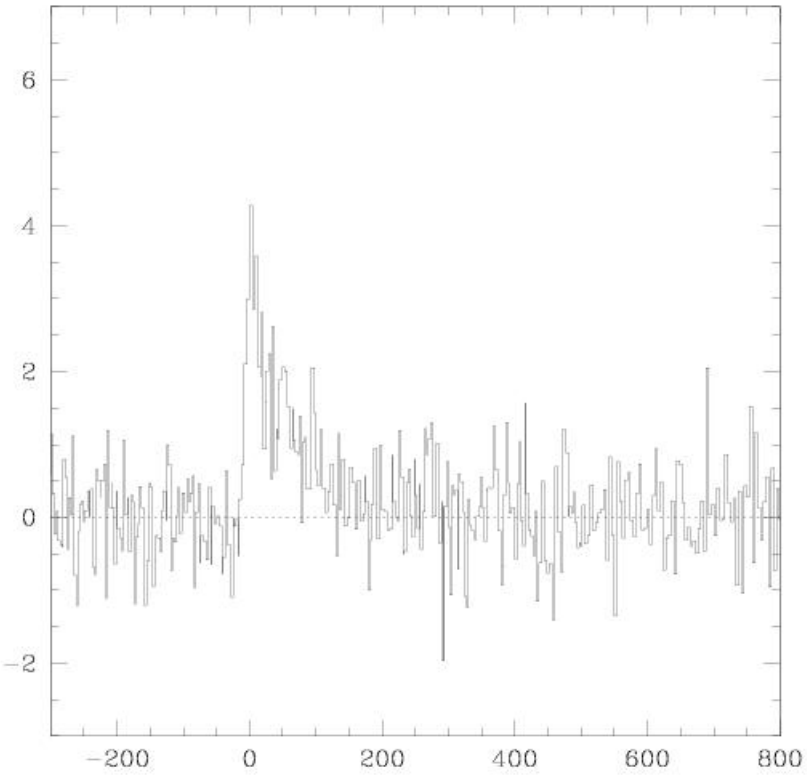
- No modulations at previously reported 2.1 hours period have been found.




- R-band lightcurves obtained on 8 – 10 Sept., 2003

# Optical emission during X-ray bursts

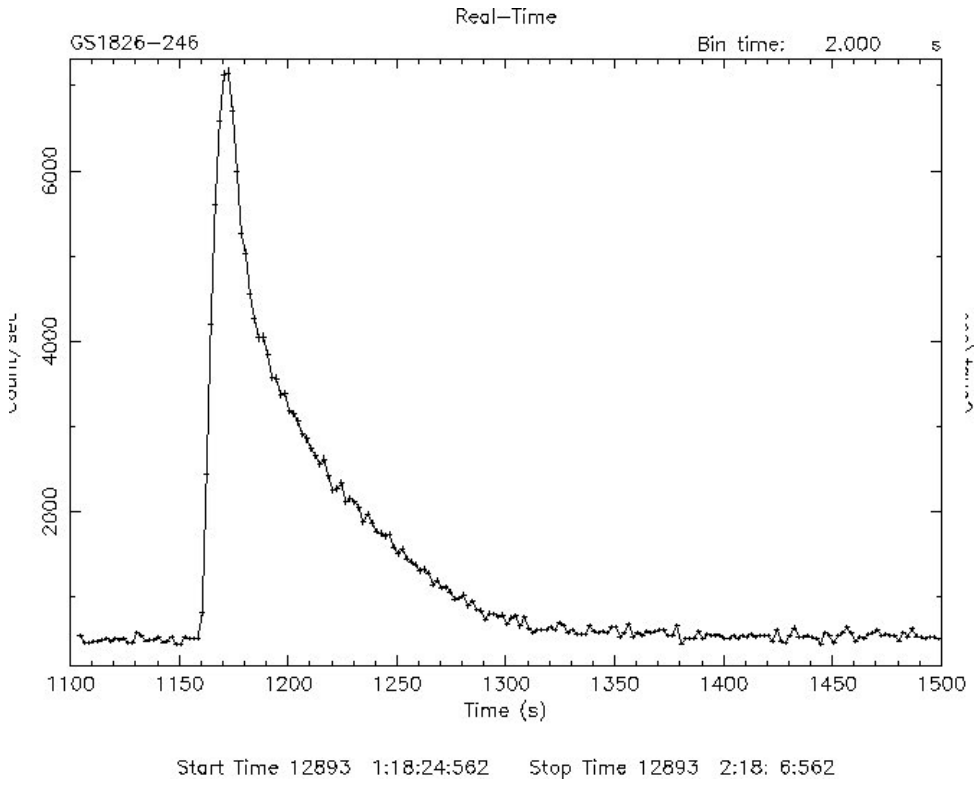
- 6 bursts have been detected in September, 2003 by RTT150




averaged burst profile in R-band

# X-ray bursts

- Only one burst is available from RXTE data




X-ray bolometric burst profile

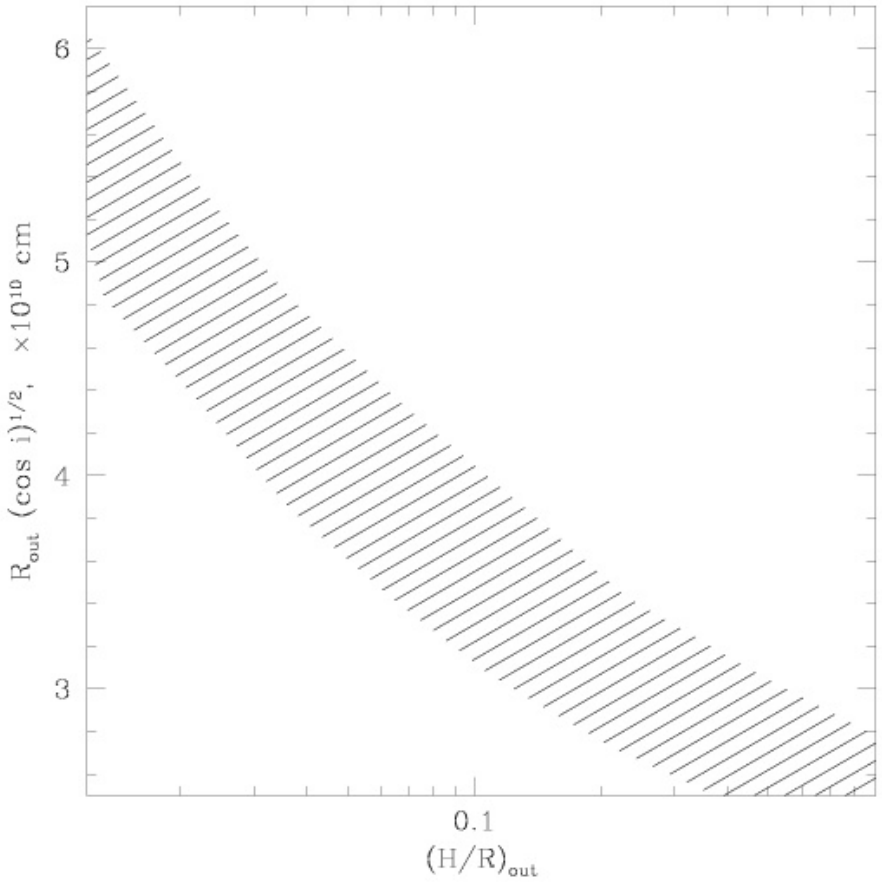
# Geometry of the accretion disk in GS1826-238

- Optical emission – reprocessing of the X-rays by the accretion disk and the donor star
- Comparison of the R-band and X-ray light-curves of X-ray bursts $\Rightarrow$ constraints on the disk geometry

# Geometry of the accretion disk in GS1826-238 qualitative consideration

- $F_{x,burst}/\langle F_x \rangle \sim (F_{opt,burst}/\langle F_{opt} \rangle)^4$
- R-band ($\lambda = 6380$A) – Rayleigh-Jeans
- $T_{disk} > hc/\lambda_{Rc} \sim 22000$ K
- $R_{disk} < 0.7\ R_\odot$

# Geometry of the accretion disk in GS1826-238 Exact calculation




H/R $\Rightarrow$ ratio of disk thickness to radius

# The future goals GS1826-238 study

- We plan to observe this source with RTT in optical band during 7 nights in 2004 in order to study the  variability of this source on various time scales.
- We plan to submit a proposal to RXTE to obtain coordinated observations in X-rays and in optical during several nights.

# The future goals GS1826-238 study

- We plan to detect about 10 type I bursts in the course of this camapin. Combined with our observations in 2003, these data will allow us to study correlations between X-ray flux from the source and the mean time between type I bursts.
- Detection of X-ray bursts during coordinated observations in optical and X-ray and measurement of the time delay between X-ray burst and its optical counterpart will allow us to consider more sofisticated models of the accretion disk. With these data we should be able to refine our estimate of the disk geometry and size and to simultaineously determine the inclination of the binary system. If the orbital period is reliably detected, the binary system parameters, in particular the Roche lobe size, can be determined and compared with the estimates of the accretion disk size.

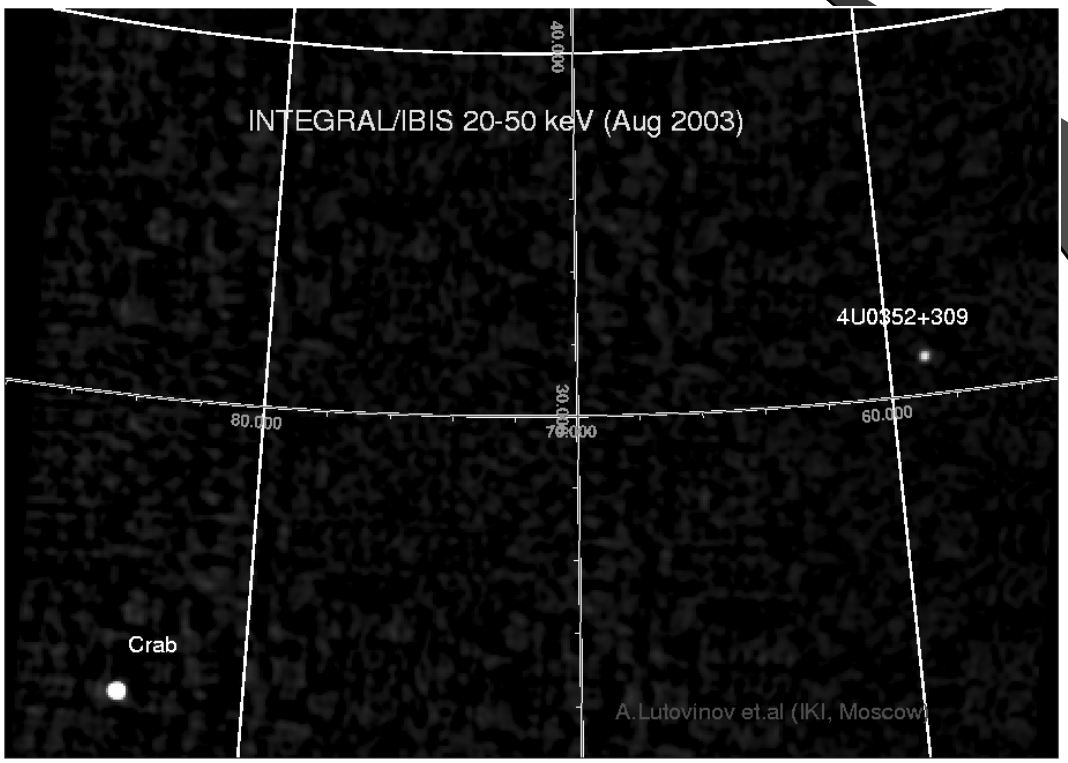
# Burster Aql X-1

- Aql X-1 was significantly detected up to 150 keV with INTEGRAL on 24-25 March, 2004 during the Sagitarius Arm Tangent observations.
- Its spectrum can be described by a simple powerlaw with the photon index of ~2.1 and flux of ~35 mCrab in both 18-60 and 60-120 keV energy bands.
- It is the first time when the source was observed in such hard state.
- Aql X-1 will be in field of view of the INTEGRAL's telescopes during 21 April, 2004.
- It is very interesting to study Aql X-1 in such hard X-ray state on different wavelength and try to understand the reason of such behavior.
- We would like to organize RTT150 and RXTE observations simultaneous with INTEGRAL.

# X Per

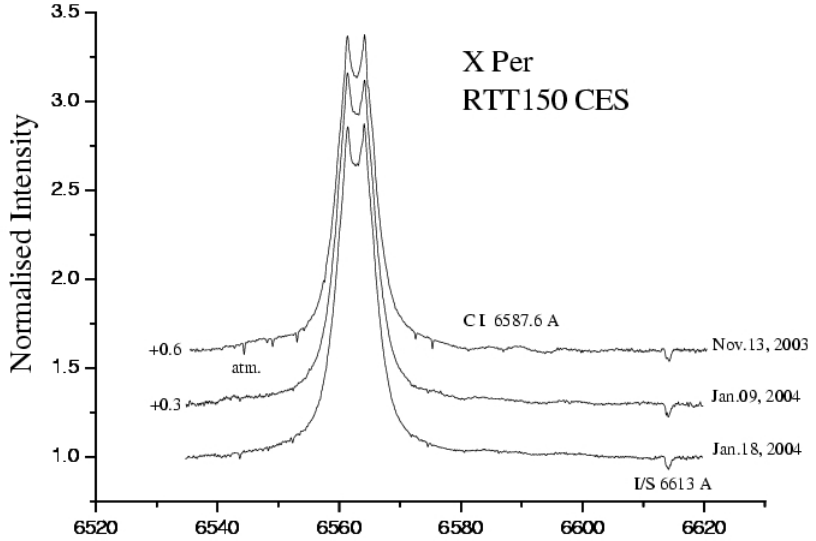
# Broadband spectroscopy of X Per with INTEGRAL and RTT-150

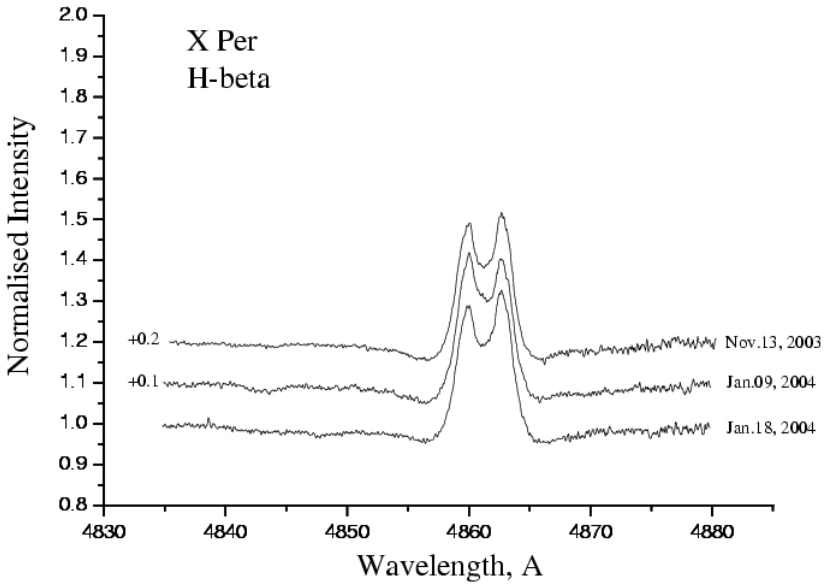
A.Lutovinov, S.Tsygankov, M.Revnivtsev, M.Chernyakova, I.Bikmaev, S.Molkov, R.Burenin, M.Pavlinsky, N.Sakhibullin




Will be submitted to the Proceeding of the 5th INTEGRAL workshop

# X Per (RTT-150)



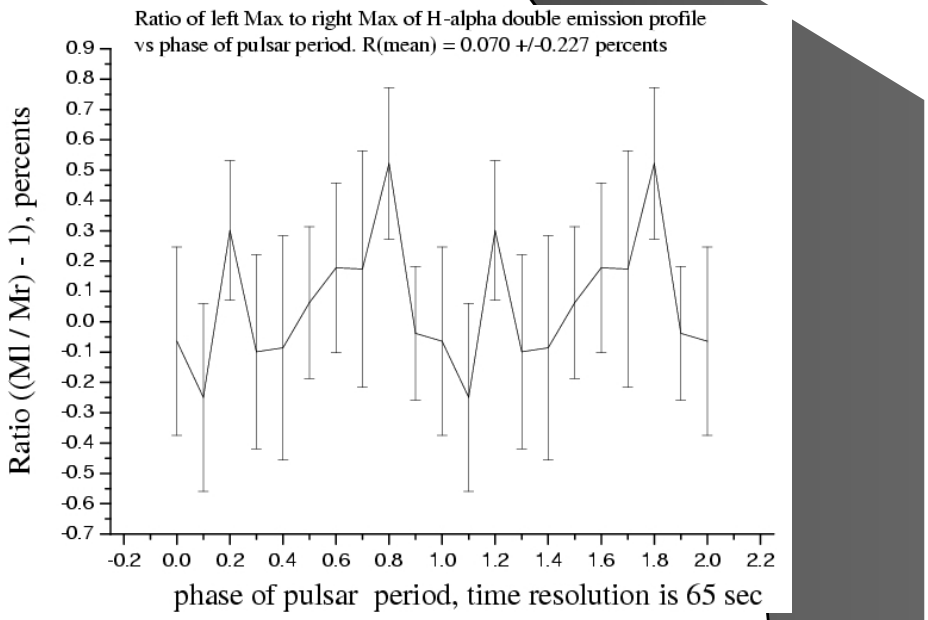




Observations were made in Sep 2003 (phot.) and Nov 2003, Jan 2004 (spectr.)

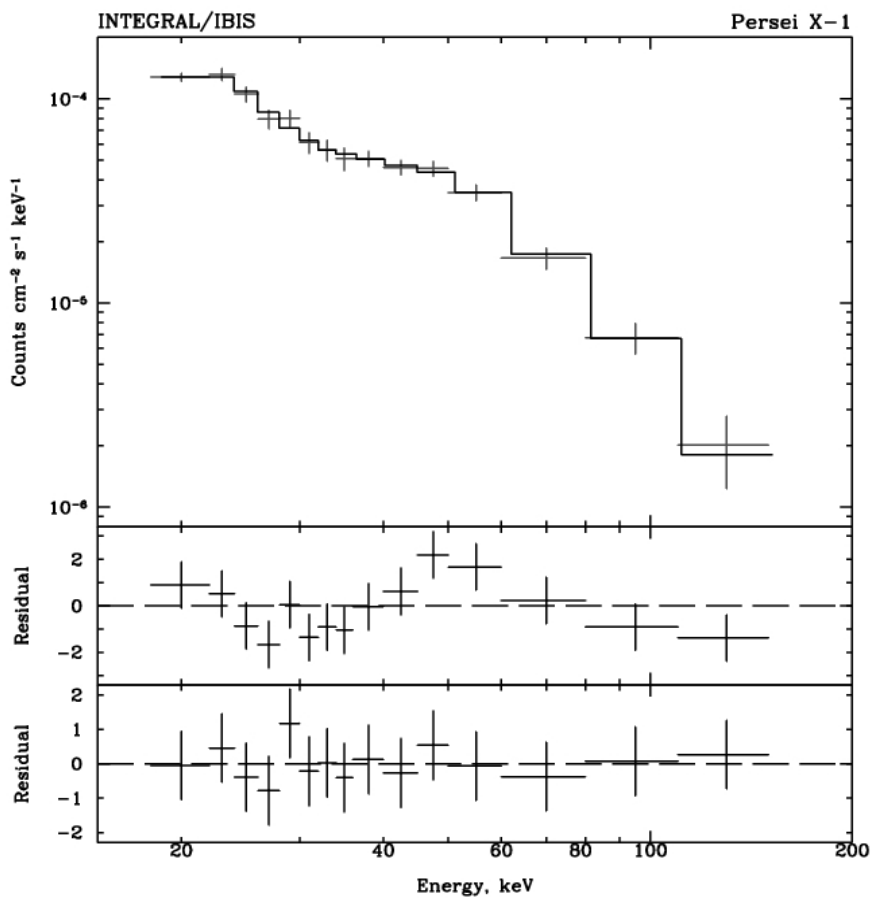
R = 5.92 mag, B = 6.6 mag

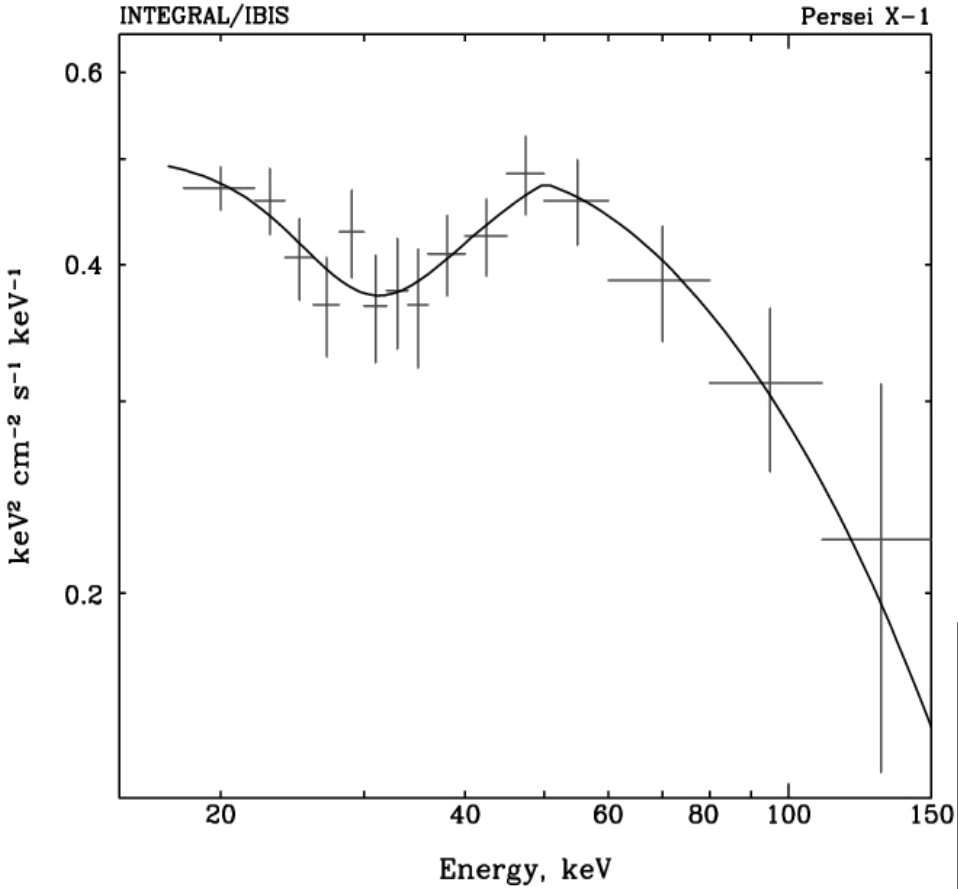
No variability ($H_\alpha$ filter) < 2%

Bikmaev et. al. (2004)



# X Per (INTEGRAL)



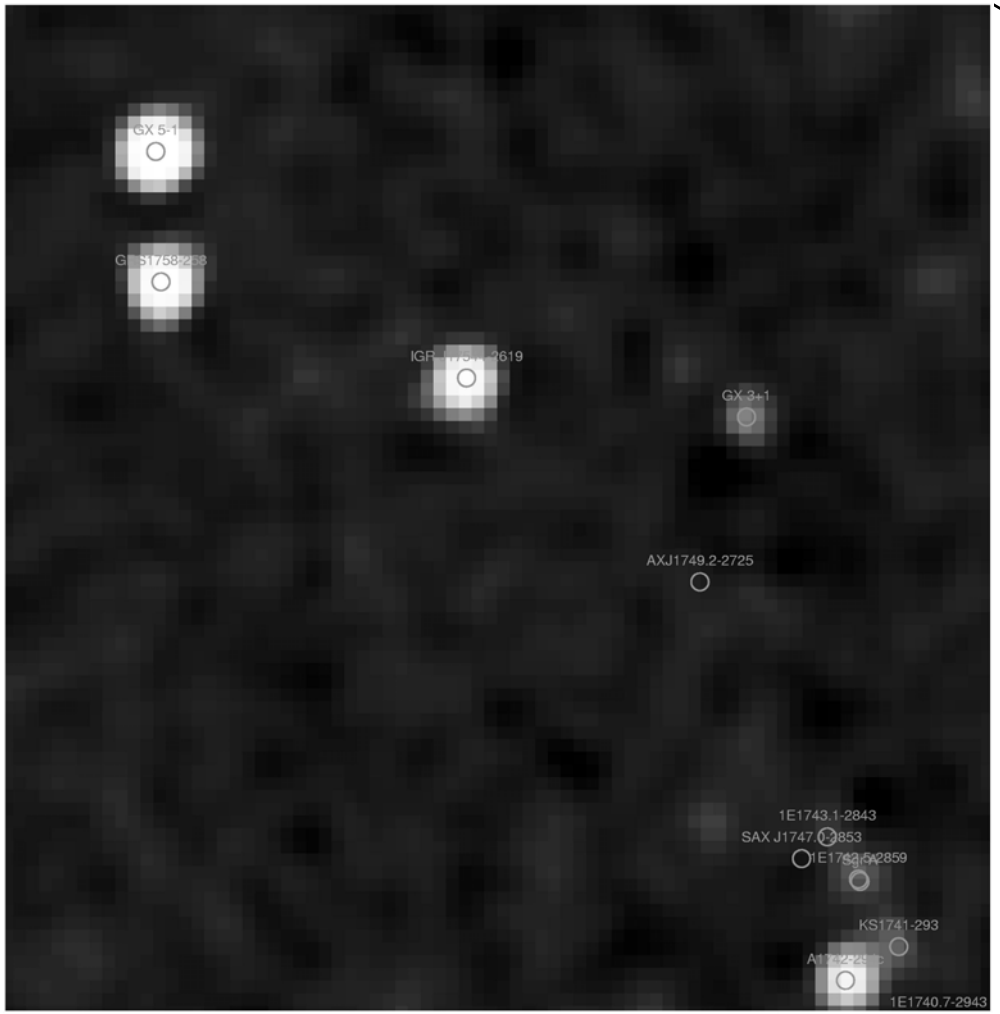

$\alpha$ = 1.92±0.19, $E_{cut}$ = 50±15 keV, $E_f$ = 77±25 keV, EW = 9 keV

$\tau$ = 0.33±0.12, $E_{cycl}$ = 28.8±2.6 keV, significance ~ 2.9$\sigma$

CRSF at 28.6 keV Coburn et. al. 2001 (RXTE)

# IGR 17544-2619

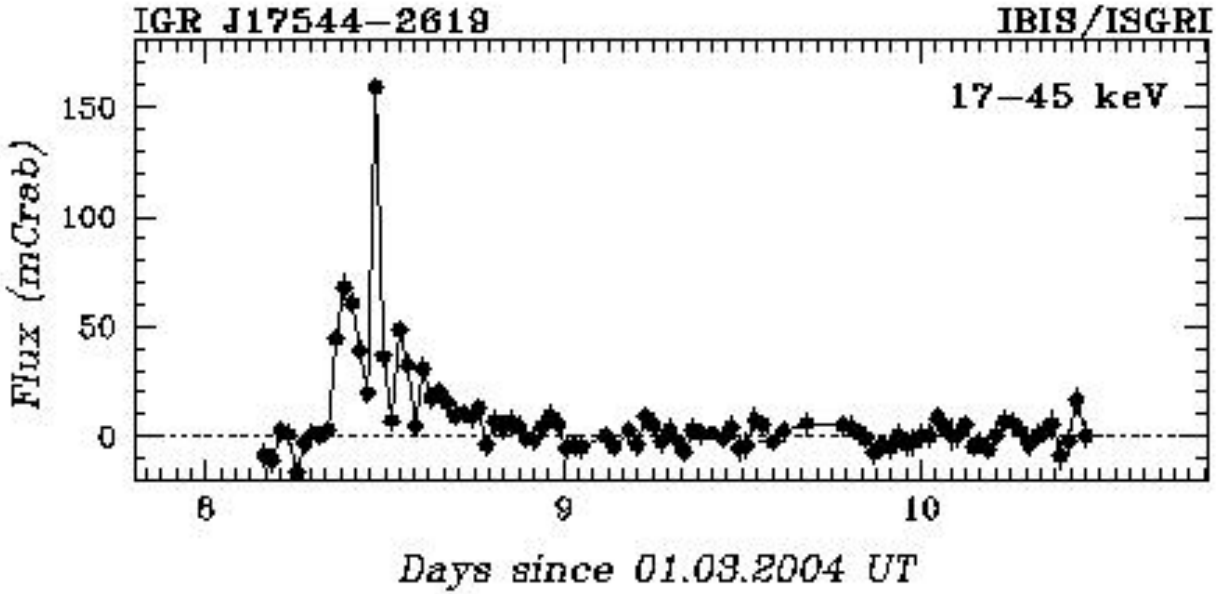
# New outburst of IGR J17544-2619 discovered with INTEGRAL




A new outburst of the hard X-ray transient IGR J17544-2619 was detected with INTEGRAL during recent observations dedicated to the Galactic Center Deep Exposure.

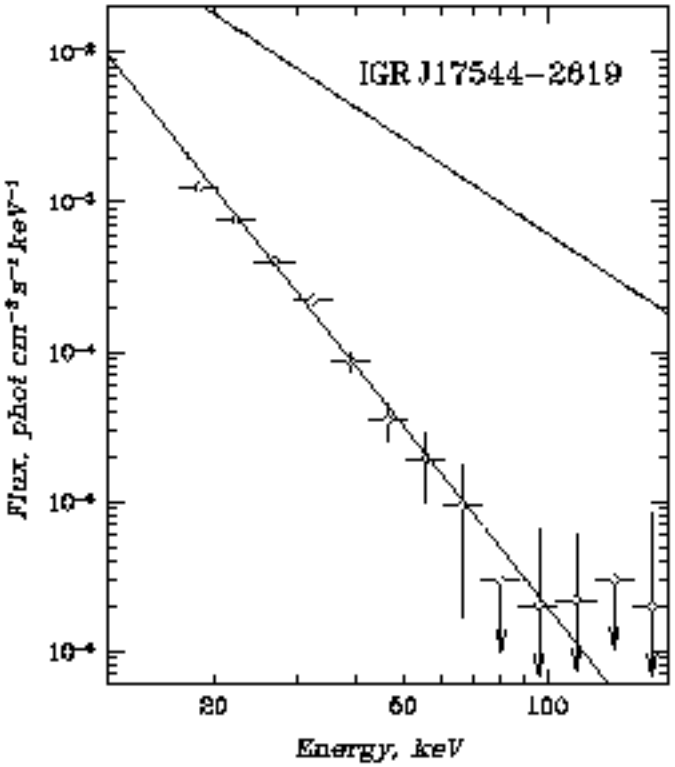
This detection shows that the outburst in Sept. when the source was discovered (ATel #190, 192) was not a unique event and IGR J17544-2619 is actually a recurrent transient.

# New outburst of IGR J17544-2619 discovered with INTEGRAL




The source was detected with IBIS/ISGRI on March 8, 2004 at 08h UTC and remained bright during at least 10 hours. The S/N ratio was equal to 33. The average 17-45keV flux was ~50 mCrab but the source reached ~160 mCrab at the peak of the outburst (at 11h UTC). The source was very variable with an oscillation-like behaviour on a time scale of 1.5-2 hours.

# New outburst of IGR J17544-2619 discovered with INTEGRAL




The source spectrum in the ISGRI 17-200 keV band was rather steep. It could be described by a power law with the photon index $\alpha \sim 4$ with some evidence for a high energy cutoff.

The source was also detected with JEM-X in the 6-30 keV band but only during the short time interval (~25 min) corresponding to the maximum of hard X-ray brightness. The S/N ratio was ~18. The spectrum was slightly flatter than that in the ISGRI band and could be described with the photon index $\alpha \sim 3$.

# SS 433

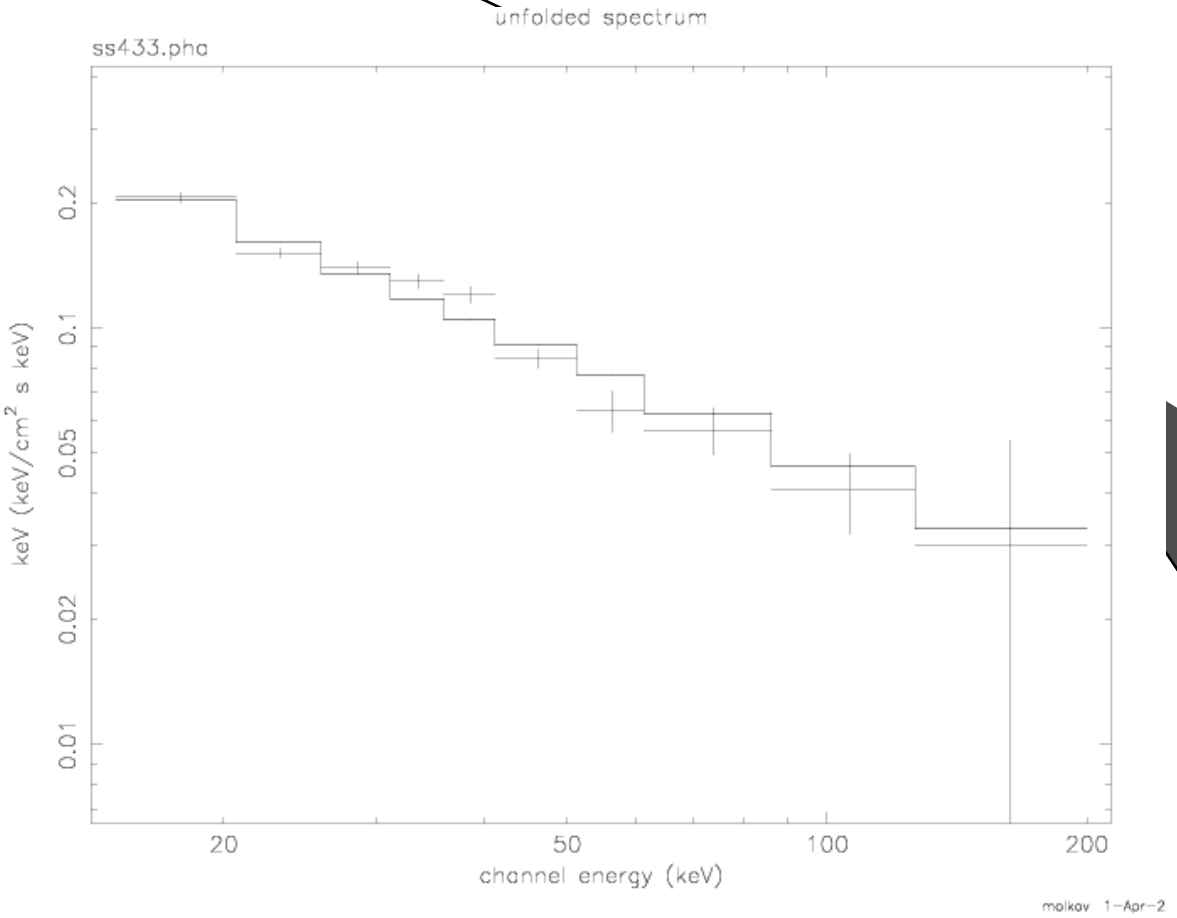
# Galactic microquasar SS433

- SS433 is a supercritically accreting microquasar with precessing accreting disk and collimated mildly relativistic (v ~ 0.26 c) jets.
- SS433 is highly variable system and shows different types of spectral and photometric periodicities:
  - 162.5 days disc precession variability;
  - 13.082 days orbital period variability;
  - 6.2877 days nutation period variability
- Being investigated by many authors since the discovery in 1978, this unique X-Ray binary system show very complicated nature, mostly due to interaction of very active and energetic processes in the limited space scale.
- Even mass of the components are still very uncertain till now.

# Galactic microquasar SS433

- The main results of INTEGRAL observations:
  - discovered hard (up to 100 keV) X-ray spectrum suggesting the presence of an extended hot (up to $10^8$ K) region in the central parts of the accretion disc;
  - showed no rapid variability in the hard X-ray band on characteristic time scales < 1 hour;
  - displayed extended wings of the X-ray eclipce at hard energies which is only little narrower than the optical one and slightly broader than in 1-35 keV energy range. This is opposite to what is found in ordinary ecipcing X-ray binaries (like Cen X-3, Vela X-1, etc.) in which the X-ray eclipce duration decreases with energy. This new fact may reflect a complicated structure of the innermost supercritical accretion disk in SS433
  - best fitted by model for the mass ratio $q = M_x/M_v \sim 0.2$

# Galactic microquasar SS433




IBIS/ISGRI spectrum of SS433 collected over INTEGRAL observations in May 2003

# Galactic microquasar SS433

- Optical photometric observations performed by 1.5-m telescope RTT150:
  - provided V-magnitude light curve sumultaneously with INTEGRAL observations;
  - clearly detected low amplitude (5-10%) intranight variability of the source on time scales 100 sec - 100 min. The physics of this kind fast optical variability is not studied yet earlier due to absence of high-quality observational data at the short time scales till this observational campaign.

# Galactic microquasar SS433

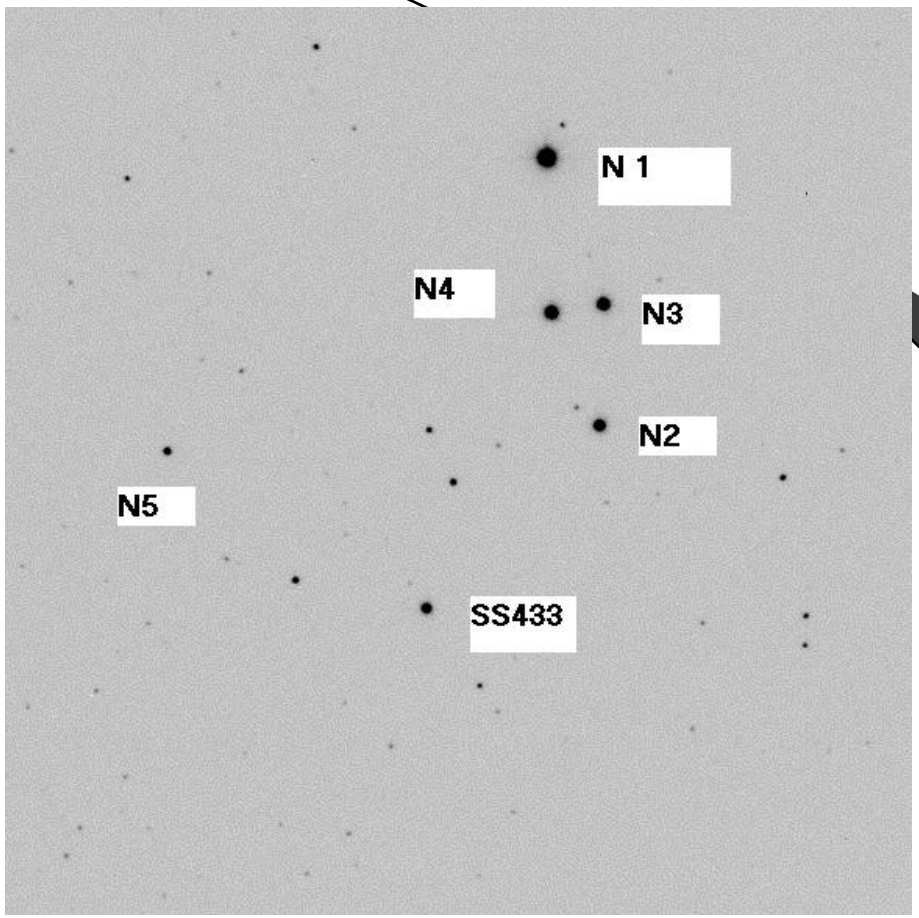
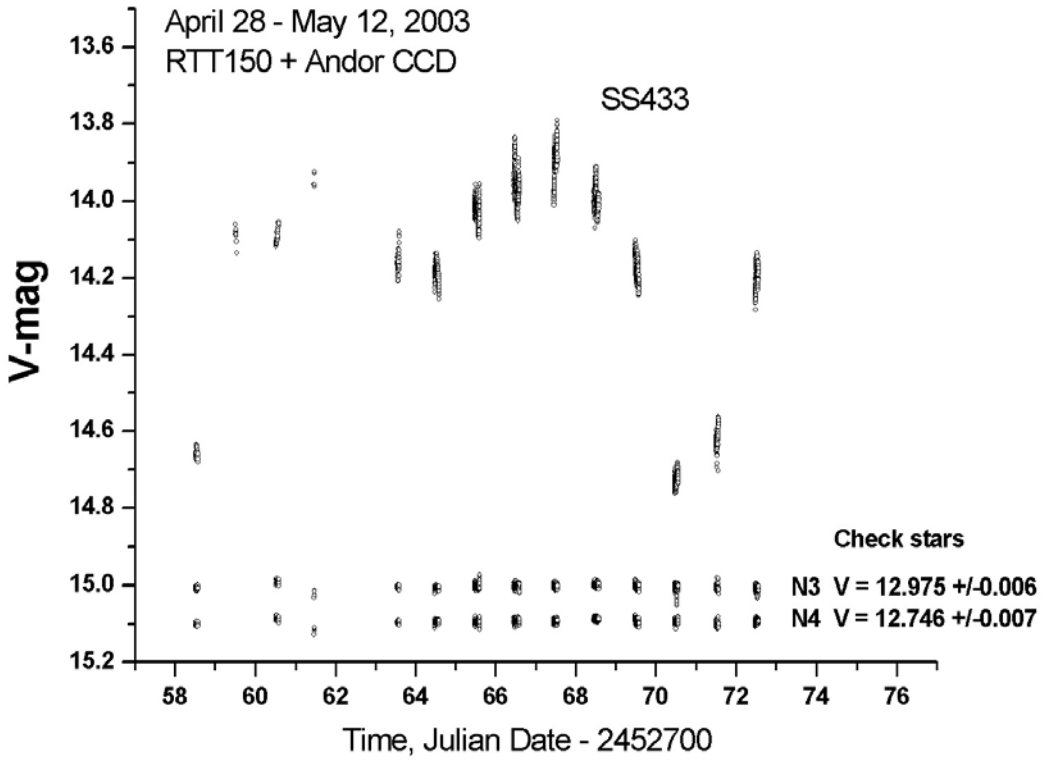


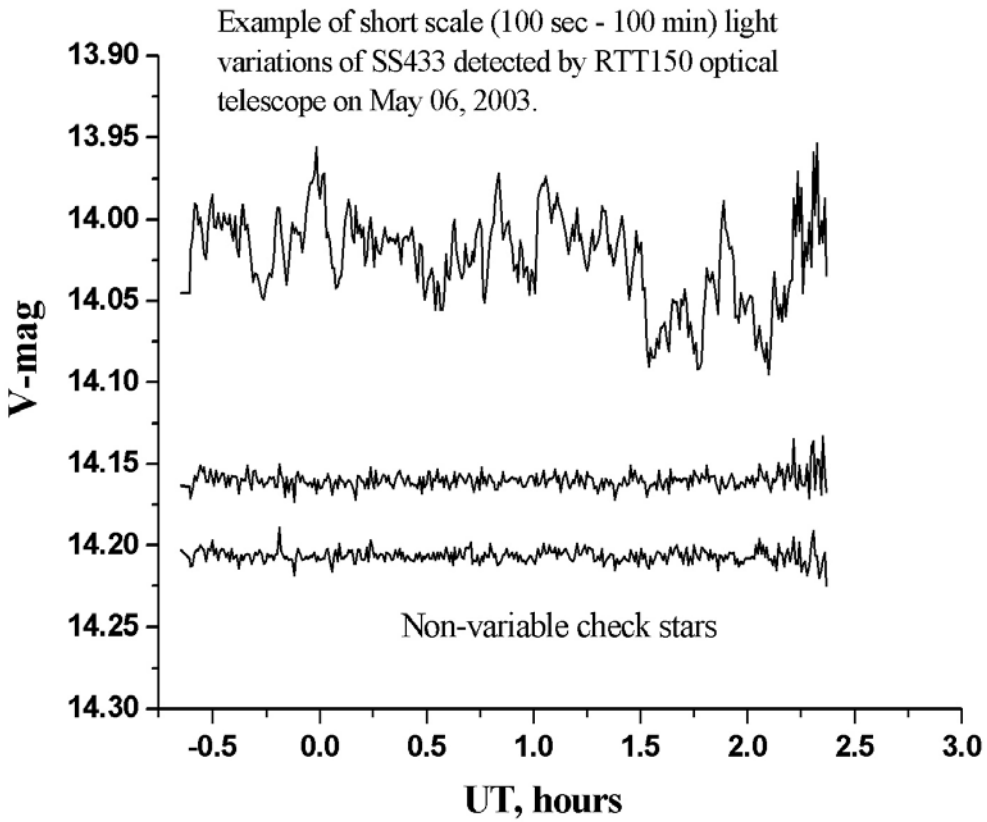

Image with 1.5-m telescope RTT150

# Galactic microquasar SS433




V-magnitude light curve by RTT

# Galactic microquasar SS433




Low amplitude (5-10%) intranight variability of the source on time scales 100 sec - 100 min.

# Galactic microquasar SS433

- Optical spectroscopy performed at the 6-m telescope with 3Å resolution:
  - discovered heating effect of the mass donor atmosphere. It was shown by analysing absorption lines that optical spectral class of the donor is A5-A7I (A-supergiant star);
  - provided data for determination of radial velocity semi-amplitude of the optical star ($K_v$ = 132±9 km/s).
- It was recognized that higher resolution spectra (< 1 Å) are needed to obtain in the near future to improve the acuracy of companions mass determinations.

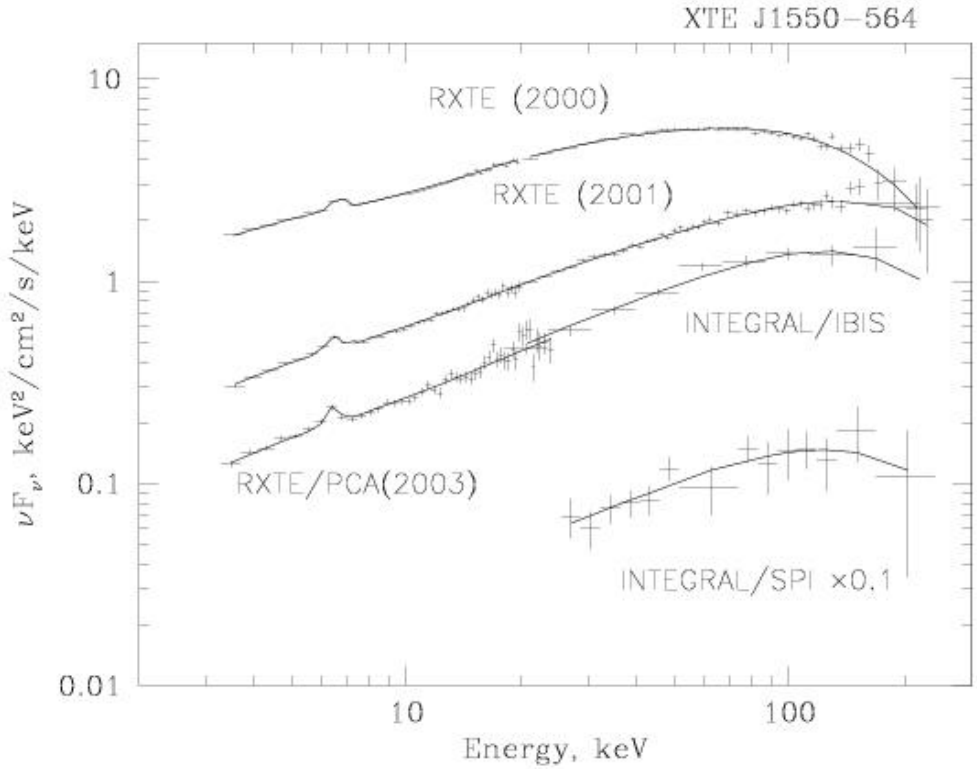
# Galactic microquasar SS433

- Future plans:
  - simultaneous RTT150/RXTE observations to study origin of fast variability at the time scales of minutes

# Broadband spectrum of BHC XTEJ1550-564 during 2003 flare

A.Arefiev, M.Revnivtsev,
A.Lutovinov, R.Sunyaev

The results of the observations of the Galactic microquasar black hole candidate XTEJ1550-564 obtaining in the wide energy band (3 - 200 keV) with INTEGRAL and RXTE observatories are presented.



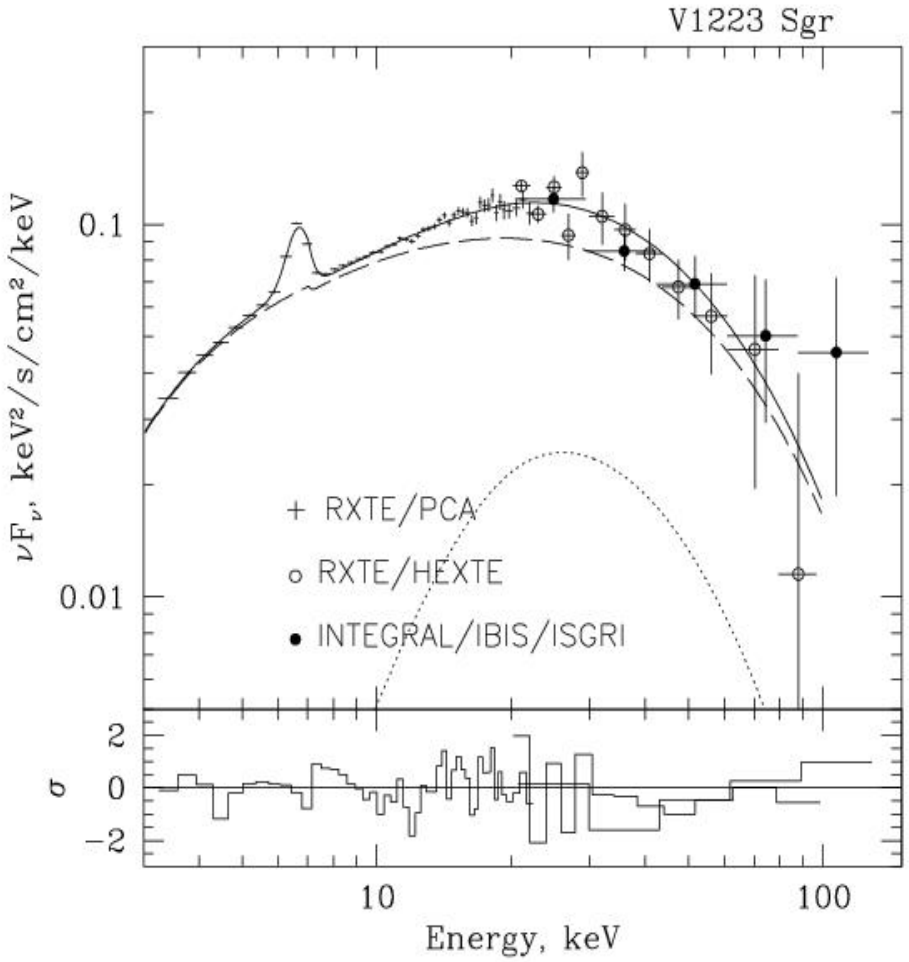

Source was observed both observatories several times during the outburst on spring, 2003. During this outburst source was found in the canonical hard state and its spectrum was the same during both the rise and declining phases of the outburst. A comparison with previous outbursts shown that current one was weaker and harder.

Submitted to the Astronomy Letters

# Broadband spectrum of intermediate polar V1223 Sgr

M.Revnivtsev, A.Lutovinov, V.Suleimanov, V.Zheleznyakov, R.Sunyaev

The broadband phase averaged spectrum of one of the brightest intermediate polars V1223 Sgr, obtained with INTEGRAL and RXTE observatories (3 - 100 keV). Good statistical quality of the spectrum in a hard X-ray energy band (INTEGRAL/IBIS and RXTE/HEXTE) allowed us to disentangle contributions of a direct optically thin plasma emission and a reflected component to the spectrum of V1223 Sgr. Obtained measurement of the post-shock temperature of the accreting matter give us confident estimation of the mass of the white dwarf and the inclination of the system.



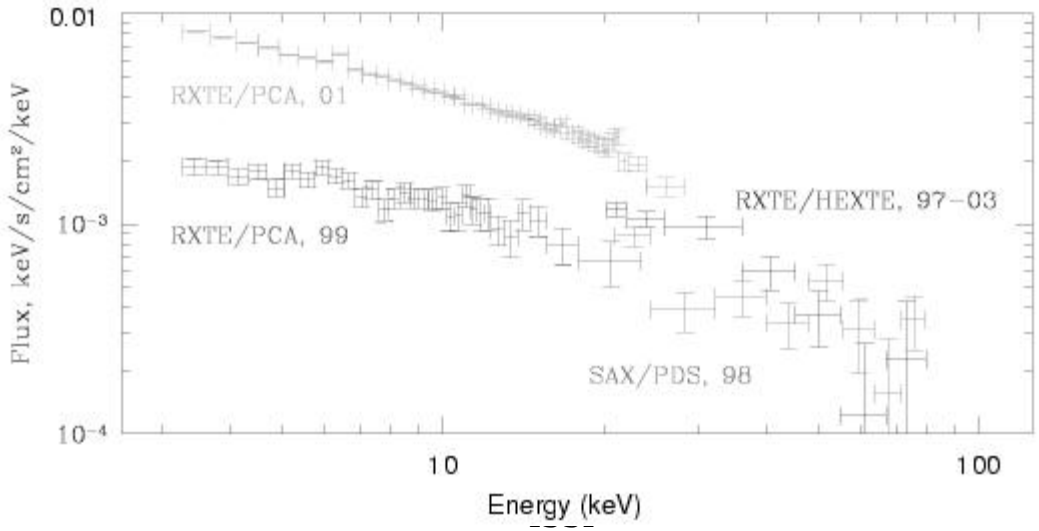

Submitted to the Astronomy & Astrophysics

# Observations of radio galaxy 3C111 with INTEGRAL and RXTE

M.Chernyakova, P.Favre, T.Courvoisier, A.Lutovinov, S.Molkov et al.

3C111 is an X-ray bright broad-line radio galaxy which is classified as a type II source with a double-lobe/single jet morphology, and reported superluminal motion. It is a well-known X-ray source, and was observed by every major X-ray observatories. In this paper the results of the current RXTE and INTEGRAL data analysis are presented and compared with the results of the previous observations.

Submitted to the Proceeding of the 5th INTEGRAL Workshop



# 7 papers have been submitted by the Team members

- «Optical and X-ray observations of thermonuclear flashes from bursters GS1826-24 in Sept.-Nov. 2003», accepted to AstL;
- «Variability of X-ray pulsars in a hard energy band observed with INTEGRAL», submitted to the Proc. of the 5th INTEGRAL Workshop;
- «New hard X-ray transient IGR J17544-2619 discovered with INTEGRAL», submitted to the Proc. of the 5th INTEGRAL Workshop;
- «Coordinated INTEGRAL and optical observations of SS433», submitted to the Proc. of the 5th INTEGRAL Workshop;
- «Broadband spectrum of XTEJ1550-564 during outburts of 2003», submitted to AstL;
- «Broadband X-ray spectrum of intermediate polar V1223 Sgr», et.al., submitted to A&A, astro-ph/0403532;
- «INTEGRAL and RXTE observations of broad-line radio galaxy 3C111», submitted to the Proc. of the 5th INTEGRAL Workshop.

# Papers in preparation on the following subjects:

- X Persei (RTT150+INTEGRAL+RXTE observations, high-resolution optical spectroscopy);
- MX0656-072 (optical counterpart);
- SAXJ2103.5+4545 (optical observation, variability on different time scales);
- IGRJ17544-2617 (optical observations, possible counterpart);
- Aql X-1 (hard x-ray state);
- Investigations of the Comptonizing regions in bright low mass X-ray binaries.