

# Status of RSDC

**Sergei Grebenev**

*Space Research Institute (IKI), Moscow*

# RSDC

- *Supports the archive of all publicly available + Russian PI data*
- *Has the current OSA + Russian INTEGRAL software installed*
- *Used by IKI scientists, scientists from Sternberg Astronomical Institute (Moscow University), Kazan University, Ioffe Institute, Pulkovo Observatory, Lebedev Physical Institute, Moscow Engineering Physics and Moscow Technical Physics Institutes*
- *Uses Russian optical telescopes for identification (and study) of new IGR sources (RTT-150 at Turkey, 6-m telescope at Nizhnii Arkhyz, AZT33IK at Sibirya/Monds)*

# RSDC

- *Supported by the Russian Academy of Sciences and Space Research Institute*
- *Archive data occupy now more than 35 Tbytes*
- *Currently there is possibility to use resources of the SRG Data Center (10 computer servers, 200 Tbytes)*
- *About 10 scientists are involved but some of them are currently spending some time developing the software for the SRG project (currently scheduled for the launch in March of 2019).*

# Russian INTEGRAL related papers and theses

- *PhD - 11 (RSDC: Chelovekov, Tsygankov, Shtykovskii, Krivonos, Molkov, Karasev, Filippova, Prosvetov, others: Arefiev, Minaev, Krassilshikov)*
- *Expected PhD - 2 (Mereminskii - on March 27 and Khorunzhev by the end of 2018)*
- *DSc - 5 (RSDC: [Revnivtsev], Sazonov, Lutovinov, others: Bikmaev, Seifina)*
- *Russian publication activity based on INTEGRAL  
>320 papers and ATELS (see INTEGRAL Russian Library in NASA/ADS by Lutovinov et al.)*

# Recent (last year) Results

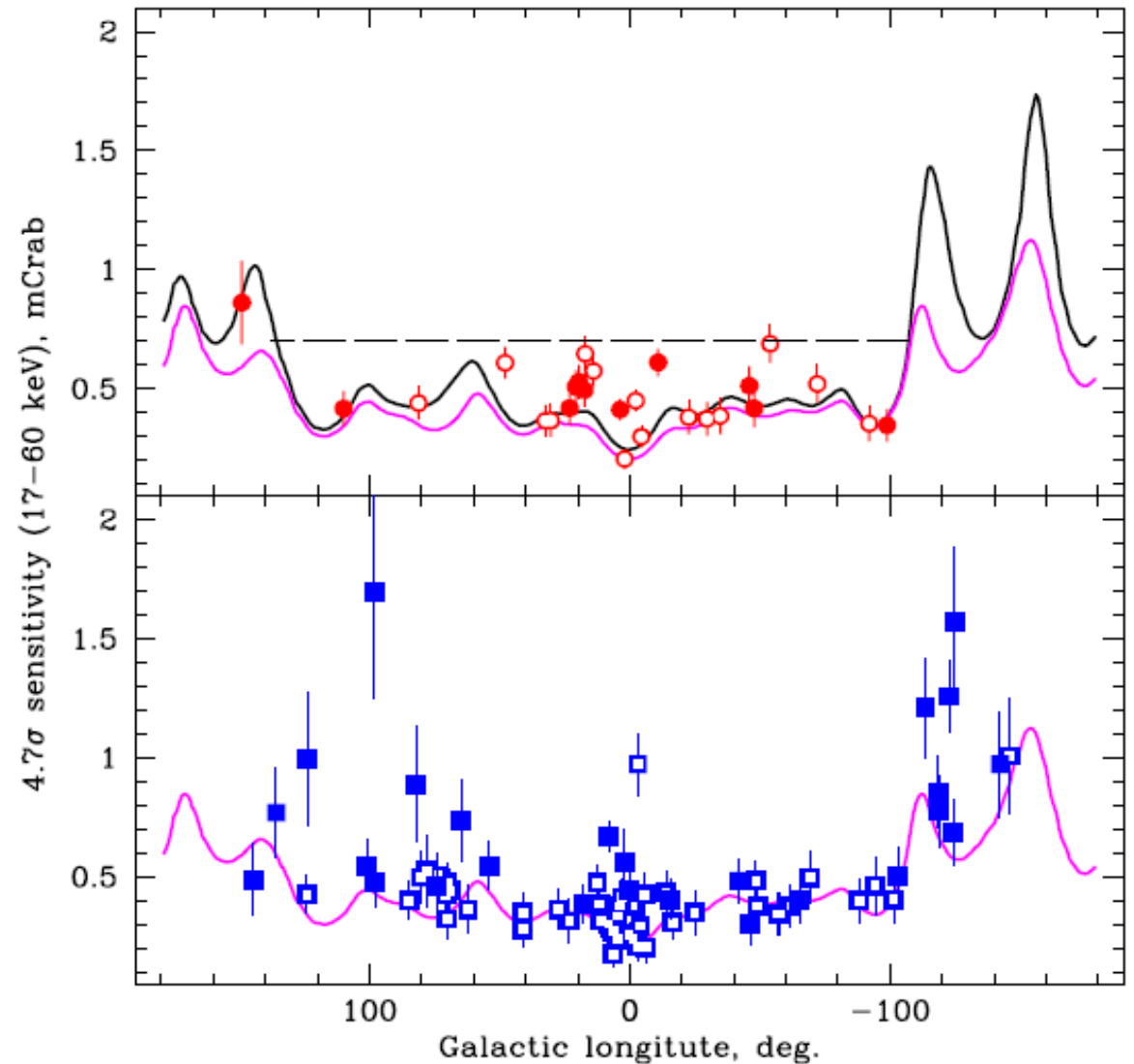
- **Type I X-ray Bursts Detected by the JEM-X Telescope Onboard the INTEGRAL Observatory in 2003–2015** (Chelovekov, Grebenev, Mereminskiy, Prosvetov)
- **Multiple X-ray Bursts and the Model of a Spreading Layer of Accreting Matter over the Neutron Star Surface** (Grebenev, Chelovekov)
- **Single X-ray Bursts and the Model of a Spreading Layer of Accreting Matter over the Neutron Star Surface** (Grebenev, Chelovekov)
- **IGR J17445-2747 — Yet Another X-Ray Burster in the Galactic Bulge** (Mereminskiy, Grebenev, Sunyaev)

# Recent & Current Activities

- **Low Frequency QPOs of the X-ray Nova MAXI J1535-571 emission at the initial stage of its outburst in 2017** (Mereminskiy, Grebenev, Prosvetov, Semena)
- **New hard X-ray sources discovered in the ongoing INTEGRAL Galactic plane survey after 14 yr of observation** (Krivonos, Tsygankov, Mereminskiy, Lutovinov, Sazonov, Sunyaev)
- **INTEGRAL observations of the new X-ray transient Swift J1658.2-424** (Grebenev, Mereminskiy, Prosvetov, Ducci, Bozzo, Savchenko, Ferrigno) **ATE1 11306**

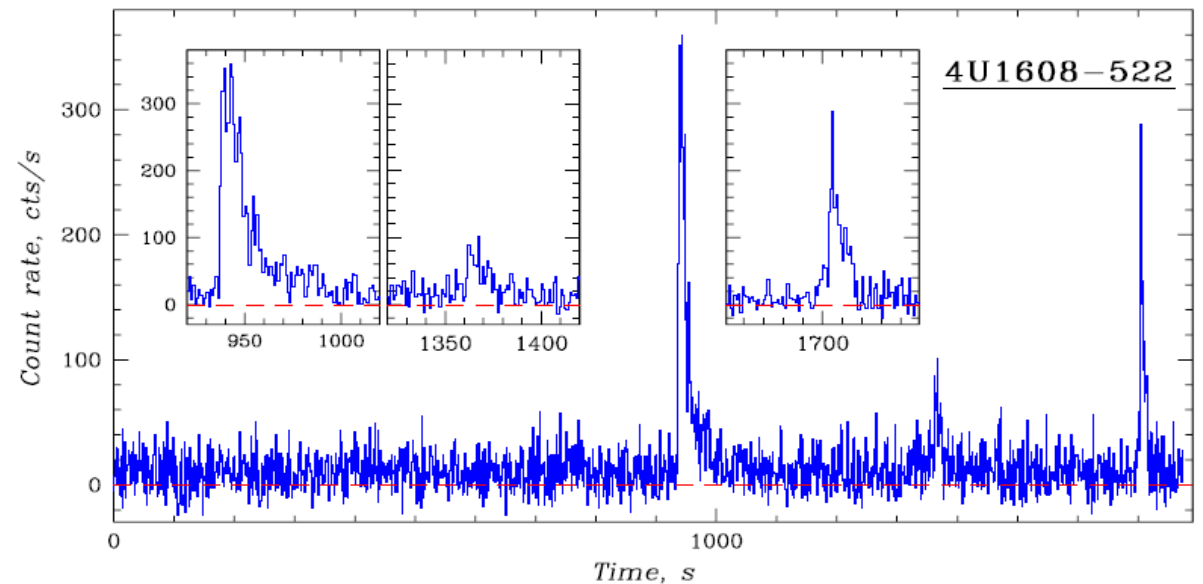
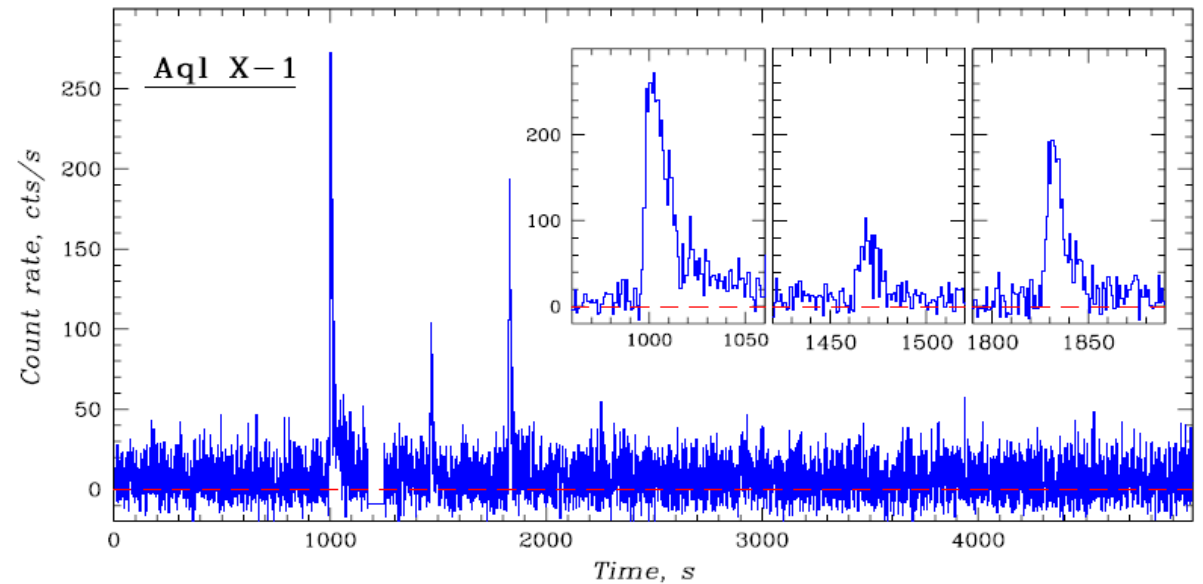
# 14-Years INTEGRAL/IBIS Galactic Plane Survey

72 new sources  
( $>4.7\sigma$ )



# Multiple X-ray bursts

Can be explained in the model of a spreading layer of accreting matter at the surface of a neutron star by Inogamov, Sunyaev (1999)

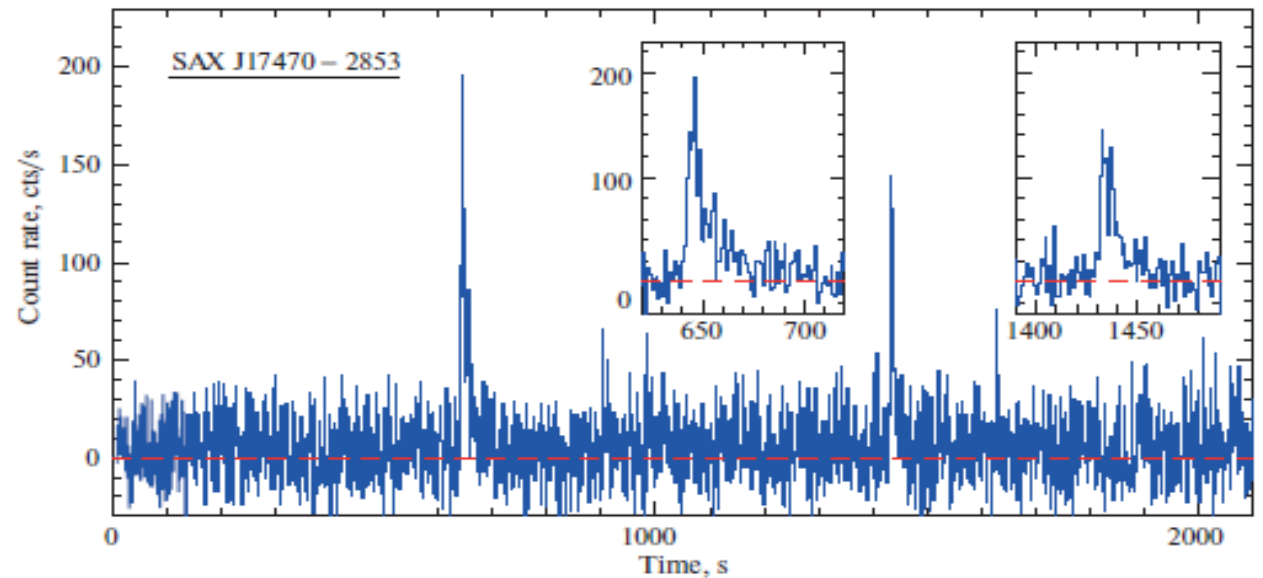
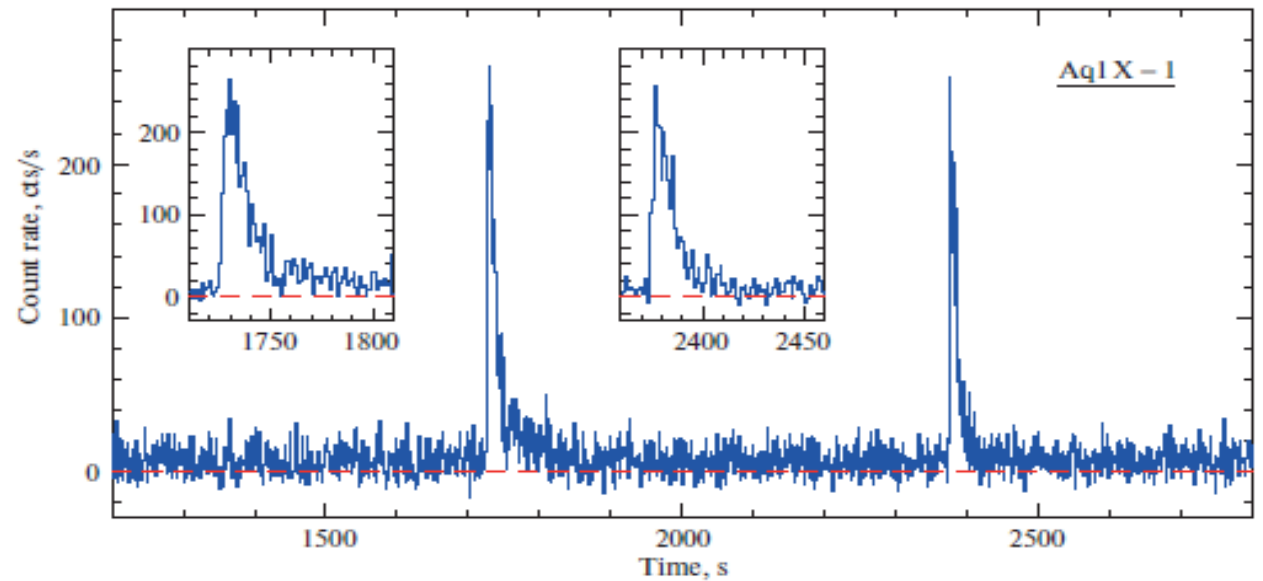


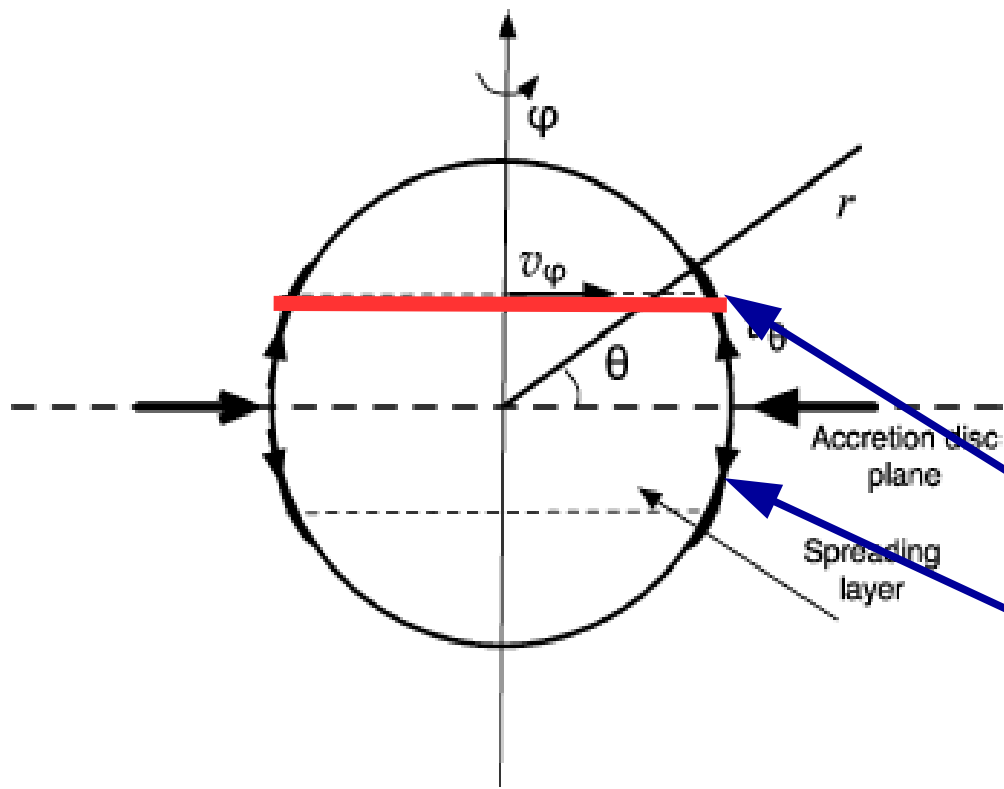


# Double X-ray bursts

The same time between the first and final bursts in the same source !

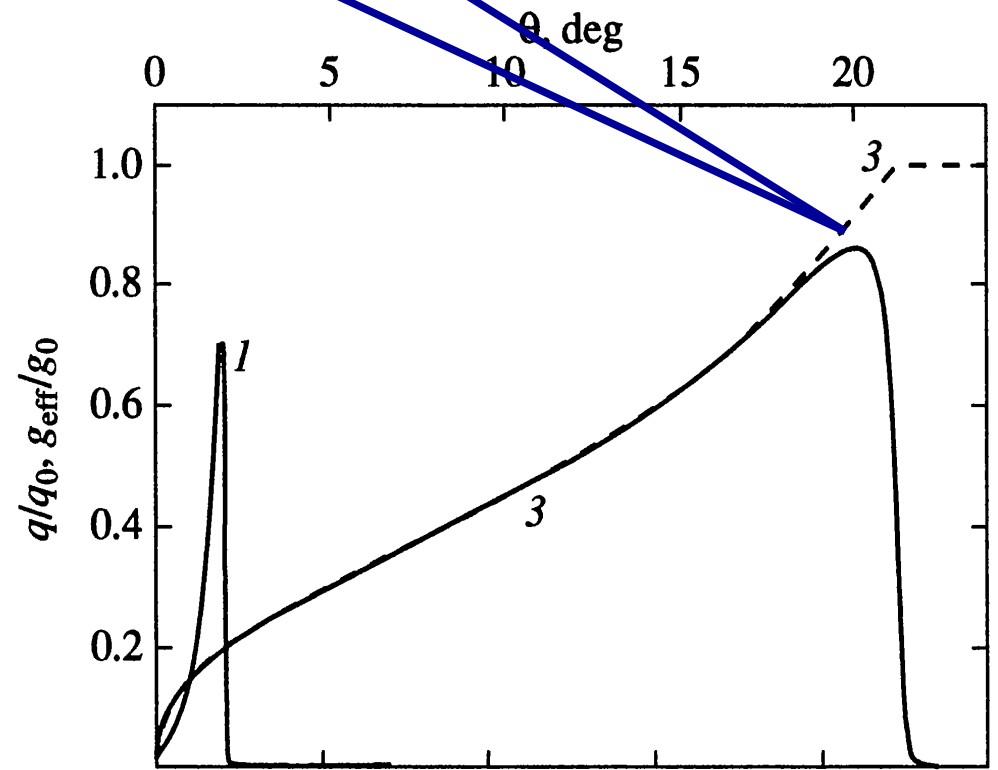
- Is such a double burst indeed a failed triple one ?

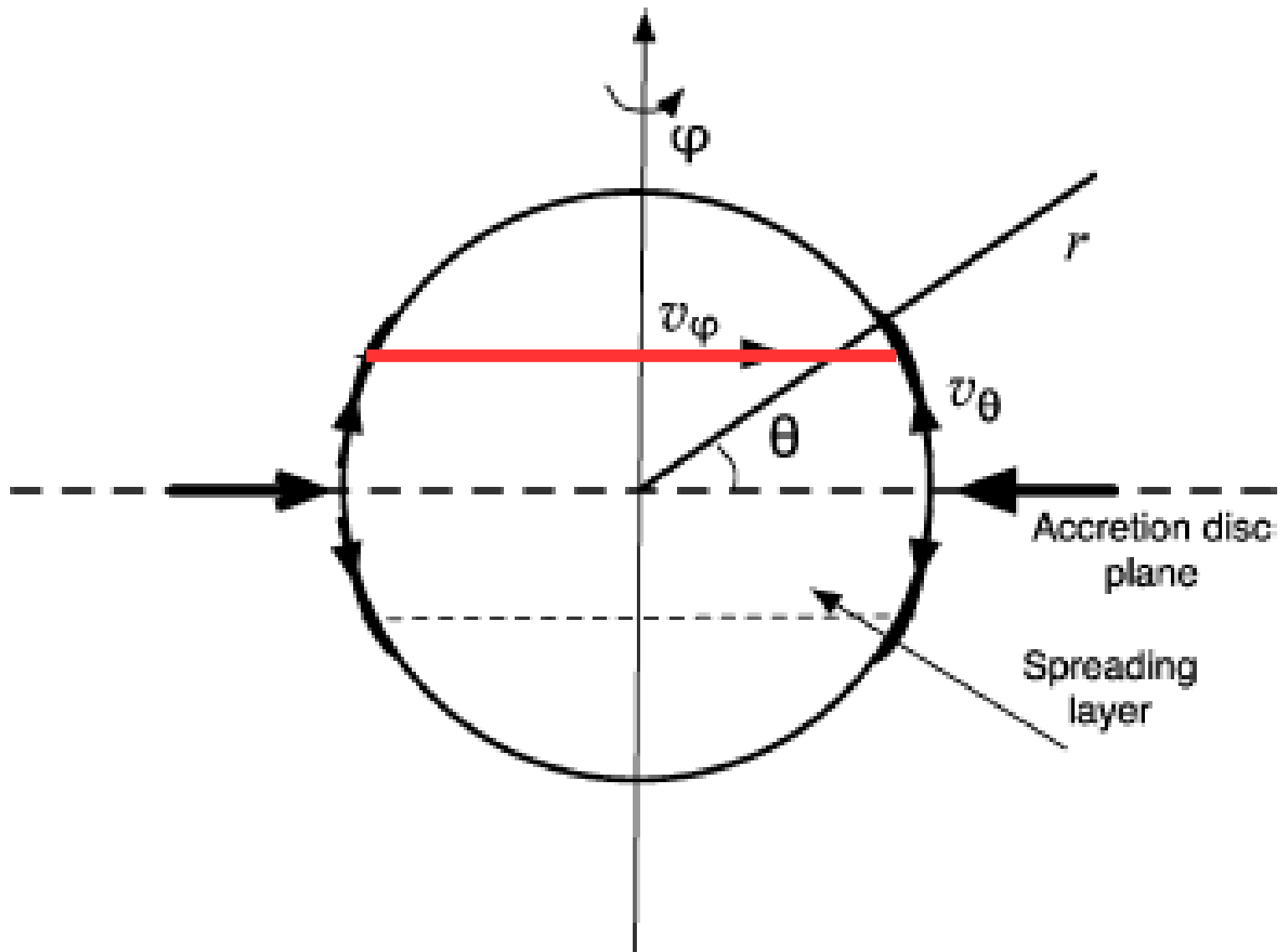


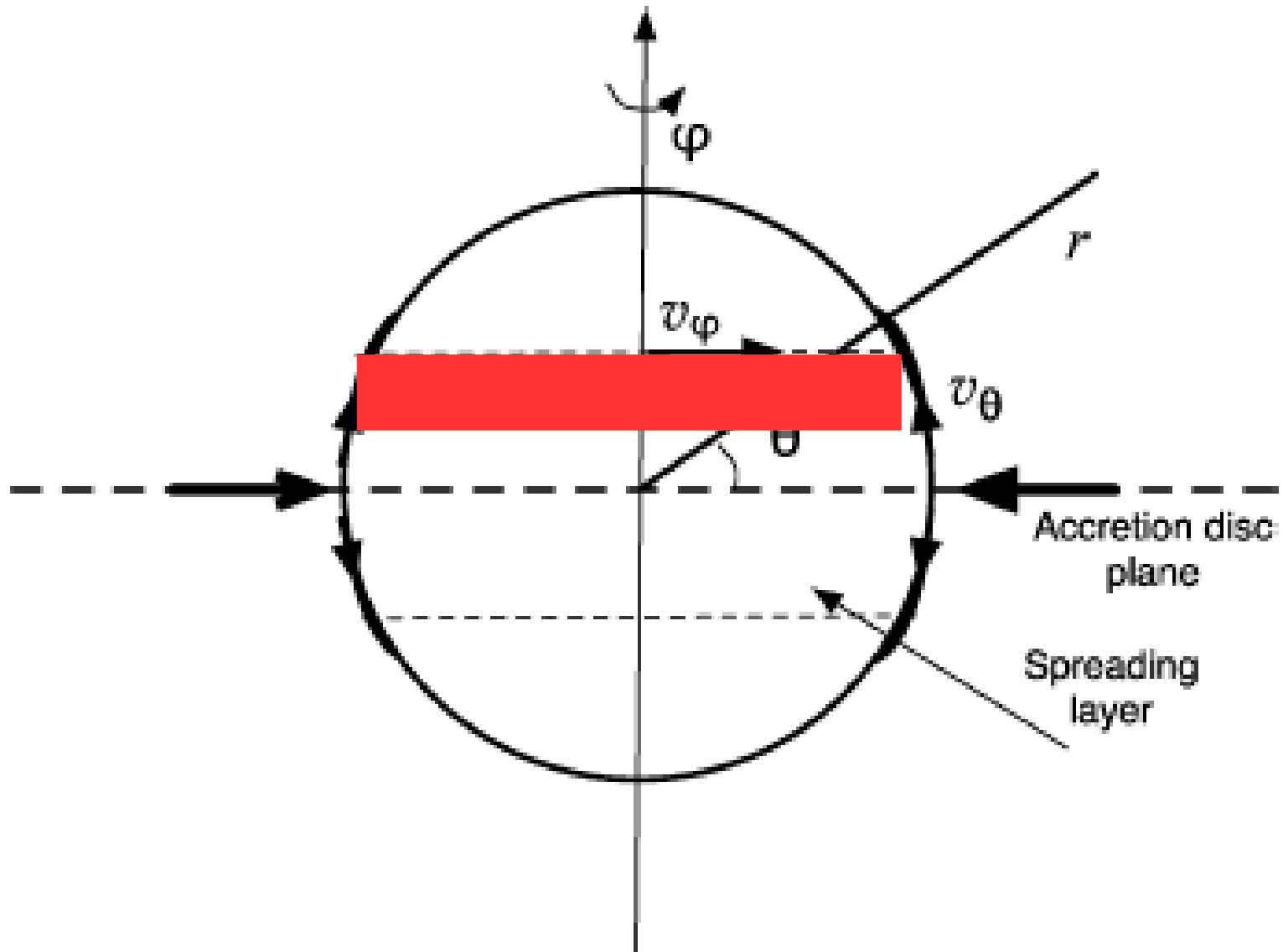


**Spreading layer**

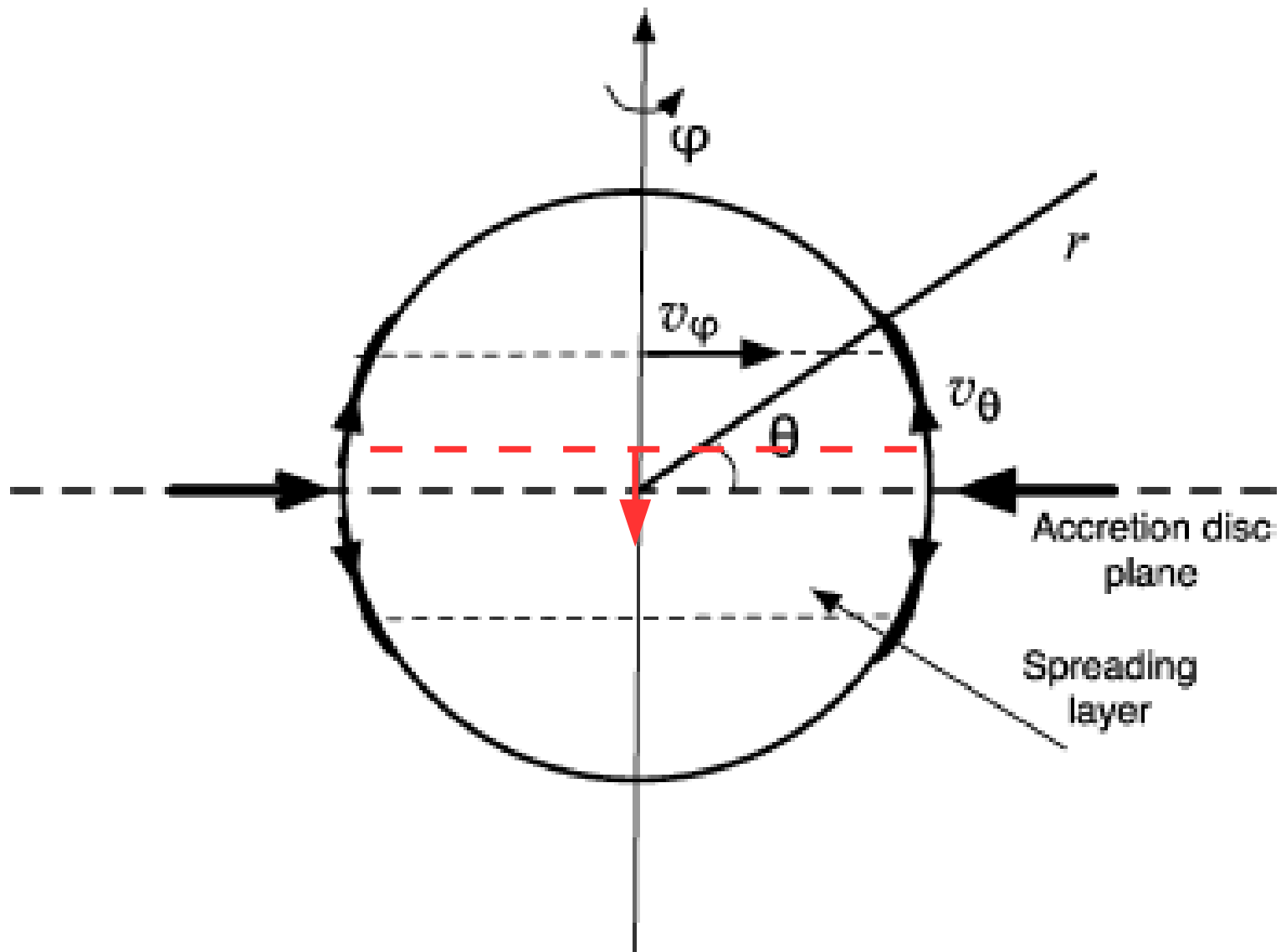
**the beginning of explosion**

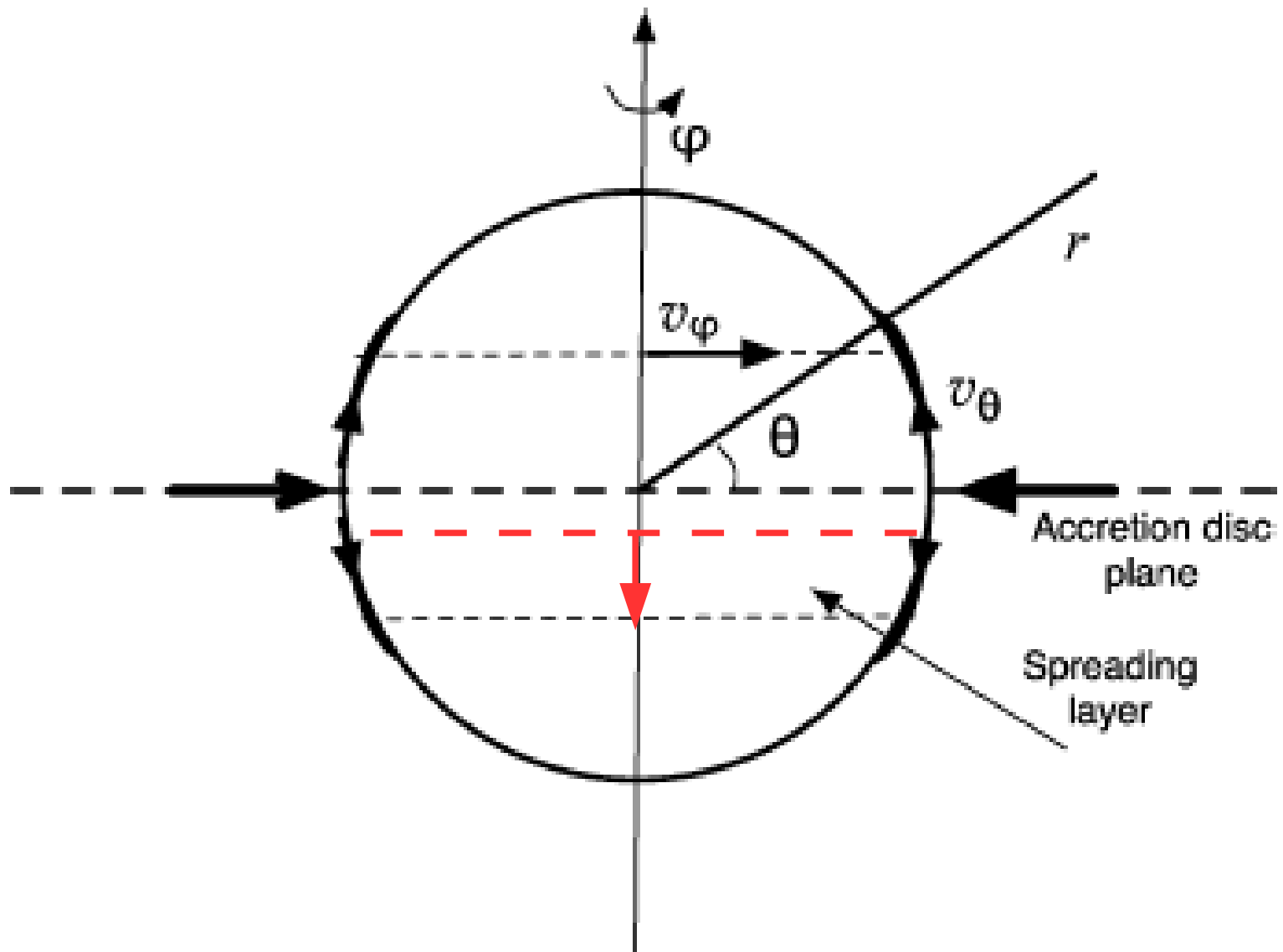


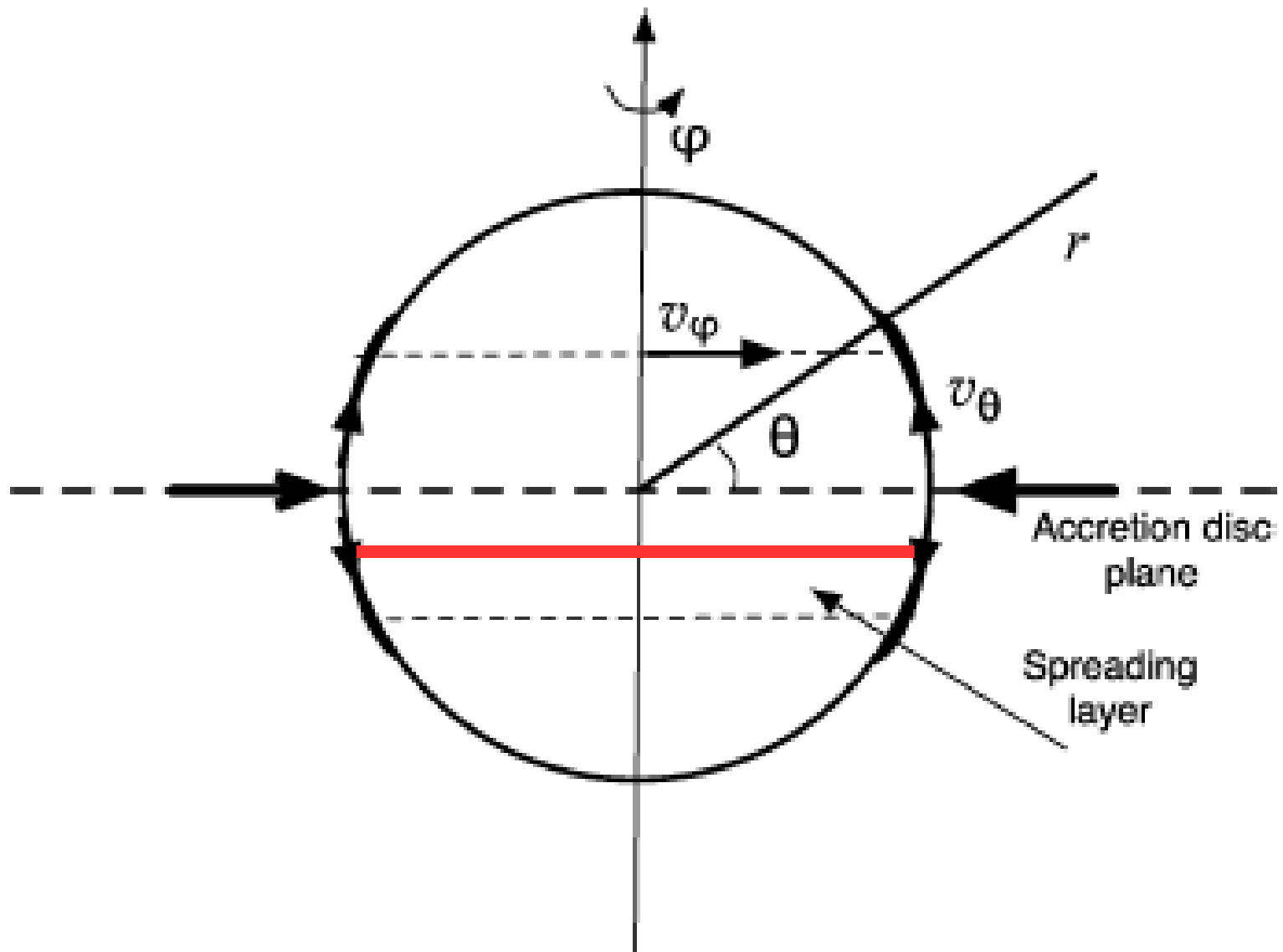


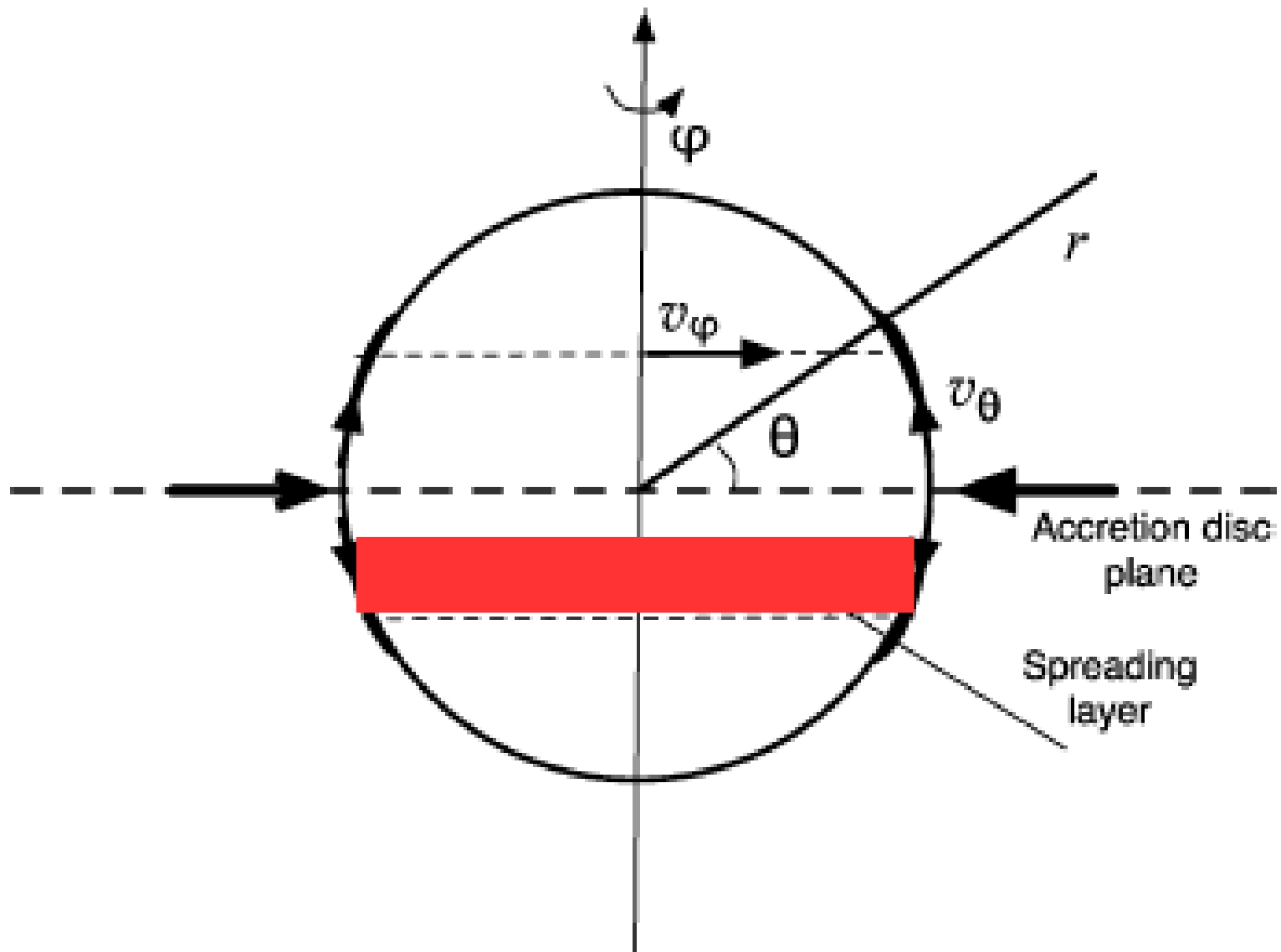


The first X-ray burst





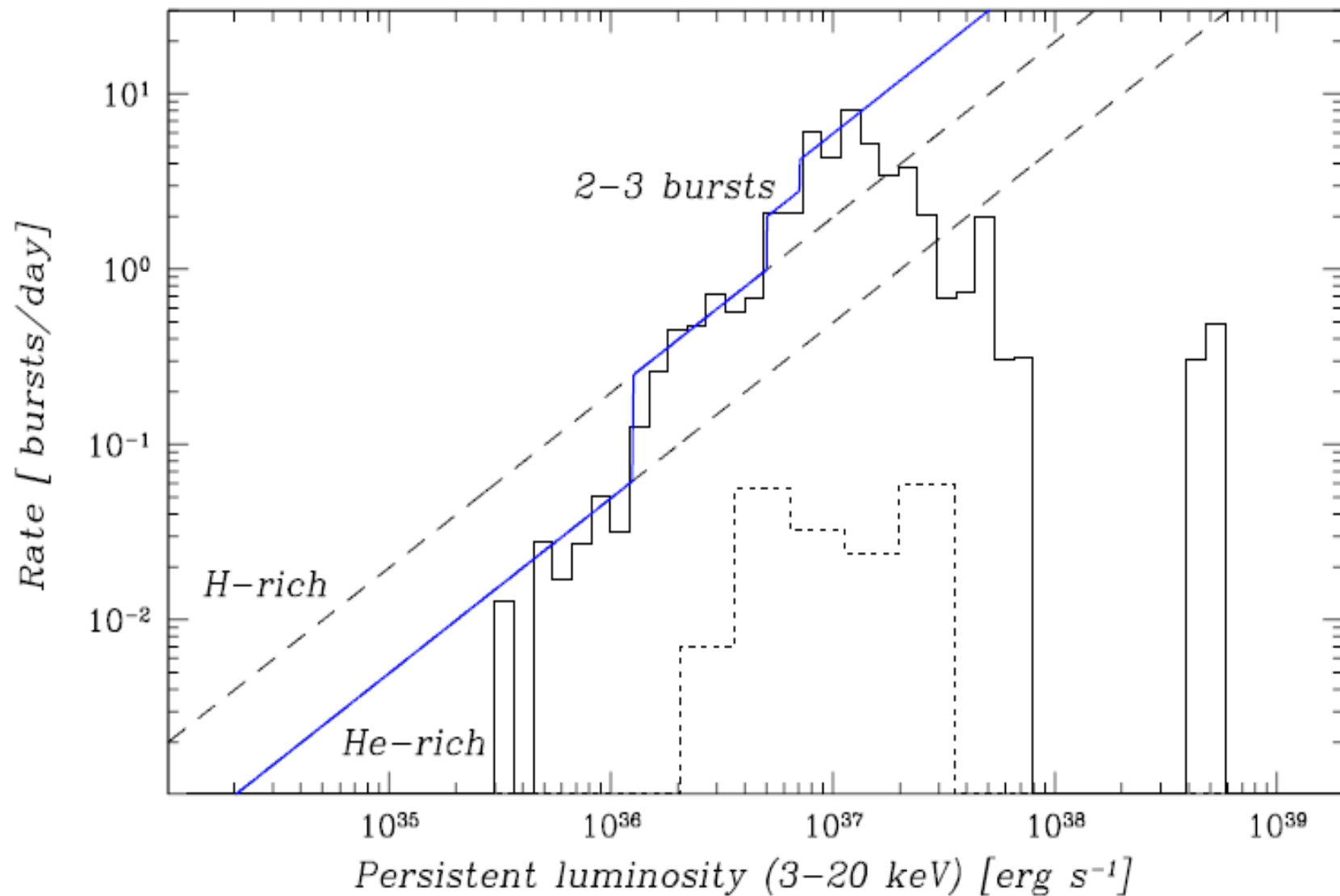




The last (second) X-ray burst

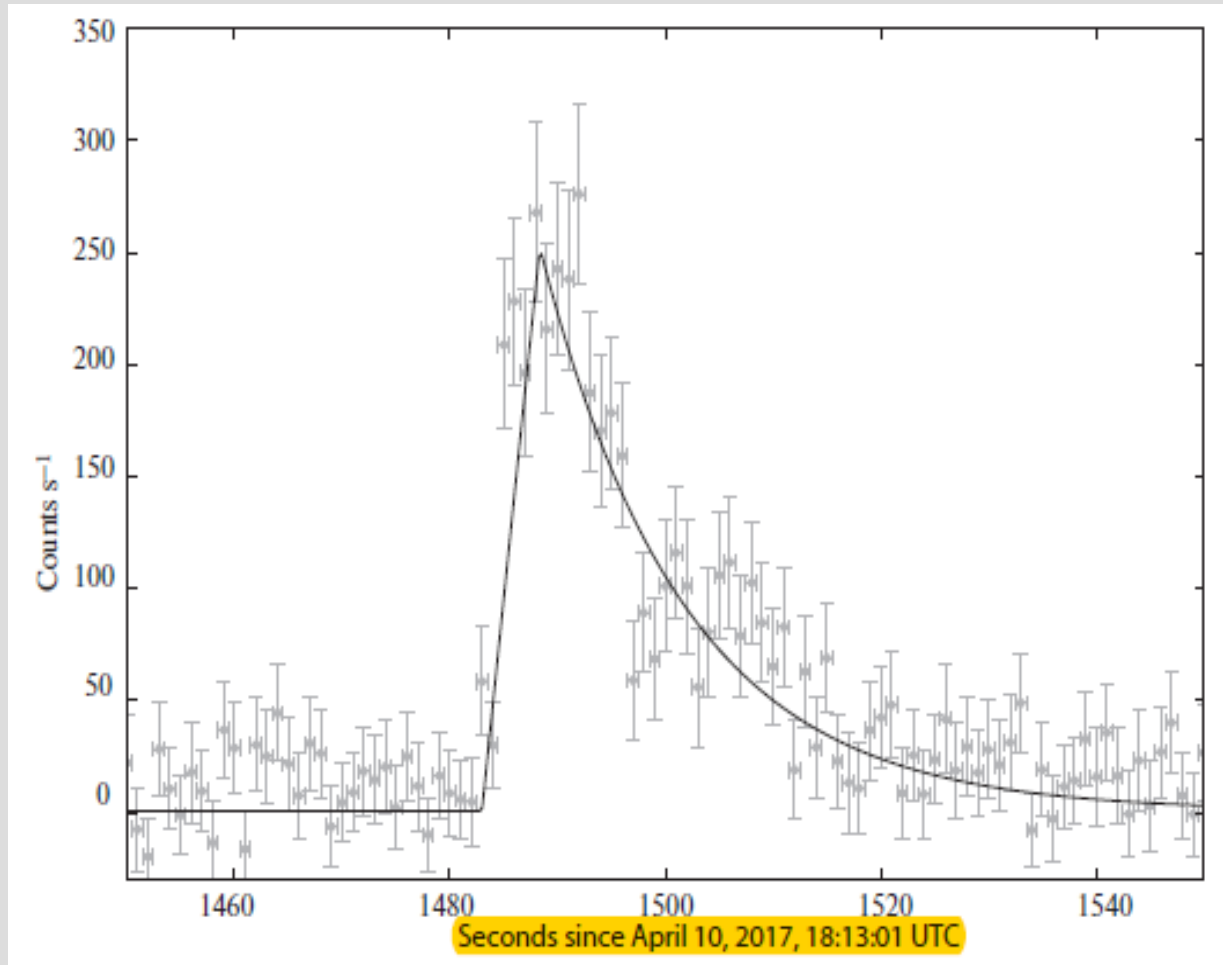


# The rate of bursts and unidentified multiple bursts

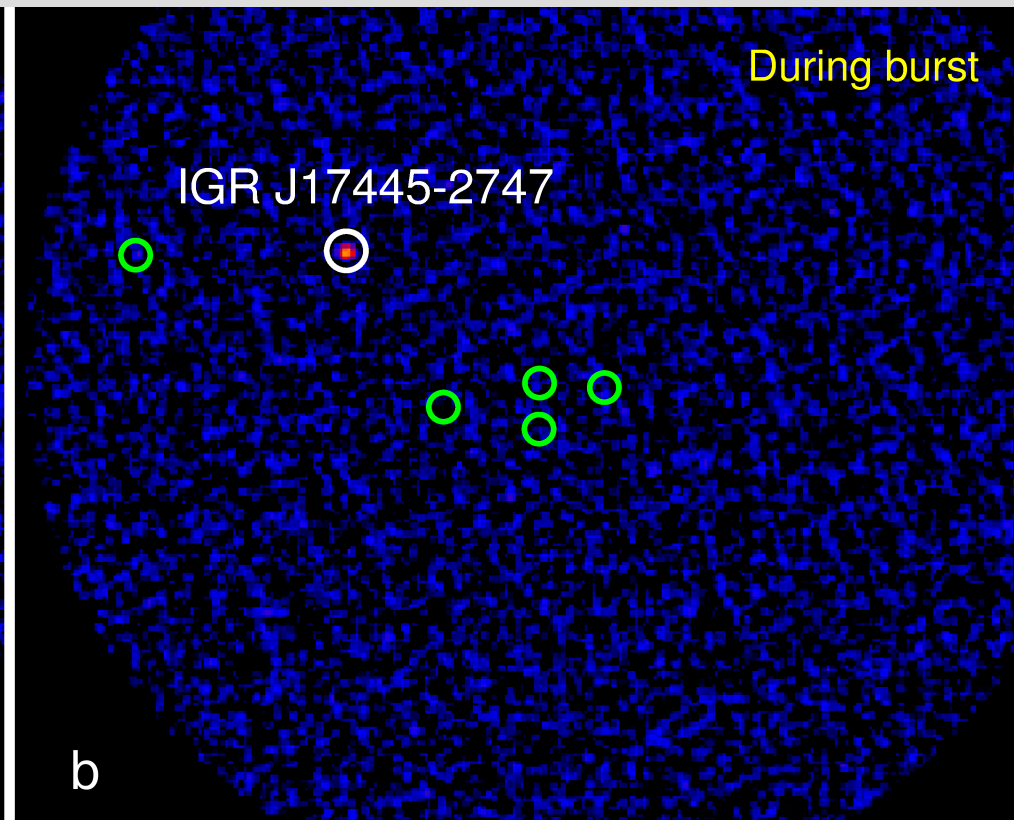
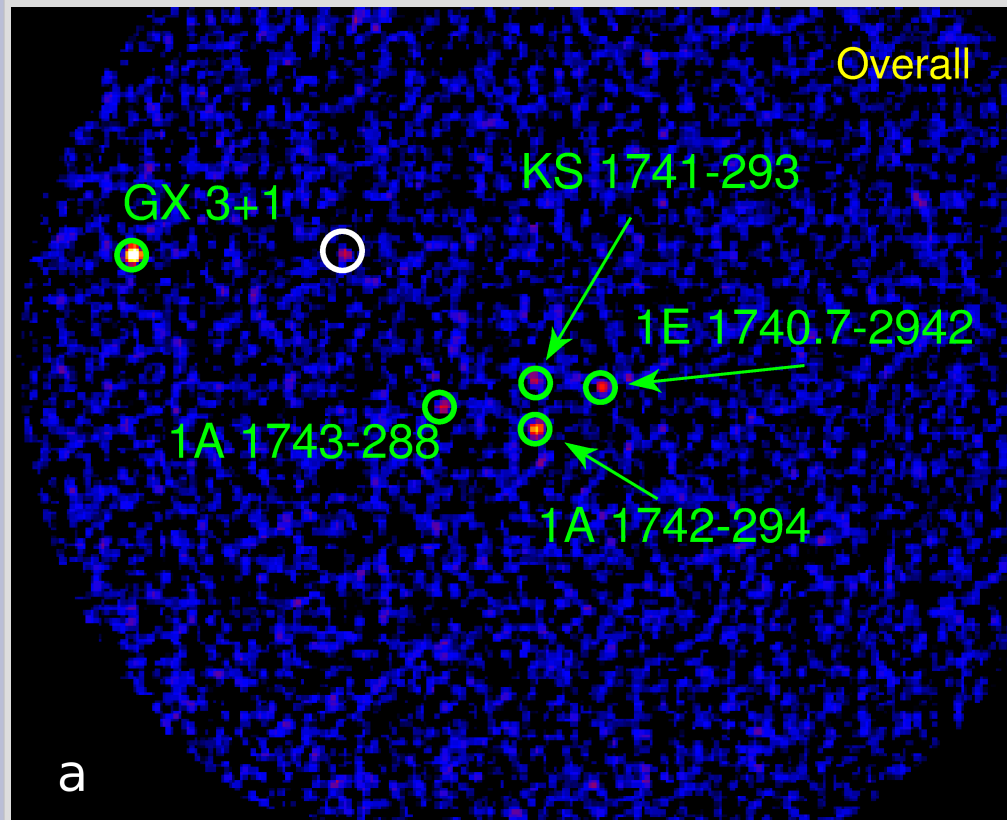


# IGR J17445-2747 — YET ANOTHER X-RAY BURSTER

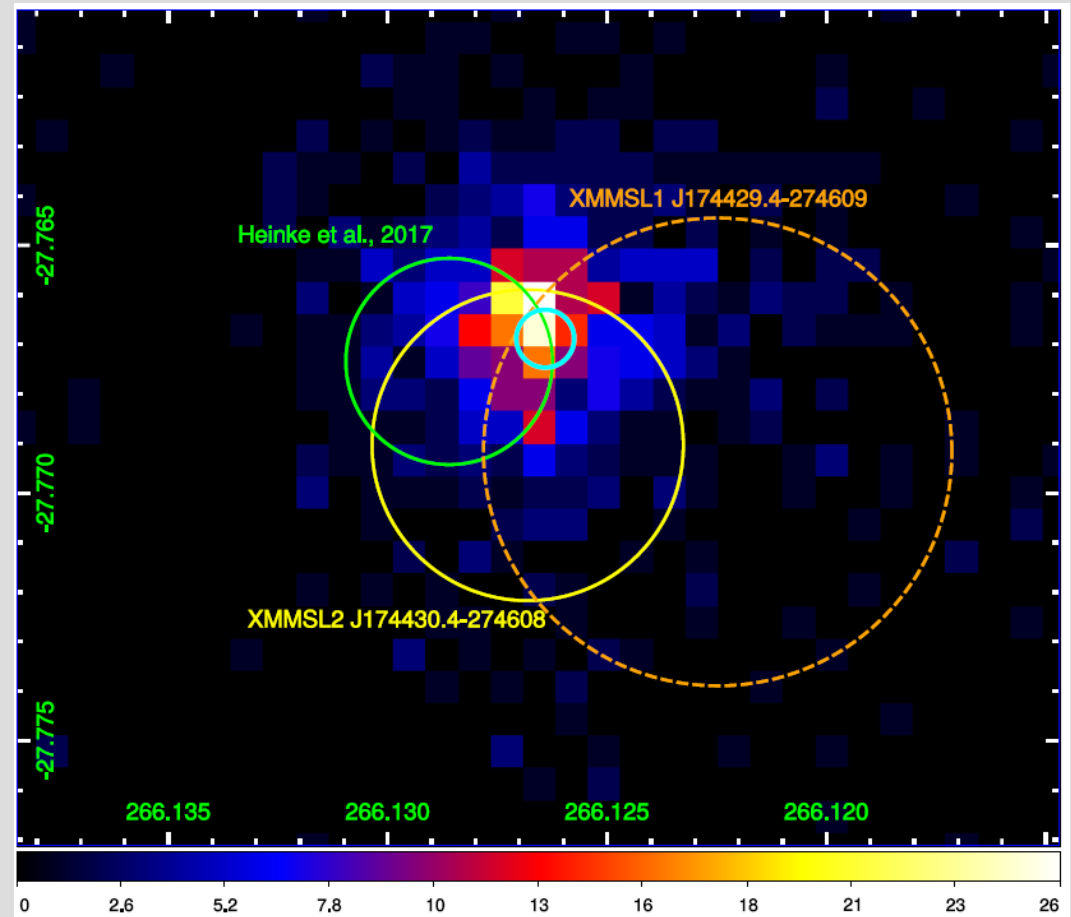
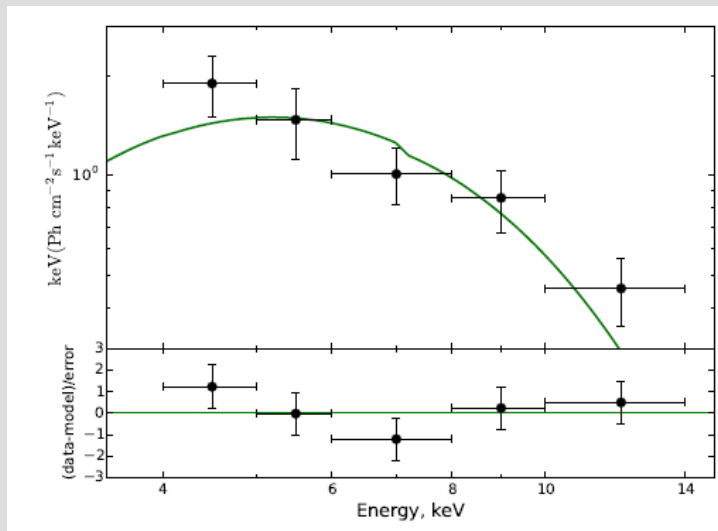
*The shown is the first X-ray burst detected from the unidentified transient X-ray source IGR J17445-2747 (on Apr. 10, 2017, with INTEGRAL/JEM-X; Mereminskiy et al. 2017)*



# IGR J17445-2747 — YET ANOTHER X-RAY BURSTER

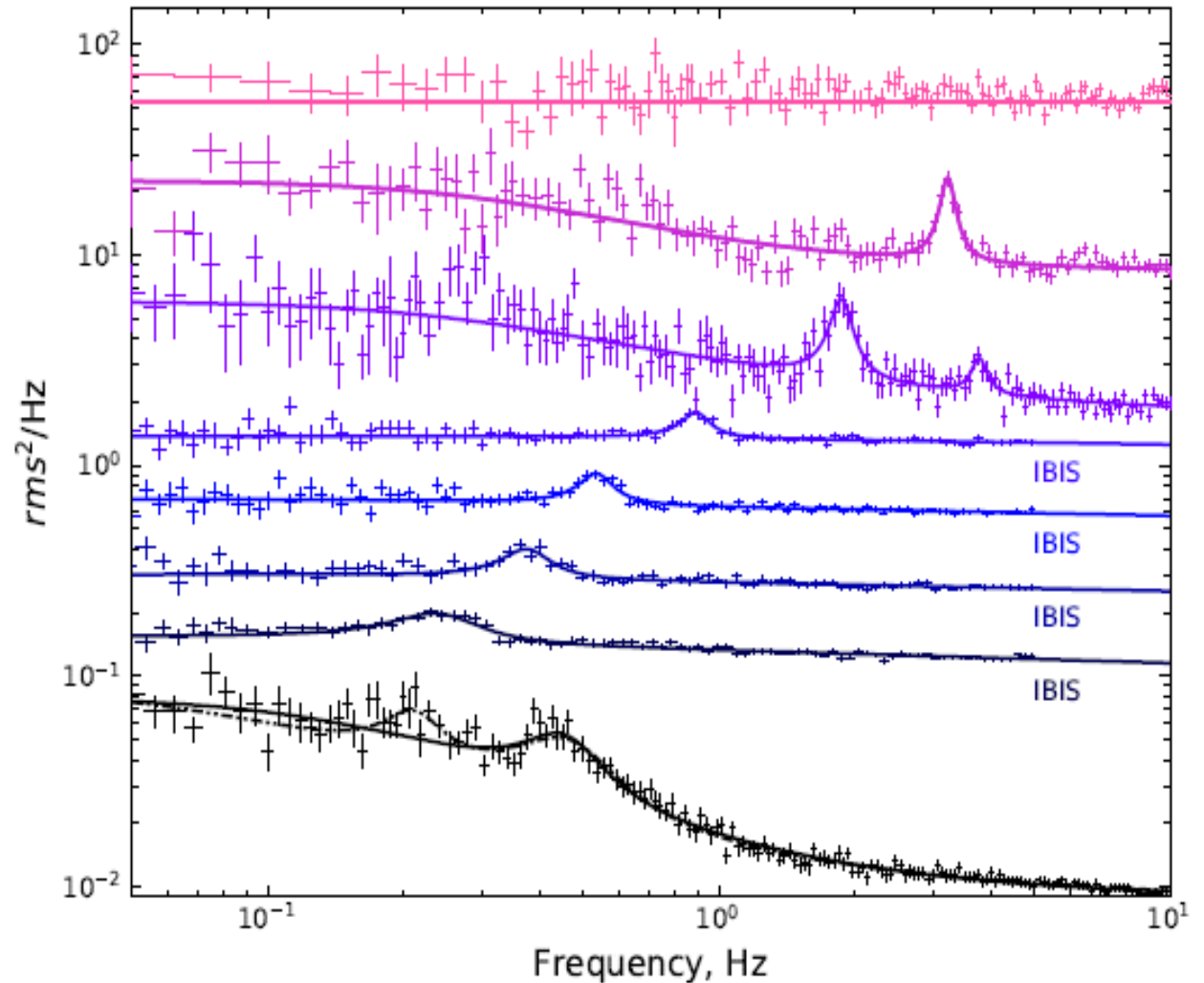


# IGR J17445-2747 — YET ANOTHER X-RAY BURSTER



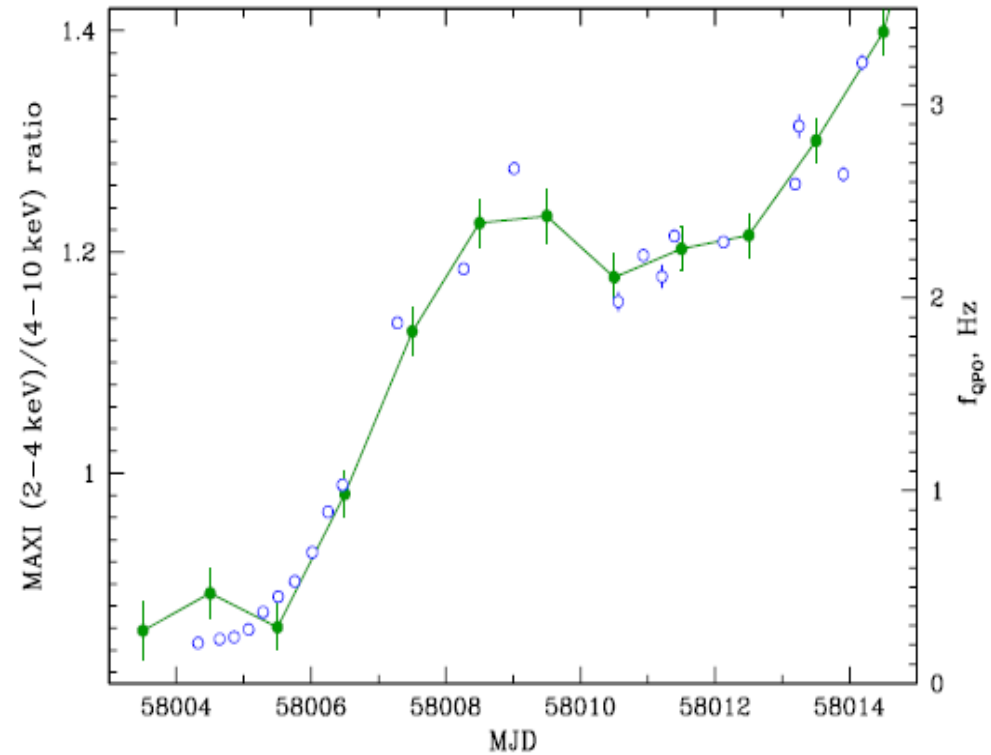
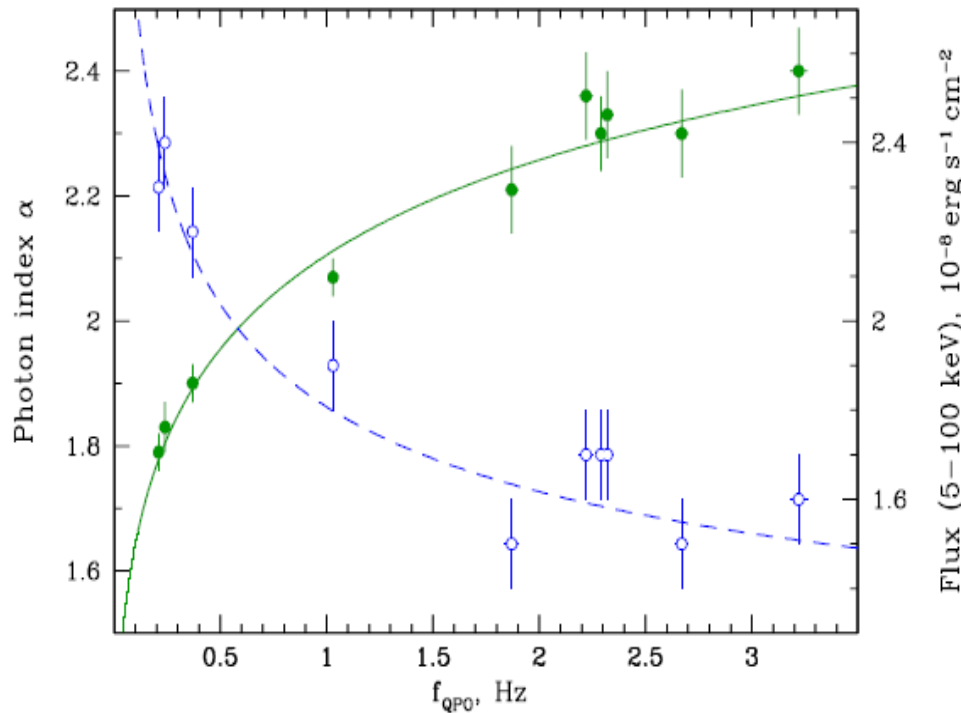
# QPOs of the X-ray Nova MAXI J1535-571

Strong evolution of the QPO frequency (Mereminsky et al., 2018)



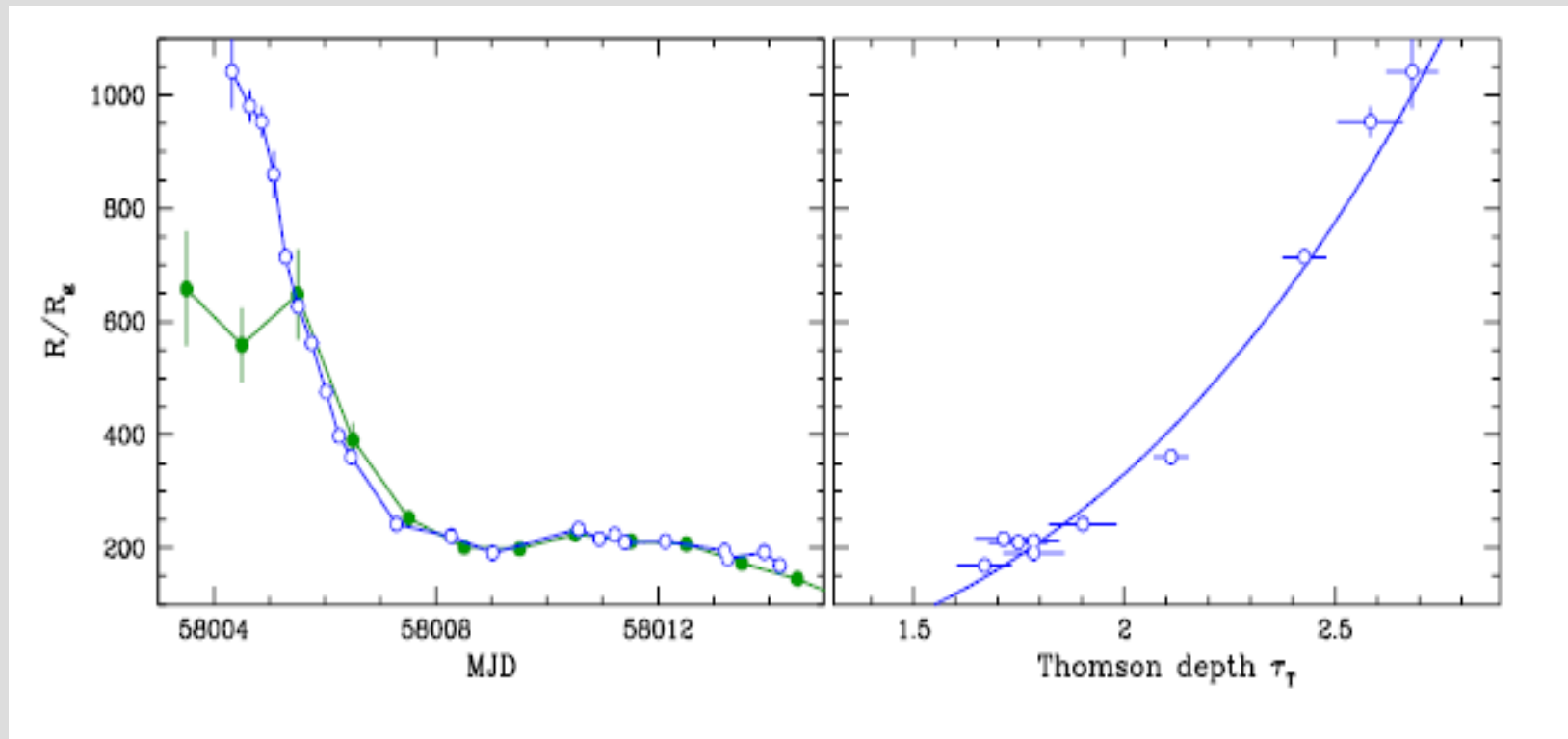
# QPOs of the X-ray Nova MAXI J1535-571

Correlation with softness (black-body component) and photon index (Thomson depth)



# QPOs of the X-ray Nova MAXI J1535-571

Correlation with softness (black-body component) and photon index (Thomson depth)



# General Problems

- Poor level of the INTEGRAL related software do not allowing make complex detailed analysis of sources based on the data from several instruments or different missions (even strict conclusions on the broad-band ISGRI spectra are very difficult!).
- It is impossible for a scientist who is not deeply involved in the INTEGRAL project to correctly analyse the data and obtain valid scientific results.
- This leads to the restricted interest from the community (many of them are theorists and have no experience of work with the X-ray data) to work themselves with the INTEGRAL data. They prefer to collaborate with IKI/RSDC scientists to check their predictions.



# Russian observations in AO-14

Russian proposals accepted to AO-14

prime and fixed time observations:

- |                                    |  |
|------------------------------------|--|
| 1420025, C, 900ks<br>(929.5 ks)    | "INTEGRAL observations of supercritical accretion disk in SS433 seen edge-on"<br>(A.Cherepashchuk)                                     |
| 1420021, A, 1800 ks<br>(579.6 ks)  | "Broad view on high energy Galactic background: Galactic Center" (R.Sunyaev)   |
| 1420022, B, 1800 ks<br>(1657.8 ks) | "Broad view on high energy Galactic background: Norma Arm" (R. Krivonos)   |
| 1420031, B, 1600 ks<br>(931.7 ks)  | "Galactic Center Field: Deep Exposure in AO-14"<br>(S.Grebenev)  |
| 1420032, A, 2200 ks<br>(2175.8 ks) | "INTEGRAL observations around the region $(l, b) = (50, -3)$ "<br>(A. Lutovinov) — proposed to compensate underreturn of Russian quota |

Russian observations take 6.27 Ms in AO-14

# Support of INTEGRAL extension



RUSSIAN ACADEMY OF SCIENCES  
SPACE RESEARCH INSTITUTE

№ 11204 /

To: Prof. Alvaro Giménez, ESA Director of Science  
Prof. Stefano Vitale, ESA SPC Chair

November 20, 2017

Re: INTEGRAL mission extension request at ESA

Dear colleagues,

By this letter I would like to support the extension of the INTEGRAL mission for the next term of two years (2019–2020). Actually I believe that INTEGRAL shall be operated as long as the health of its instruments allows.

During last years a number of excited results have been obtained by INTEGRAL which demonstrated its unique capabilities and power for nuclear astrophysics, gamma-ray astronomy, fundamental physics. Among these results there were the first-ever detection of X-ray lines from the radioactive decay of  $^{44}\text{Ti}$  in the remnant of the greatest core-collapse supernova (SN 1987A) and the first detection of  $^{56}\text{Ni}$  and  $^{56}\text{Co}$  decay gamma-ray lines from the nearby type Ia supernova (SN 2014J), that proved the thermonuclear origin of SN Ia explosions. There were also the first large-scale map in the 511 keV line produced by positron annihilation, showing the presence of large amounts of anti-matter in the central parts of our Galaxy, the proof for the Galaxy-wide origin of  $^{26}\text{Al}$ , from which the current rate of core-collapse supernovae in the Galaxy could be derived, and the discovery of the gamma-ray polarization in the Crab Nebula, black-hole binary Cygnus X-1, and several gamma-ray bursts. Even in the field of traditional X-ray astronomy INTEGRAL demonstrated a great advantage in competition with other satellites — it discovered hundreds of new hard X-ray sources on the sky doubling their total number and revealing two previously unknown populations of the objects: obscured high mass X-ray binaries and supergiant fast X-ray transients.

# Support of INTEGRAL extension

The recent discovery by INTEGRAL and FERMI-GBM of the electromagnetic counterpart to the unique source of gravitational waves GW170817, detected by the advanced LIGO and Virgo detectors, allowed this source to be identified as the event of merging of two neutron stars and provided an outstanding confirmation of existing theories. This discovery triggered follow-up observations of the source at different wavelengths and opened a new window for future INTEGRAL studies. Another new window for the INTEGRAL activity is connected with the search for the sources of ultra-high-energy neutrino in the Universe detected by the Ice Cube.

Being compared with XMM and Chandra, INTEGRAL usually loses in number of publications and reports due to the necessity of accumulating long exposures for getting confident results. But the science which INTEGRAL provides is really unique, very interesting, sometimes unexpected and always fundamental. It can not be repeated by any other satellite currently orbiting or planning for the launch in near future. The legacy of INTEGRAL will include several dozens of brilliant results.

That is why I and all astrophysics of the Moscow Space Research Institute are strongly supporting the extension of the INTEGRAL mission. Russian scientists are deeply involved in the data analysis of its instruments. After more than 15 years in space, all four telescopes on board INTEGRAL are still functioning very well and are ready to surprise us with new greatest results and discoveries.

Sincerely yours,

Prof. Lev Zelenyi  
Director



117997, PROFSOYUZNAYA 84/32, GSP-7, MOSCOW, RUSSIA e-mail: iki@cosmos.ru TEL: +7 (495) 333 5212 FAX: +7 (495) 333 1248  
333 2588 333 5178  
333 1000

A handwritten signature in blue ink, appearing to read 'L. Zelenyi', is written over the contact information.