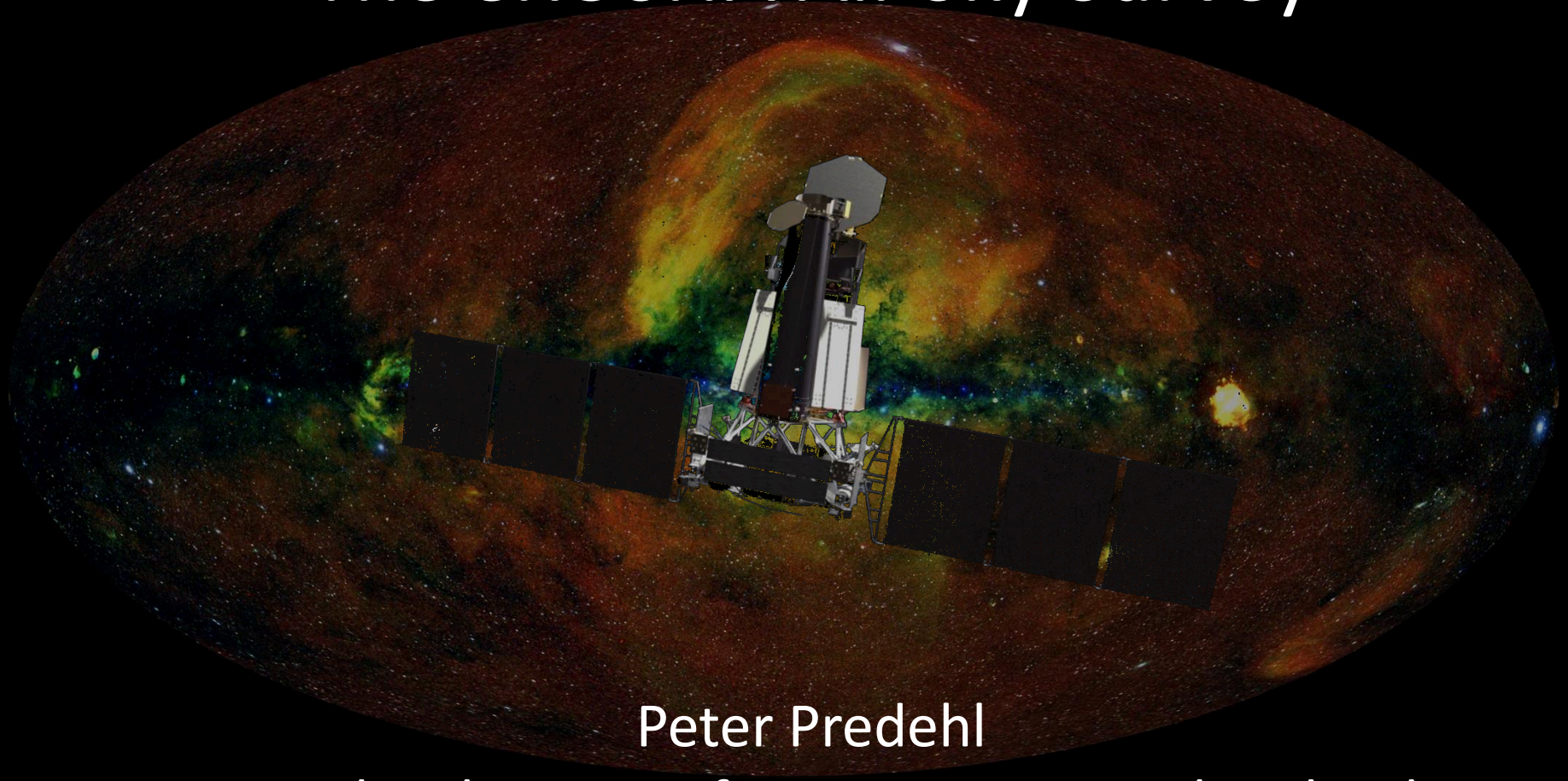
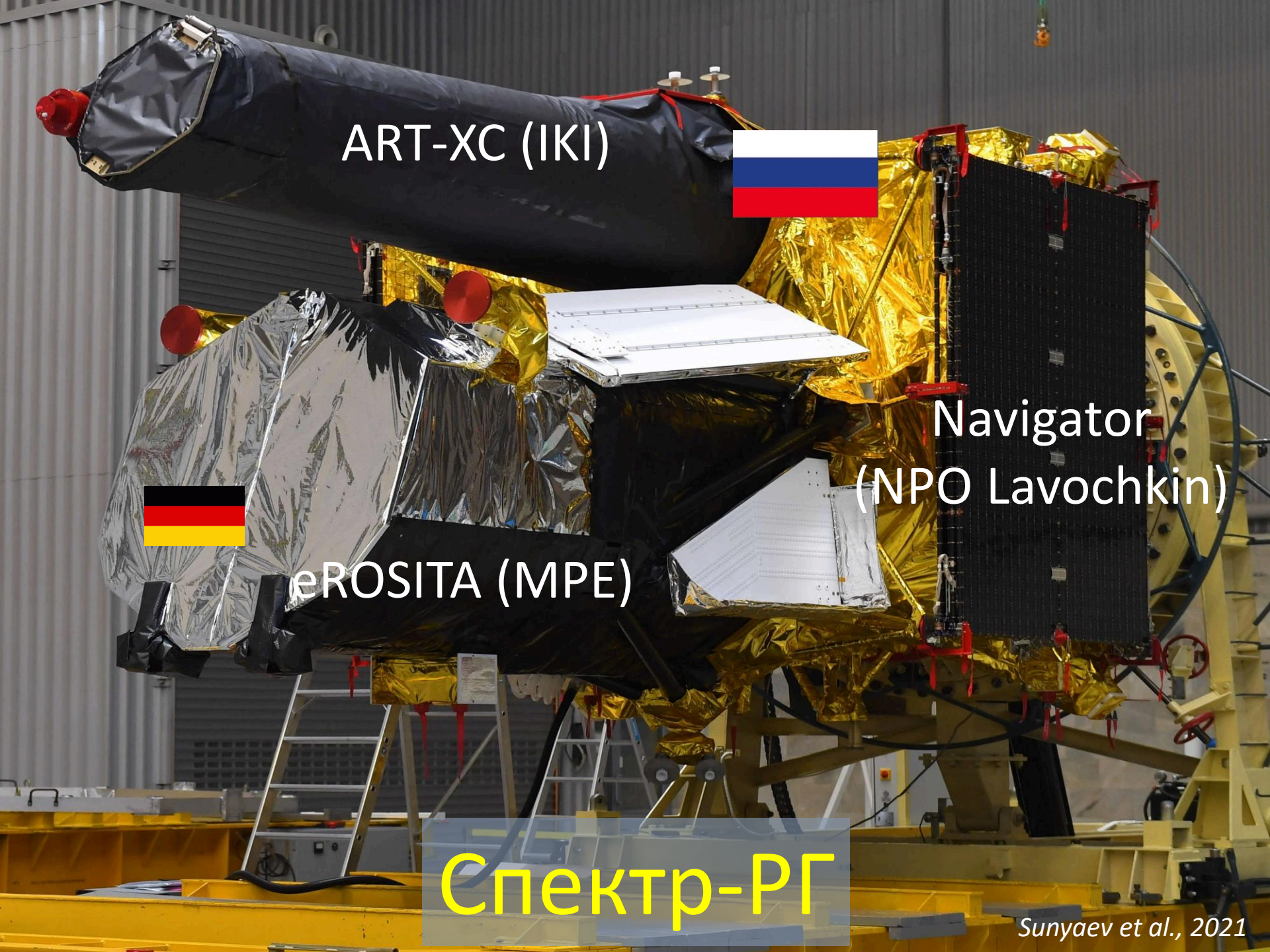
The eROSITA All-Sky Survey



Peter Predehl
Max-Planck-Institut für extraterrestrische Physik

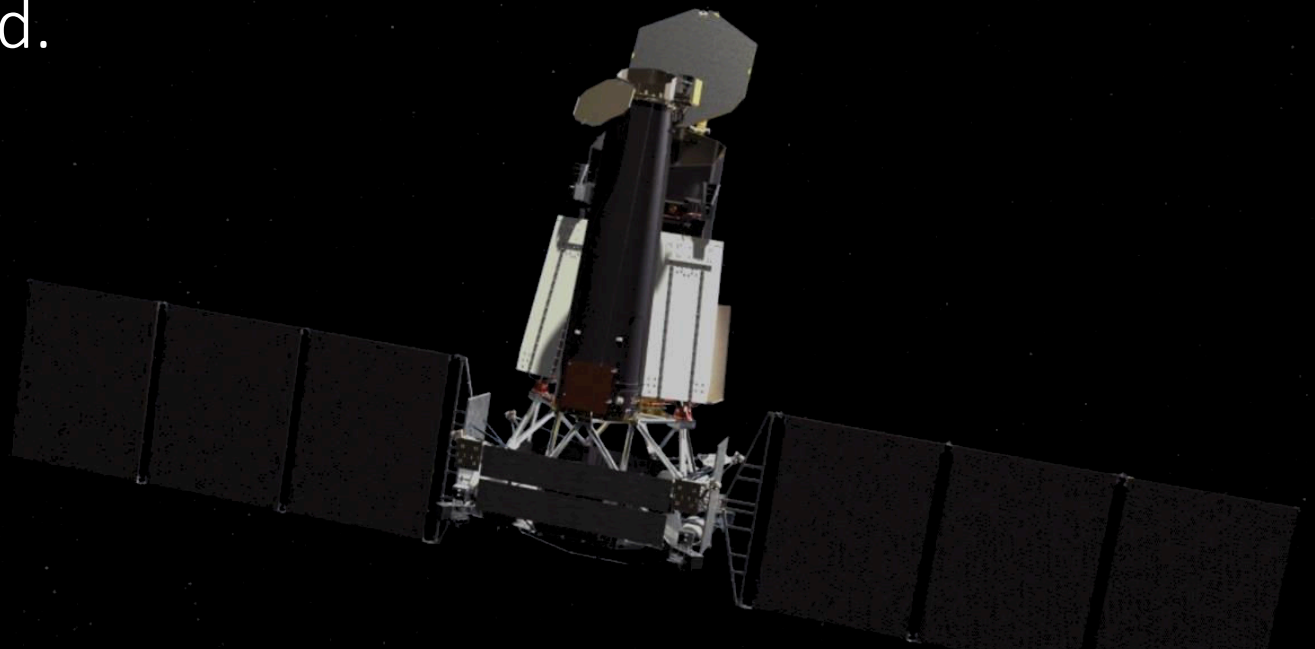
AXRO, Prague 2022


ART-XC (IKI)
Navigator
(NPO Lavochkin)
eROSITA (MPE)
Спектр-РГ
Sunyaev et al., 2021

Current Situation

Following the recommendation to suspend co-operation with Russia, eROSITA was placed into safe mode during the ground contact on Saturday 26th February.

Science operations with the instrument are currently paused.

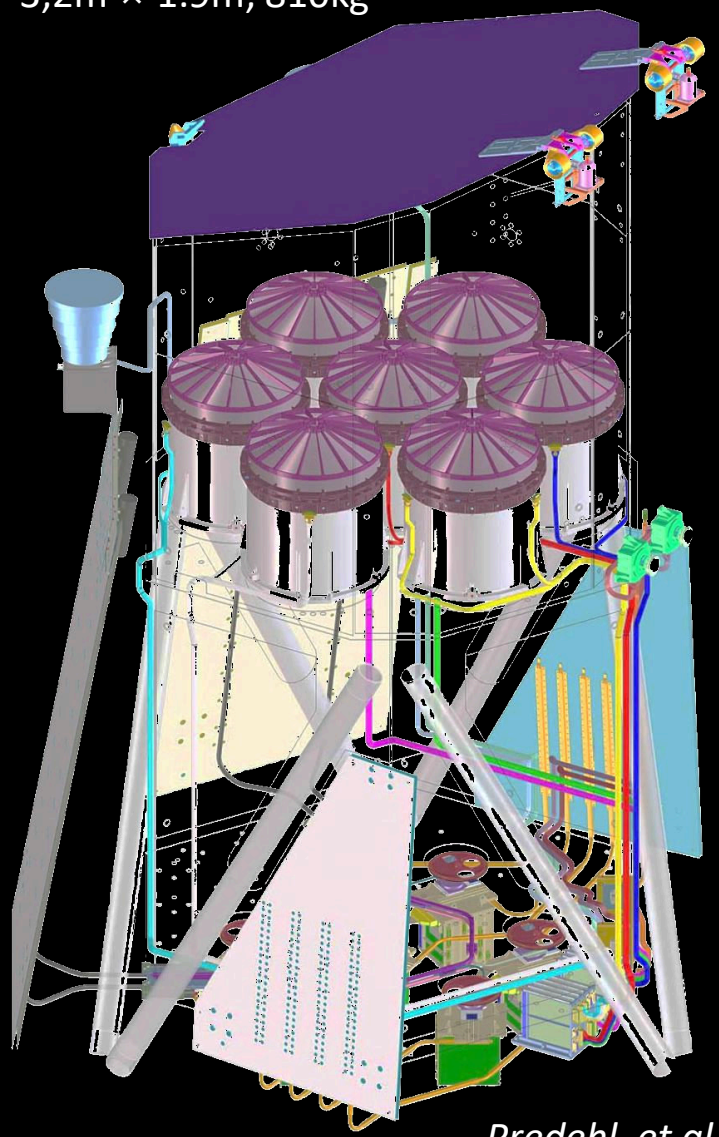


eROSITA Telescope

- PSF (onaxis/FoV) 18/28 arcsec
- eff. area 2000 cm^2

- FoV 28x28mm (Ø 65 arcmin)
- Energy resolution 60-140eV
- Time resolution 50msec

3,2m × 1.9m, 810kg



Predehl, et al., 2021

eROSITA Collaboration

Core Institutes (DLR funding):
MPE, Garching
Universität Erlangen-Nürnberg
IAAT (Universät Tübingen)
SB (Universität Hamburg)
Leibniz-Institut für Astrophysik Potsdam

Associated Institutes:
USM (LMU München)
AIFA (Universität Bonn)

Russian Partner Institute:
IKI, Moscow

Industry:

Media Lario/I	Mirrors, Mandrels
Tecnotron/D	PCBs
Kayser-Threde/D	Mirror Structures
Carl Zeiss/D	ABRIXAS-Mandrels
Invent/D	Telescope Structure
pnSensor/D	CCDs
IberEspacio/E	Heatpipes
RUAG/A	Mechanism
HPS/D,P	MLI

+ many small companies

NPOL – Lavochkin Association

MPE: Scientific Lead Institute, Project Managment
Instrument Design, Manufacturing, Integration & Test
Data Handling & Processing, Archive etc.

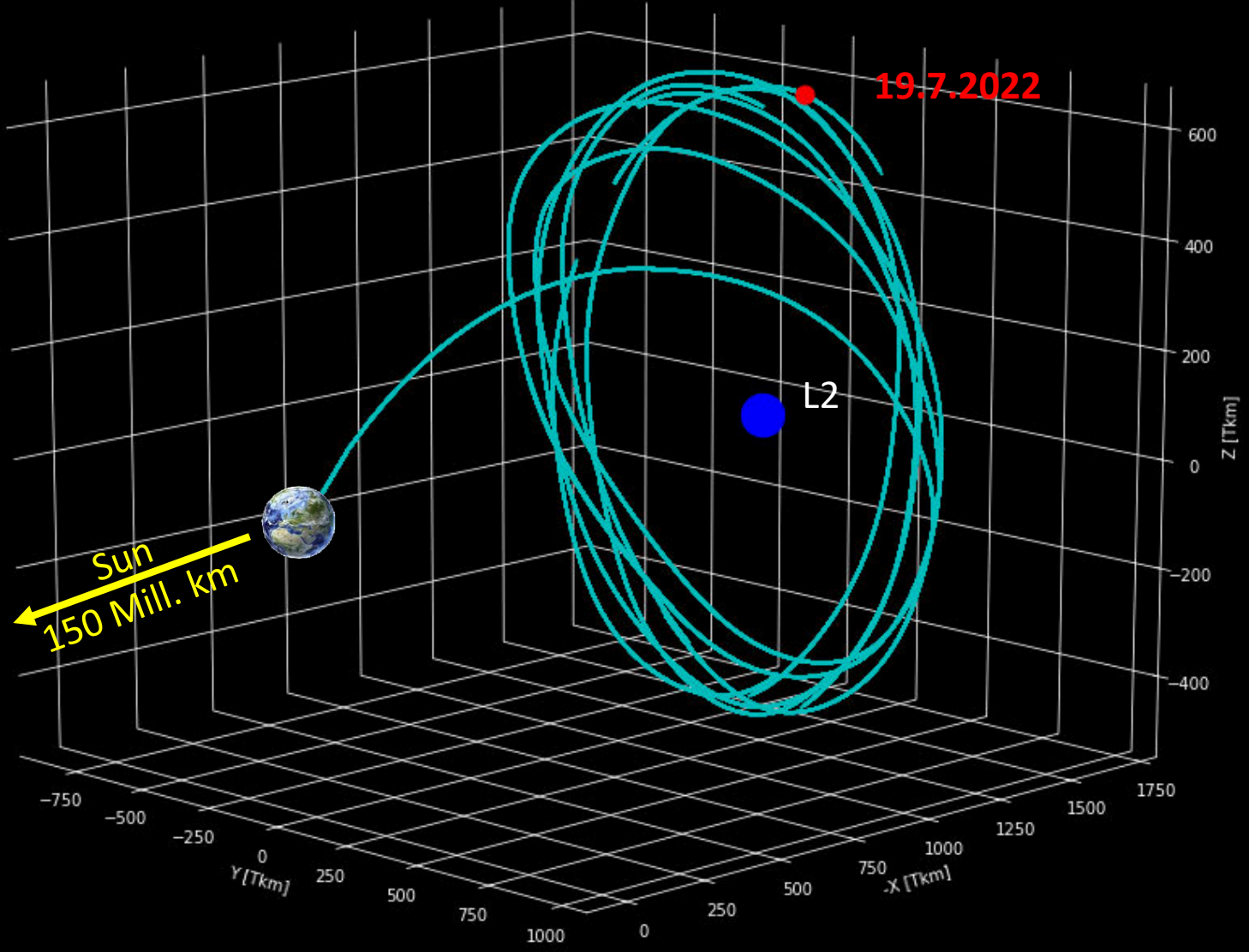
13.07.2019, 17:31

Cosmodrom Baikonur/Kazakhstan

Proton-M / BLOK-DM03

Credit: Roscosmos

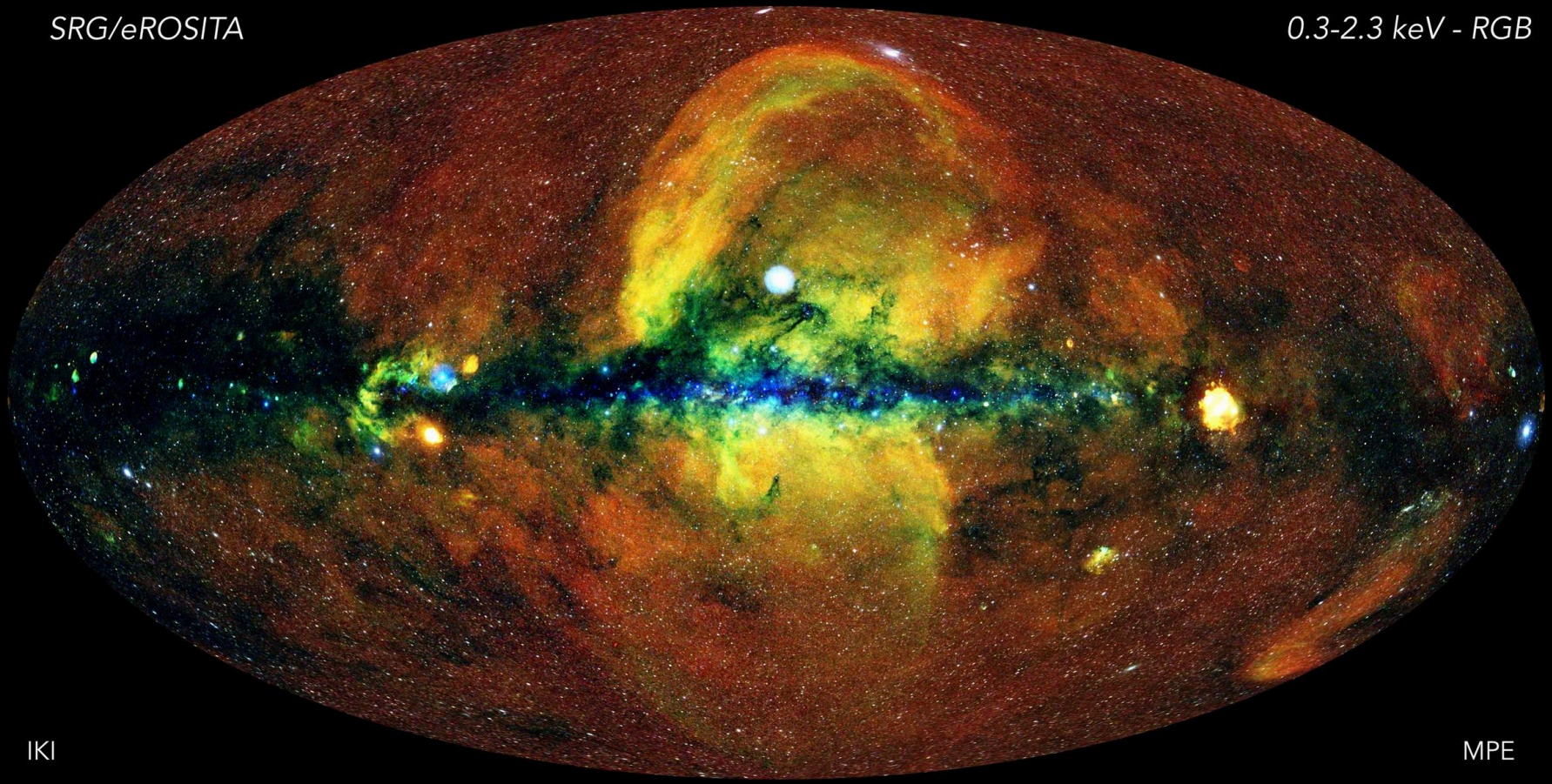
SRG Orbit



- **4 years**

8 all sky surveys (6 rotations/day)

eRASS1 (1/8)



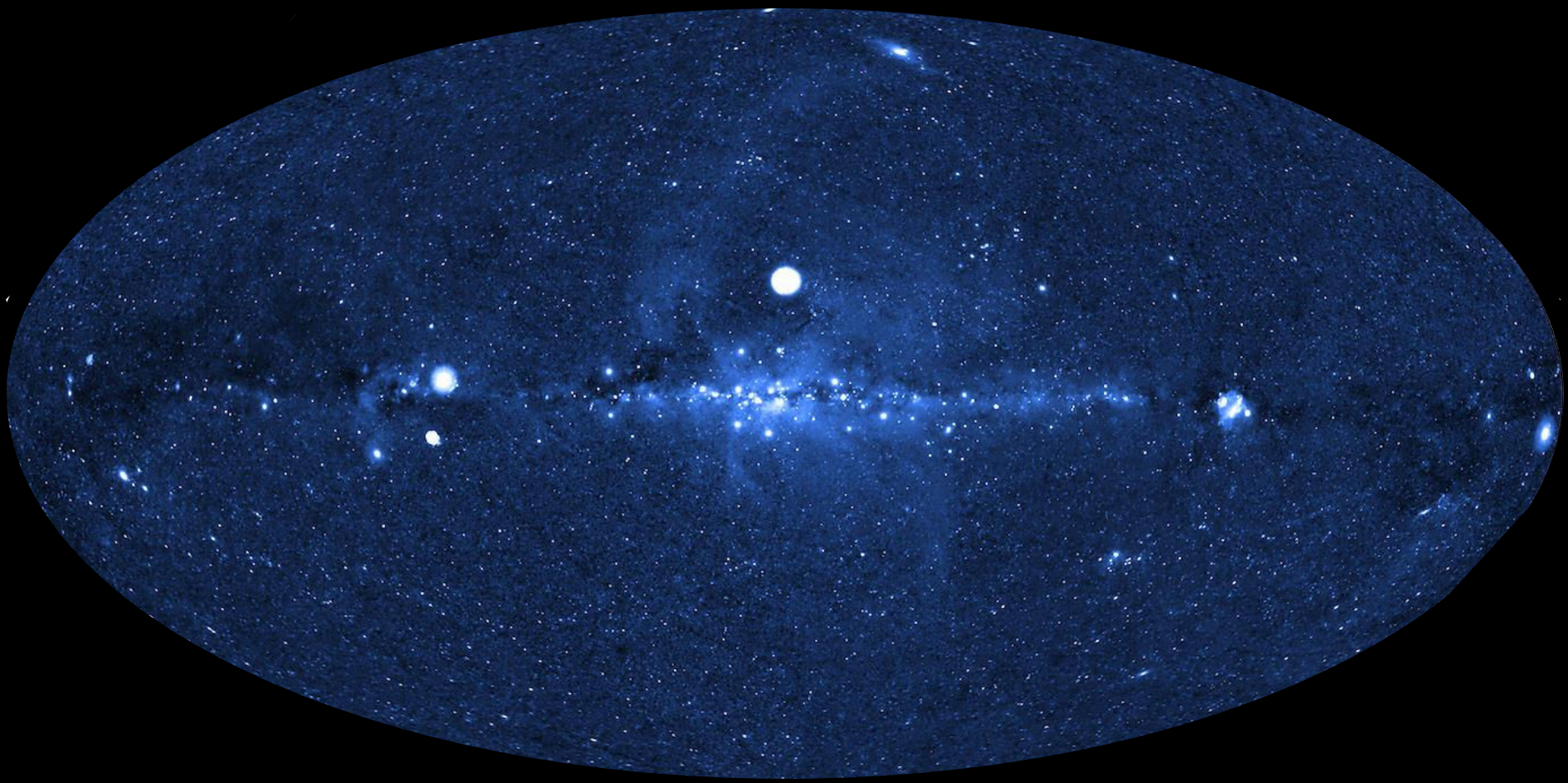
> 1.000.000 X-ray sources found

More than all X-ray observatories of the last 50 years together

J. Sanders, H. Brunner, E. Churazov, M. Gilfanov, and the eSASS team

SRG/eROSITA

1.0-2.3 keV



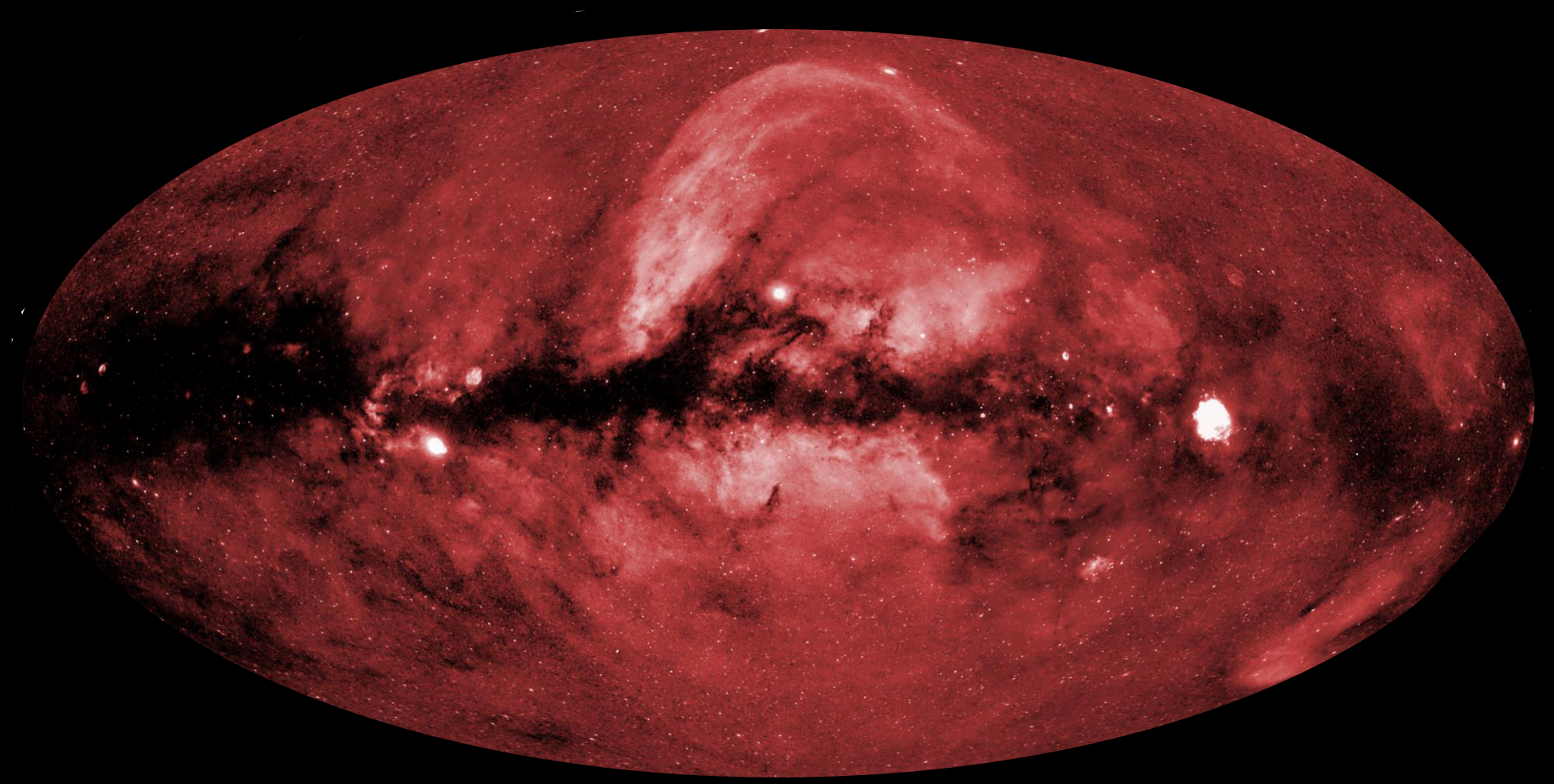
IKI

MPE

credit: J. Sanders

SRG/eROSITA

0.3-0.6 keV

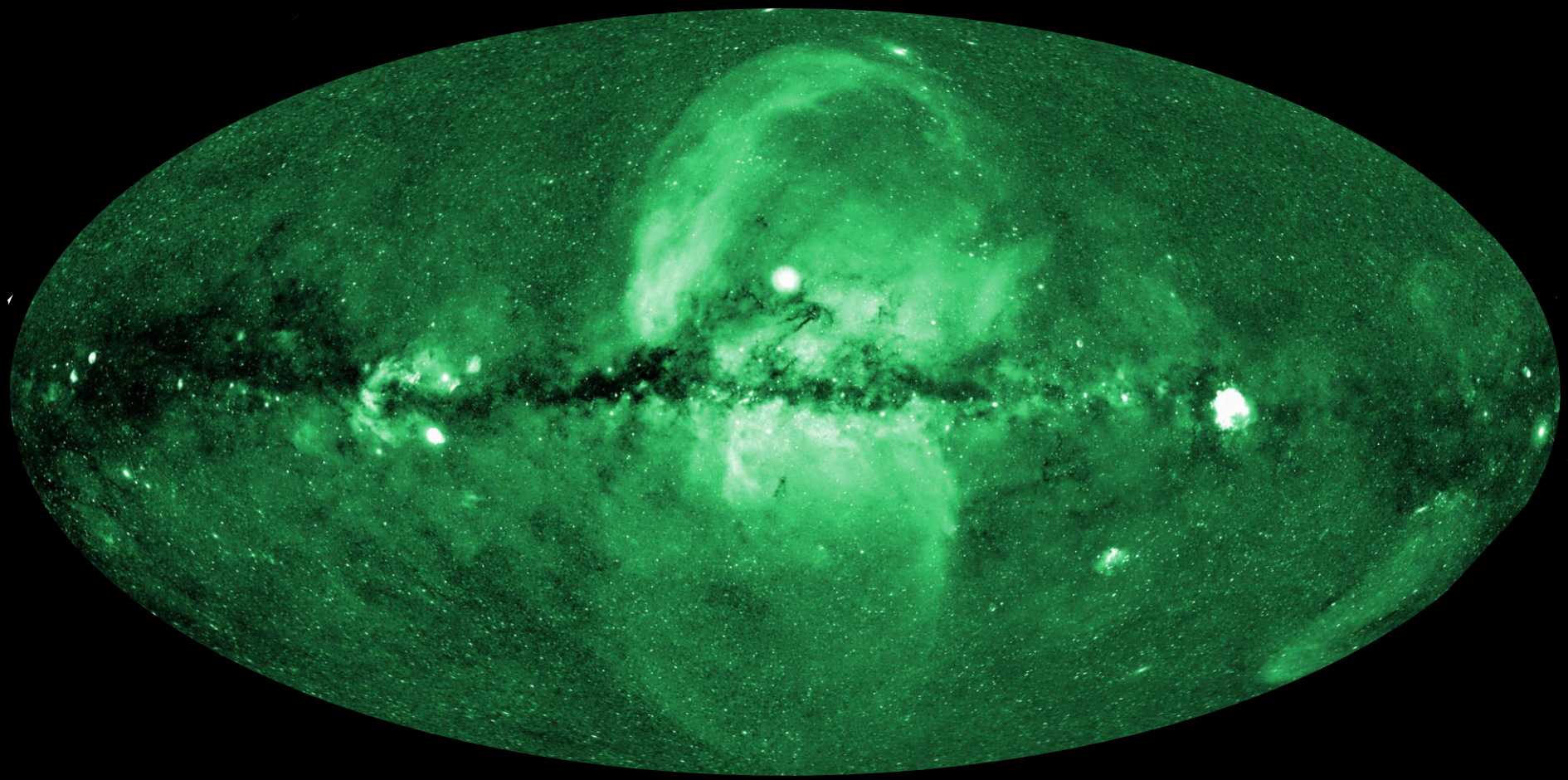


IKI

MPE

credit: J. Sanders

0.6-1.0 keV

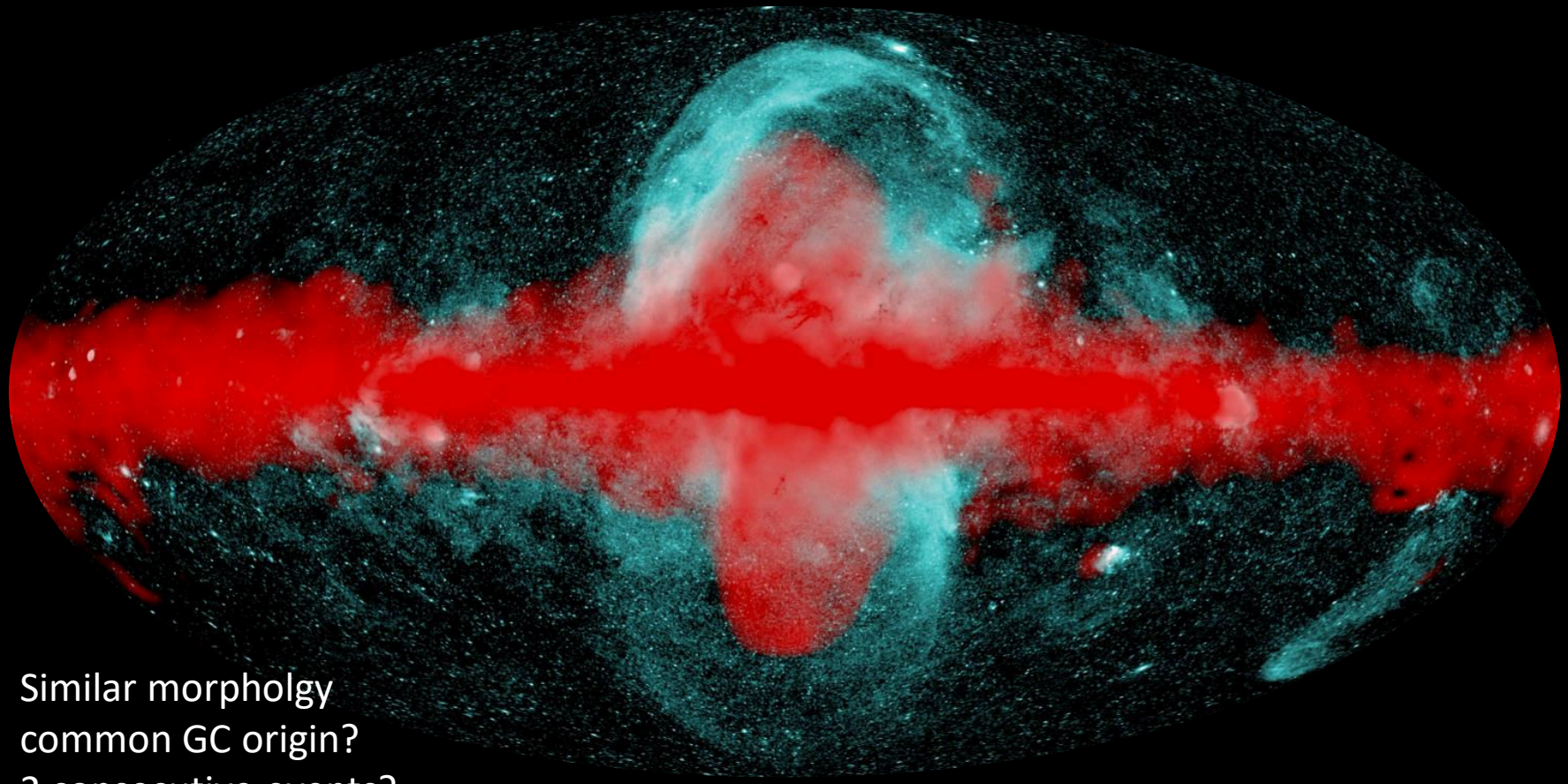


IKI

MPE

credit: J. Sanders

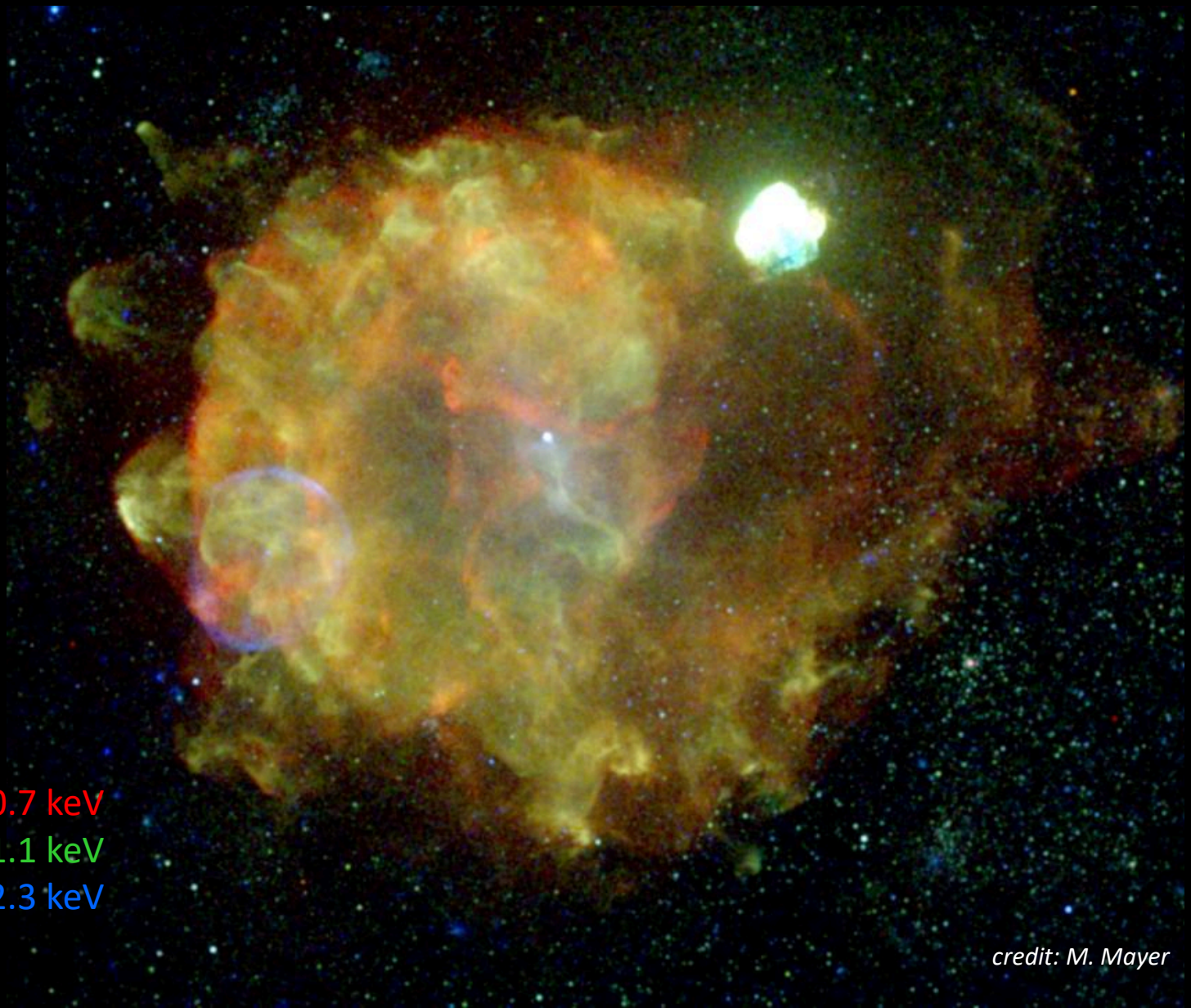
eROSITA & Fermi Bubbles



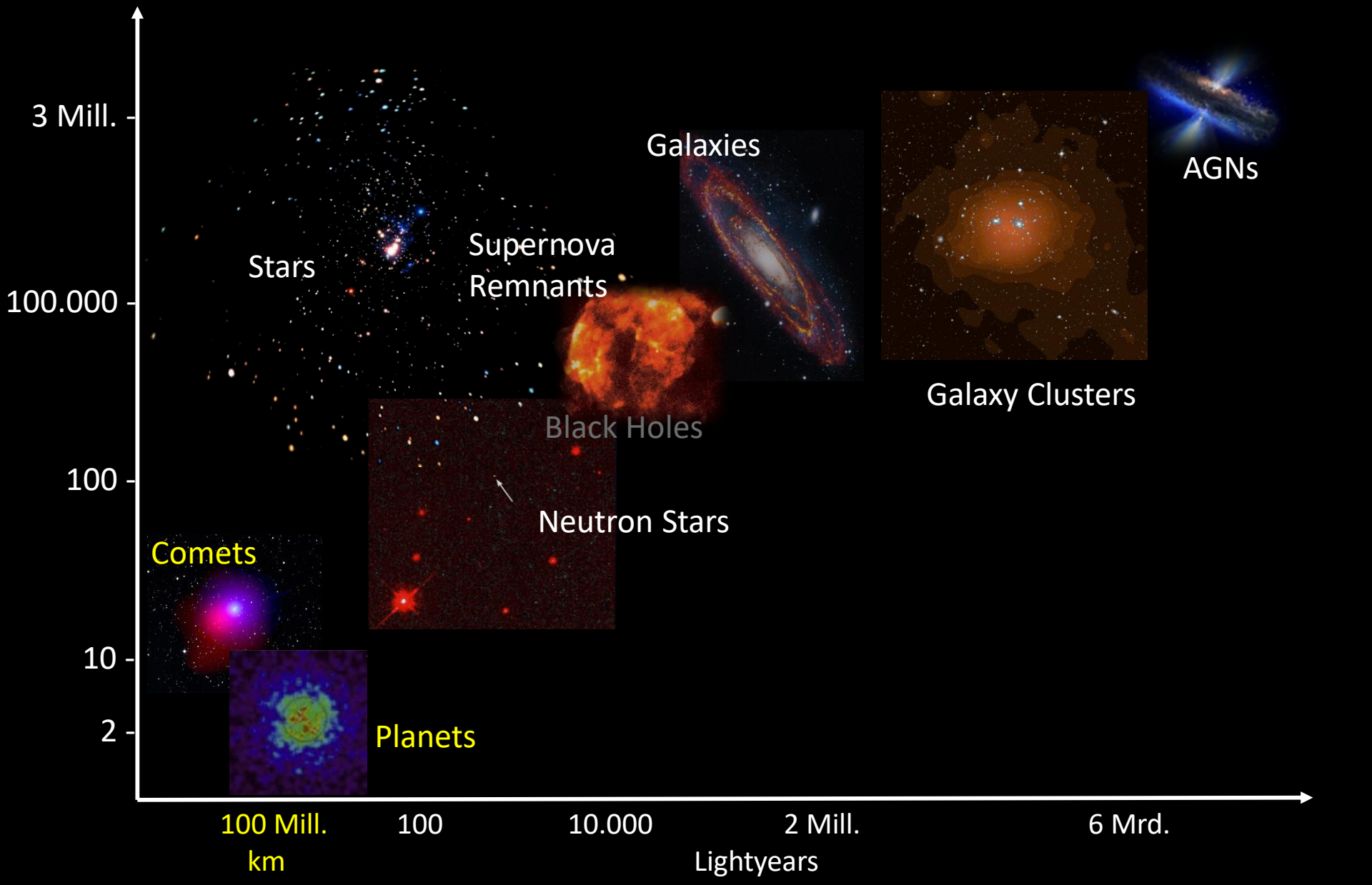
- Similar morpholgy
  common GC origin?
- 2 consecutive events?
  Starburst or AGN activity
- NPS/Loop I somewhat peculiar

Predehl, Sunyaev et al. (Nature, 2021)

Vela & Friends



The X-ray Sky

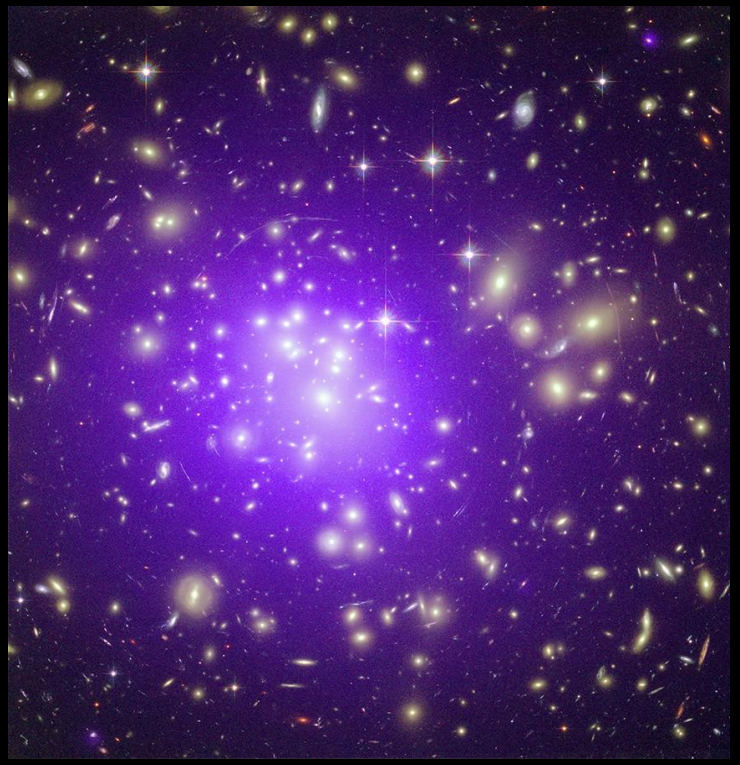

3 Mill.
100.000
100
10
2
Stars
Supernova Remnants
Galaxies
AGNs
Galaxy Clusters
Black Holes
Neutron Stars
Comets
Planets
100 Mill. km
100
10.000
2 Mill.
6 Mrd.
Lightyears

Clusters of Galaxies

Most massive entities in Universe

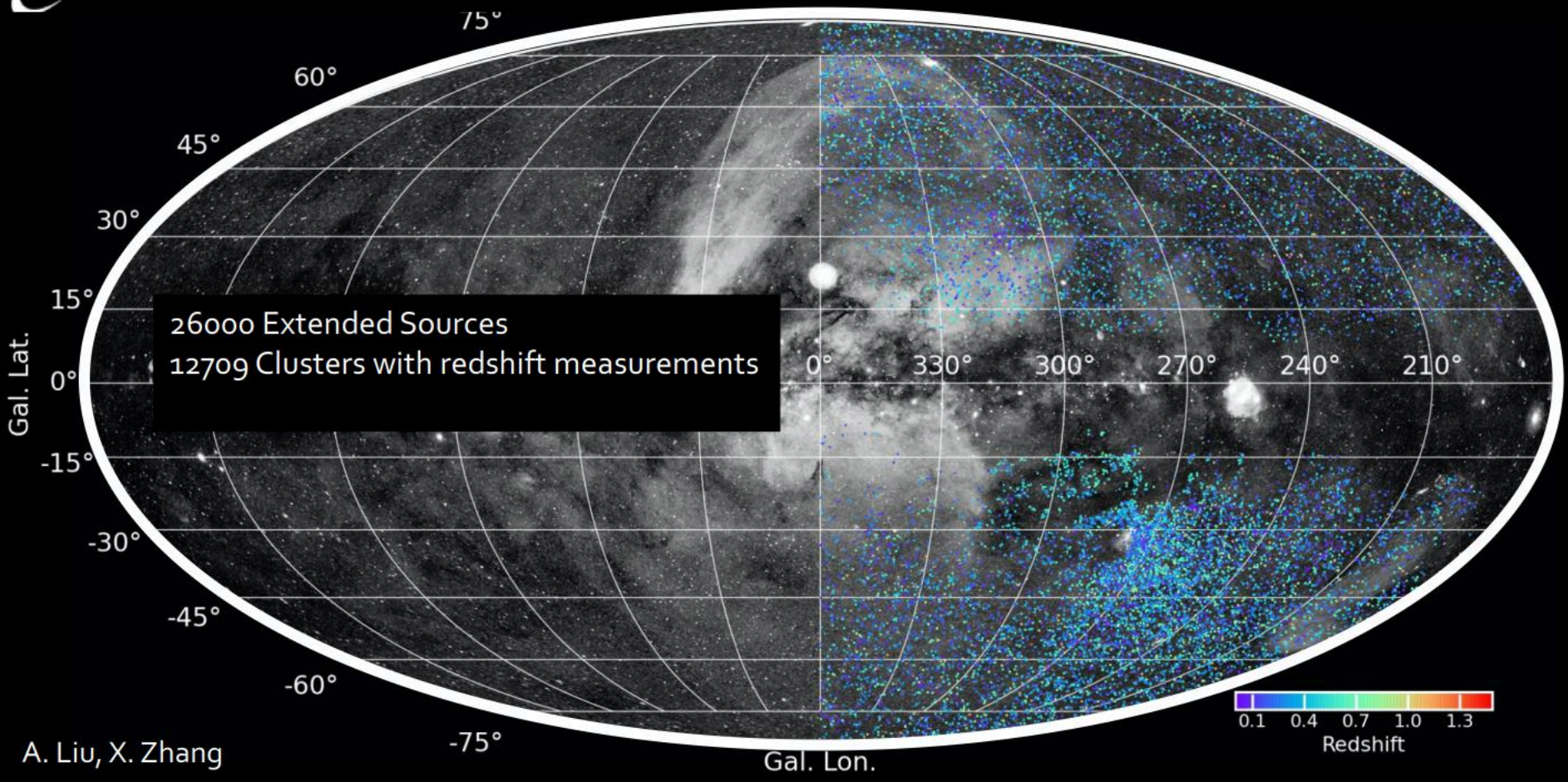
- Typically contain ~1000 galaxies
- The majority of the mass is in dark matter
- Majority of the baryonic mass in hot dilute ICM
- Emits primarily in X-rays through thermal Bremsstrahlung
- Their number density and distribution across the Universe is a probe of cosmology

„Design Driving Science of eROSITA“
to detect 100.000 Clusters



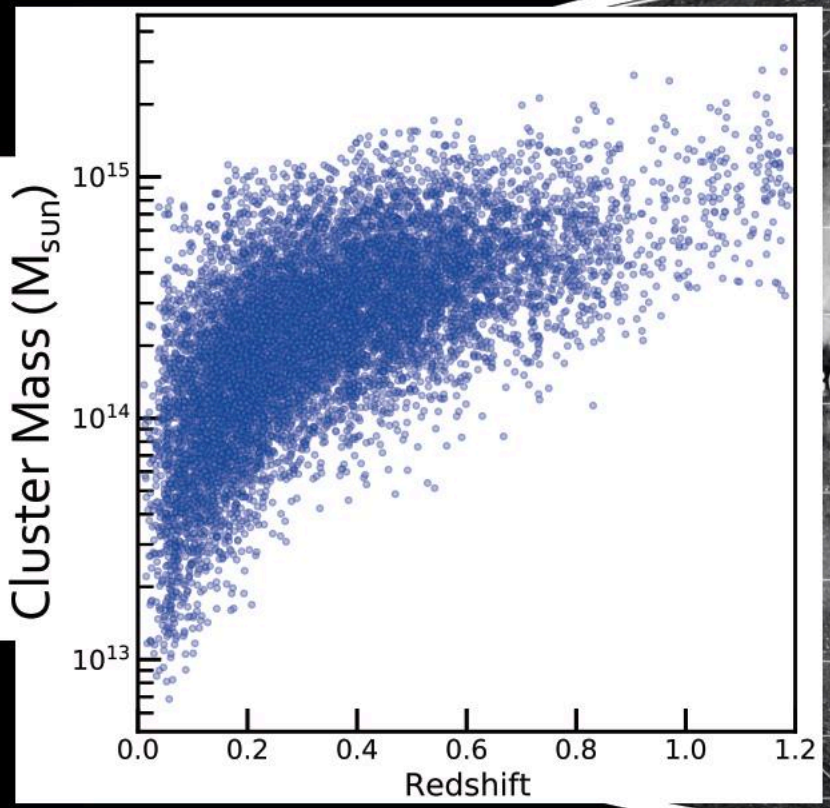
Credit: HST & Chandra

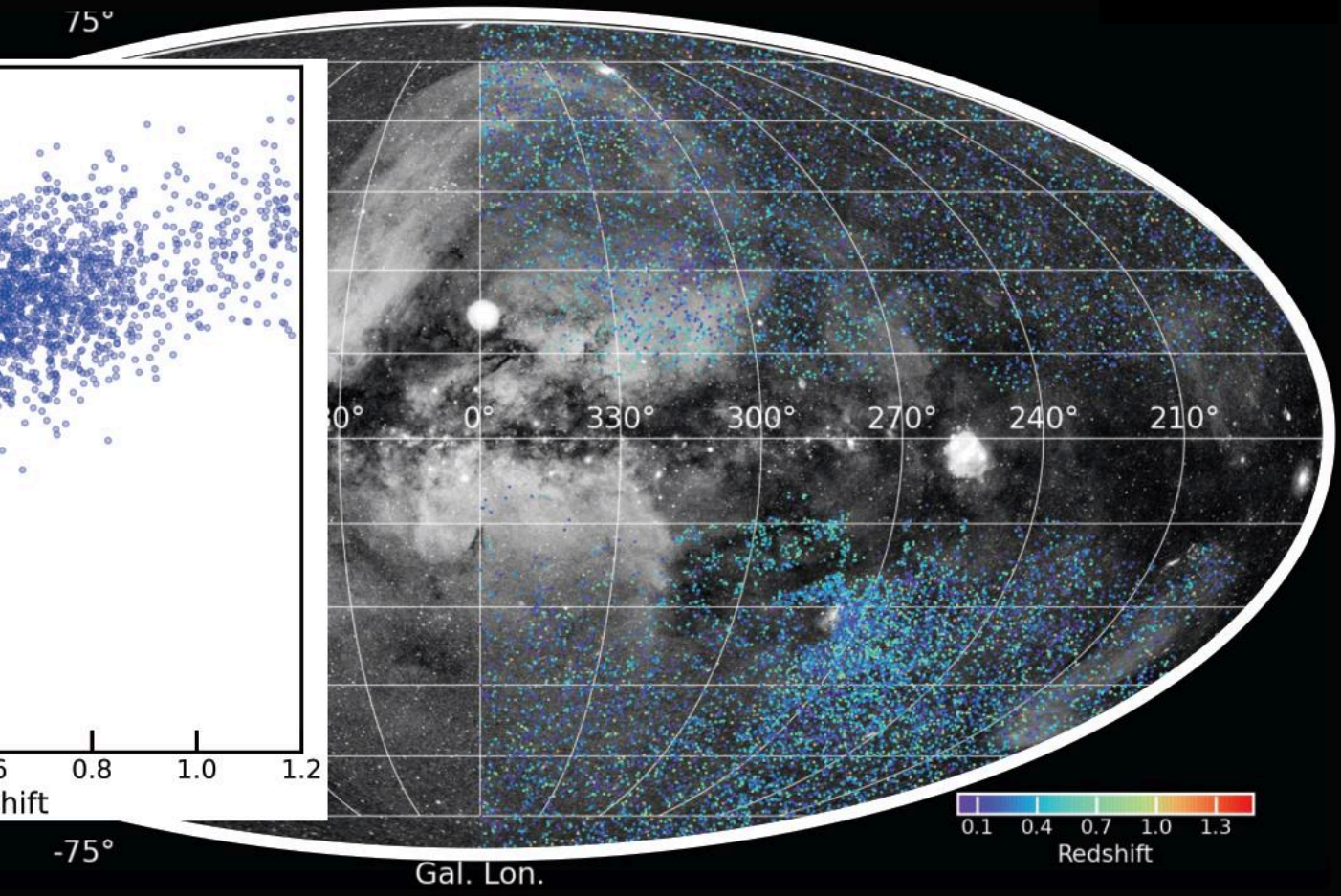
Clusters and Groups in the First eROSITA All-Sky Survey



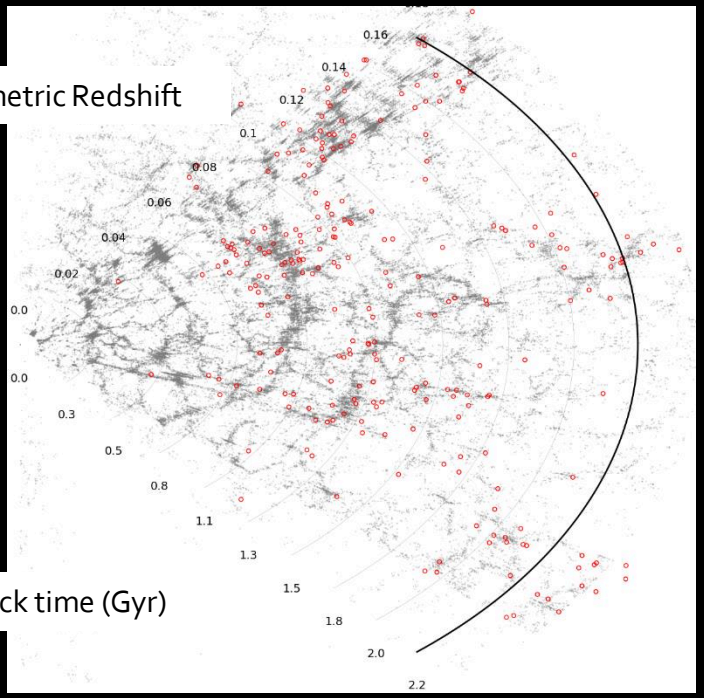
A. Liu, X. Zhang

Clusters and Groups in the First eROSITA All-Sky Survey

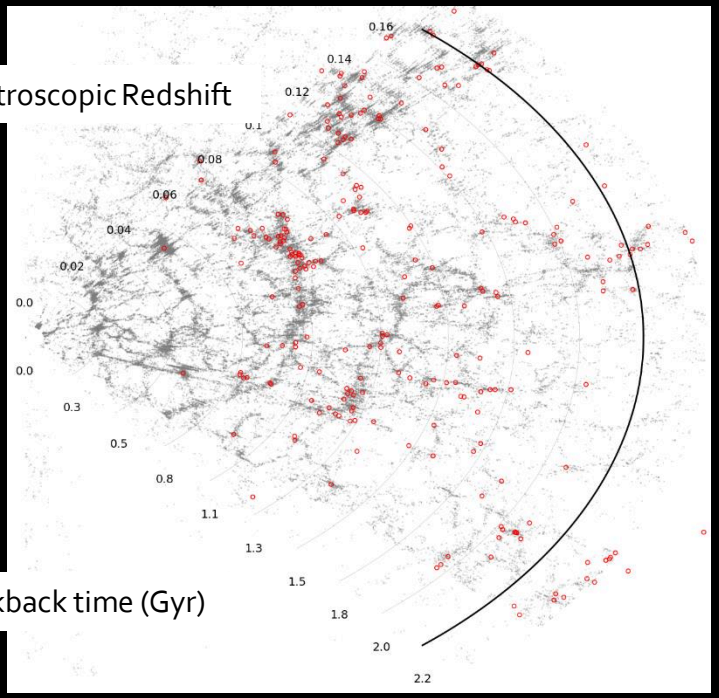




Coming Soon:
Large Scale Structure and Cosmology

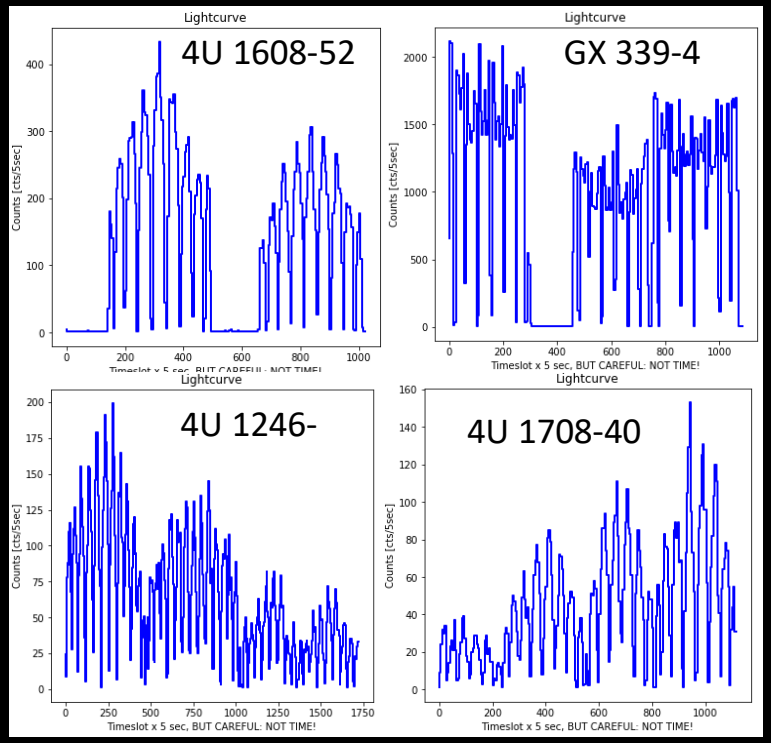


Credit: J. Comparat, J. Ider-Chitham, S. Shreeram, E. Bulbul

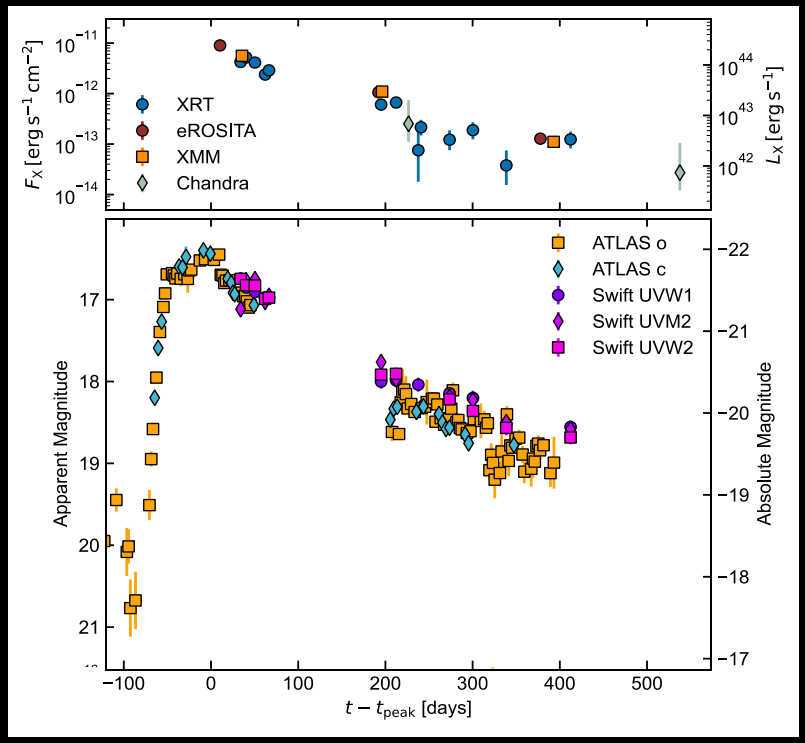


Complete Coverage of eROSITA-DE Sky is planned with SDSS V and 4MOST

Variabilities I (XRB & TDE)



Almost all compact objects are variable

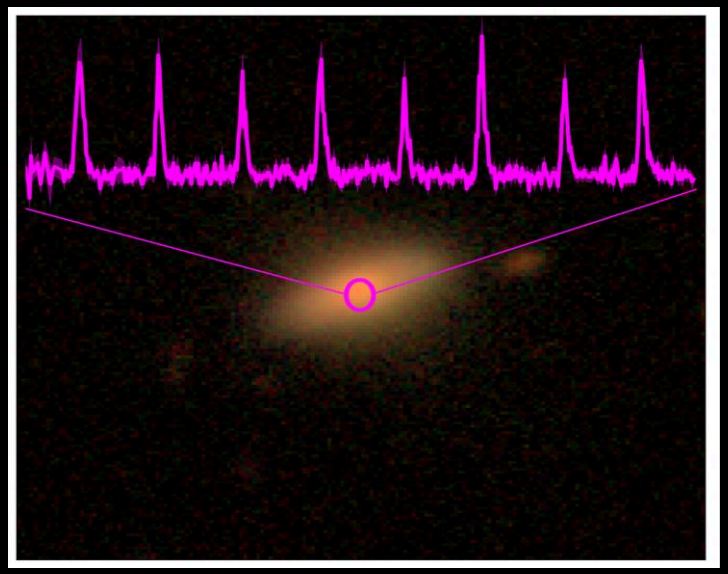


- Most luminous eROSITA-selected tidal disruption flare
- No prior X-ray detection
- Ultrasoft spectrum

credit: A. Malyali

Variabilities II (QPE)

QPEs are high-amplitude quasi-periodic soft X-ray bursts from galactic nuclei



Extragalactic, but **no typical AGN**

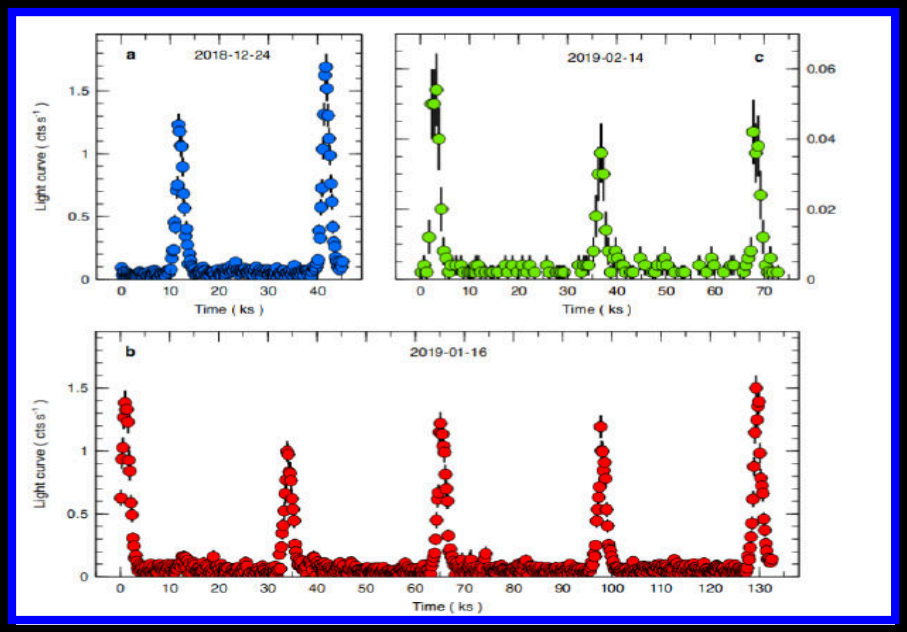
Massive black holes ($10^5 - 10^6 M_\odot$ (in low-mass galaxies)

Transients: they last a few years to decades

Can be discovered only through **X-rays**

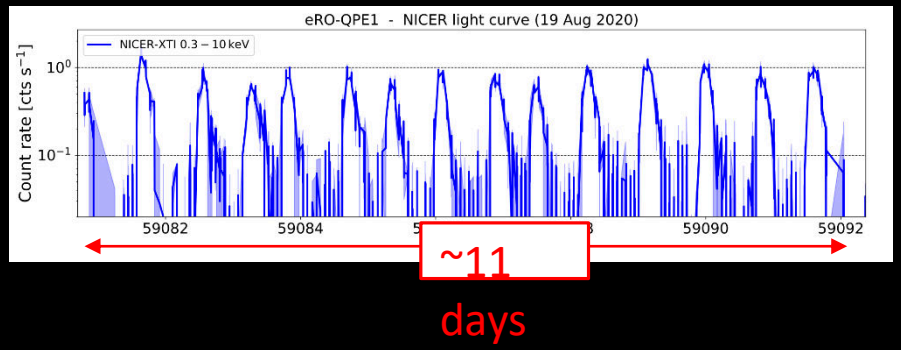
see Miniutti+19; Giustini+20; Arcodia+21; Chakraborty+21

Variabilities II (QPE)



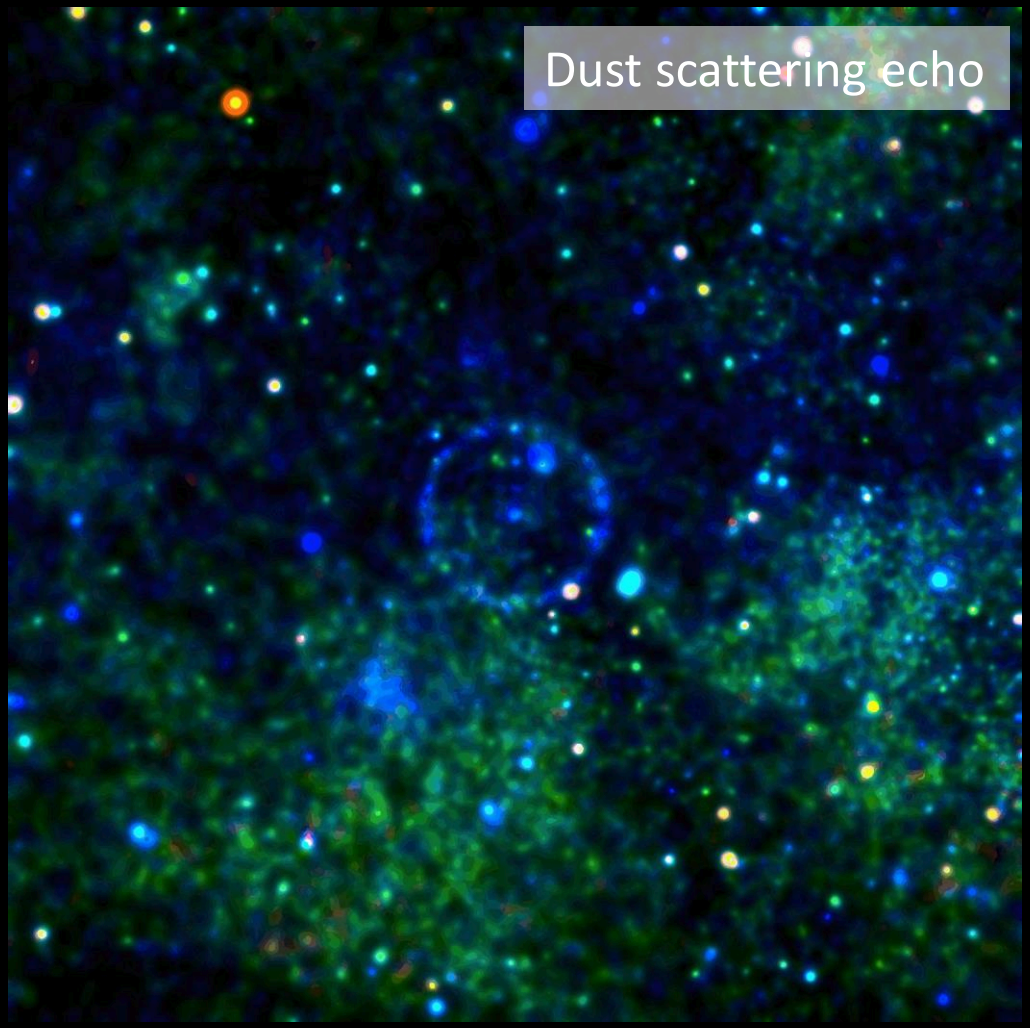
Quasi periodic eruptions

eROSITA can provide candidates follow up observations are needed



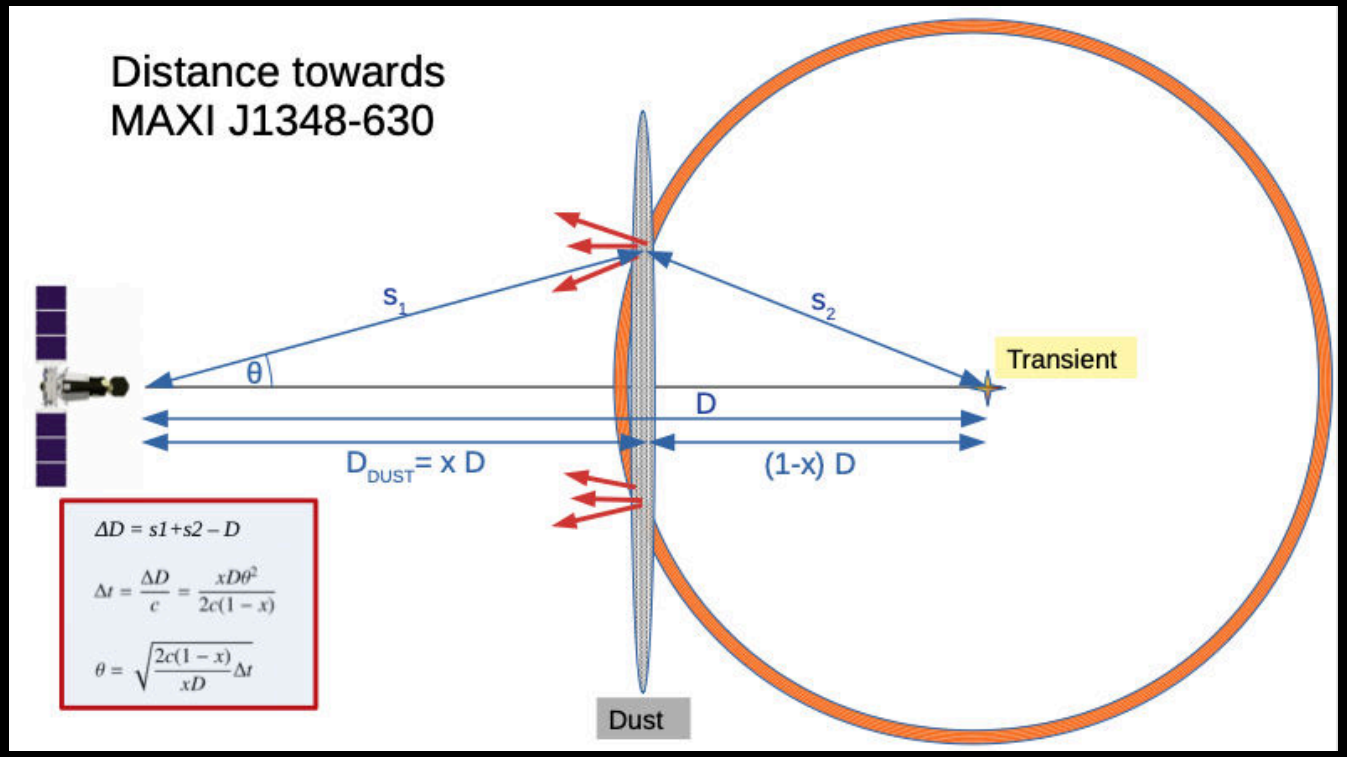
- Unlikely to be “classical” radiation pressure instability of the inner accretion.
- Periodic interaction with an orbiting compact object?

Arcodia et al., 2021



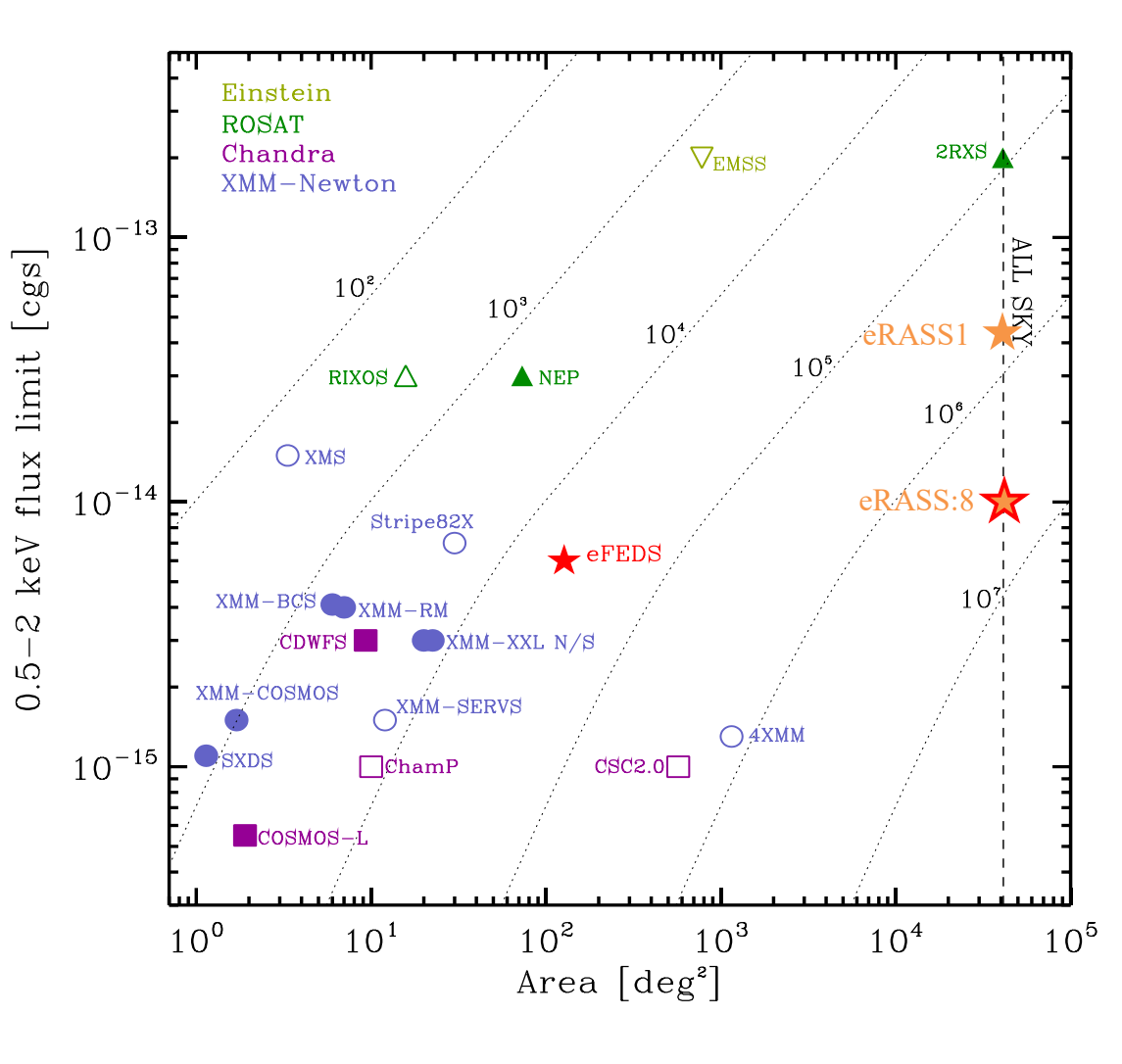
Lamer et al., 2021

Dust scattering ring



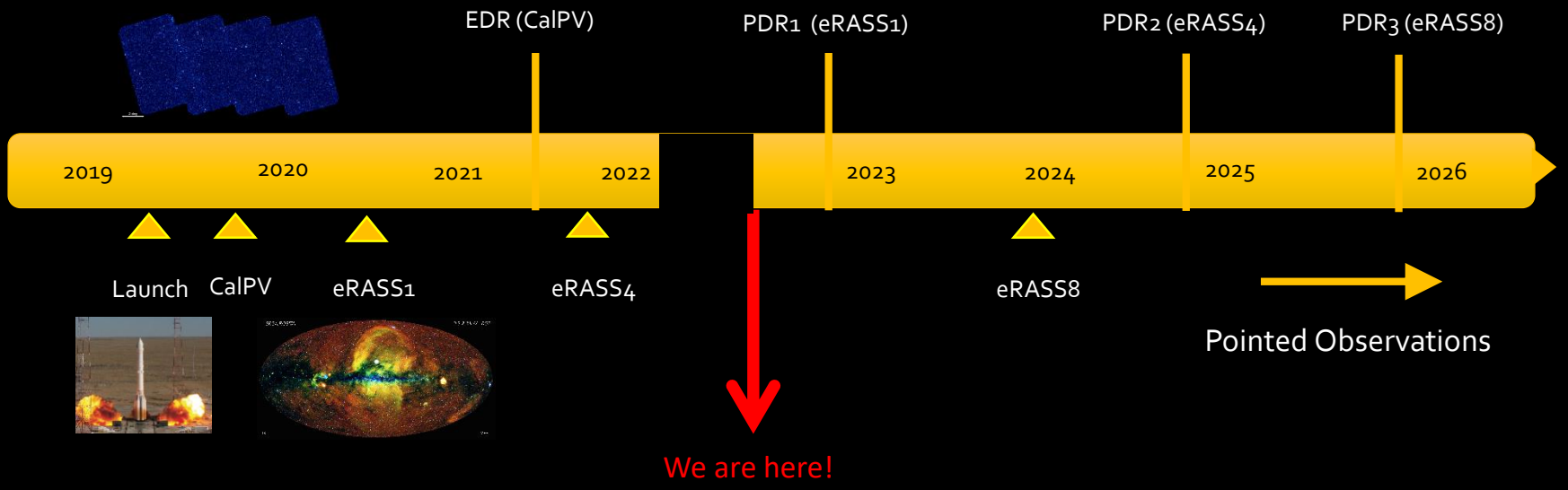
G. Lamer et al. 2021

Surveys



MPE/IKI

eROSITA
Yesterday, Today, Tomorrow…



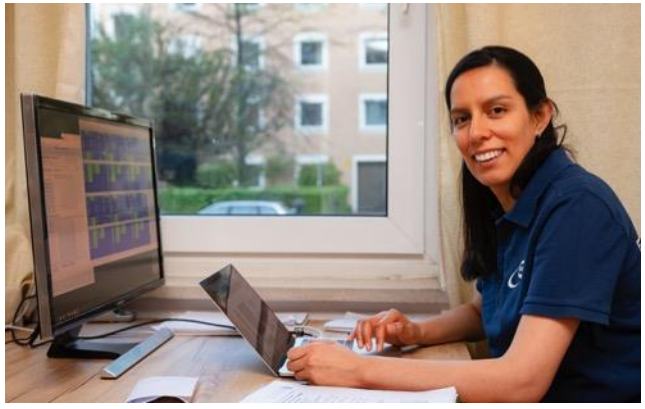
eROSITA by Numbers

Survey	Initial date (UTC)	End time (UTC)	Days	Total session duration [hrs]	Total number of issued commands	Total dumped data [GB]
eRASS1	2019-12-11 21:30	2020-06-11 11:00	184	716	11,992	74.8
eRASS2	2020-06-11 11:00	2020-12-15 12:30	188	794	15,204	84.3
eRASS3	2020-12-15 12:30	2021-06-16 16:00	184	749	14,217	83.0
eRASS4	2021-06-16 16:00	2021-12-19 17:30	187	772	17,892	85.5

Survey	TM1	TM2	TM3	TM4	TM5	TM6	TM7
eRASS1	98.5	96.6	96.1	97.6	92.9	96.7	96.3
eRASS2	96.9	96.8	96.5	92.6	92.1	94.7	94.6
eRASS3	89.5	93.9	95.4	89.0	91.8	93.5	90.0
eRASS4	95.3	93.8	94.7	93.9	90.7	94.8	91.5
eRASS1:4	94.5	94.6	95.2	92.5	91.3	94.4	92.4

M. Ramos-Ceja, D. Coutinho

since April 2020



Operations @Home

Coutinho et al., 2021

IKI Team

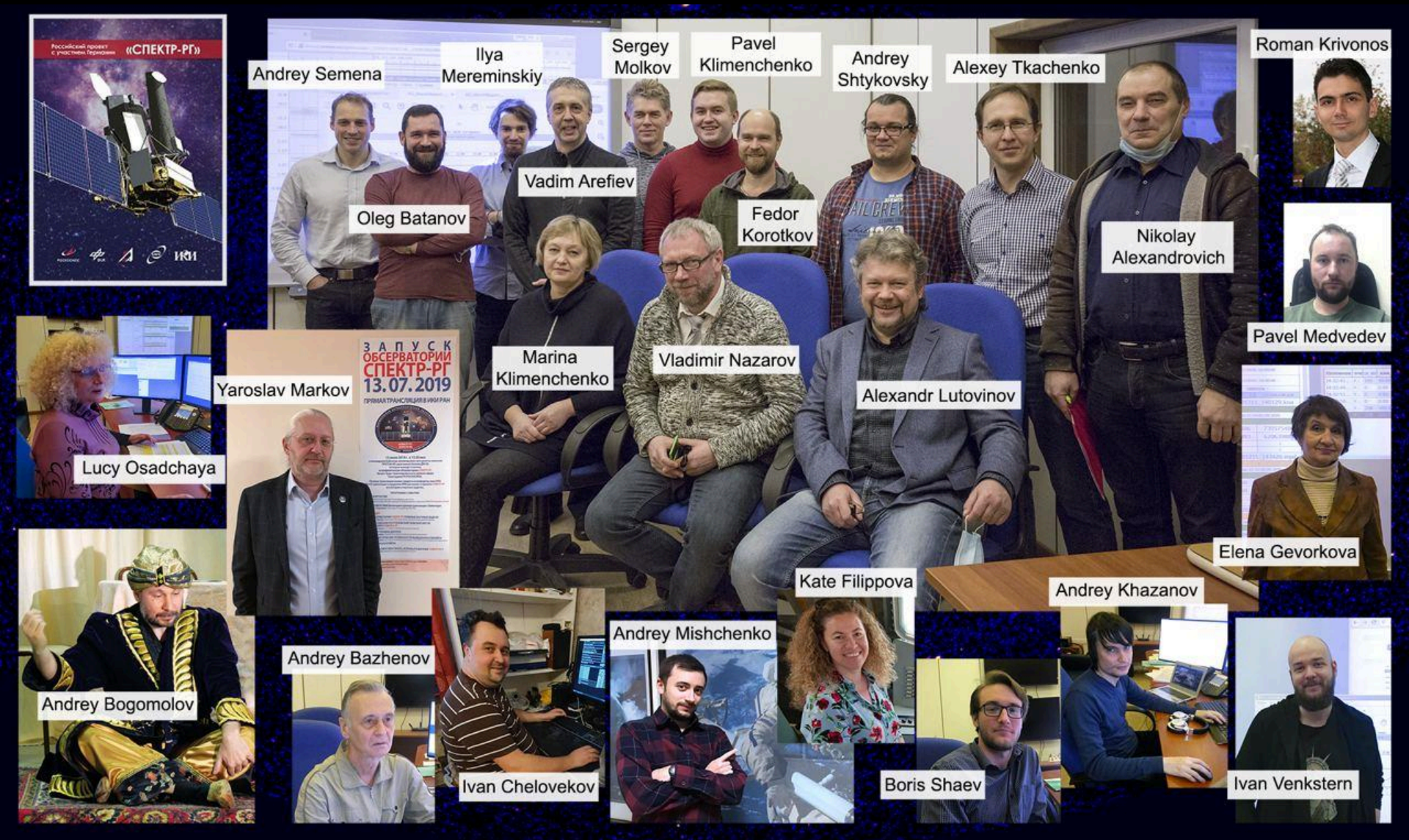

«СПЕКТР-РГ»
ИКИ
Andrey Semena
Ilya Mereminskiy
Sergey Molkov
Pavel Klimenchenko
Andrey Shtykovsky
Alexey Tkachenko
Roman Krivonos
Vadim Arefiev
Oleg Batanov
Fedor Korotkov
Nikolay Alexandrovich
Pavel Medvedev
Marina Klimenchenko
Vladimir Nazarov
Alexandr Lutovinov
Yaroslav Markov
ЗАПУСК ОБСЕРВАТОРИИ СПЕКТР-РГ 13.07.2019
Lucy Osadchaya
Elena Gevorkova
Kate Filippova
Andrey Khazanov
Andrey Mishchenko
Andrey Bazhenov
Andrey Bogomolov
Ivan Chelovekov
Boris Shaev
Ivan Venkstern

Photo: V. Burwitz (MPE)