https://erosita.mpe.mpg.de/

Revealing the Hidden Beauty of the Universe: eROSITA Sees First Light

most material from:

eROSITA First light press kit
http://www.mpe.mpg.de/7362694/presskit-erosita-firstlight

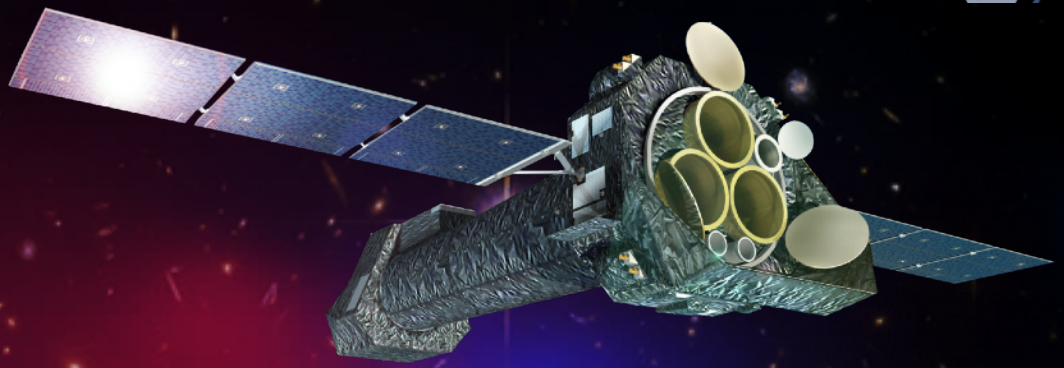
eROSITA Twitter account:
https://twitter.com/eROSITA_SRG

eROSITA Science Book (Merloni+2012)
eROSITA First light symposium presentations
Paul's Nandra's presentation at #Chandra20
Andrea Merloni's presentation at #xrayastronomy19

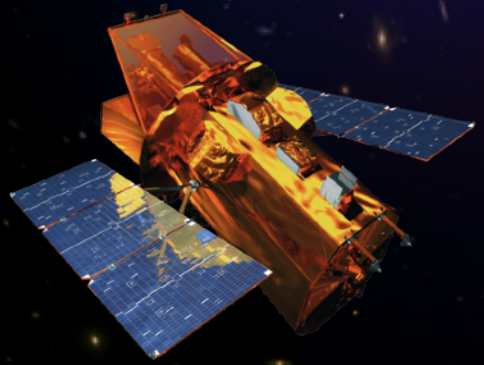
The current X-ray fleet

Chandra
(0.5-7 keV)

1999
20 years !

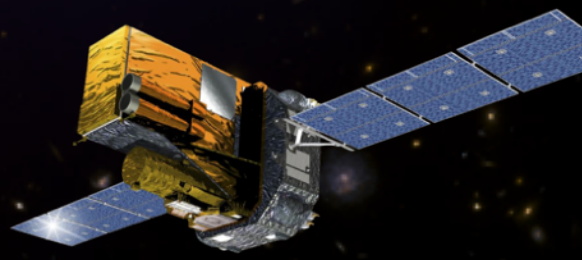


XMM-Newton
(0.2-12 keV)



Swift 2004
(0.2-150 keV)

NuSTAR 2011
(0.3-78 keV)



INTEGRAL 2002
(E>15 keV)

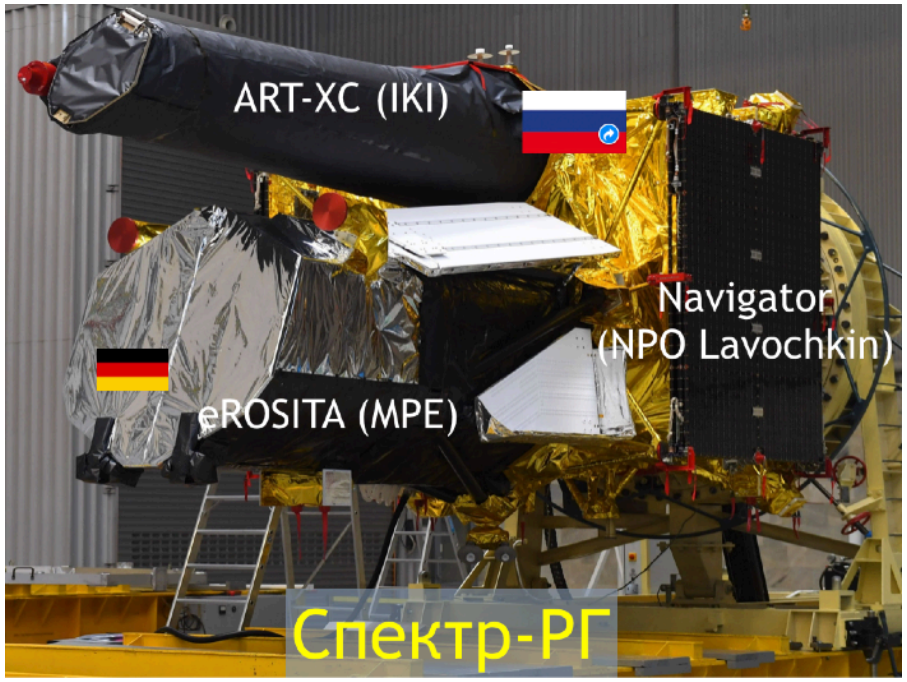
The eROSITA revolution

eROSITA: extended ROentgen Survey with an Imaging Telescope Array

Built by consortium led by MPE (PI: **Peter Predehl**), launched in July 2019
on the Spectrum Röntgen Gamma (SRG) mission along with ART-XC (5-30 keV; IKI)

Next Generation All-sky X-ray survey telescope (0.2-10 keV)

4 years Survey phase (8 all-sky surveys)



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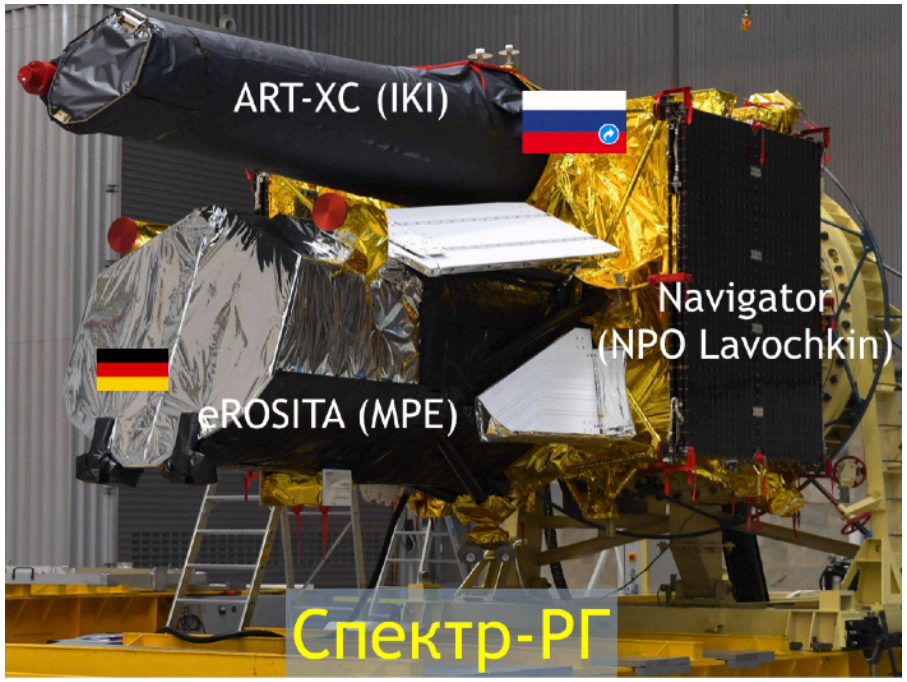
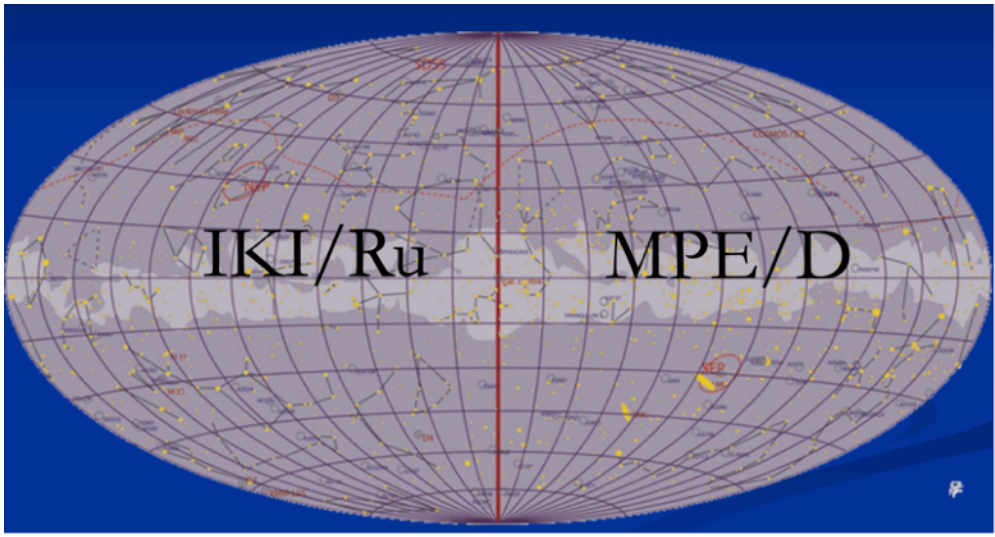
GERMAN/RUSSIAN MISSION

Half sky each





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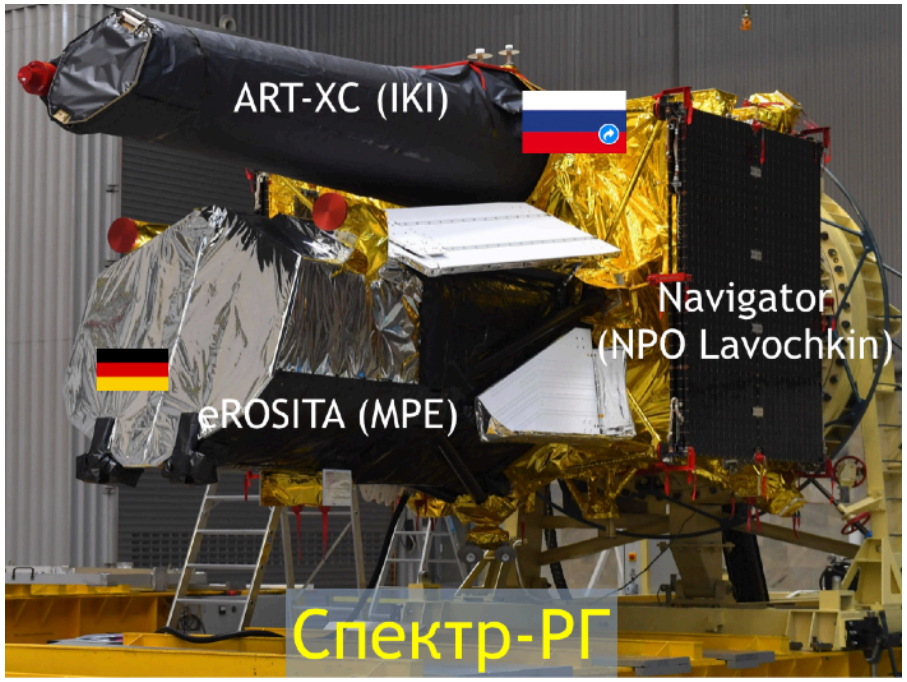


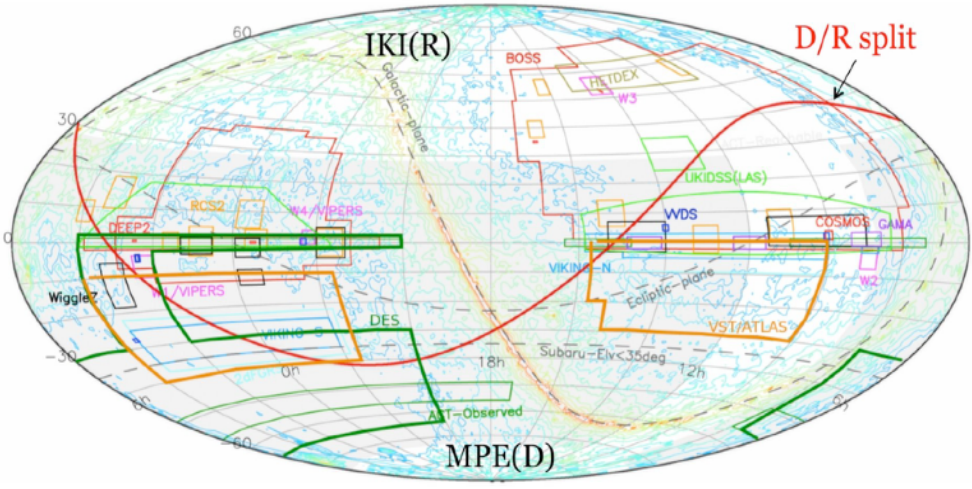


Image A. Nishizawa (IPMU), AM

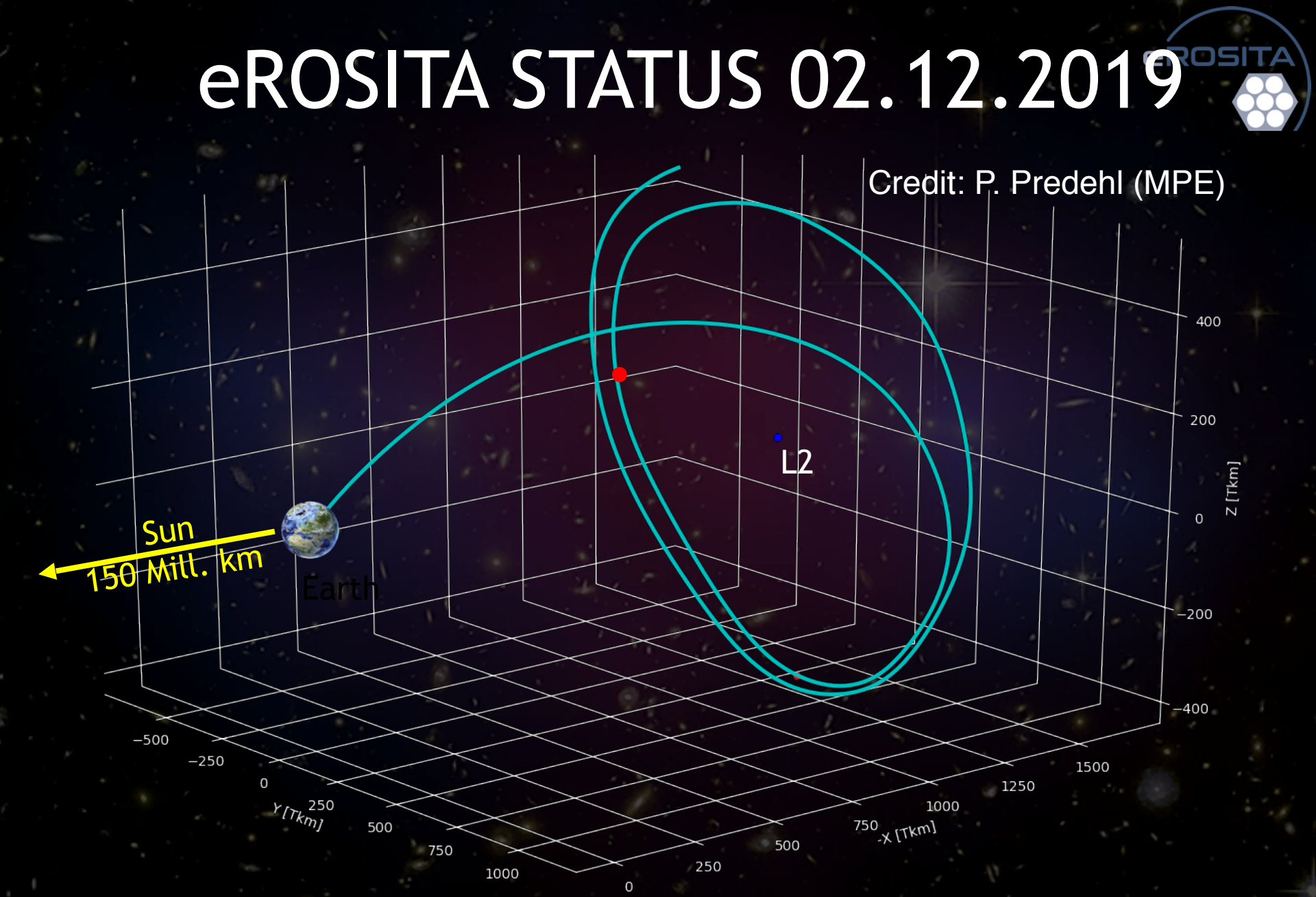
A. Merloni – Surveys ESO, 10/2012

eROSITA

13.07.2019, 17:31

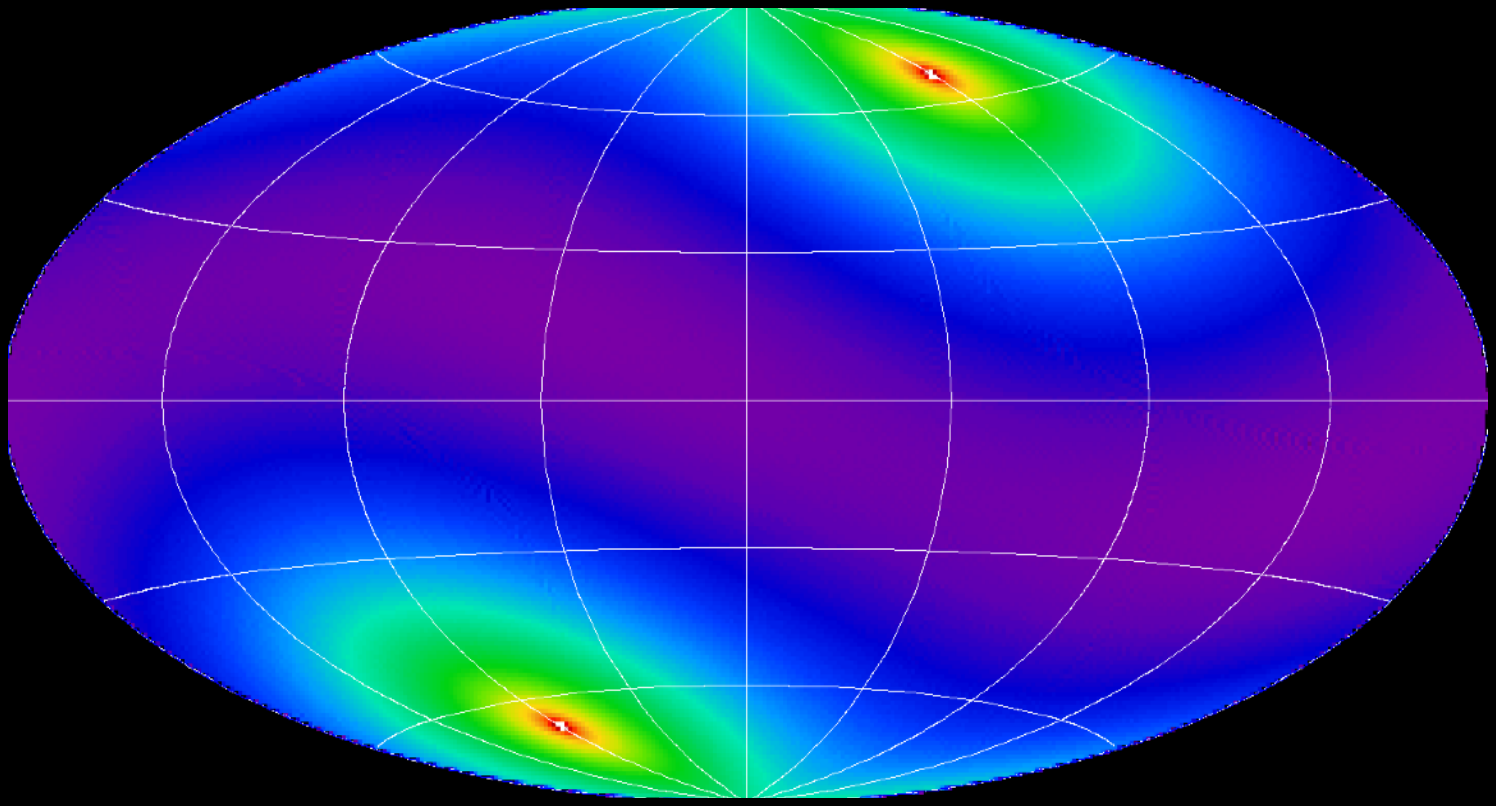
MPE DLR РОСКОСМОС ИКИ EBERHARD KARLS UNIVERSITÄT TÜBINGEN UHH LMU LUDWIG MAXIMILIANS UNIVERSITÄT MÜNCHEN UNIVERSITÄT BONN AIP

eROSITA STATUS 02.12.2019



First X-ray telescope in L2 (next: Athena, 2030s)

eROSITA Cadence Map



48 60 120 360 2160

# of eROSITA visits over 4yrs

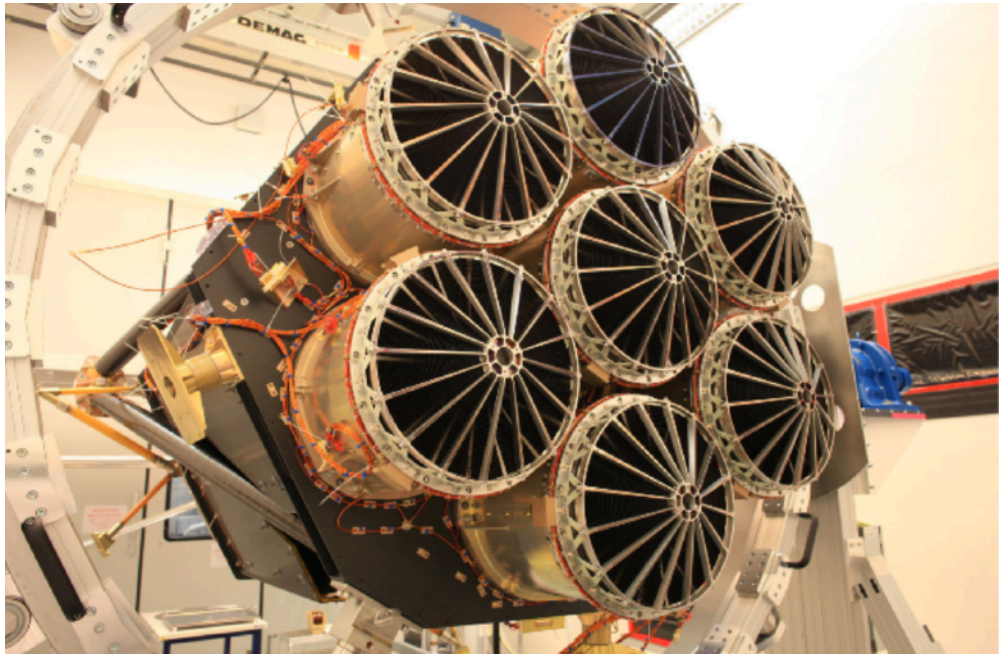
1 daily visit → $F_{0.5\text{-}2} \sim 5 \times 10^{-14}$ erg/s/cm^2 →

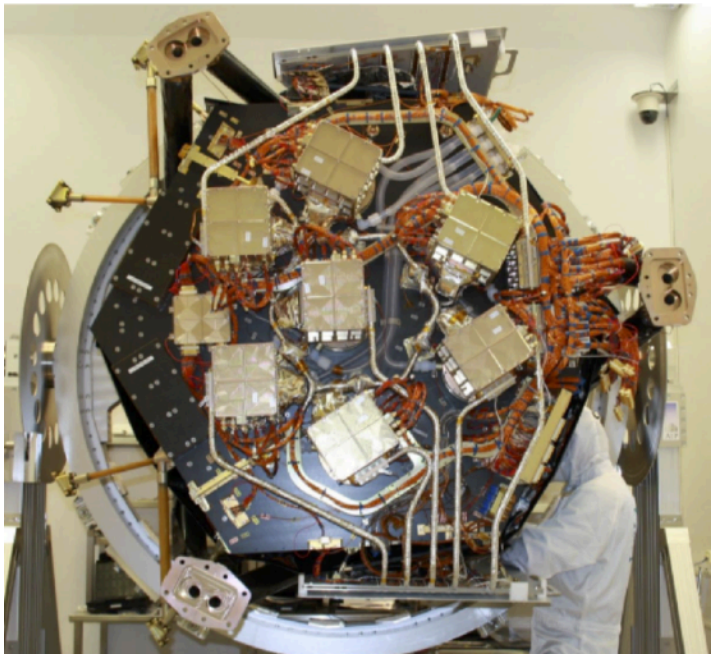
The eROSITA revolution

eROSITA: extended ROentgen Survey with an Imaging Telescope Array

Next Generation All-sky X-ray survey telescope

Focal length: 1.6m
Field of View: 1 degree (diameter)
Half Energy Width (HEW): ~18" on axis / ~28" survey mode
Source location accuracy: 3-10"
Spectral resolution at all energies within expectations (~80 eV at 1.5 keV)
Extremely good detector uniformity, no chips gaps





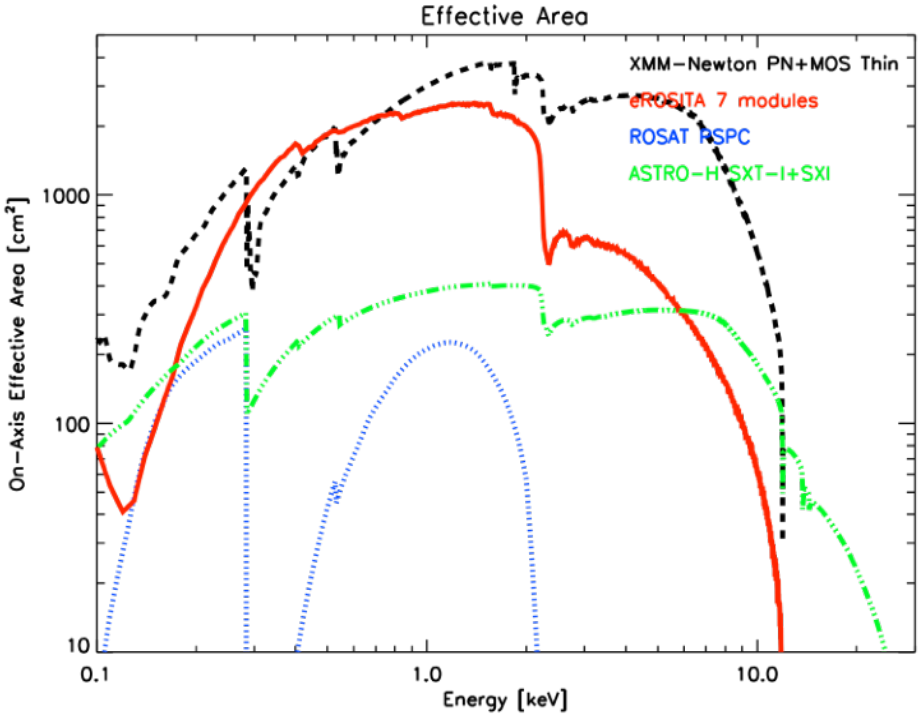
7 Mirrors + pnCCDs

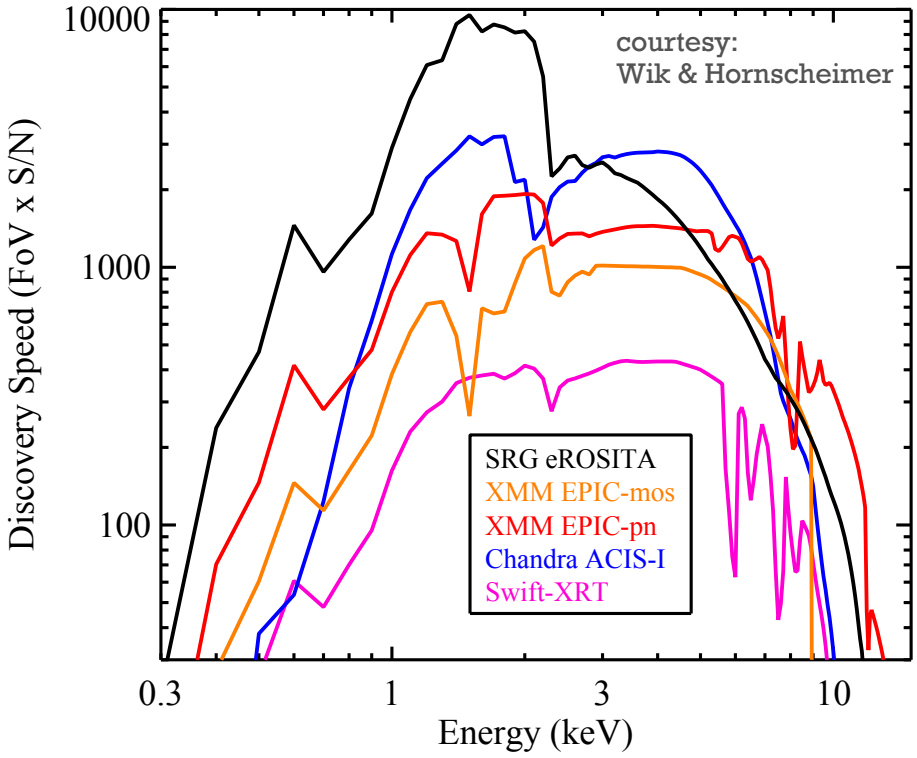
The eROSITA revolution

eROSITA: extended ROentgen Survey with an Imaging Telescope Array

Next Generation All-sky X-ray survey telescope

Effective area: 1700 cm2 / FOV averaged at 1 keV (comparable to XMM-Newton)
Survey speed: 5-7 larger than any current X-ray misssion

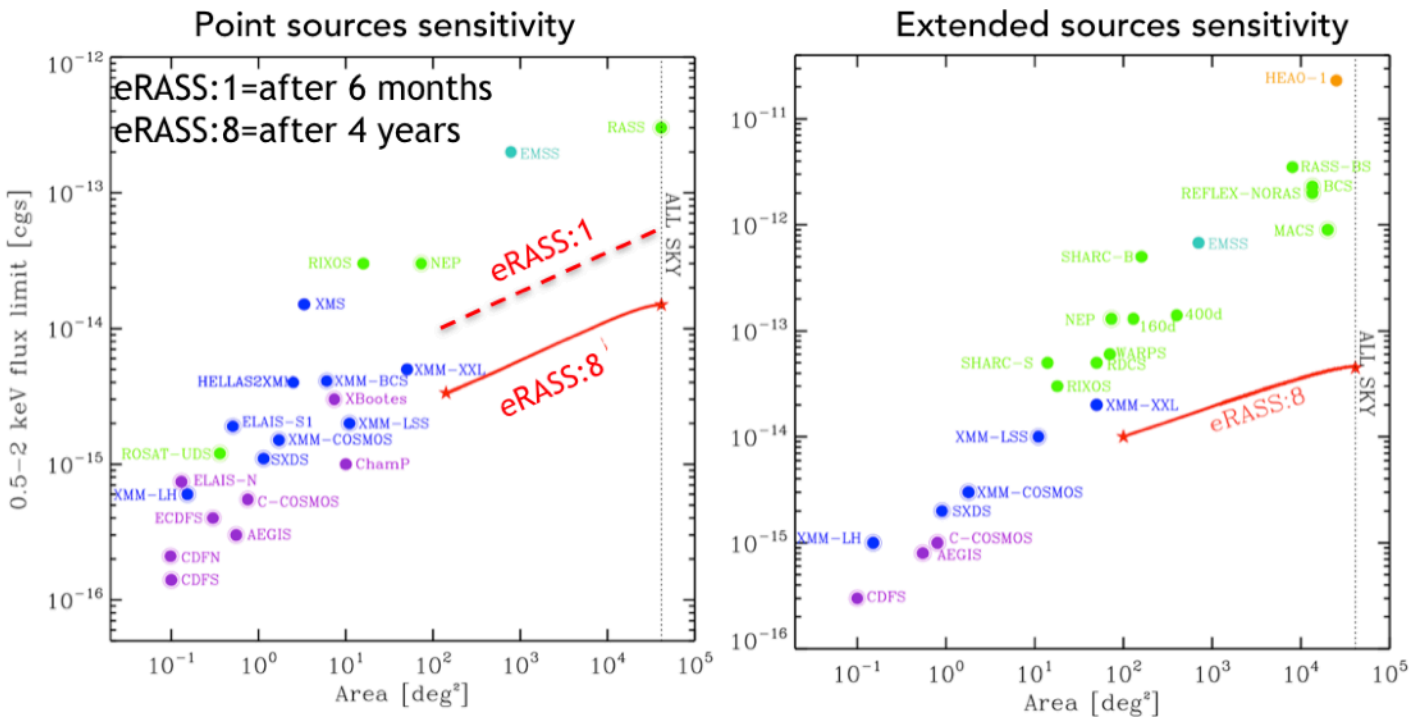




The eROSITA revolution

eROSITA: extended ROentgen Survey with an Imaging Telescope Array

Next Generation All-sky X-ray survey telescope
4 years Survey phase (8 all-sky surveys) + pointed phase (GO)



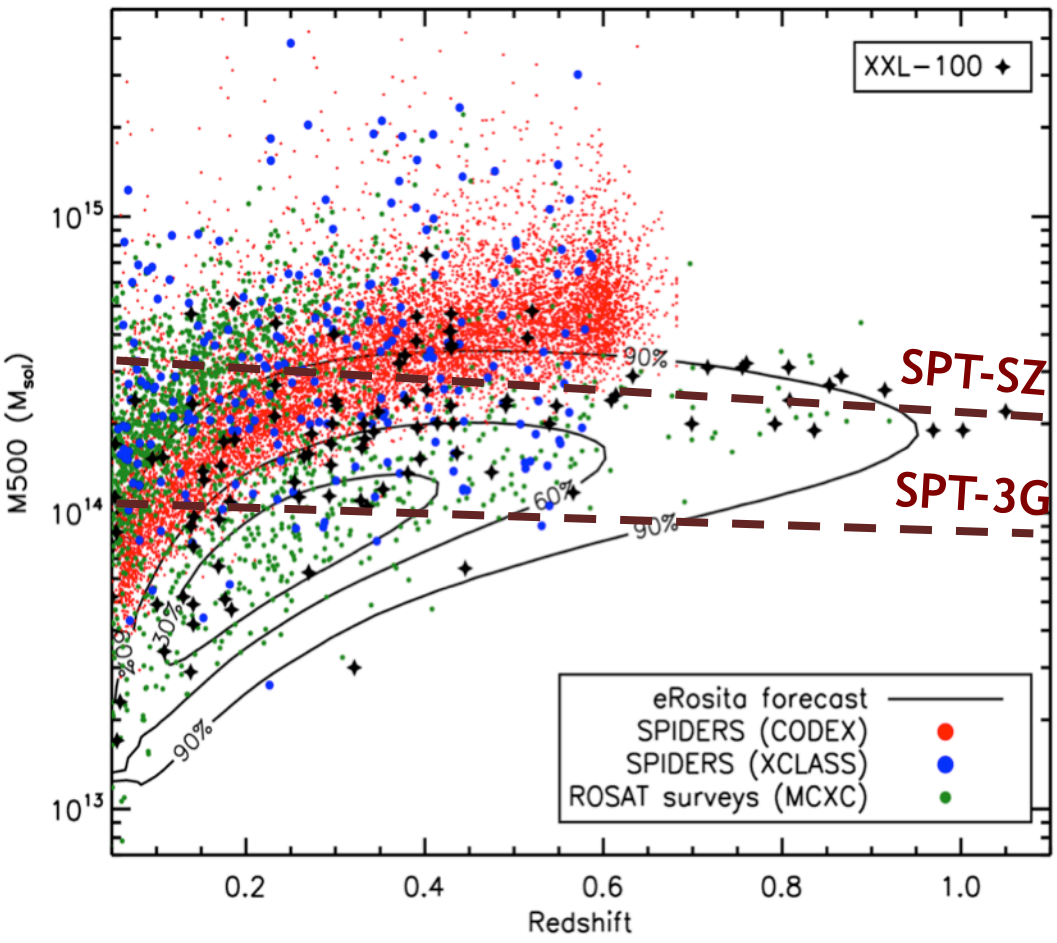
30× deeper than ROSAT

Driving science:

1) detect >100.000 clusters (cluster cosmology) - Merloni+2012, Pillepich+2018
2) detect >3Million AGN, including most luminous, obscured ones
Merloni+2012, Comparat+2019

BONUS: 500.000 stars (!!!), SNR, planets, etc.

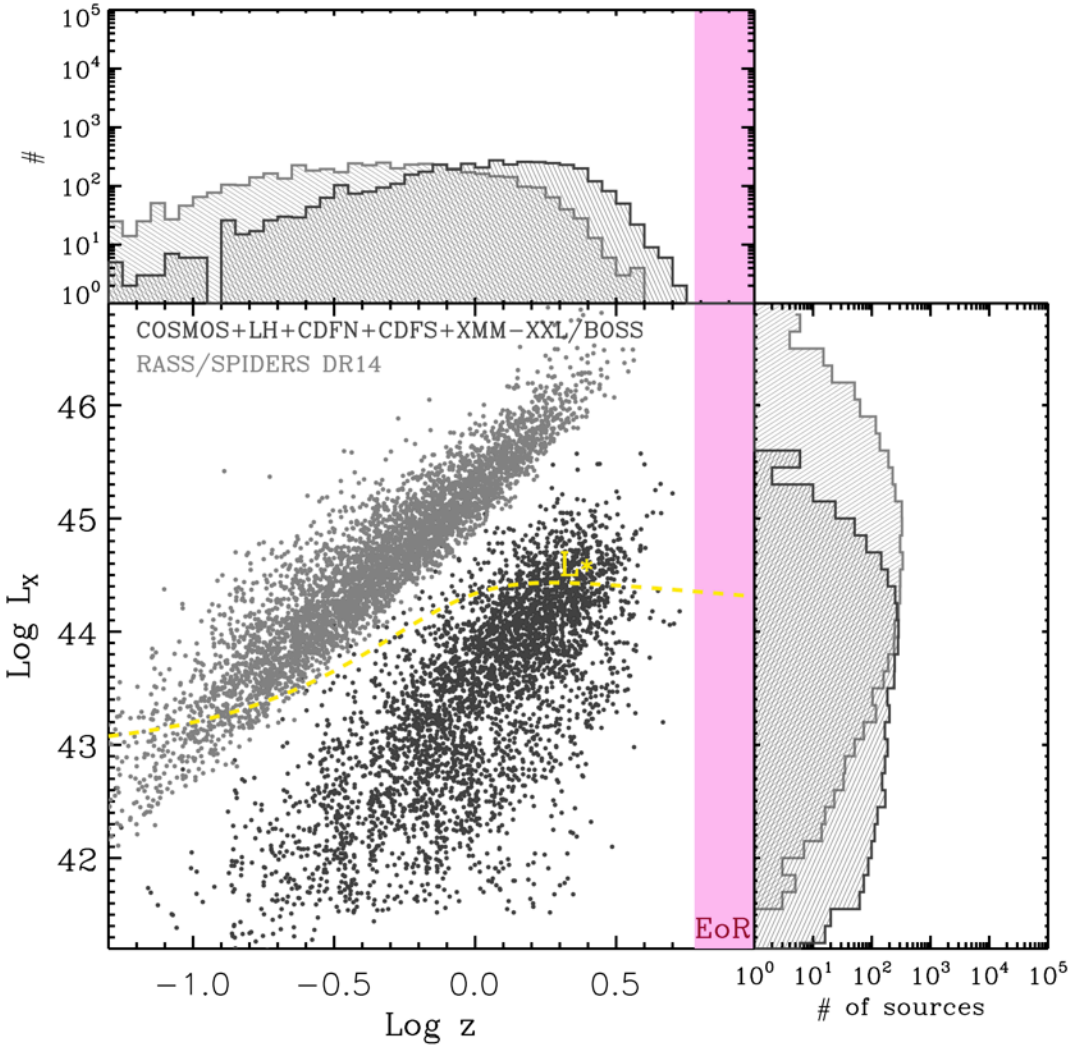
ALL Massive Clusters



Borm et al. (2014); Clerc et al. (2018)

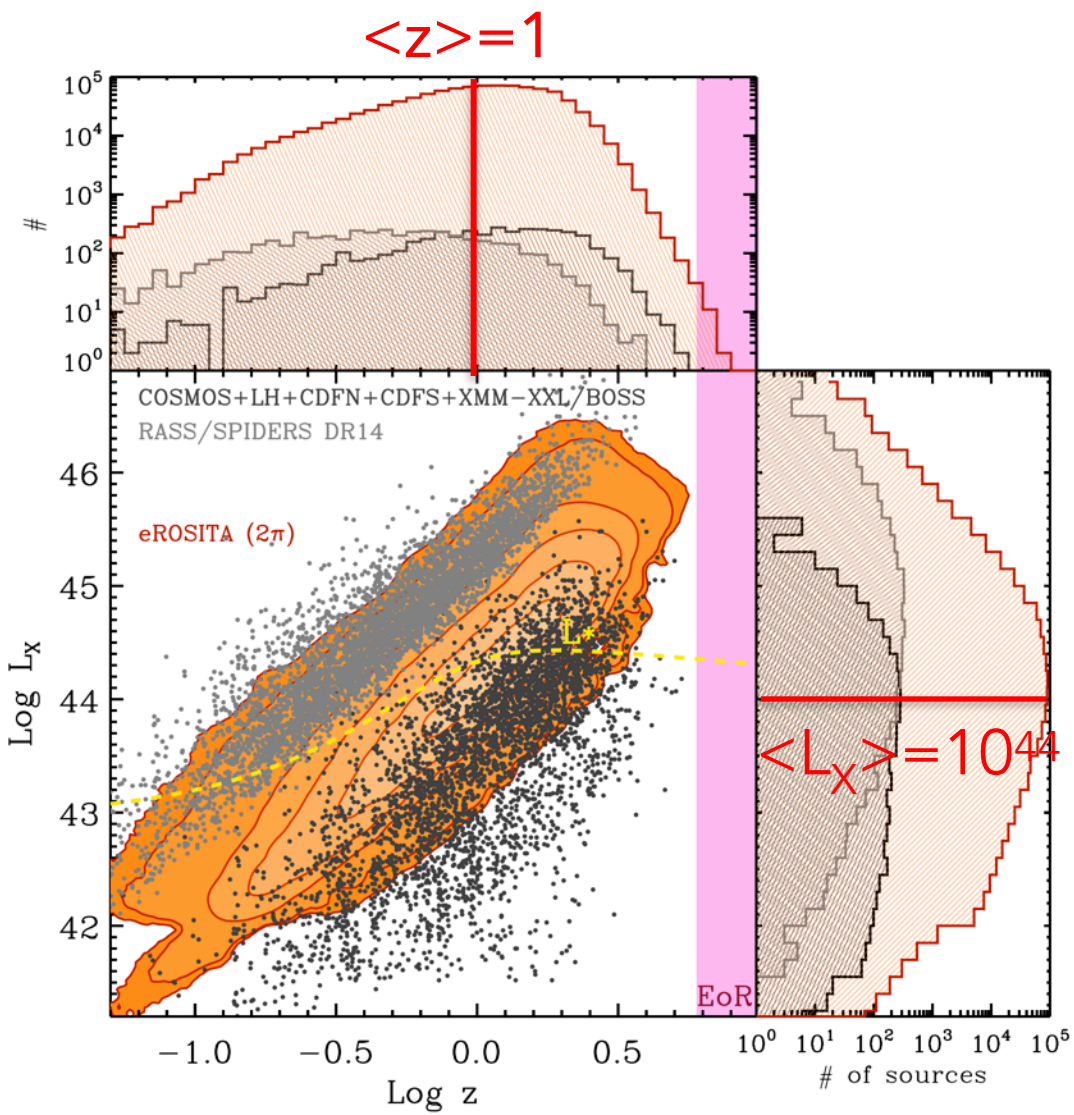
- eROSITA will detect ~100k clusters with more than 50 net counts; 2k with more than 1000 counts
- ~20k clusters with good redshift determination, up to z~0.45
- ~2k clusters with precise Temperature (to <10%)
- eROSITA PSF is good enough to resolve ~0.3R_{500} regions at z=1 for $10^{14}M_{\odot}$ clusters
- For cosmology, M_{gas} and core-excised L_X are excellent mass proxies with very low scatter (~10%)

3 Million AGN



- The most luminous AGN, tracers of large scale structure: the "quasar" mode of AGN feedback
- (Obscured and Un-obscured) accretion history
- High-z AGN
- Huge effective volume, BAO with biased tracers
- SED vs. L, L/L_{EDD}
- Soft spectral response
- Uninterrupted view!
- changing look AGN

3 Million AGN



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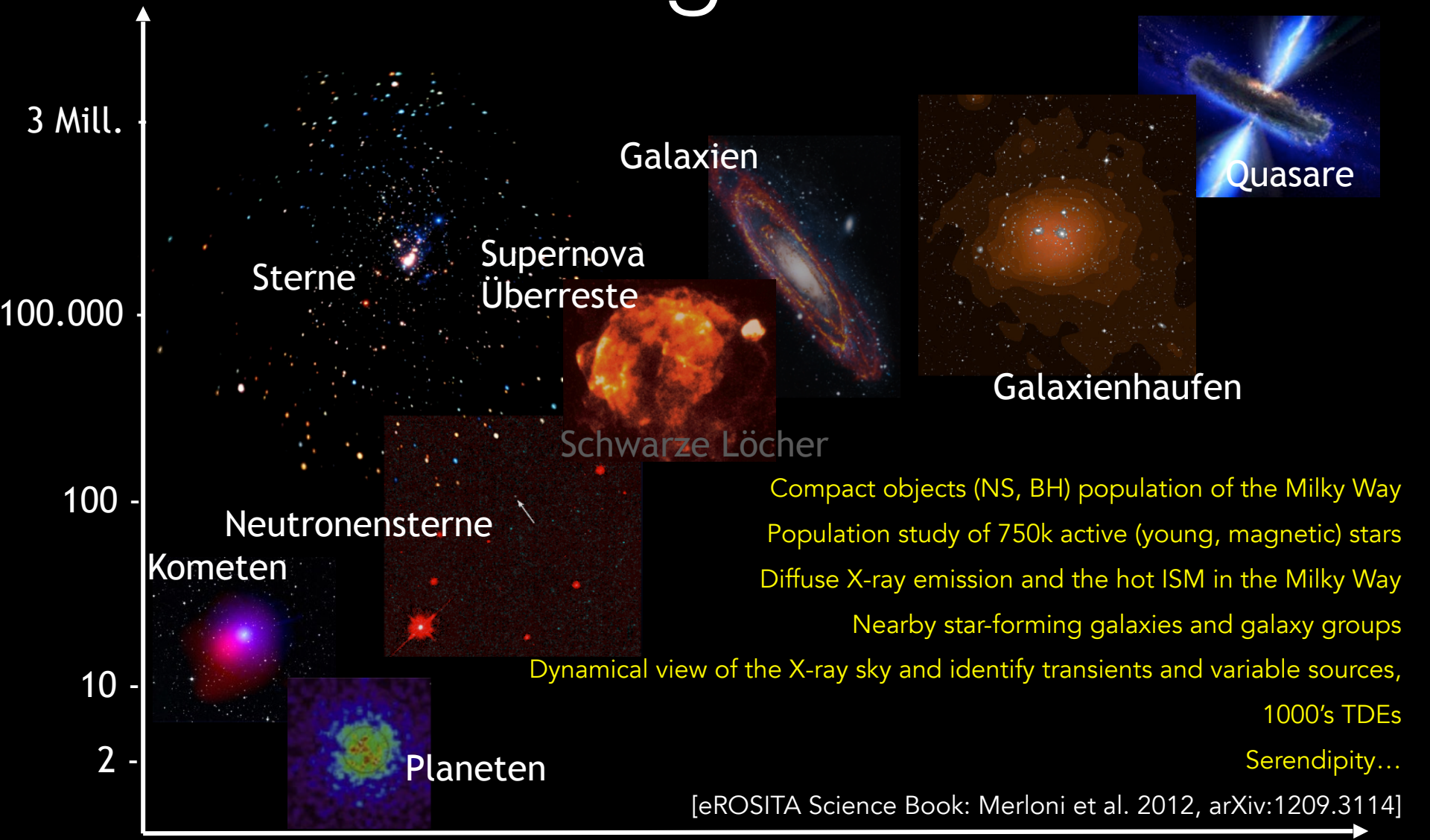
- Uninterrupted view!
- changing look AGN

SDSS like AGN/QSO sample

Der Röntgenhimmel



Compact objects (NS, BH) population of the Milky Way

Population study of 750k active (young, magnetic) stars

Diffuse X-ray emission and the hot ISM in the Milky Way

Nearby star-forming galaxies and galaxy groups

Dynamical view of the X-ray sky and identify transients and variable sources, 1000's TDEs

Serendipity…

[eROSITA Science Book: Merloni et al. 2012, arXiv:1209.3114]

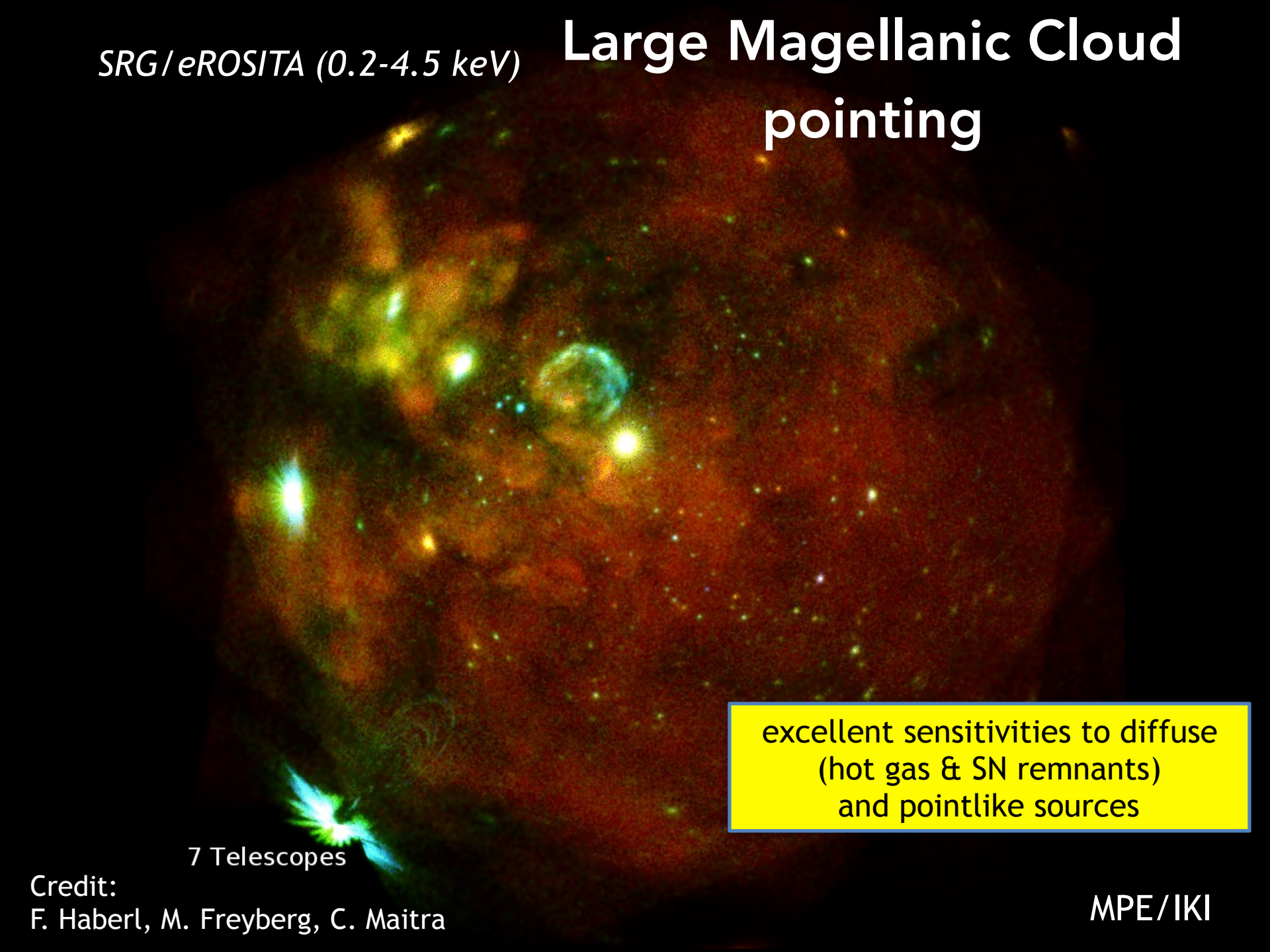
Der Röntgenhimmel

eROSITA CalPV phase

~ September / November 2019

SRG/eROSITA (0.2-4.5 keV)

Large Magellanic Cloud pointing



excellent sensitivities to diffuse (hot gas & SN remnants) and pointlike sources

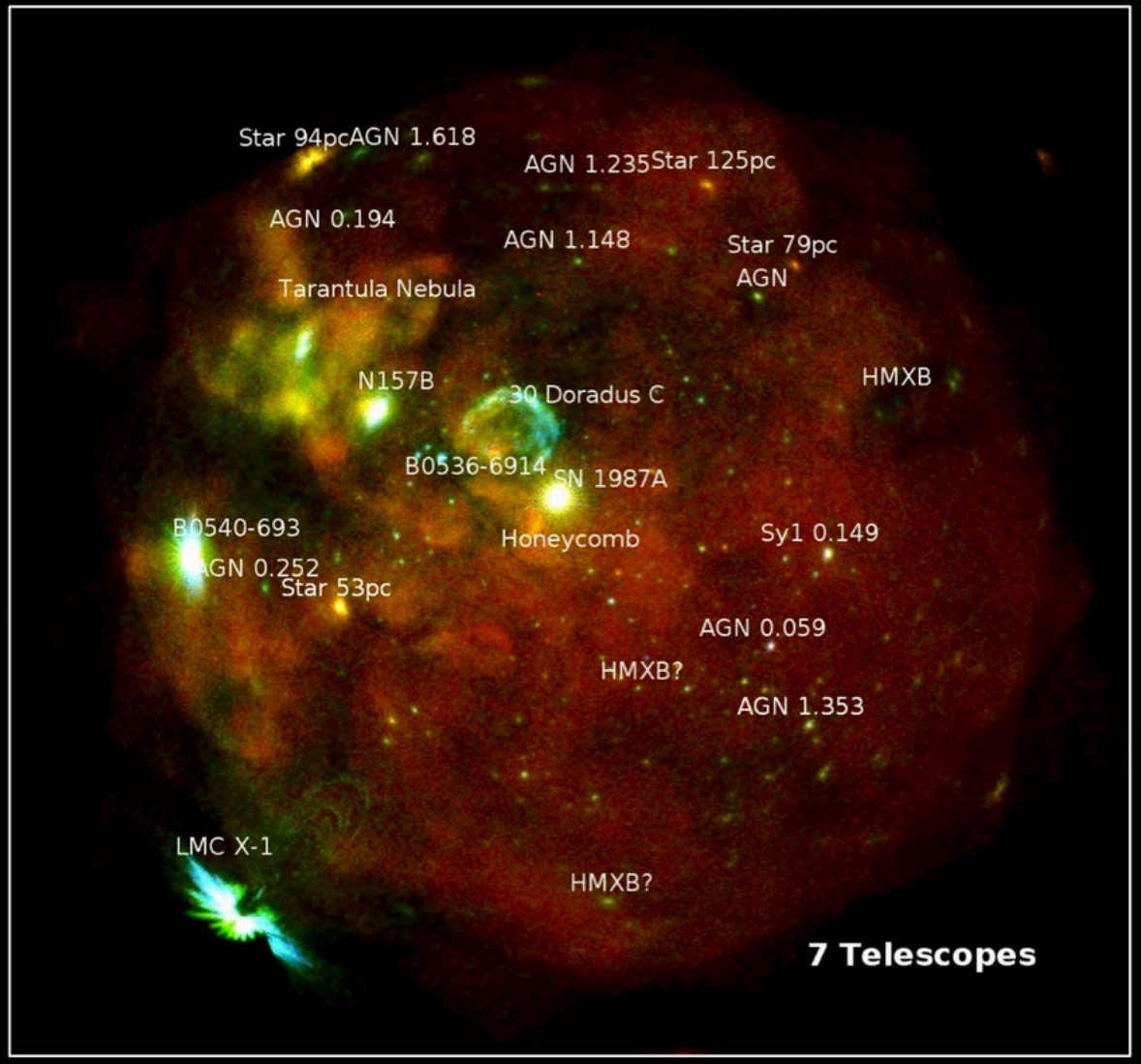
Credit:
F. Haberl, M. Freyberg, C. Maitra

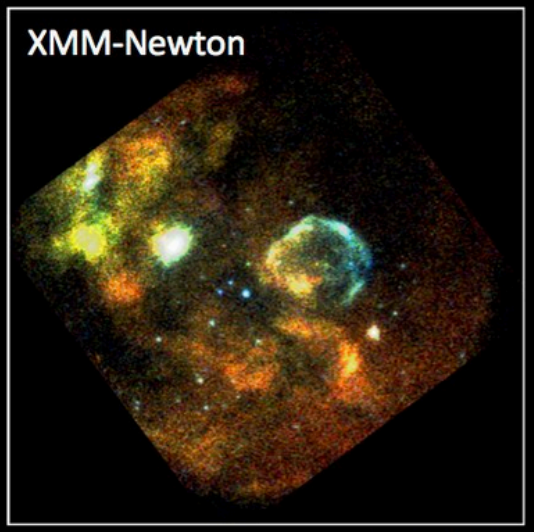
MPE/IKI

Large Magellanic Cloud

SRG/eROSITA

eROSITA vs. XMM





EPIC-PN FL
Dennerl et al. 2001

Power of FoV + effective area

excellent sensitivities to diffuse and pointlike sources

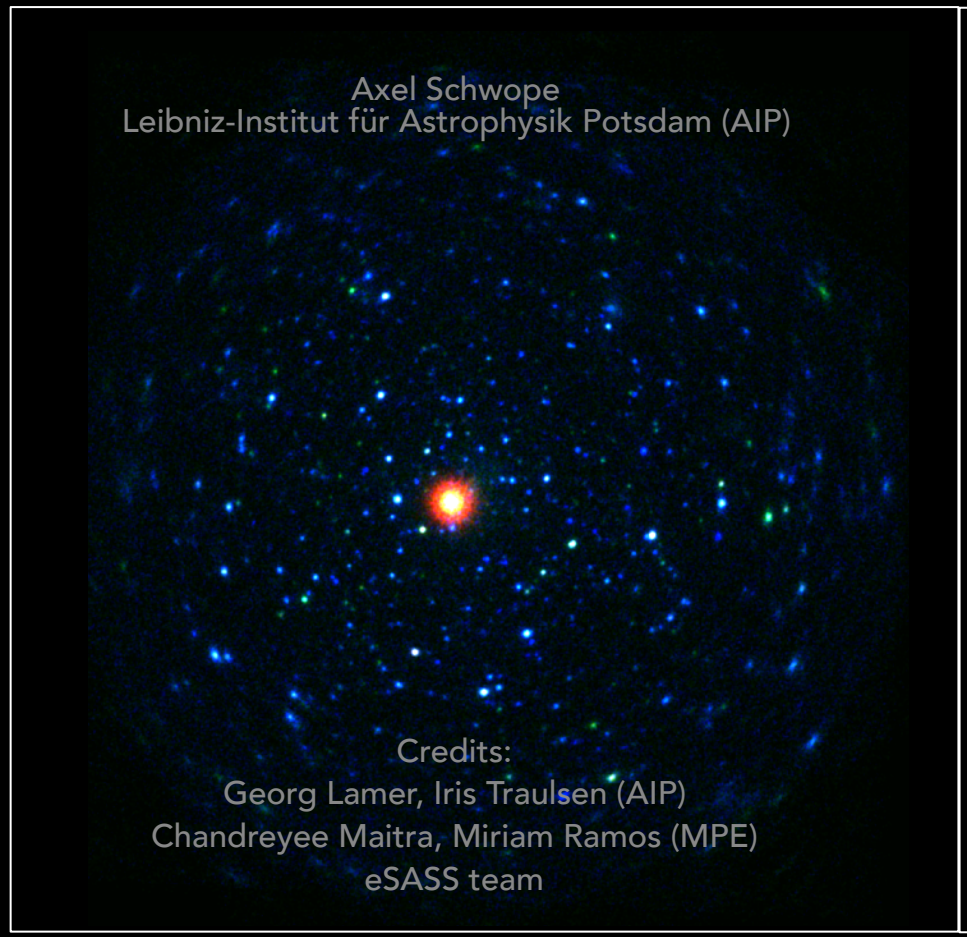
MPE/IKI

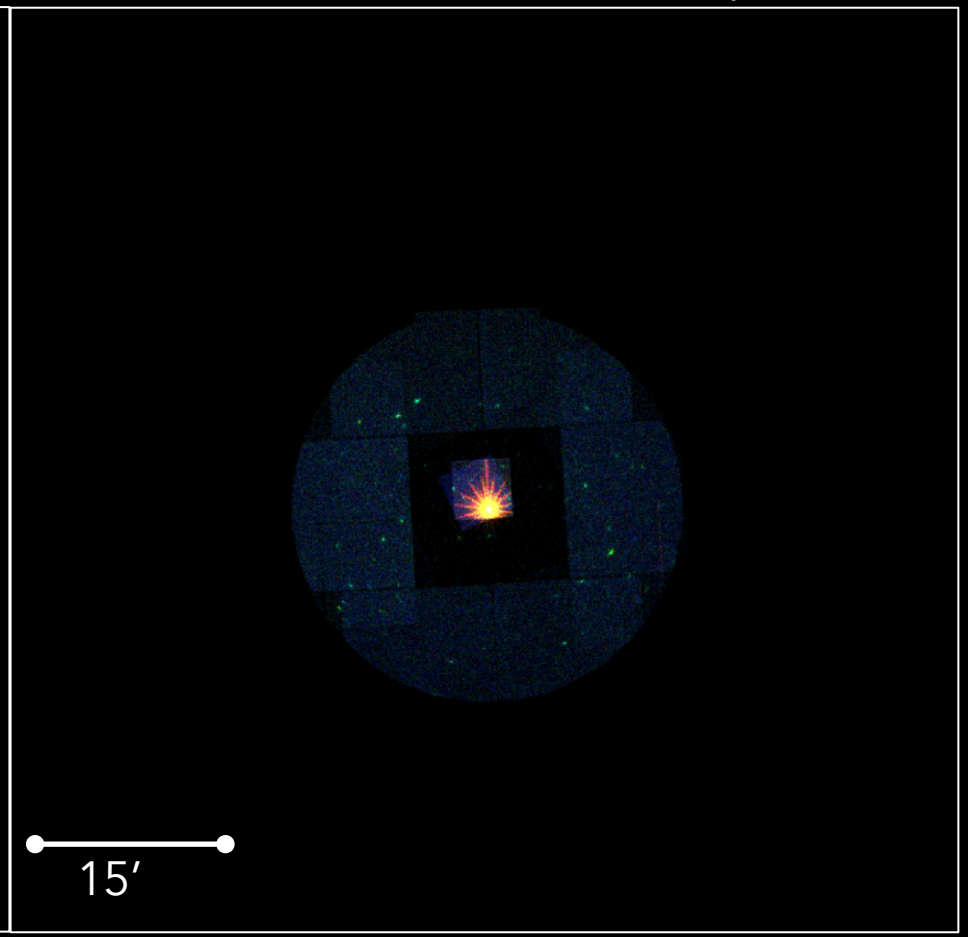
Credit:
F. Haberl, M. Freyberg, C. Maitra

The eROSITA view of the isolated neutron star B0656+14

SRG/eROSITA 0.2/0.7/1.2/3keV

XMM-Newton pn+MOS





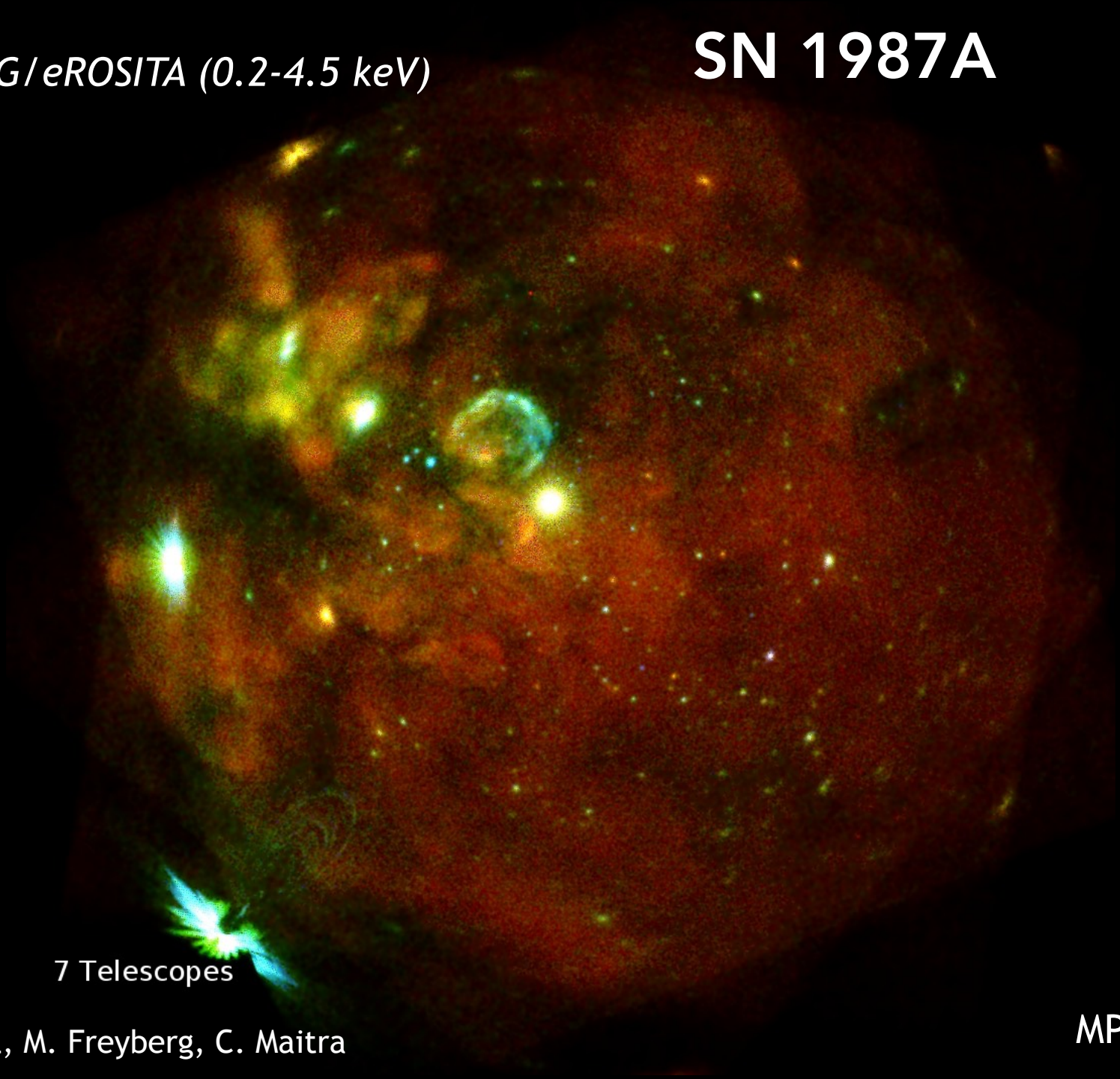
MPE/IKI

ESA

No pile-up problems !

SRG/eROSITA (0.2-4.5 keV)

SN 1987A

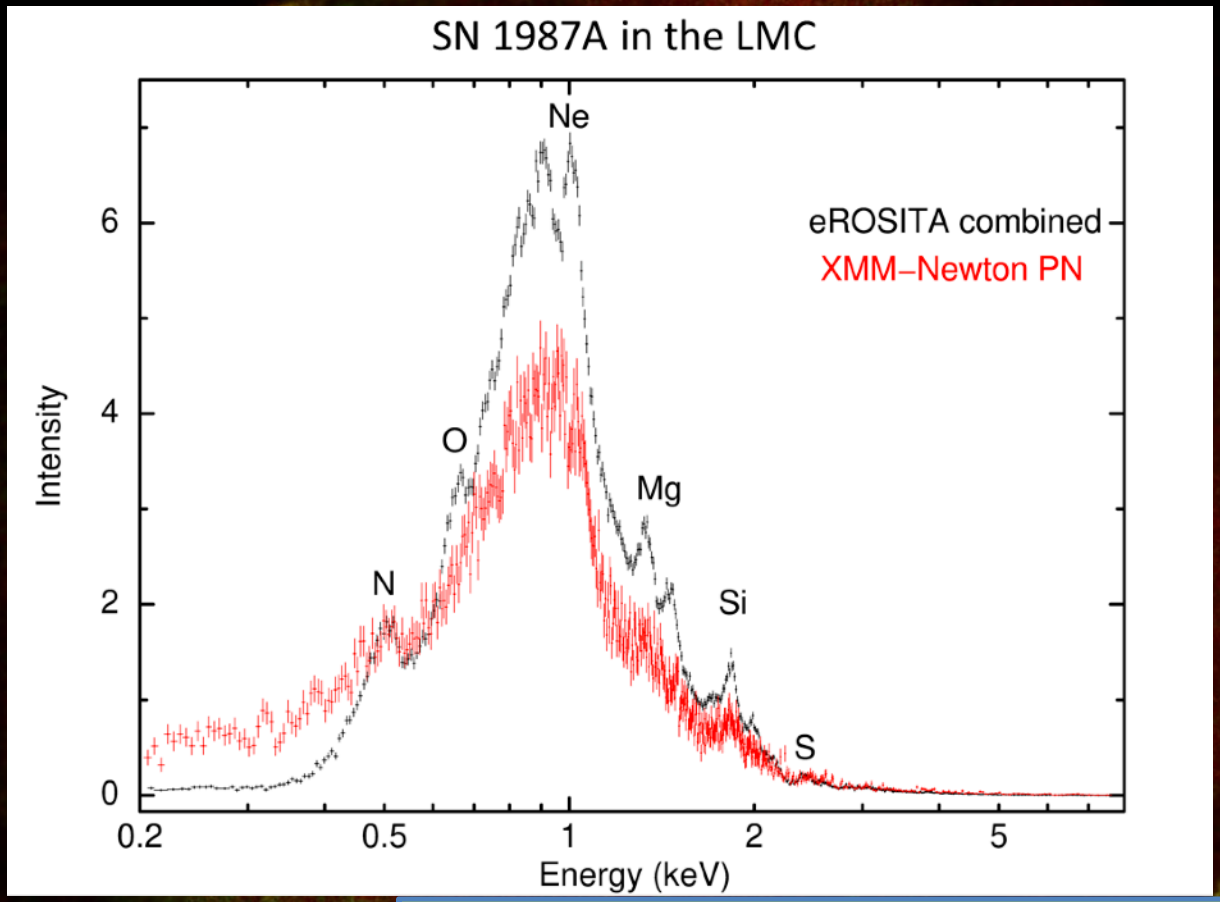


Credit:
F. Haberl, M. Freyberg, C. Maitra

MPE/IKI

SRG/eROSITA (0.2-4.5 keV)

SN 1987A



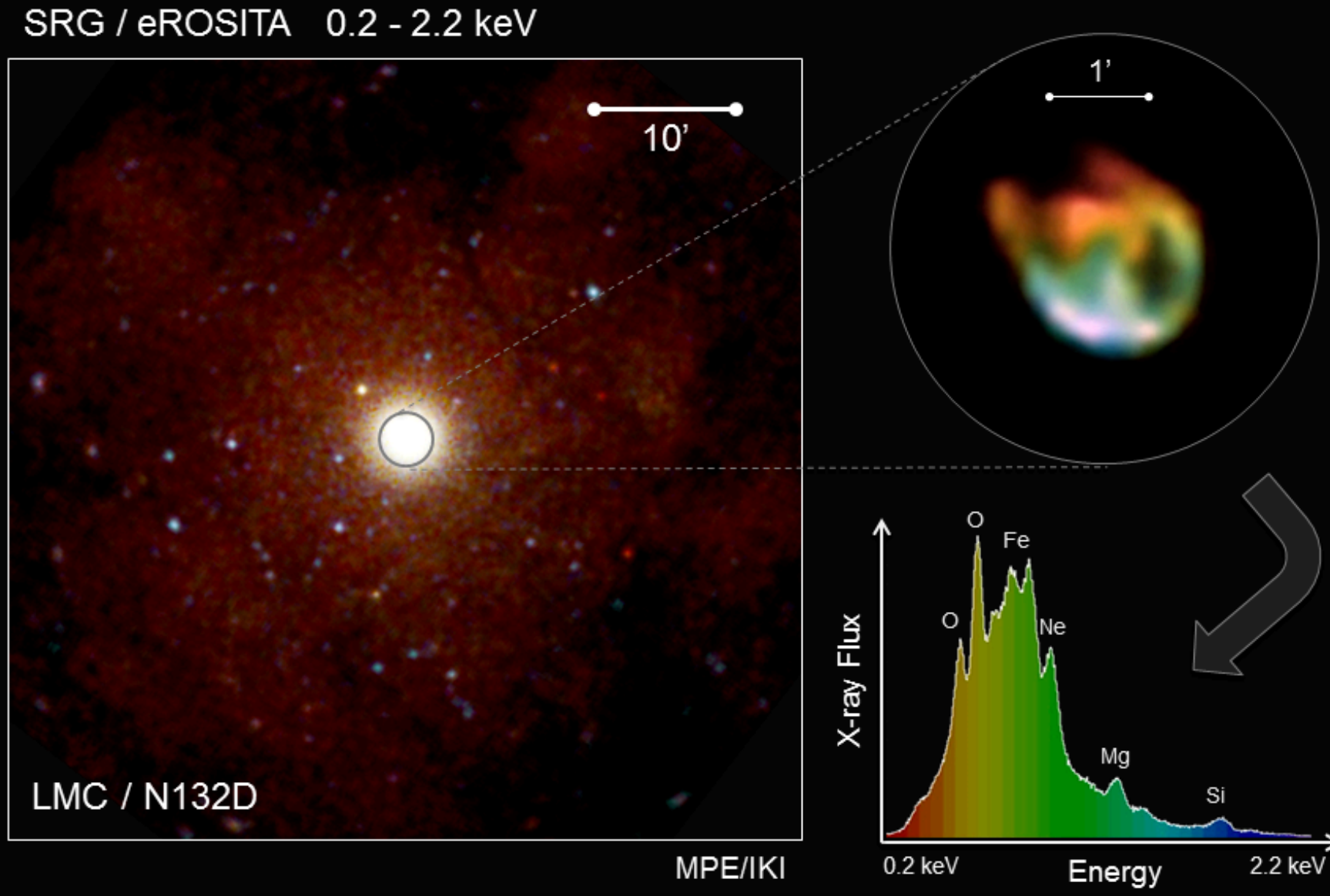
higher throughput &
better spectral resolution than XMM
the best CCD camera available in space
spectral resolution: ~100 eV vs. 150 eV XMM

7 Telescopes

Credit:
F. Haberl, M. Freyberg, C. Maitra

MPE/IKI

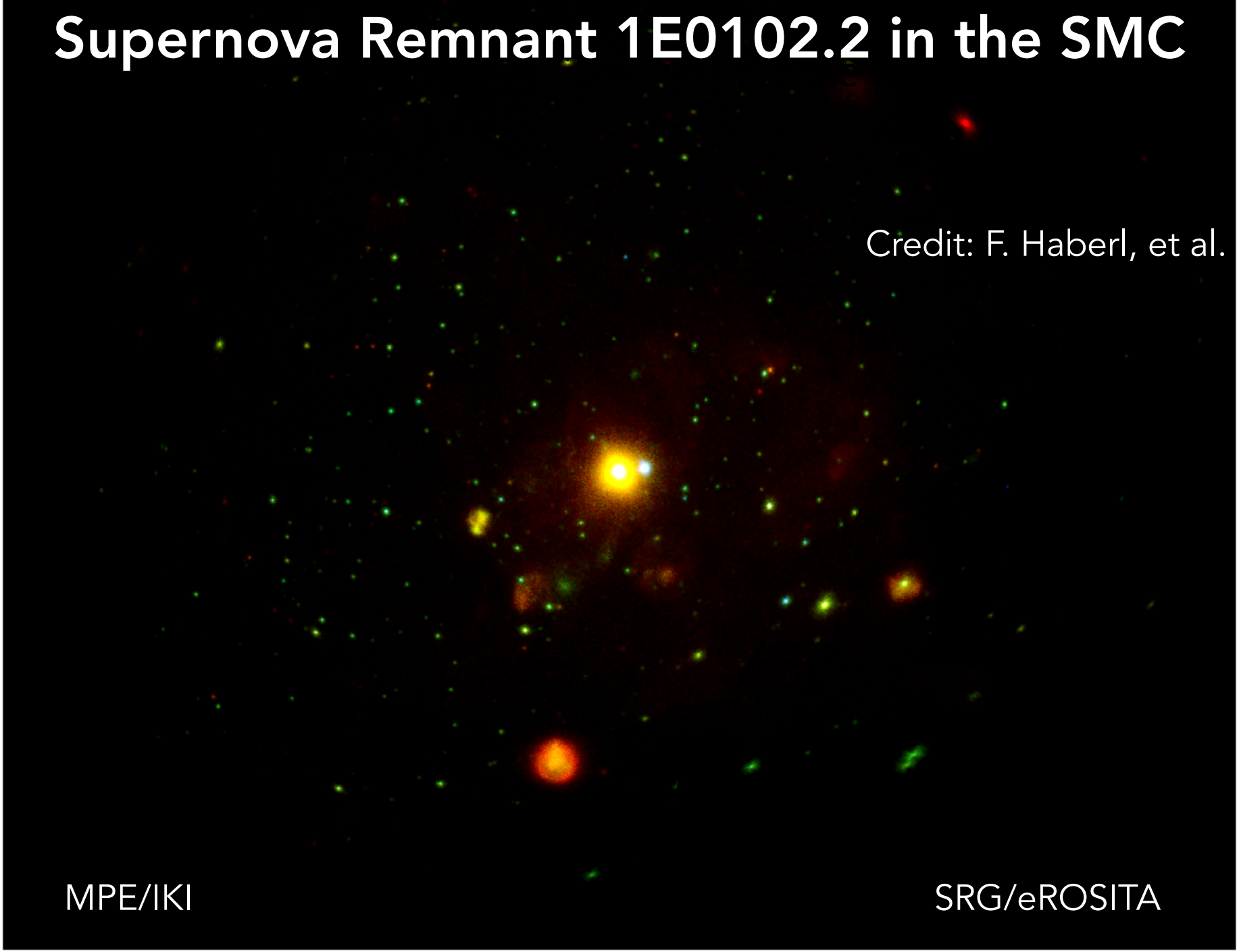
Supernova Remnant N132D in the LMC



Credit:
K. Dennerl

extremely high dynamical range (x5000)
excellent spatial and spectral resolution

Supernova Remnant 1E0102.2 in the SMC



Credit: F. Haberl, et al.

MPE/IKI

SRG/eROSITA

Supernova Remnant 1E0102.2 in the SMC

Credit: F. Haberl, et al.

Discovery of X-ray pulsations from the Be/X-ray binary XMMU J010429.4-723136 in the SMC with SRG/eROSITA

ATel #13312; *F. Haberl (MPE), S. Carpano (MPE), C. Maitra (MPE), M. Freyberg (MPE), K. Dennerl (MPE), A. Schwope (AIP), A. Merloni (MPE), P. Predehl (MPE), H. Brunner (MPE), D. A.H. Buckley (SAAO), I. M. Monageng (SAAO/UCT)*

*on **25 Nov 2019; 20:29 UT***

Credential Certification: Frank Haberl (fwh@mpe.mpg.de)

Subjects: Optical, X-ray, Binary, Neutron Star, Transient, Pulsar

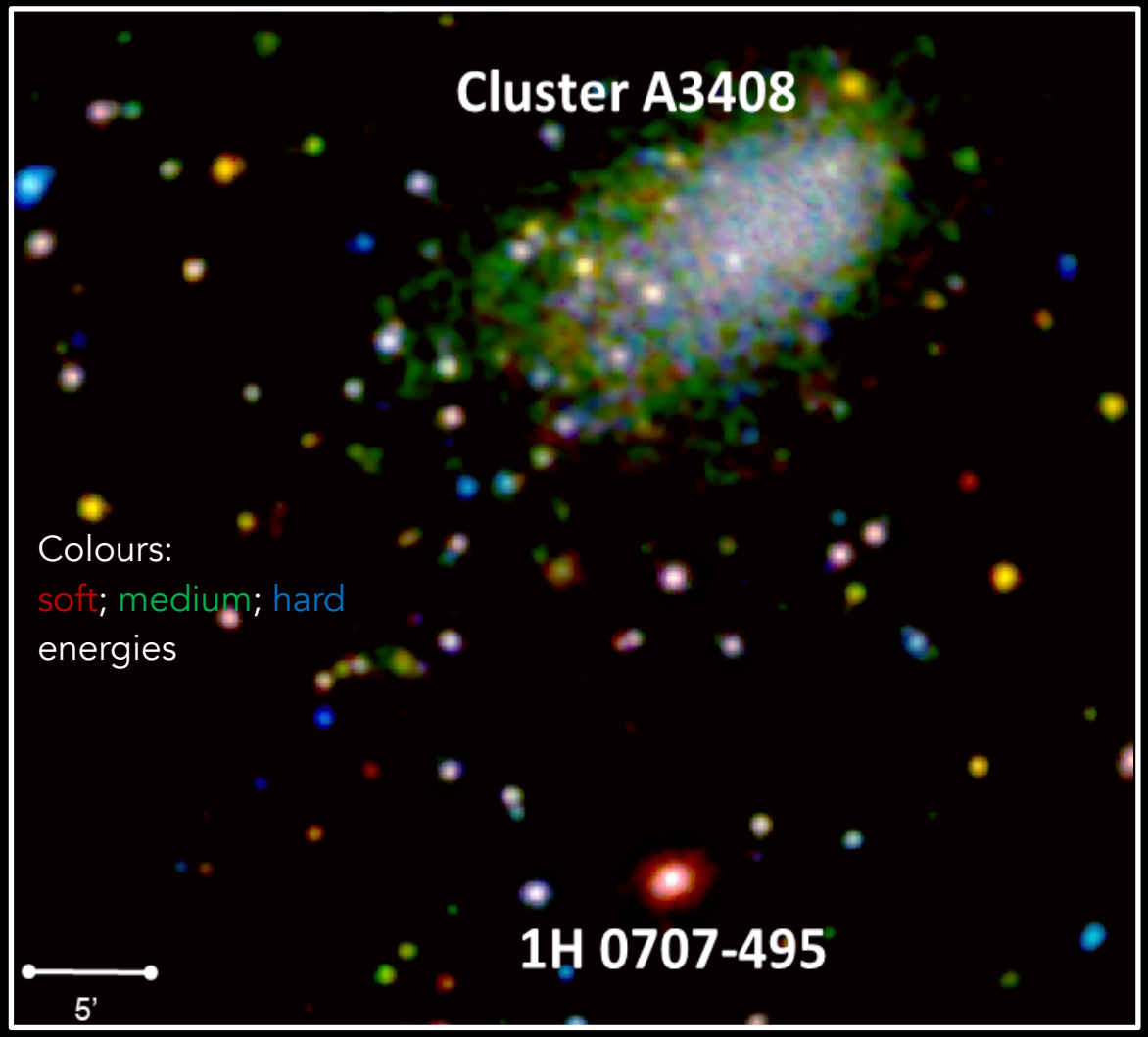
HMXB pulsar
period of ~164 s

MPE/IKI

SRG/eROSITA

SRG/eROSITA PV observations of 1H 0707-495

Th. Boller, E. Bulbul, M. Freyberg, T. Liu

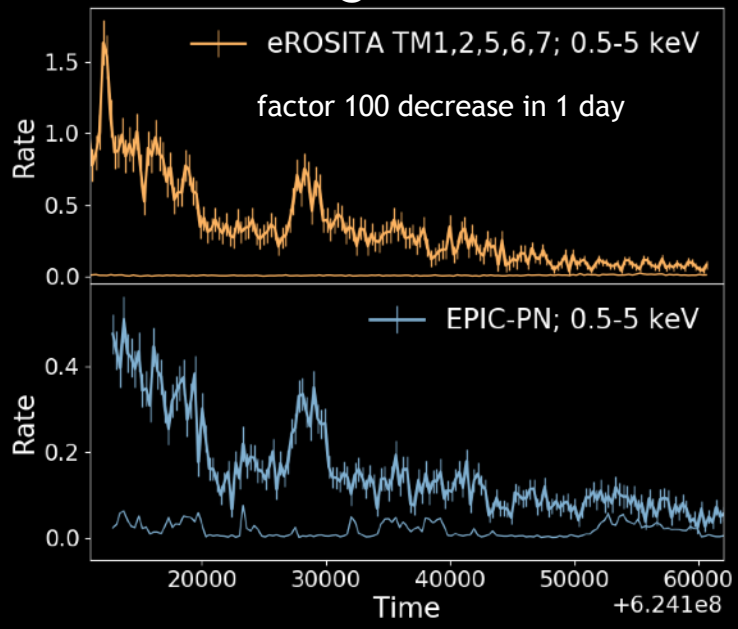


1H 0707-495

Highly variable Narrow-Line Seyfert 1 Galaxy with a complex, steep X-ray spectrum

Simultaneous XMM-Newton observations

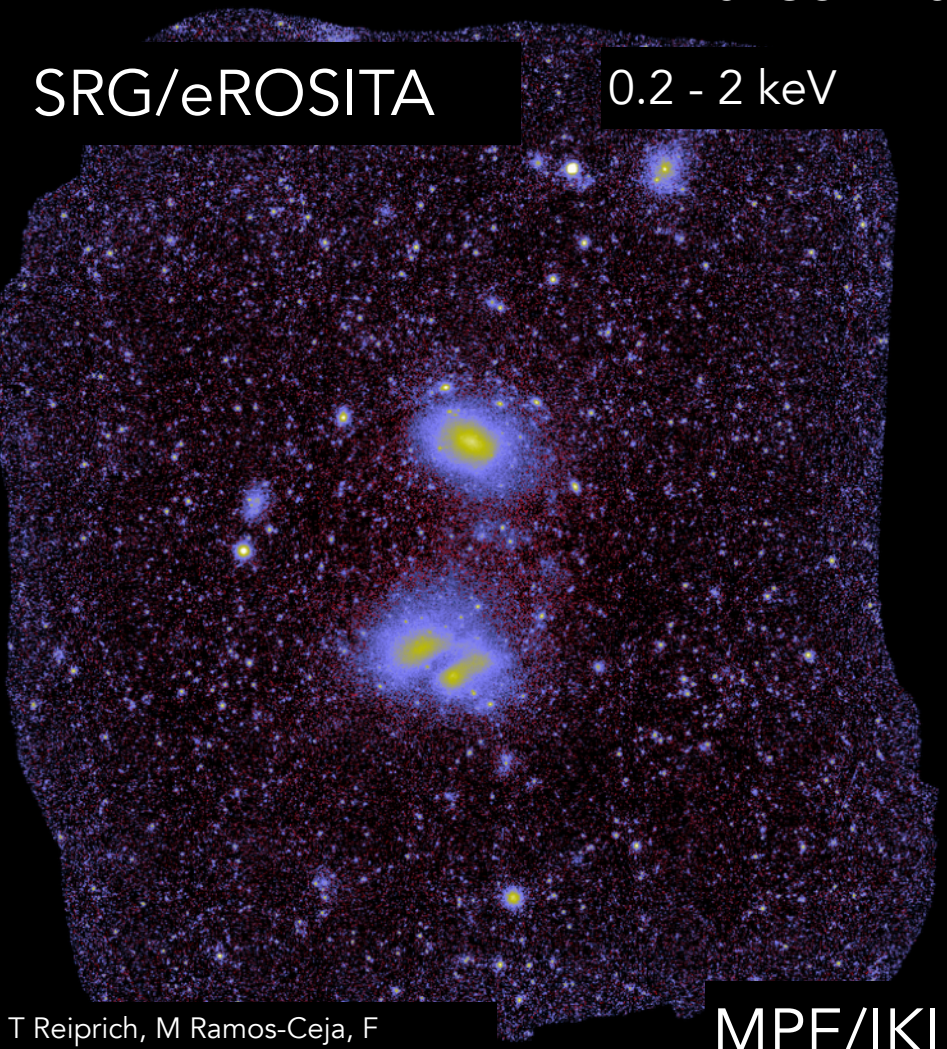
1H 0707-495 light curves

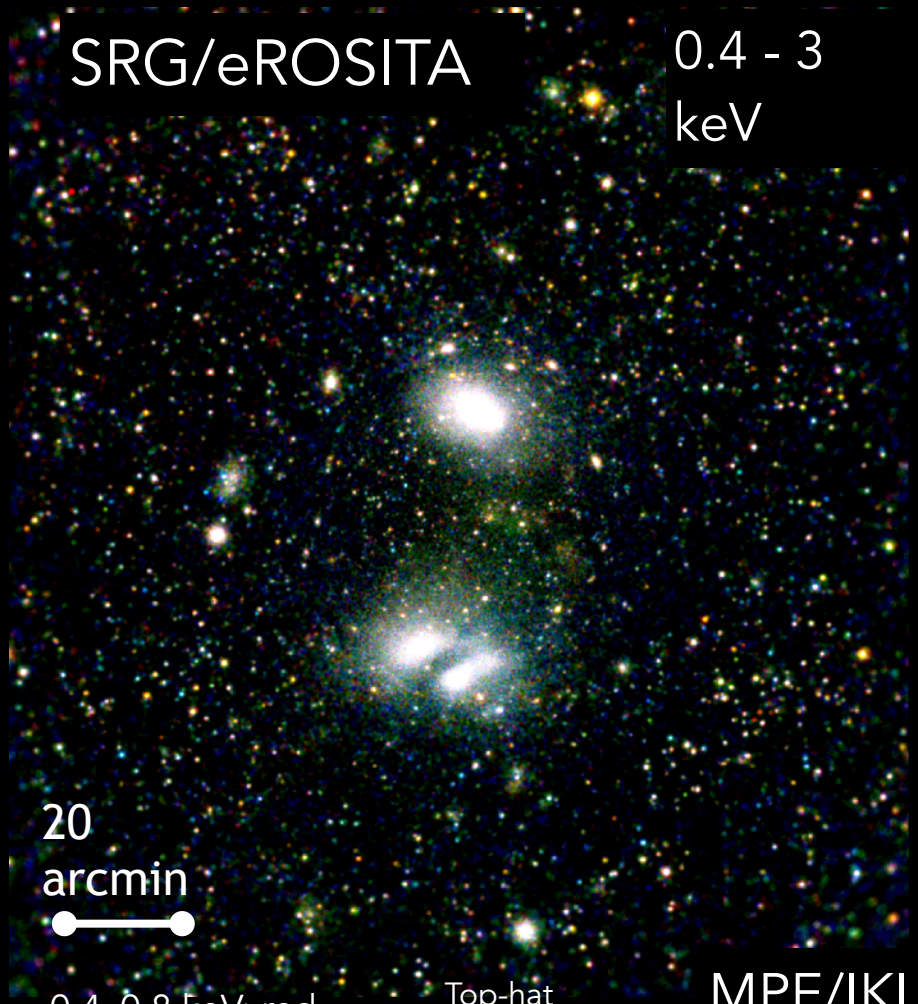


Higher count rate (larger effective area) & Very stable background (no fluctuations)

A3391/3395

eROSITA observations





T Reiprich, M Ramos-Ceja, F Pacaud, N Ota, J Sanders, D Eckert, E Bulbul, V Ghirardini

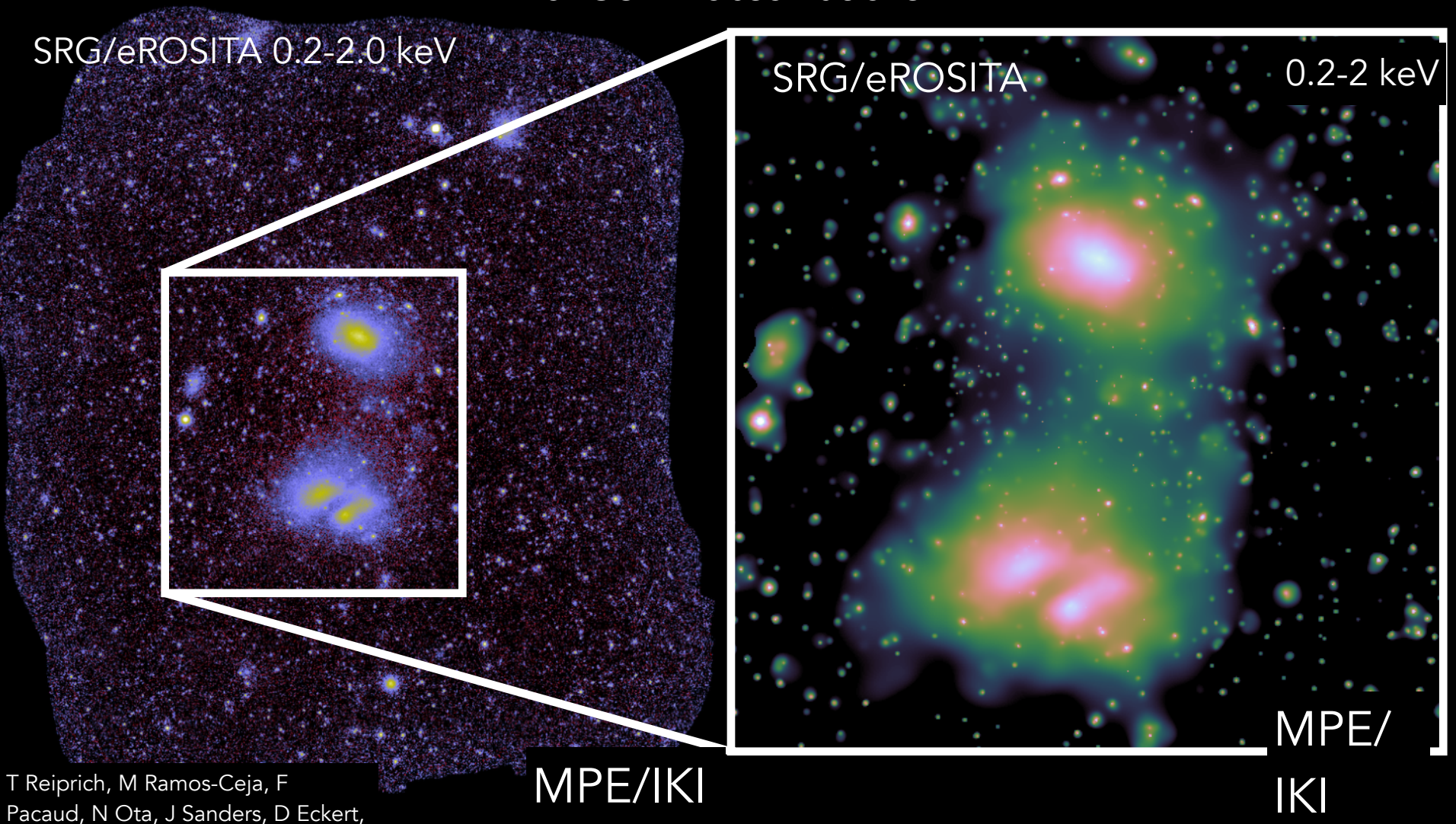
0.4–0.8 keV: red
0.8–1.5 keV: green
1.5–3.0 keV: blue

Top-hat adaptive smoothing (raise floor)

Power of FoV + effective area

A3391/3395

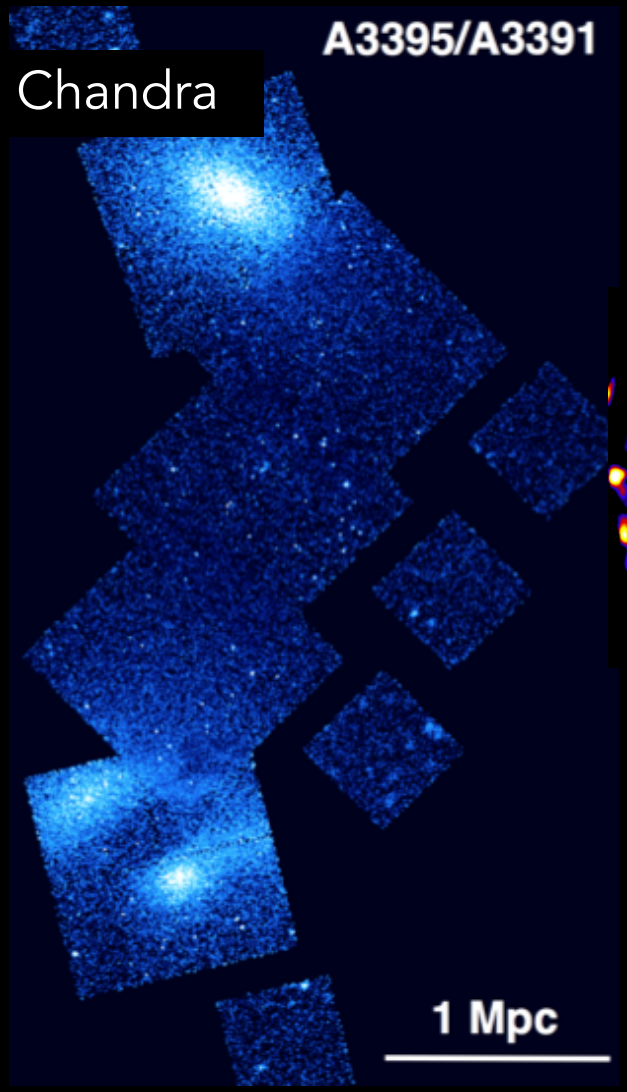
eROSITA observations

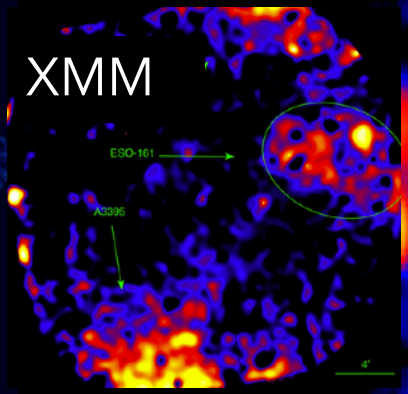


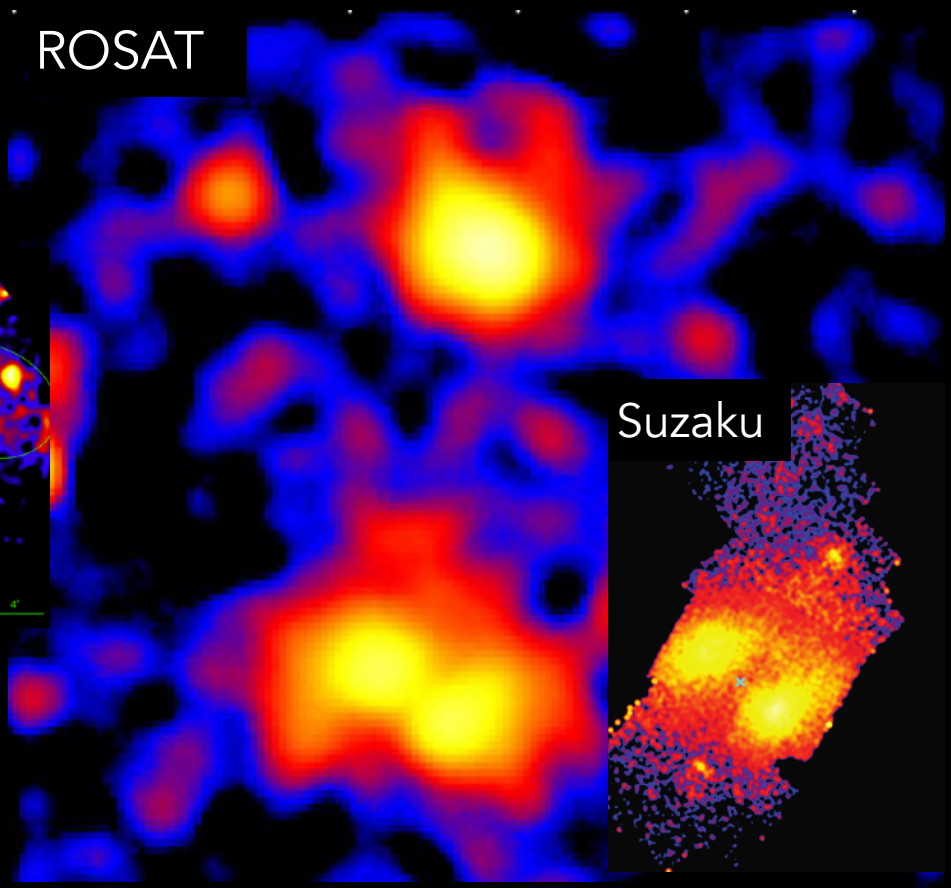
T Reiprich, M Ramos-Ceja, F Pacaud, N Ota, J Sanders, D Eckert, E Bulbul, V Ghirardini

A3391/3395

past observations







Credits:

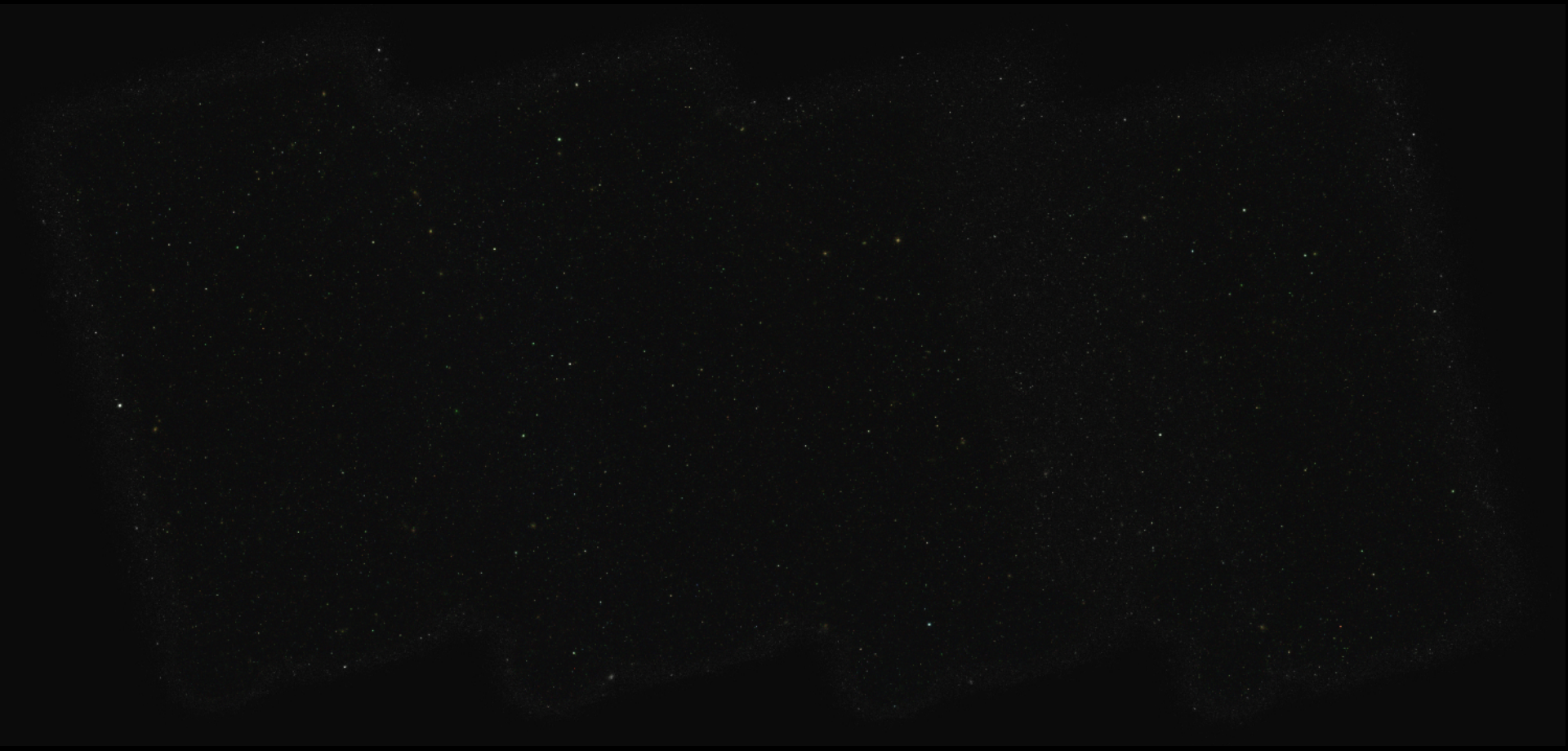
Alvarez et al. 2018, ApJ, 858, 44

Sugawara et al. 2017, PASJ, 69, 93

Power of FoV + effective area

eFEDS: eROSITA Final Equatorial Depth Survey

- eROSITA_DE PV program ~***120 deg²*** at nominal 2.5ks exposure over equatorial field covered by Subaru HSC + **SDSS-IV dedicated targeting**
- ***Full eRASS:8 depth***, prediction ~100 AGN and ~3-4 clusters /deg²



SRG/eROSITA Credit: V. Ghirardini, M. Salvato, G. Lamer, T. Liu et al. MPE/IKI

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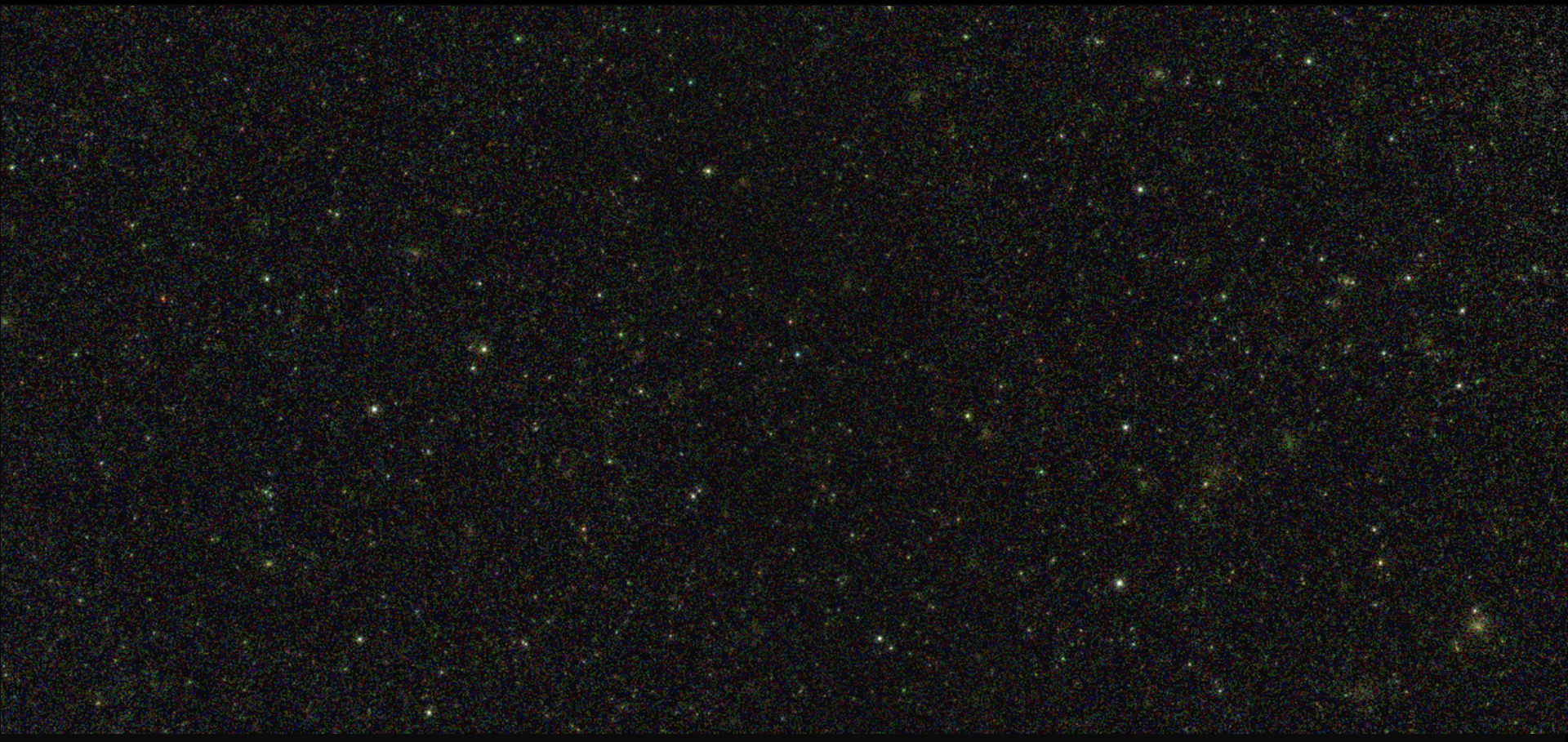

SRG/eROSITA Credit: V. Ghirardini, M. Salvato, G. Lamer, T. Liu et al. MPE/IKI

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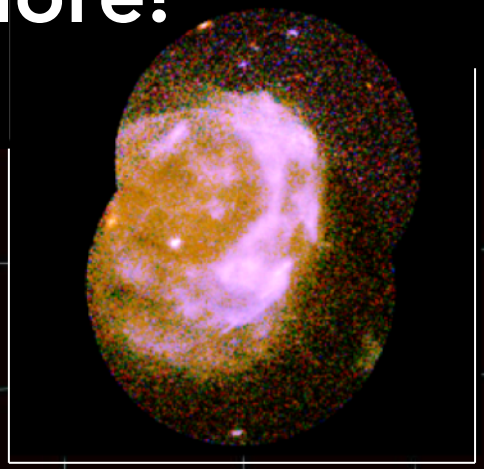
http://arxiv.org/abs/1912.03068
Ahumada et al. 2019, **SDSS DR16 paper**

5.3.8. *Future plans for SPIDERS*

In addition to the these programs, completed and fully released in DR16, the performance verification data being taken as part of the eROSITA Final Equatorial Field Depth Survey (eFEDS) is currently planned to be available by November 2019 and should consist of 120 deg^2 observed to the final eROSITA all-sky survey depth over an equatorial field overlapping with the GAMA09 (Robotham et al. 2011) survey window. To address at least part of the original goals of SPIDERS (i.e. eROSITA follow-up) within SDSS-IV, we plan to dedicate a special set of twelve special plates for these targets, to be observed in Spring 2020, and released as part of the final seventeenth data release. An extensive eROSITA follow-up program, is also planned for the next generation of the survey, SDSS-V (Kollmeier et al. 2017, and see Section 7) and 4MOST (Finoguenov et al. 2019; Merloni et al. 2019).

SRG/eROSITA Credit: V. Ghirardini, M. Salvato, G. Lamer, T. Liu et al. MPE/IKI

A whole sky to explore!



All-sky survey began

December 8th 2019 for 4 years

http://193.232.10.38/monthplan/tracking

ИКИ/МПЕ

Image credit: R. Sunyaev, IKI

eROSITA Status: Summary

- **Launched 13th July 2019 from Baikonur aboard SRG**
  - Now in large halo orbit around L2 point
  - All-sky survey began December **8th 2019** for 4 years

- **Performance & predictions confirmed:**
  - Superb image quality, excellent spectral resolution
  - Survey predictions (e.g. >100k clusters, >3M AGN) look good
  - CalPV phase results will be presented in an international conference in **Garching, 16-20 March 2020** (*deadline: December 22th*)

- **Data release policy** (German data only)
  - PV/Cal data – after 1 year / **November 2020!**
  - Survey: eRASS1, eRASS4 (TBC), eRASS8 - 2 years after completion
  - Pointed phase follows survey, open AO w/GTO – 1 year
  - come to me for more info (including collaborations)