Galactic Frontiers 2026: Advancing X-Ray Astronomy in a Multiwavelength Universe

858. WE-Heraeus-Seminar

14 - 18 June 2026

at the Physikzentrum Bad Honnef, Germany

WILHELM UND ELSE
HERAEUS-STIFTUNG

Introduction

The Wilhelm und Else Heraeus-Stiftung is a private foundation that supports research and education in science with an emphasis on physics. It is recognized as Germany's most important private institution funding physics. Some of the activities of the foundation are carried out in close cooperation with the German Physical Society (Deutsche Physikalische Gesellschaft). For detailed information see https://www.we-heraeus-stiftung.de

Aims and scope of the 858. WE-Heraeus-Seminar:

The WE-Heraeus seminar "Galactic Frontiers 2026" aims to bring together leading scientists and early-career researchers in the field of Galactic X-ray astronomy to explore recent advances enabled by today's X-ray observatories, e.g., eROSITA, XMM-Newton, Chandra, and XRISM. These instruments provide an unprecedented dataset for studying both diffuse and point-like X-ray sources across the entire sky, with a focus on the Milky Way and its satellite galaxies.

The seminar will address a range of key topics: the nature and origin of diffuse X-ray emission in the interstellar medium (ISM), supernova remnants (SNRs) as sources of energetic particles and feedback into the ISM, and the population and evolution of compact stellar remnants like white dwarfs, neutron stars, and black holes. A central theme will be the synergy of X-ray data with observations across the electromagnetic spectrum, including optical, radio, infrared, and gamma-ray bands. Particular attention will also be given to the growing contributions of international amateur astronomy networks in the optical detection of degree-wide extended SNRs and nebulae.

The seminar will take place from June 15 to 18, 2026, at the Physikzentrum in Bad Honnef. The program includes invited overview talks, contributed presentations, and poster sessions. A concluding excursion to the Effelsberg 100m radio telescope is also planned. The event aims to bring together researchers at all career stages, support early-career scientists through additional funding from the DFG-funded eRO-STEP project, and lay the groundwork for collaborative, multiwavelength research on Galactic high-energy phenomena.

Introduction

Scientific Organizers:

Prof. Dr. Werner Becker	Max-Planck-Institut für extraterr. Physik Garching, Germany
Prof. Dr. Manami Sasaki	Dr. Karl Remeis-Sternwarte, Friedrich-Alexander-Universität Erlangen-Nürnberg Bamberg, Germany

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Introduction

Venue:

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Registration:

Nadine Mock (WE Heraeus Foundation)
at the Physikzentrum, reception office
Sunday (17:00 h – 21:00 h) and Monday morning

Program

Program

Sunday, 14 June 2026

17:00 - 21:00	Registration
18:30 - 20:00	*BUFFET SUPPER and informal get-together*

Program

Monday, 15 June 2026

07:30 - 08:30	*BREAKFAST*	
08:30 - 08:45	Werner Becker/ Manami Sasaki	**Welcome & Introduction**
08:45 - 09:00	Stefan Jorda	**About the Wilhelm and Else Heraeus Foundation**

Morning Session: Stars & Stellar Evolution

09:00 - 09:45	Christian Schneider	**X-rays from low-mass stars**
09:45 - 10:30	Yaël Nazé	**X-ray studies of massive stars**
10:30 - 11:00	*COFFEE BREAK*	
11:00 - 11:20	Sebastian Freund	**Coronal and chromospheric activity observed by eROSITA and Gaia**
11:20 - 11:40	Bhawna Mukhija	**Multiple Giant Eruptions in Massive Stars Before Core Collapse**
11:40 - 12:00	Gloria Sala	**The X-ray future of nova explosions**
12:00 - 12:30	**Poster Flash Talks**	
12:30 - 12:40	CONFERENCE PHOTO (in front of the main entrance)	
12:40 - 14:00	*LUNCH*	

Program

Monday, 15 June 2026

Afternoon Session: Compact Objects

14:00 - 14:45	Anna Watts	**What we know - and don't know - about neutron stars**
14:45 - 15:30	Marta Burgay	**Searching for pulsars with MeerKAT**
15:30 - 16:00	*COFFEE BREAK*	
16:00 - 16:20	Bettina Posselt	**Faint but important - the role of UVOIR observations in understanding neutron star physics**
16:20 - 16:40	Hsiang-Kuang Chang	**Observational correlations among spectral properties of X-ray and gamma-ray emissions from pulsars**
16:40 - 17:00	Sayantan Bhattacharya	**Multiwavelength Characteristics of The Wolf-Rayet + Black Hole High Mass X-ray Binary : IC 10 X-1**
17:00 - 17:20	Chuanyu Wei	**How do the thermonuclear X-ray bursts affect the accretion flow?**
17:20 - 18:00	**Poster Flash Talks**	
18:00 - 20:00	*DINNER*	

Program

Tuesday, 16 June 2026

07:30 - 09:00	*BREAKFAST*	

Morning Session: Supernova Remnants

09:00 - 09:45	Robert Fesen	**Discovery of Galactic Supernova Remnants via Deep Optical Imaging**
09:45 - 10:30	Anne Decourchelle	**Studies of supernova remnants in the X-ray**
10:30 - 11:00	*COFFEE BREAK*	
11:00 - 11:20	Silvia Mantovanini	**SNR Searches with SKA Precursor Radio Surveys**
11:20 - 11:40	Federico Zangrandi	**Supernova Remnants in the Large Magellanic Cloud**
11:40 - 12:00	Manan Agarwal	**Latest XRISM Insights into the Explosion Asymmetry and Ejecta Composition of Cassiopeia A**
12:00 - 12:30	**Poster Flash Talks**	
12:30 - 14:00	*LUNCH*	

Program

Tuesday, 16 June 2026

14:00 - 14:20	Dominique Meyer	**Plerionic supernova remnants**
14:20 - 14:40	Marie Prucker	**Hydrodynamic Simulations of the Supernova Remnant Puppis A with PLUTO**

Afternoon Session: Observations of Extended Galactic Structures by International Amateur Astronomy Networks

14:40 -15:30	Steeve Body / Carl Björk/ Tim Schaeffer	**From Pixels to Publications: A Collaborative Approach to High-Resolution Deep Space Imaging and Discovery**
15:30 - 16:00	*COFFEE BREAK*	
16:00 - 16:50	Rainer Raupach	**Bridging Amateur and Professional Astronomy: Scientific Contributions from Advanced Astrophotography**
16:50 - 17:20	**Poster Flash Talks**	
17:20 - 18:00	**Poster Session**	
18:00 - 20:00	*DINNER*	

Program

Wednesday, 17 June 2026

07:30 - 09:00	*BREAKFAST*	

Morning Session: Interstellar Medium and Galactic Diffuse Emission

09:00 - 09:45	Mike Yeung	**Recent advances on understanding the soft X-ray background using SRG/eROSITA**
09:45 - 10:30	Martin Mayer	**X-raying the multi-phase ISM in the LMC**
10:30 - 11:00	*COFFEE BREAK*	
11:00 - 11:20	Jürgen Kerp	**Fueling the Milky Way's star formation**
11:20 - 11:40	Mohammadreza Ayromlou	**The Baryon Budget of the Universe**
11:40 - 12:00	Sanskriti Das	**The hot circumgalactic medium, the hidden treasure trove of galaxies**
12:00 - 14:00	*LUNCH*	

Program

Wednesday, 17 June 2026

Afternoon Session: Population Studies of Galactic Sources

14:00 - 14:45	Elias Kyritsis	**Towards a truly unbiased X-ray survey of star-forming galaxies in the nearby Universe with eROSITA**
14:45 - 15:30	Antara Basu-Zych	**Exploring Galactic Frontiers Far Beyond the X-ray Observable Universe: A Multiwavelength View of Energetic Processes in High-Redshift Analogs**
15:30 - 16:00	*COFFEE BREAK*	
16:00 - 16:20	Chandreyee Maitra	**The population of X-ray emitting compact stars in the Magellanic system detected during the eROSITA all-sky survey**
16:20 - 16:40	Jan Kurpas	**Growing the population of thermally emitting isolated neutron stars with SRG/eROSITA**
16:40 - 17:00	Sandro Mereghetti	**Magnetars beyond the Local Group**
17:00 - 17:30	**Poster Flash Talks**	
17:30 - 18:30	**Poster Session**	
18:30 - 20:30	*HERAEUS-DINNER*	

Program

Thursday, 18 June 2026

07:30 - 09:00	*BREAKFAST*	
09:00 - 16:00	**Excursion to the 100m Radio Telescope in Effelsberg**	**Preregistered participants**

End of the seminar and departure

Posters

Posters – Stars & Stellar Evolution

Thijs Dorhout	**Identifying Ultra Cool Dwarfs in eROSITA eRASS1 by Stellar Flares (#A1)**
Pratyush Singh	**eROSITA X-ray Census of the Young Nearby Stellar Moving Group Tucana Horologium (#A2)**

Posters – Relevant Physics

Miccola Bondarenco	**Self-consistent field screening corrections for inner atomic shell energies and wave functions (#B1)**
Thorsten Döhring	**Development of astronomical X-ray telescope optics at Aschaffenburg University (#B2)**

Posters - Compact Objects

Katrin Berger	**Flux variability of the "10 keV feature" of 4U 0115+63 (#C1)**
Tuğba Boztepe	**XMM-Newton and NuSTAR observations of thermonuclear bursts from 4U 1323–62 (#C2)**
Jaco Brink	**Volume-limited sample of cataclysmic variables (#C3)**
Giulia Brunelli	**Deep X-ray investigation on the nature of the ultra-high-energy source 1LHAASO J1740+0948u (#C4)**
Bhawesh Chandwani	**Preliminary Study of Photoabsorption edges in the spectrum of HETE J1900.1-2455 (#C5)**
Çağatay Kerem Dönmez	**Timing Analysis of the 2020 Type II Outburst of GRO J1008−57 (#C6)**
Lorenzo Ducci	**A0538-66: a standout accreting pulsar with fast multiwavelength variability (#C7)**
Katharina Egg	**Joint eROSITA, Fermi, and H.E.S.S. analysis of the Pulsar Wind Nebula MSH 15-52 with Gammapy (#C8)**
Seth Gagnon	**Exploring Pulsar Wind Nebulae Across the Electromagnetic Spectrum (#C9)**
Kala G. Pradeep	**Solving the Soft X-ray Puzzle Using XMM-Newton Observation of the Highest-Field Polar AR Uma (#C10)**
Santiago Hernández Díaz	**Unveiling the period-bounce population of Cataclysmic Variables: Spectroscopic and time-domain follow-up of eROSITA-selected candidates (#C11)**
Sanja Lazarevic	**A Newborn Spider System at the Core of a Radio Shell: Evidence for a Low-Energy Supernova? (#C12)**

Galina Lipunova	**Transition to the quiescent state in the accreting magnetised neutron star: no propeller required? (#C13)**
Adriana Mancini Pires (Presented by Jan Kurpas)	**Isolated neutron star candidates from the fourth generation XMM-Newton catalogues (#C14)**
Tathagata Saha	**eRASSU J043115.8-711730: Discovery of the first symbiotic super soft X-ray source in the Magellanic Bridge (#C15)**
Hina Shaikh	**Evidence of Persistent Obscuration in Stellar Mass Black Hole GRS 1915+105 (#C16)**
Surodeep Sheth	**Isolated Neutron Stars and other soft-sources in eROSITA super-soft X-ray catalog (#C17)**
Ramanshu Prabhakar Singh	**Multi-Mission Broadband Spectral–Timing and High-Resolution X-ray Spectroscopy of GX 339-4 During the 2023 Outburst (#C18)**
Jakob Van Den Eijnden	**Accretion from massive stars: unravelling the spectrum from radio to X-rays (#C19)**
Jing Xue	**Assessing the Effects of Comptonization on Black Hole Spin Estimates for LMC X-1 (#C20)**

Posters - Supernova Remnants

Panos Boumis	**Investigating LMC Supernova Remnants using MUSE/IFS (#D1)**
Alena Khokhriakova	**Multiwavelength search for supernova remnants in the Circinus constellation (#D2)**
Chuan Jui Li	**Probing Type Ia Supernova Progenitors with Supernova Remnants in the Milky Way and Nearby Galaxies (#D3)**
Ekaterina Makarenko	**Why Supernova Remnants look the way they do: multiwavelength insights from 3D simulations (#D4)**
Katarzyna Nowak	**Simulations of Elongated Supernova Remnants (#D5)**
Aditya Pandya	**From stellar birth to stellar death: tracing high energy processes in Sh2-284/G213.0-0.6 complex (#D6)**
Günay Payli	**Investigation of supernova remnant IC 443 and G189.6+3.3 with LAMOST (#D7)**
Gerd Pühlhofer	**The Supernova remnant candidate HESS J1614-518 seen with eROSITA (#D8)**
Ping Zhou	**The soft X-ray all-sky map and supernova remnants observed with the lobster-eye focusing wide-field telescope onboard the Einstein Probe (#D9)**

Ken Hall

From Survey Hint to Science-Ready Products: A Networked Amateur Pipeline for Faint SNR Filaments (Hoinga G249.5+24.5 as a Demonstrator) (#E1)

Posters – Interstellar Medium and Galactic Diffuse Emission

Mar Canal i Saguer	**Systematic Study of HII regions in the Magellanic Clouds (#F1)**
Roman Laktionov	**Unveiling the Hot Interstellar Medium in Nearby Galaxies with eROSITA (#F2)**

Posters – Population Studies of Galactic Sources

Aafia Zainab Ansar	**Low luminosity behaviour of BeXRBs: contribution to the HMXB luminosity function (#G1)**
David Markus Kaltenbrunner	**How the LMC star-formation history formed the current population of HMXBs (#G2)**
Maria Kopsacheili	**New X-ray Supernova Remnants in NGC 7793 (#G3)**
Dhrubojyoti Sengupta	**Seeing Through the ISM: Recovering Intrinsic X-ray Emission in Metal-Poor Dwarf Galaxies (#G4)**
Emily Walls	**Long Term Star Formation in M82 with e-MERLIN and the EVN (#G5)**
Andreas Zezas	**A framework for the characterization of Galactic and extragalactic X-ray binaries (#G6)**

Abstracts of Talks

(in alphabetical order)

Latest XRISM Insights into the Explosion Asymmetry and Ejecta Composition of Cassiopeia A

M. Agarwal[1,2], **J. Vink**[1,2], **P. Plucinsky**[3], **L. Gu**[2], **A. Bamba**[4], **T. Sato**[5]

[1] *Anton Pannekoek Institute/GRAPPA, University of Amsterdam, Amsterdam, The Netherlands*
[2] *SRON Netherlands Institute for Space Research, Leiden, The Netherlands*
[3] *Harvard-Smithsonian Center for Astrophysics, Cambridge, USA*
[4] *University of Tokyo, Tokyo, Japan*
[5] *Meiji University, Kanagawa, Japan*

Cassiopeia A (Cas A), the youngest known core-collapse supernova remnant (SNR) in the Milky Way, offers an unparalleled view of the explosions of massive stars. A >350 ks observation with XRISM/Resolve has delivered an unprecedented high-spectral-resolution X-ray view of this archetypal remnant and produced the mission's most productive dataset to date, with 5+ published papers.

In this talk, I will present these latest XRISM results. Key breakthroughs include the first X-ray detections of the odd-Z elements P, Cl, and K in any SNR[1]. We uncover an incomplete ejecta shell in which Si- and S-rich components exhibit distinct ionization states and velocity structures. Near the projected center, we detect narrow, low-velocity emission lines likely associated with circumstellar material. Using the new Bayesian spectral tool UltraSPEX[2], we present the first comprehensive microcalorimeter-based plasma mapping of an SNR. We identify clear kinematic differences between intermediate-mass (IMEs) and iron-group elements (IGEs), and a strong anti-correlation between ionization timescale and electron temperature, consistent with significant ejecta clumping (overdensities of ~10 for IGEs and up to ~100 for IMEs) and reduced historical reverse-shock velocities. Finally, we disentangle thermal and non-thermal components, showing that synchrotron emission contributes at least 47% of the 4–6 keV flux at XRISM resolution.

References

[1] XRISM Collaboration, NatAs, 10, 144 (2025)
[2] M. Agarwal, ApJ, 1000, 47 (2026)

The Baryon Budget of the Universe

M. Ayromlou[1]

[1]Argelander-Institut für Astronomie, Auf dem Hügel 71, D-53121 Bonn, Germany

In this talk, I will present a new study of the baryon budget of the Universe, focusing on the redistribution of baryons within and beyond the halo boundary. Using a suite of cosmological hydrodynamical simulations, as well as several X-ray observations of halo gas, I will describe how baryons are distributed in and around halos. Moreover, I will discuss how a novel, physically motivated AGN feedback model that we have developed affects large scale baryon redistribution both within the halo boundary and, in particular, beyond it out to the closure radius. The new simulation ties AGN feedback to intrinsic properties of the supermassive black hole, in addition to those of its immediate environment. Focusing on halos ranging from Milky Way mass scales to galaxy clusters, I will demonstrate how different feedback models influence outflows and how these results compare with X ray observations of halo gas from eROSITA, XMM Newton, and XRISM.

Exploring Galactic Frontiers Far Beyond the X-ray Observable Universe: A Multiwavelength View of Energetic Processes in High-Redshift Analogs

A. Basu-Zych[1,2]

[1] *University of Maryland, Baltimore County, Baltimore, MD, USA*
[2] *NASA Goddard Space Flight Center, Greenbelt, MD, USA*

In the spirit of this meeting's theme, *Galactic Frontiers*, this talk focuses on a frontier beyond the reach of current and upcoming (e.g. *NewAthena*) X-ray telescopes: the early Universe. While JWST is uncovering growing evidence that energetic processes power the emission in galaxies at redshifts $z > 6–10$[1], these galaxies remain inaccessible in X-rays. Additionally, recent results from the Hydrogen Epoch of Reionization Array (HERA) suggest that X-ray emission from high-mass X-ray binaries (HMXBs) in early galaxies left a strong imprint on the observed (redshifted) 21-cm signal[2], highlighting the role of X-ray sources in heating the early Universe. These results motivate the need to study X-ray emission in galaxies that resemble those from these early epochs. Fortunately, nearby analogs, such as metal-poor starbursts and Lyman break analogs, provide that opportunity. Over the past decade, studies of these galaxies have revealed that X-ray emission scales inversely with metallicity[3, 4], which has been key in interpreting the HERA results and is consistent with theoretical predictions from X-ray binary population models. In this talk, I will highlight how multiwavelength observations can be used to first identify these rare analogs, then measure their global properties (including metallicity, star formation rate, stellar mass, and star formation history), and finally to connect those properties to their total X-ray power. By utilizing the combined emission from X-ray sources and the stellar population, we construct photoionization models[5] that produce emission line ratios comparable to those observed in high-redshift galaxies. Therefore, by leveraging all the available data in the nearby Universe we are exploring the frontier beyond the present X-ray horizon.

References

[1] Tang et al., ApJ, 1001, 38 (2026)
[2] HERA Collaboration et al., ApJ, 945, 124 (2023)
[3] Basu-Zych et al., ApJ, 774, 152 (2013)
[4] Brorby et al., MNRAS, 457, 408 (2016)
[5] Garofali et al. ApJ, 960, 13 (2024)

Multiwavelength Characteristics of the Wolf–Rayet + Black Hole Binary IC 10 X-1

S. Bhattacharya[1], S. G. T. Laycock[2] and D. M. Christosoulou[2]

1 Tata Institute of Fundamental Research, Mumbai, India, 400005

2 Lowell Center for Space Science and Technology,

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IC 10 X-1 is a rare high-mass X-ray binary composed of a black hole and a Wolf–Rayet (BH+WR) star with a 34.9 hr orbital period. The mass of the compact object remains uncertain because the X-ray irradiation from the accretion disk alters the ionization structure of the WR wind, shifting the spectral line formation region and producing a radial-velocity curve that may not represent the true orbital motion. We investigate the spectral and timing properties of IC 10 X-1 using a new 30 ks Chandra observation together with snapshot monitoring from Swift/XRT, complemented by archival data. These observations allow phase-resolved X-ray spectroscopy to probe the interaction between the compact object and the dense WR wind. We also examine multiple-epoch eclipse light curves to constrain the orbital period derivative and long-term evolution of the system. Our study is further strengthened by multiwavelength results, including optical and spectroscopic analyses by Bhattacharya et al. (2023), which highlight the role of X-ray photoionization in shaping the WR wind and observed emission lines. With only a handful of BH+WR systems currently known, IC 10 X-1 provides an important laboratory for understanding the evolution of massive binaries that may later merge into compact objects and become gravitational-wave sources.

References

[1] Bhattacharya, Sayantan, et al. "Probing the Stellar Wind of the Wolf–Rayet Star in IC 10 X-1." The Astrophysical Journal 944.1 (2023): 52.

[2] Bhattacharya, Sayantan, et al. "Accreting black holes skewing and bending the optical emission from massive Wolf–Rayet companions–a case study of IC10 X-1." Monthly Notices of the Royal Astronomical Society 524.3 (2023): 4752-4764.

From Pixels to Publications: A Collaborative Approach to High-Resolution Deep Space Imaging and Discovery

Tim Schaeffer[1], Carl Björk[1], and Steeve Body[1]

[1] Deep Sky Collective

While individual amateur setups lack the aperture of professional observatories, high-quantum-efficiency CMOS sensors and global connectivity have birthed a new era of "distributed astronomy". As a multinational team, we bypass traditional constraints like localized weather and limited institutional time. By aggregating hundreds of hours of integration time, often exceeding professional surveys, we are able to resolve extremely low-surface-brightness features. This presentation explores how our collaborative framework transforms amateur data into scientifically valid contributions, effectively bridging the gap between aesthetic imaging and astrophysical research.

Our talk breaks down the collaborative pipeline into four key stages:

- **Organisation and Target Selection:** Led by Tim Schaeffer, we discuss the logistics of managing a multi-contributor project. We cover target selection, from planetary nebulae to distant galaxies, and our methodology for coordinating observation schedules across different geographical locations to ensure a steady stream of high-quality data.
- **Data Reduction:** Carl Björk focuses on the technical challenges of preprocessing data from diverse sources. We dive into the mathematical foundations of stacking and optimal weighting to maximize signal-to-noise ratios, ensuring pixel-level accuracy across various sensors, focal lengths, and sky conditions.
- **Post-Processing Ethics and AI:** Steeve Body addresses post-processing in the "AI era", examining the impact of tools like BlurXTerminator and StarXTerminator on data validity. We focus on a "non-inventive" processing philosophy, balancing aesthetic appeal with the strict requirement to stay true to original data and avoid artifacts.
- **Scientific Contributions:** We showcase the real-world results of this workflow, including the discovery of ghost planetary nebulae (e.g., SDS01), and our ongoing collaborative work with professional institutions in supernova monitoring and galaxy imaging.

By combining disciplined preprocessing with careful post-production, we demonstrate that organized amateur teams can provide high-fidelity data for real astrophysical research. Ultimately, the gap between "amateur" and "professional" is no longer defined by hardware, but by the rigor of the process.

Searching for pulsars with MeerKAT

M. Burgay, on behalf of the TRAPUM team
INAF - Osservatorio Astronomico di Cagliari, via della Scienza 5, 09047, Selargius (CA), Italy

Pulsars, thanks to their extreme characteristics and their clock-like nature, are unique laboratories to probe many aspects of astrophysics and fundamental physics: from stellar and binary evolution to the study of the interstellar medium and of the Galactic magnetic field, from nuclear physics to relativistic gravity and gravitational waves.

The extraordinary sensitivity of the MeerkAT telescope has, in only a few years, led to much progress and many discoveries in this field. In this talk I will describe the pulsar search experiments carried out in the last five years in the framework of the TRAPUM (TRAnsients and Pulsars with Meerkat) Large Survey Projects. I will report on some of the most interesting results, both from pulsar searches and follow-up studies, with a particular focus on searches targeting Globular Clusters and Fermi unidentified sources, real treasure maps to find exotic binary pulsars, often exhibiting a rich phenomenology across the electromagnetic spectrum.

Observational correlations among spectral properties of X-ray and gamma-ray emissions from pulsars

Hsiang-Kuang Chang

Institute of Astronomy, National Tsing Hua University, Hsinchu, Taiwan

68 pulsars with non-thermal X-ray emissions are collected in this study. Among them, 32 are found to have a thermal component in their X-ray emissions, and 44 are with gamma-ray emissions detected by Fermi. Among the 44, 22 are with thermal X-ray emissions. Consistent with several earlier reports, the non-thermal X-ray (0.5-8 keV) and gamma-ray (0.1-100 GeV) luminosities are strongly correlated with pulsars' spin-down energy loss rate and magnetic field strength at the light cylinder. It is found that the gamma-ray luminosity is proportional to the square-root of the non-thermal X-ray luminosity. The power index of the power law describing the non-thermal X-ray component is anti-correlated with the non-thermal X-ray luminosity, that is, a harder spectrum for a higher luminosity. For those with thermal X-ray emissions, the three spectral properties, i.e., non-thermal X-ray luminosity, its power-law photon index, and the gamma-ray luminosity, are all found to be strongly correlated with pulsars' surface temperature. Each of these three properties may also be well described by a function of surface temperature and thermally-emitting area radius. The above correlations indicate that the surface thermal emission, non-thermal X-ray emission and gamma-ray emission are all connected in some way. The anti-correlation between luminosity and photon index provides a certain clue on models of the particle acceleration and emission mechanisms. In addition, the fact that a considerable number of pulsars are without detectable thermal emission may suggest a different, faster cooling curve for those pulsars. They may be of a different kind of neutron stars whose cooling mechanism is more exotic or they are more like quark stars.

References

[1] H.-K. Chang, J.-Y. Hsiang, C.-Y. Chu, Y.-H. Chung, T.-H. Su, T.-H. Lin and C.-Y. Huang, MNRAS **520**, 4068 (2023)

[2] A. Aravindaraj and H.-K. Chang, MNRAS **546**, id.stag142 (2026)

The hot circumgalactic medium, the hidden treasure trove of galaxies

Sanskriti Das[1], Smita Mathur[2], Anjali Gupta[3], Armando Lara-Dias-Infante[4], Joy Bhattacharyya[2], Rebecca McClain[2], Manami Roy[2], Mukesh Singh Bisht[5], Fabrizio Nicastro[6], Yair Krongold[4]
[1]Stanford University, Stanford, USA
[2]The Ohio State University, Columbus, USA
[3]Columbus State Community College, Columbus, USA
[4]Universidad Nacional Autónoma de México, Mexico City, Mexico
[5]Raman Research Institute, Bengaluru, India
[6]Observatorio Astronomico di Roma - INAF, Rome, Italy

The hot circumgalactic medium (CGM), a reservoir of missing baryons, metals, and energy, plays a key role in galaxy evolution. However, extraordinary observational challenges make the hot CGM one of the least understood components of galaxies. Studying the hot CGM was not an objective for current observing facilities in the design phase. Nonetheless, observations of the hot CGM have emerged as a promising discipline in the last two decades. Currently, the Milky Way is the only galaxy where the hot CGM has been characterized in detail.

The hot 10^6 K virial phase of the Milky Way CGM is usually traced using He- and H-like oxygen ions. We pioneered a novel X-ray spectroscopic decomposition technique for absorption (Chandra/XMM gratings) and emission (XMM/Suzaku CCDs) by incorporating He- and H-like ions of light elements (C, N, Ne, Mg, Si, S) and M- and L-shell ions of Fe. This revealed, for the first time, multiple chemically, thermally, and kinematically distinct phases of the hot (sub-virial, virial, and super-virial) CGM [1,2,3,4,5,6,7,10]. It unveils a significant reservoir of metals, questioning our knowledge of the metal- and energy-loading factor of galactic winds. The distinct chemical composition of emitting vs absorbing phases indicates enrichment from different species of stellar feedback [1,2,3,4,10]. By contrasting these observations with emission measured toward dense molecular clouds and absorption toward X-ray binaries, we confirm that we are tracing the CGM, not the Milky Way ISM [8,9]. Overall, these exercises have set the precedent for exploring the hot CGM of external galaxies with future missions like NewAthena.

[1] Das et al. 2019a, ApJL, 882(2):L23, [2] Das et al. 2019b, ApJ, 887(2):257, [3] Das et al. 2021, ApJ, 918(2):83, [4] Bhattacharyya et al 2023, ApJ, 952(1):41, [5] McClain et al. 2024, MNRAS, 527(3):5093–5101, [6] Lara-DI et al. 2024, MNRAS, 531(3):3034–3041, [7] Das et al. 2024, ApJL, 963(2):L48, [8] Roy et al. 2025, ApJ, 982(1):8, [9] Gupta et al. 2025, ApJ, 989(2):194, [10] Singh Bisht et al. 2025, arXiv:2509.02019

Studies of supernova remnants in the X-ray

A. Decourchelle

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Supernova remnants (SNRs) play a fundamental role in galactic ecosystems. They are primary drivers of chemical enrichment, injecting heavy elements synthesized during stellar evolution and explosive nucleosynthesis into the interstellar medium (ISM). Their shocks heat and structure the ISM, regulate phase balance, and contribute to turbulence and magnetic field amplification, as sources of Galactic cosmic rays.

Supernova remnants are thus key laboratories for studying high-energy astrophysical processes, including collisionless shock physics, particle acceleration, nucleosynthesis and supernovae explosion mechanisms. X-ray observations provide a uniquely powerful complementary probe of these systems, as they directly trace shock-heated plasma at temperatures of 10^6–10^8 K and reveal the distribution of synthesized elements and the thermodynamical conditions prevailing in the shocked plasma.

In this presentation, I will review recent advances in X-ray studies of SNRs from spatially resolved spectroscopy and high-resolution imaging. Spatially resolved abundance patterns, ejecta stratification, and asymmetries revealed in X-rays provide constraints for core-collapse and thermonuclear explosion scenarios. Measurements of Fe-group and intermediate-mass element (Si, S) temperatures and ionization states, inform on the various physical conditions in the plasma, the level of mixing processes, and explosion energetics. Comparisons between observed remnant properties and 3D hydrodynamic simulations set constraints on the progenitor channels, explosion mechanisms, and circumstellar environments.

On the non-thermal side, thin X-ray synchrotron rims at forward shocks reveal efficient particle acceleration and strong magnetic-field amplification. The coupling between thermal plasma properties and non-thermal emission provides critical insight into cosmic-ray acceleration efficiency and its dynamical back-reaction on shocks.

Finally, I will present the most recent results from high-spectral resolution observations with XRISM/Resolve. With the determination of emission line Doppler shifts, they open a new window by providing three-dimensional information on ejecta geometry and explosion asymmetries. With the advent of this new-generation high-resolution X-ray spectroscopy, XRISM now and NewAthena in the future, SNRs are entering an era of precision plasma diagnostics. These observations promise transformative progress in our understanding of shock physics, explosion mechanisms and interaction with the ambient circumstellar and interstellar medium.

Discovery of New Galactic Supernova Remnants via Deep Optical Images

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Abstract

Of the over 300 known Galactic supernova remnants (SNRs) some 15% have angular dimensions greater than one degree. The discovery of new large remnants can sometimes be difficult in both the radio or X-rays due to confusing neighboring emissions. They are also difficult to image optically using large telescopes with typical FOVs less than half of a degree. However, small aperture telescopes with fast optics and relatively large FOVs have been proven capable of detecting very faint optical nebular emissions. The development of affordable large-format CMOS detectors and extremely high transmission narrow passband filters has recently lead to a revolution in deep optical emission-line imaging of SNRs by amateurs who have combined dozens and even hundreds of hours of exposures to reveal previously unknown Galactic SNRs - both large and small, and near and far off the Galactic plane. I will present and discuss some of these new SNR discoveries many of which have been confirmed by follow-up optical spectra.

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Coronal and chromospheric activity observed by eROSITA and Gaia

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The eROSITA all-sky survey (eRASS) provides an unprecedented data set for the study of stellar X-ray activity. Combining coronal activity measured in X-rays with information from chromospheric emission lines permits a broad view of stellar activity. Gaia DR3 published more than two million measurements of the Ca II infrared triplet (IRT). In this talk, I will show how we separate reliable measurements from those dominated by random errors. Correlating those with eROSITA provides 43 200 sources with reliable IRT activity indices and eROSITA X-ray detections. I will highlight the strong correlation between the coronal and chromospheric activity indicators, which depend on spectral type, and their similar dependence on stellar rotation.

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Fueling the Milky Way's star formation

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In what way has the Milky Way been supplied with hydrogen throughout cosmic time?

Since the beginning of the cosmos, stars have been forming from the interstellar medium, which is a marvel of our galaxy's evolution. While a continuous supply of hydrogen is clearly necessary, the source of this supply remains unclear.

In this talk, I will examine high- and intermediate-velocity clouds that populate the halo and disk-halo interface of the Milky Way. Using data from radio, optical, far-infrared and X-ray surveys, I will investigate the role of these clouds as gas reservoirs.

Growing the population of thermally emitting isolated neutron stars with SRG/eROSITA

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Making use of the wide survey area and unprecedented sensitivity at soft X-ray energies, searches in the SRG/eROSITA All-Sky Survey allow to significantly grow the population of thermally emitting isolated neutron stars (INSs). This will not only give insights into the intrinsic and population properties of still rare INS types, like the class of X-ray dim isolated neutron stars, but is likewise important to constrain the composition and evolution of the overall Galactic INS population. In this talk, we will review the applied search strategy[2], describe the resulting candidate sample of 33 promising sources[2], and give an update on the results of an ongoing dedicated follow-up campaign[1,3,4] that targets the selected candidates from radio to gamma-rays with the goal to place them among the population of Galactic INSs.

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Towards a truly unbiased X-ray survey of star-forming galaxies in the nearby Universe with eROSITA

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The integrated X-ray emission (Lx) of normal galaxies (i.e. those not harbouring active galactic nuclei, AGN) arises from X-ray binary populations (XRBs) and diffuse hot gas. Studying these components is crucial for understanding the most luminous XRBs and their connection to host galaxy properties. Over the past 25 years, numerous studies of normal galaxies have shown that their integrated X-ray emission is correlated with their stellar population parameters such as the star-formation rate (SFR) and the stellar mass (M*), specific SFR (sSFR; SFR/M*), the metallicity and the age of the stellar populations. However, all these studies have so far relied on relatively small galaxy samples, and most of them are focused on the nearby Universe (D<50 Mpc), providing only a partial view of the SFR-M*-Metallicity parameter space. In this talk, I will first give a short overview of all the main results on the studies of XRBs in normal galaxies. Then, I will present how, by using the results of the first scan of the eROSITA all-sky survey (eRASS1) combined with the updated version of the HECATEv2 galaxy catalogue, we studied the connection between the integrated X-ray emission for the least biased and the most statistically robust galaxy sample to date. Our analysis revealed a sub-population of X-ray luminous starburst galaxies showing up to ~2 dex excess relative to current scaling relations. These systems exhibit higher sSFRs, lower metallicities, and younger stellar populations. We examine possible origins of this excess, including enhanced hot-gas emission, luminous low-mass XRBs, stochastic sampling, and contamination from background or low-luminosity AGN. Our results suggest that high X-ray luminosities primarily stem from luminous XRBs associated with young, low-metallicity populations. Finally, I will discuss how the deeper eRASS:4 observations and the inclusion of higher-redshift galaxies will reveal rare populations and establish more robust correlations between the integrated X-ray emission and host galaxy properties.

The population of X-ray emitting compact stars in the Magellanic system detected during the eROSITA all-sky survey

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4. Southern African Astronomical Observatory, South Africa
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The Magellanic Clouds are our closest star-forming galaxies with low Galactic foreground absorption and well determined distances. The SMC hosts a large population of Be/X-ray binaries associated with high star formation activity 25-40 Myr ago. The HMXB population in the LMC is associated with a star formation period at an earlier epoch and a lower HMXB formation efficiency. The Magellanic Bridge is a product of the tidal interaction between the LMC & SMC. It contains both gas and stellar components, with young stellar components (HMXBs) which is thought to have formed in situ, as well as on older population of stars . The recent eROSITA all-sky survey marks the first comprehensive X-ray coverage of the entire Magellanic system, offering a broad band X-ray coverage. Proximity to the SEP facilitates extended monitoring of LMC sources during each survey, enabling a deep total exposure and the exploration of long-term temporal behaviour of X-ray emitting compact stars. This presentation will unveil the findings from our study of the X-ray binary population across the MS through the SRG/eROSITA all-sky survey. Additionally, we will showcase unique discoveries, including a He burning white dwarf, double degenerate compact binary system a population of X-ray emitters in the Magellanic Bridge.

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SNR Searches with SKA Precursor Radio Surveys

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Modern radio surveys with SKA precursor arrays (MeerKAT, ASKAP, and MWA) are increasing the observed population of supernova remnants (SNRs): hundreds of new candidates have been identified along the Galactic Plane [1,2]. However, confirming their nature remains challenging. Interferometric limitations can affect flux measurements of extended sources, introducing uncertainties in spectral indices, crucial for identifying non-thermal emission.

The recent data release of the MWA GLEAM-X survey [3] helps address these limitations. GLEAM-X covers the Galactic plane between 70 and 230 MHz, and is sensitive to a wide range of angular scales (45” to 15°), enabling a robust recovery of extended emission leading to accurate measurements of the integrated flux. The capabilities of this low-frequency survey are well-suited for constraining radio spectra, hence distinguishing thermal and non-thermal components, as well as for identifying spectral curvatures that may otherwise remain undetected.

In this work, we combine GLEAM-X data with GHz survey data to assess the SNR nature of recently reported candidates. In addition, we investigate absorption features at low frequencies to trace interactions between SNR shocks and the surrounding interstellar medium and analyze the environmental conditions. These radio measurements can be further complemented by X-ray observations from eROSITA [4,5], enabling a more comprehensive view of the relativistic particle population and the thermal plasma.

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X-raying the multi-phase interstellar medium in the Large Magellanic Cloud

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A large fraction of the interstellar volume of most galaxies is occupied by million-degree hot ionized gas, energized primarily by supernovae and stellar winds. While tenuous, this phase provides significant pressure compared to colder phases of the interstellar medium (ISM), and is crucial for driving outflows and regulating star formation. X-ray observations provide a unique window into the characteristic thermal emission of this hot diffuse plasma, particularly in nearby galaxies where its distribution can be effectively mapped, the prime example being the Large Magellanic Cloud (LMC). Given its location close to the survey pole, the LMC was observed with exceptionally deep coverage in the SRG/eROSITA All-Sky Survey (eRASS), offering an unprecedented view of its hot ISM phase, and complementing existing observations tracing cooler gas components.

In this talk, I will give a broad overview of the multiwavelength view of ISM in the LMC, with special emphasis on the complementary role of diffuse X-ray emission from the hot gas component.
X-ray spectroscopy reveals that the hot ISM phase exhibits typical temperatures of 3×10^6 K and pressures of 10^4 to 10^5 K/cm^3, permeating the majority of the galaxy. I will show how the spatial distribution and energy content of this hot ISM phase traces energy input from recent star formation, thereby illuminating models of stellar feedback and galaxy evolution. Finally, I will discuss strong spatial variations in the composition of the X-ray emitting gas, tracing the ongoing alpha-enrichment in regions of massive star formation in the LMC.

Magnetars beyond the Local Group

Sandro Mereghetti[1]

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Soon after the discovery of the first magnetar giant flares (MGFs) in the Large Magellanic Cloud and in our Galaxy more than forty years ago, it was realised that these powerful events reaching peak luminosity up to 10^{47} erg/s could be detected up to distances of several tens of megaparsecs, at least during their initial phase lasting less than one second. Although these events are difficult to distinguish from the much more frequent short gamma-ray bursts, a few candidates were proposed and different estimates of their relevance in the short GRB population derived.

In recent years the small sample of (candidate) extragalactic MGFs has nearly doubled thanks to the precise localisation of 231115A in the starburst galaxy M82 with INTEGRAL, and with the discovery of other candidates such as 200415A and 180128A in NGC 253, 070222 in M83, and 241107A in PGC 86046.

Thanks to this increased sample it is now possible to derive tighter constraints on the rate of occurrence of giant flares. Since these flares involve a significant fraction of the available magnetic energy, constraining their rate of occurrence is important to understand the evolution and dissipation of magnetic field in these extreme neutron stars.

In this talk I will review the most recent observational and theoretical advances on extragalactic MGFs obtained with gamma-ray satellites and discuss how the future X-ray missions will allow us to extend also to lower energies the study of magnetars beyond the Local Group.

Plerionic supernova remnants

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Pulsar wind nebulae are among the most striking outcomes of massive-star evolution, but their observed structure is shaped by much more than the pulsar itself. In this talk, I will discuss how the surrounding environment inherited from the progenitor star, including supernova ejecta, circumstellar material, and large-scale magnetic fields, plays a central role in determining the dynamics and appearance of these systems. I will focus on how the interaction between pulsar winds and their evolving surroundings can bend elongated jet-like features, distort outflows, and generate a broad range of radio morphologies, from elongated and arced nebulae to more complex irregular structures. Special attention will be given to the effects of magnetic-field orientation and pulsar motion, both of which can strongly modify the geometry and emission properties of the nebula. These results highlight the importance of connecting present-day pulsar wind nebulae to the prior mass-loss history and final explosion of their massive progenitor stars, providing a more complete framework for interpreting the diversity of observed pulsar remnants.

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Multiple Giant Eruptions in Massive Stars Before Core Collapse

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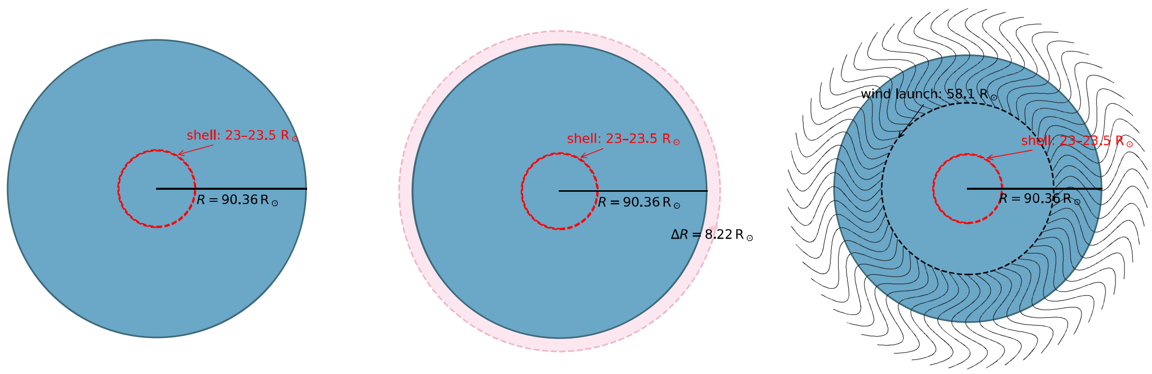
The late evolutionary stages of massive stars are driven by complex processes of mass loss and episodic eruptions that reshape their structure and fate. In some massive stars, multiple giant eruptions occur before core collapse, ejecting significant portions of the envelope and altering the star's internal profile. Understanding these presupernova mass-loss events is essential for interpreting the diversity of supernova progenitors and their explosive outcomes. In this study, I use one-dimensional hydrodynamical simulations to investigate how sudden energy deposition deep within the envelope triggers large-scale outflows in evolved massive stars. I compare static and dynamic models and show that only dynamical evolution leads to genuine ejection of material. Eruptions driven by stronger energy release result in more powerful mass loss and modify the evolutionary track by reducing luminosity and driving structural changes in temperature and radius. These results highlight the importance of non-steady mass-loss episodes in shaping the presupernova structure of massive stars. I also extend this analysis to massive binary systems, where eruptive winds interact with companions and can be accreted or modified by orbital dynamics. This work provides new insights into the link between giant eruptions, stellar structure prior to collapse, and the observable diversity of core-collapse.



(a) **(b)** **(c)**

Figure 1: Schematic diagram of a $70\,\mathrm{M}_{\odot}$ star undergoing to the eruption phase.

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X-ray studies of massive stars

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Among stellar populations, objects born with masses exceeding ten solar masses clearly show off – and they should! With their high luminosities, dense stellar winds, and extreme evolution paths (mergers, supernovae, GRBs, GW events), they actually lie at the intersection of several major topics in astrophysics. Fifty years ago, they were found to be sources of X-rays. These high-energy emissions provide a unique probe into their properties and their interactions, boosting our understanding of these impactful stars. Much was learned in the last years, thanks to XMM, Chandra, Swift, eROSITA, or XRISM, and this paves the way for the next generation of X-ray facilities.

Faint but important -
the role of UVOIR observations in understanding neutron star physics

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Different neutron star populations show pronounced diversity in their multiwavelength properties. While X-ray, radio and gamma-ray properties are well characterised for many pulsars, only a small fraction of neutron stars have been detected in the ultraviolet (UV), optical (O), or infrared (IR) regime. Yet, UVOIR data are crucial to connect X-ray hot spot emission with the bulk surface emission, to assess the low end of the energy distribution of accelerated particles, and to identify additional emission components including thermal emission from surrounding matter or any nonthermal IR-optical component produced by a previously unnoticed population of magnetospheric particles. We will review the current UVOIR properties of isolated neutron stars and discuss their interpretation in conjunction with other constraints such as X-ray data. Particular emphasis will be placed on recent infrared observations obtained with HST and JWST for members of different isolated neutron star populations. We will discuss the implications of these new data on neutron star physics.

Hydrodynamic Simulations of the Supernova Remnant Puppis A with PLUTO

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Abstract

Puppis A is a Galactic supernova remnant, studied extensively in multiwavelength observations. Above all else, it is known for its peculiar morphology, especially in X-rays, whose origins still remain unclear. Here, we present preliminary results of 3D hydrodynamic simulations with the PLUTO code to investigate the structures in the surrounding interstellar medium of Puppis A, in particular the interaction of the shock front with an interstellar cloud towards the north-eastern edge of the remnant. The overall goal is to find a model setup with parameters derived from the observations that is able to recreate the rectangular appearance of Puppis A sufficiently well. The focus lies on recreating the X-ray morphology and the X-ray spectra, specifically.

Bridging Amateur and Professional Astronomy:
Scientific Contributions from Advanced Astrophotography

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The Capella Observatory Team is among the pioneers in remote astronomy. With facilities located in both the Northern and Southern Hemispheres, the entire celestial sphere is accessible. Its portfolio comprises more than 25 years of imaging data, ranging from Solar System objects to Galactic targets and distant galaxies.

In recent years, particular emphasis has been placed on surveys in optical emission lines aimed at the discovery of new planetary nebulae and the identification of optical counterparts to supernova remnants. Such investigations require deep exposures over wide sky areas, a field in which advanced amateur astronomers have become increasingly significant contributors over the past decade. Several previously unknown objects have been identified by the Capella Observatory and, in part, already cataloged.

These observations may provide valuable contributions to scientific research, as the detection of specific optical components constrains key physical parameters. Although astrophotography often prioritizes the production of visually compelling images, scientifically meaningful results require rigorous physical calibration and data processing. This includes procedures such as continuum subtraction, which are frequently omitted in the creation of aesthetically optimized images. The use of artificial intelligence represents an additional critical issue, as many algorithms currently employed in astrophotographic image processing do not meet the standards required to preserve data integrity.

The X-ray future of nova explosions

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Classical and recurrent novae are among the most luminous transient X-ray sources in the Galaxy, powered by thermonuclear runaway on accreting white dwarfs. Their eruptions probe extreme regimes of nuclear burning, mass ejection, radiative feedback, and shock physics, and they play a measurable role in Galactic chemical evolution. X-ray emission from novae arises from two coupled regions: the hot white dwarf atmosphere, visible during the supersoft source phase, and shock-heated plasma within the ejecta or at interfaces with circumstellar material. High-resolution X-ray spectroscopy uniquely constrains white dwarf temperatures, surface composition, mass-loss rates, and velocity fields, while also diagnosing shock velocities, ionization states, and plasma abundances in the expanding ejecta. Observations to date reveal complex, rapidly evolving spectra that challenge static atmosphere and simple shell models, but current samples remain limited by sensitivity and cadence. Future X-ray observatories, with large effective area, high spectral resolution, and rapid response, will enable time-resolved studies of novae across all evolutionary phases, from the earliest shock formation to the decline of nuclear burning. These capabilities will allow systematic measurements of elemental yields, including key isotopes such as lithium, tests of mixing and mass-retention efficiency, and direct links between shocks, particle acceleration, and multi-wavelength emission. By transforming novae from case studies into population probes, next-generation X-ray astronomy will establish them as fundamental laboratories for thermonuclear astrophysics and stellar feedback in the Galaxy.

X-rays from low-mass stars

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Low-mass stars (0.1 - 2.0 Msun) constitute the vast majority of the stellar population in the Milky Way and beyond. Despite their diversity, they all share a common feature: magnetic activity. High-energy emission, from X-rays to UV wavelengths, serves as a primary tracer of magnetic activity in low-mass stars and stars are (usually) the second most numerous source category in flux limited X-ray surveys, surpassed only by AGN.
In this talk, I will discuss how X-ray observations help us to better understand magnetic activity and its consequences, from influencing star formation to the evolution of planetary atmospheres. I will specifically highlight how eROSITA data are currently transforming our picture of magnetic activity. First, the all-sky survey provides a truly unbiased sample of stars, second, the multi-epoch character provides the means of systematically studying flares, and, third, supporting data allows us to robustly link X-ray emission with other activity tracers such as chromospheric emission and stellar rotation.
Finally, I will demonstrate how X-ray emission serves as a powerful diagnostic for identifying young stars based on the decay of X-ray emission with stellar age. While our Sun is currently a weak X-ray source, the heightened activity of young stars allows us to distinguish them from the old field population. I will illustrate this by showcasing how eROSITA's sensitivity and coverage improves our understanding of the recent star-formation history in the solar neighborhood.

What we know - and don't know - about neutron stars

A.L.Watts[1,2]

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Nearly 60 years after their discovery, we have made huge progress in our understanding of neutron stars. But the list of open questions is equally long! In this talk I will review what we have learned about these enigmatic and energetic stars from observations across the electromagnetic spectrum (and beyond), and the major puzzles that remain.

How do the thermonuclear X-ray bursts affect the accretion flow?

Chuanyu Wei[1], Nathalie Degenaar[1] and Jakob van den Eijnden[1]

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Thermonuclear X-ray bursts are observed from weakly magnetized neutron stars in low-mass X-ray binaries (LMXBs). In these systems, accreted material such as hydrogen and/or helium from a donor star undergoes unstable thermonuclear burning on the NS's surface. Each burst releases a tremendous amount of energy (~10^{39} erg) and recurs on timescales of hours to days, acting as controlled irradiation experiments on the surroundings, including the accretion disk, corona and jet[1]. While the immediate (~10 s) behaviors after the burst have been extensively investigated[2], the longer timescale (~minutes) remains largely unexplored. In this talk, I will present new observational evidence that thermonuclear bursts influence the accretion flow on the longer timescale. We find that in X-ray binary 4U 1820-30 the light curves after the bursts deviate from the exponential decay. The count rate fluctuates repeatedly on a time scale of minutes and returns to the pre-burst rate only after ~1000 seconds (Fig.1). The time-resolved spectroscopy using NICER data (0.2-10 keV) shows an anti-correlation between the flux of disk and corona, indicating a different response to the burst irradiation. Complementary RXTE data (2-25 keV) further show that the Fe K emission line, tracing the disk reflection, is also influenced by the burst, offering critical insight into the disk geometry. Our new approach can be applied to other bursting LMXBs, which serves as a powerful tool to probe the dynamic accretion flow on an unexplored timescale.

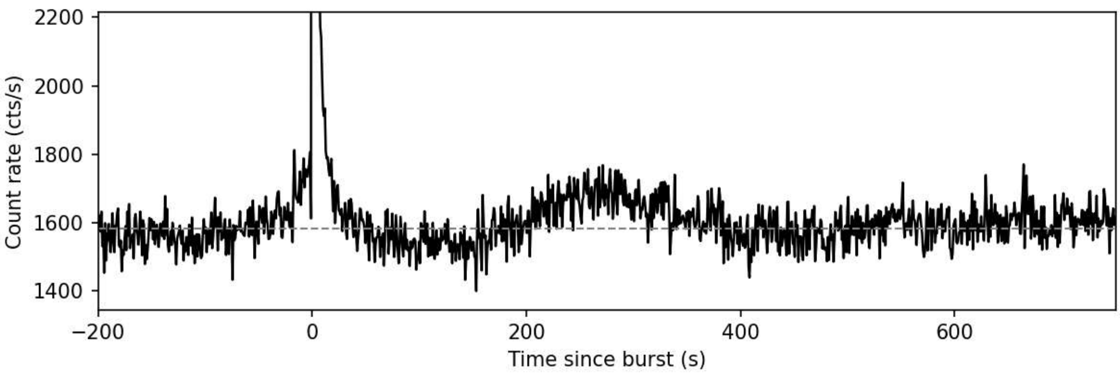

Figure 1. X-ray lightcurve of 4U 1820-30 observed by NICER, which shows a thermonuclear X-ray burst and the fluctuation after the burst. The grey dashed line indicates the mean pre-burst count rate.

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Recent advances on understanding the soft X-ray background using SRG/eROSITA

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The soft X-ray background (SXRB) carries a wealth of information about astrophysical processes occurring on scales from AU to kpc. However, that information is always manifested in the SXRB as a mixture; the challenging part is to decompose these processes and physical components. In this talk, I will introduce these processes and physical components and present recent efforts to decompose the SXRB in the eROSITA All-Sky Surveys and to extract physical information about these components individually.

SRG/eROSITA observes the X-ray sky from the Lagrangian point L2, which has the advantage of being free from the highly variable geocoronal solar wind charge exchange (SWCX) emissions, resulting from the Earth's exosphere interacting with the inflowing ISM into the Solar System. Combined with four consecutive surveys starting from solar minimum, the stabler heliospheric SWCX emissions originating from the solar wind's interaction with interplanetary neutrals were isolated and studied. Conversely, this accurate quantification of the SWCX also enables us to produce the cleanest view of the soft X-ray sky yet, as one would observe outside of the heliosphere.

Beyond the realm of heliophysics, the fact that we observe non-zero diffuse soft X-rays even towards the thickest and closest molecular clouds in this SWCX-free map verifies the existence of the local hot bubble beyond reasonable doubt. A full spectral decomposition of the eROSITA western Galactic hemisphere reveals the 3D structure of the low-density hot gas ($T \sim 10^6$ K) we dwell in, with channels connecting nearby superbubbles, potentially forming a wider, interconnected network of the hot ISM in the Galaxy.

Another question that eROSITA can address is how much of the SXRB is truly diffuse. Spectral stacking of low-mass stars in the solar neighbourhood enables an estimation of their average X-ray luminosity per stellar mass. Scaling this average luminosity with the Milky Way stellar mass distribution revealed a close resemblance to the normalisation and spatial distribution of the ~ 0.7 keV component commonly introduced to fully explain the SXRB spectrum.

Lastly, I will present the high-S/N spectra of the enigmatic eROSITA bubbles and their substructures. Through these spectra, I will discuss the bubbles' connection to the North Polar Spur and the Milky Way halo. The constraints on the 3D geometry of the bubbles will also be explored.

Supernova remnant population in the Large Magellanic cloud with eROSITA

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Abstract

A statistical study of supernova remnants (SNRs) inside a galaxy is important for the understanding of the chemical enrichment and the energy budget inside a galaxy. The complete coverage of the Large Magellanic Cloud (LMC) and its surroundings provided by eROSITA allows us to investigate the SNR candidates proposed in radio and optical and to detect new SNR candidates never observed by another X-ray telescope before. Of particular interest is the increasing population of SNRs detected in the outskirts of the LMC. We present the most updated catalog of SNRs in the LMC. We compare the X-ray luminosity function (XLF) of the SNRs in the LMC with the XLF in the Local Group galaxies. Furthermore, we perform a morphology study on the X-ray SNRs in the LMC finding indications of a sub-sample of elongated SNRs.

Abstracts of Posters

(in alphabetical order)

Low luminosity behaviour of BeXRBS: contribution to the HMXB luminosity function

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The X-ray luminosity function of High Mass X-ray Binaries (HMXBs) is an important tracer for star formation rate of galaxies. For studies of the Milky Way, the XLF has never been modelled below $\sim 10^{35}\mathrm{erg\,s^{-1}}$ thus far. This is the luminosity limit below which the low luminosity behaviour of HMXBs has a significant impact. Of the two main subclasses, while the Supergiant X-ray binaries (SgXBs) are mostly persistent bright sources, the more numerous class of Be X-ray binaries (BeXRBs), where neutron stars orbit and accrete from a Be star were long considered transient sources owing to their massive outbursts at periastron ($\sim 10^{36} - 10^{38}\mathrm{erg\,s^{-1}}$). Their behaviour outside of outburst has been a longstanding question, with early research suggesting predicting the propeller effect at low mass-accretion rate. Recent NuSTAR observations have however shown that several Galactic BeXRBs indicate signs of accretion at low luminosities ($\sim 10^{33} - 10^{34}\mathrm{erg\,s^{-1}}$). We use the eROSITA all-sky survey to probe the prevalence of this behaviour on a systematic level, since eROSITA allows a uniform study of the entire population of BeXRBs, at least in the Western hemisphere. The question of prevalence of the propeller regime has implications for both the study of accretion onto highly magnetised neutron stars, and the low end of the HMXB luminosity function. We show using eROSITA that this effect is marginal for the Galaxy, with only a few systems hinting at this behaviour. We further remark on the effect of the intrinsic variability of BeXRBs -- characterised using monitoring lightcurves from RXTE and MAXI, on salient properties of the XLF for the Milky Way, and discuss implications for population studies of extragalactic compact objects.

Flux-dependent behavior of the “10 keV feature” of 4U 0115+63

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The Be X-ray binary system 4U0115+63 has one of the highest numbers of detected harmonics of its cyclotron resonant scattering features (CRSFs), a pronounced spectral component known as the “10 keV feature,” and strong quasiperiodic oscillations (QPOs).
NuSTAR observations of 4U0115+63, taken during the decay of a Type II outburst in 2015, showed that the source flux varies by a factor of 2 during the QPOs (approximately 500s long). We present our results from flux-resolved analysis of the “10 keV feature,” aiming to disentangle it from the broadband continuum and CRSFs and investigate its origin. Comparing the flux-resolved spectra of a given observation with the respective total dataset revealed a distinct change in overall spectral shape at the position of the “10 keV feature” but no comparable deviation at the energies of the harmonic CRSFs.
We find indications for an anticorrelation between the continuum flux and the ratio of the “10 keV feature” flux to the continuum flux within each observation.
We present evidence that the “10 keV feature” shows independence from the remaining features, as it seems to have a different formation mechanism than the continuum emission, while still originating from the same physical environment.

Self-consistent field screening corrections for inner atomic shell energies and wave functions

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In the theory of characteristic X-ray radiation, there remain several discrepancies with the experimental observations, including astrophysical ones. One of the reasons for them may be the simplified treatment of the inner atomic shell wave functions. Even in Hartree-Fock methods, inner shell trial functions are often chosen in a relatively simple form, structurally close to that for hydrogen, with an adjustable effective charge. Whereas that should be relatively harmless for K shell, for L shell, whose radius is larger, that may be questionable. At the same time, the sensitivity to the shape of wave functions is high for the X ray fluorescence yield.

In the present work, it is demonstrated that energies of inner-shell atomic electrons are accurately described by including a perturbative correction due to the difference between the self-consistent potential of the entire atom and the pure Coulomb potential, along with a relativistic perturbative correction. This implies that electrons of all the atomic shells contribute to screening of the inner shells collectively. By using the Thomas-Fermi model, the screening correction for the K shell may further be simplified to a form of an expansion in noninteger powers of 1/Z, which refines Moseley's law. For L shell, this does not prove to be possible.

Within this framework, screening corrections to the hydrogenic wave functions of K- and L-shells are also evaluated. The corresponding corrections to the dipole matrix elements are computed. For K shell, the correction is moderate, whereas for L shell it is sizable. For the matrix element of the K-L transition, the correction is sizable, as well.

Investigating LMC Supernova Remnants using MUSE/IFS

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We investigate the knots in the Balmer – Dominated Supernova Remnants (SNRs) SNR 0509-68.7 and 0505-679 (LMC), using IFS data of MUSE@VLT. Knots are formations of the dense circumstellar matter released during mass loss episodes of supergiant stars or binaries. We identify more than 100 emission lines and extract the equivalent line maps of the SNR, corrected for interstellar extinction. Using selected line ratios, we estimate the electron densities and temperatures of the knots, ranging from 4000 to ≥ 10^4 cm^{-3} (and from 6000 to 13000 K, respectively). Based on classification diagnostic diagrams, we conclude that the knots radiate due to their ionization by multiple shock waves that followed the supernova explosion. We also show that the forbidden lines [O I] & [O III], seemingly associated with the shell of the SNR, have a pre-shock origin.

Title: XMM-Newton and NuSTAR observations of thermonuclear bursts from 4U 1323–62

Abstract:
X-ray observations of thermonuclear X-ray bursts provide important clues on a various number phenomena such as nuclear burning processes under such extreme conditions, properties of neutron stars and also on the interaction between the accretion flow and the immense burst radiation. 4U 1323-62 is one of the well known persistent bursters. It is one of the few sources for which the orbital period is known, X-rays dips are observed and is a known clocked burster with rough periodicity of about three hours. X-ray bursts are typically slow, with rise times that can reach up to 10~s and typical decay lengths of about 100 s. It is thought that bursts show a fast cooling phase at first than a shallow cooling. In this contribution we present an overview of the simultaneous XMM-Newton and NuSTAR observations of the source performed in August 2024. We report the detection of 9 bursts with XMM-Newton, 6 of them are observed simultaneously with NuSTAR. We detected two double bursts, one with the NuSTAR and another one observed with both missions. The separation of the bursts are ~400s and ~1000s in each case respectively. We present our limits on the cooling of the corona due to the burst emission and present the results from time-resolved X-ray spectral analysis of the bursts.

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eROSITA selected volume-limited sample of cataclysmic variables

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Accreting compact binaries (ACB) are among the most luminous X-ray sources within the Galaxy. By incorporating machine learning techniques, we have identified roughly 11,000 potential ACB candidates, more specifically cataclysmic variables (CVs) in the eROSITA data sample. Optical spectroscopic observations are, however, now required to determine whether these candidates are true CVs. For this project we are, therefore, conducting follow-up optical spectroscopic observations of these candidate systems using various instruments across the world, including SDSS, ESO and SAAO facilities. However, identification spectra are not enough to determine the probable subclass of a CV. Therefore, following the positive identification as a CV, time-resolved photometric observations are obtained, primarily using the SPECULOOS-south and STELLA telescopes, to determine the orbital periods of these systems, which would enable further sub-classification. The primary goal of these observations is to obtain a complete 500pc volume limited sample of all CVs. Many questions still remain unanswered in CV research, such as their space density, population demographics between magnetic (mCVs) and non-magnetic systems including their orbital period distribution [1], and the contribution of the mCVs to the Galactic Ridge X-ray Emission [2]. Both volume-limited [3] and flux limited [4] population studies of CVs have been done in the past, as this is one of the most robust ways to attempt to answer these above-mentioned questions. However, all of these studies had their limitations, as the volume-limited studies suffered from low-number statistics, while the flux-limited studies were biased to the brightest systems. All of our observations are ongoing, and has already yielded around more than 300 new CV systems. In this talk I will give an overview of these observations, talk about some of the results, and discuss the future prospects of this project.

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Deep X-ray investigation on the nature of the ultra-high-energy source 1LHAASO J1740+0948u

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Pulsars and their pulsar wind nebulae are among the most powerful particle accelerators in our Galaxy, as supported by the large fraction of very-high-energy (VHE) sources detected in their vicinity. A prominent example is 1LHAASO J1740+0948u, detected up to 300 TeV, and likely associated with the middle-aged PSR J1740+1000 powering a bow-shock tail. Two main scenarios could explain the VHE emission origin: either 1LHAASO J1740+0948u is the VHE counterpart of the tail or it could be the halo of the pulsar.

Multi-wavelength studies are crucial in constraining the source parameters via spectral energy distribution (SED) modelling. In particular, X-ray observations provide key insights into the system's magnetic field and particle energetics.

We present the results of an in-depth analysis based on ~500 ks of XMM observations centred on PSR J1740+1000, aimed at investigating the origin of the VHE emission. We performed the first deep search for diffuse non-thermal X-ray emission, both around the pulsar and close to the location of 1LHAASO J1740+0948u, and derived stringent 3σ flux upper limits. We revisited the tail spectrum and found no evidence for synchrotron cooling. We tested the proposed VHE origin scenarios through SED modelling, obtaining new estimates on the magnetic field, both in the tail and in the non-thermal diffuse emission. Our study suggests a halo-like nature for 1LHAASO J1740+0948u, but deeper multi-wavelength observations are needed to confirm the hypothesis.

Systematic study of HII regions in the Magellanic Clouds

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Abstract

HII regions are zones composed of ionized gas surrounding massive stars, which are formed by the star's radiation and reach temperatures of 10000K. On top of the ionizing radiation, stars produce winds, which shock the medium, further ionize it, and yield temperatures of 10^6K. Extended HII regions are a result of multiple stars in a stellar cluster or association and SNe resulting from the death of massive stars. They can be observed as superbubbles with a hot plasma interior. Because of the nature of eROSITA all-sky survey, we now have the opportunity to perform a systematic study of the HII region and superbbuble population in the Magellanic Clouds, complementing and expanding the studies of their plasma properties done by XMM-Newton. We present the analysis of DEM L196 (or N51E), one of the hundreds of HII reigons in the LMC found towards the south west of the super giant shell 4. In this region we noticed a faint, unusual emission in the 1.1-2.3 keV band. We use a combination of eROSITA and XMM-Newton observations to try to unveil the nature of the source's emission.

Preliminary Study of Photoabsorption edges in the spectrum of HETE J1900.1-2455

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X-ray spectra of thermonuclear (Type-I) X-ray bursts are generally well described by blackbody spectra. However, during especially powerful Photospheric Radius Expansion (PRE) bursts the evidence of enrichment of neutron star atmospheres by heavy elements are observed. In particular, absorption edges in the observed spectra become significant at certain stages during the burst. Here, we return to study one such X-ray burst of HETE J1900.1-2455 whose spectra were obtained by RXTE/PCA observations [1]. In this work, it was established that at specific stages during X-ray burst, the absorption edges in the spectra are prominent. Here, we try to re-fit those spectra using modified function for an edge in order to describe and compare the results with recently published spectra of hot NS atmospheres enriched with thermonuclear ashes [2]

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Development of astronomical X-ray telescope optics at Aschaffenburg University

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Since several years, reflective coatings for astronomical X-ray optics were developed at the “Aschaffenburg Competence Center for Astronomical and Space Instrumentation” (ACCASI) [1] [2] [3]. As part of a Bavarian-Czech cooperation between Aschaffenburg University and the Czech Technical University of Prague, two mechanically identical telescopes were built [4] [5]. One telescope optic was equipped with conventional gold-coated mirrors, manufactured by the Czech project partners. The 34 X-ray mirrors of the second telescope use an innovative coating system made of chromium and iridium, which was applied at the Aschaffenburg coating laboratory (see figure 1). Both telescopes are designed according to the bionic principle of a reflecting lobster eye. The optics works with two consecutive reflections on mutually perpendicular mirror surfaces. This enables a large field of view with many square degrees in diameter, which, however, comes at the price of a reduced angular resolution. An extensive X-ray characterization of these telescopes was carried out at the PANTER test facility of MPE, which simulates parallel starlight incident on the telescopes. The telescopes have an angular resolution of about 4 arc minutes in X-rays and a focal length of about 2 meters [4]. The development of X-ray coatings as well as the design and testing of the X-ray telescope optics is presented within this contribution.

Fig. 1: Lobster-Eye telescope

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Timing Analysis of the 2020 Type II Outburst of GRO J1008−57

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GRO J1008−57 is a Be-type X-ray binary characterized by regular Type I outbursts, occurring roughly 249 days apart and corresponding to the pulsar's orbital period, as well as occasional Type II outbursts. Our work focuses on the timing analysis of the 2020 Type II outburst, which reached a peak luminosity of $\sim 1.4 \times 10^{37}$ erg s^{-1}. Phase-connecting the *NICER/XTI* observations allowed us to obtain precise spin-frequency measurements, complementing existing *Fermi/GBM* data. Luminosity-sorted pulse profiles reveal that the double-peaked pulse profiles maintain stability despite a change in X-ray luminosity of two orders of magnitude throughout the observation period, suggesting that the standard cylindrical accretion column models may need modification for this source. Finally, we demonstrate that the spin-frequency evolution during the outburst is compatible with thin disk accretion models.

Identifying Ultra Cool Dwarfs in eROSITA eRASS1 by Stellar Flares

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Ultra cool dwarfs (UCDs) are stellar and sub-stellar objects with late-M and early-L spectral types, masses around the hydrogen burning limit and very low temperatures ($\lesssim$ 2700 K). Some are low-mass stars while others are brown dwarfs. Since UCDs are very faint, their X-ray properties are not well understood. Stelzer et al. (2022) [1] detected 96 out of roughly 20.000 nearby UCDs in the first eROSITA survey, eRASS1. The observed activity levels (L_X/L_{bol}) were mostly higher than the 'saturation' value of 10^{-3} for highly active stars. The hypothesis is therefore, that UCDs, when in quiescence, must typically be too faint to be detected. When they flare however, their X-ray brightness increases significantly, which could explain the high L_X/L_{bol} levels of the eROSITA detections. This HiWi (student job) project aims to validate this by producing lightcurves for the 96 UCDs using eventlist data from eRASS1 and check whether or not flares can indeed be identified (as sharp, relatively short lived spikes in the lightcurves).

Lightcurves of the eRASS1 detected UCDs were successfully produced. Most of the targets show clear evidence of flaring, while some of the lightcurves appear relatively flat. I will present the eRASS1 variability statistics of this UCD sample.

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A0538-66: a standout accreting pulsar with fast multiwavelength variability

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The Be/X-ray binary A0538-66 in the Large Magellanic Cloud is a uniquely extreme system that has challenged our understanding of accretion physics for nearly 50 years. It hosts the fastest-known pulsar in its class (69 ms) in a remarkably short (16.6 d) and eccentric (e~0.7) orbit. The source exhibits extraordinary multiwavelength variability, including seconds-long X-ray flares with a dynamic range >1000 and peak luminosities exceeding 1E38 erg/s, which are correlated with bright, fast optical flares. Recently, it also displayed an outburst reaching luminosities typical of ultraluminous X-ray sources. The combination of extreme properties shown by this source is unmatched among accreting pulsars. We will present the most recent multiwavelength observational results on this binary system. Finally, we will discuss how these findings constrain the physical mechanisms, such as magnetic field geometry and accretion flow dynamics, responsible for its unique variability.

Joint eROSITA, Fermi, and H.E.S.S. analysis of the Pulsar Wind Nebula MSH 15-52 with Gammapy

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Pulsar wind nebulae (PWNe) are extended sources that arise from the interactions of charged particles accelerated by a pulsar with magnetic and radiation fields. The non-thermal emission resulting from these interactions can be detected across a large stretch of the electromagnetic spectrum, from radio up to very-high-energy (VHE) gamma-rays, making multiwavelength (MWL) analyses essential to understanding their underlying physics.

We present a joint analysis of the PWN MSH 15-52 with X-ray data from the eROSITA mission [1, 2], as well as gamma-ray data from Fermi-LAT [3], and VHE gamma-ray data from the H.E.S.S. telescope array [4] using the Gammapy package, a Python package for gamma-ray data analysis [5]. We showcase our custom pipeline to convert eROSITA X-ray data into a Gammapy-compatible three-dimensional (RA, Dec, Energy) format. We draw conclusions on the underlying particle spectrum powering the PWN and give an outlook on future modelling efforts.

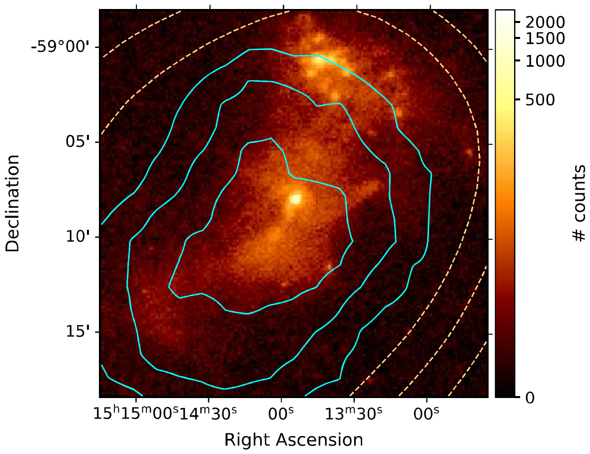

Figure 1: eROSITA counts map of MSH 15-52 with 9, 12, and 15 sigma contours of Fermi-LAT (dashed) and H.E.S.S. (solid) significance.

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Solving the Soft X-ray Puzzle Using XMM-Newton Observation of the Highest-Field Polar AR UMa

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Canonical models of accretion in magnetic cataclysmic variables (MCVs) predict that half of the hard X-ray radiation emitted by the shock-heated plasma should be reprocessed into a soft X-ray blackbody component. Contrary to this expectation, several polar MCVs show an excess of soft component, a ROSAT-era observation known as 'Soft X-ray puzzle'. The soft excess is currently understood to be a deficiency in hard X-ray, often attributed to 'blobby accretion' in which the accretion stream, discretised into dense blobs, penetrates deep into the white dwarf photosphere burying the accretion shock. The cause of blobby accretion, however, remains unclear, with potential drivers being the magnetic field strength, the location of the threading region, etc. In this contribution, we revisit the soft X-ray puzzle using the high-state XMM observation of AR UMa, the highest field polar (B=230 MG). AR UMa, which has long escaped high-state X-ray observations, was captured in its 2023 high-state by a triggered XMM-Newton observation. Utilizing the broad spectral coverage enabled by OM and EPIC instruments, we derive a comprehensive energy budget for the source. By quantifying the energy-balance of polars at the magnetic extreme, we provide a critical benchmark for understanding the origin of soft X-ray excess in MCVs.

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Exploring Pulsar Wind Nebulae Across the Electromagnetic Spectrum

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Pulsar Wind Nebulae (PWNe) are some of nature's most unique laboratories for studying the radiation emitted by high-energy particles around pulsars from radio wavelengths all the way to ultra-high energy (UHE) gamma-rays. Observations across the EM spectrum provide complementary diagnostics of particle escape and energetics in these systems. We present a population study of pulsar wind nebulae combining X-ray observations from the Chandra X-ray Observatory with radio and gamma-ray measurements. In the X-ray band we can probe the particle injection spectrum and constrain properties such as the magnetic field. We also search for correlations between parameters related to pulsar geometry (viewing angle and magnetic inclination) and the acceleration mechanism (photon index and radiative efficiency). Radio and gamma-ray observations further constrain the particle SED and trace out particle diffusion on larger scales. Many PWNe have been detected in UHE (>1 PeV) observations by LHAASO. These observations probe the maximum particle energy, in some cases showing that pulsars are able accelerate particles to a large fraction of the potential drop across the neutron star polar cap, which is much higher than previously thought possible. This multiwavelength perspective provides new insight into how pulsars accelerate particles and shape their surrounding nebulae.

From Survey Hint to Science-Ready Products: A Networked Amateur Pipeline for Faint SNR Filaments (Hoinga G249.5+24.5 as a Demonstrator)

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This poster describes an end-to-end workflow used by the New Horizon Team to pursue faint, extended SNR emission that is difficult to capture with conventional allocations of telescope time. Using Hoinga (SNR G249.5+24.5) as a demonstrator, we show how distributed amateur sites can accumulate ~600 hours over ~6 months of narrowband imaging (Hα, [S II], [O III]) and convert it into products suitable for professional uptake: calibrated stacks, astrometric solutions, emission-line maps, mosaics, and annotated multiwavelength overlays. We highlight pitfalls that can erase real low-surface-brightness structure (over-aggressive gradients, star removal artefacts, non-uniform flats) and present conservative processing choices designed to preserve diffuse morphology. The same pipeline has been applied to additional faint SNR filaments, and we will also present images and results from these other targets. The poster concludes with suggested "handover standards" for amateurs (metadata completeness, exposure accounting, processing logs, and uncertainty notes) to support reproducibility and efficient follow-up.

Unveiling the period-bounce population of Cataclysmic Variables

Spectroscopic and time-domain follow-up of eROSITA-selected candidates

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Cataclysmic variable stars (CVs) are compact binary systems in which a white dwarf (WD) primary accretes material from a low-mass main-sequence secondary star (the donor) that fills its Roche lobe. CVs evolve toward shorter orbital periods ($\mathrm{P_{orb}}$) until reaching a minimum $\mathrm{P_{orb}}$ near $P_{\mathrm{orb}} \sim 80$ min. Beyond this point, the donor becomes out of thermal equilibrium or increasingly degenerate, causing the system to "bounce back" to longer $\mathrm{P_{orb}}$ values. Such highly evolved systems are known as period-bouncers. Although 40–80% of all CVs are expected to have reached this stage, only 3–25% of known CVs are confirmed period-bouncers, likely due to their intrinsic faintness associated with lower mass-transfer rates.

In search for new period-bouncers, we have matched the eROSITA catalogs with the white dwarf catalog from Gentile Fusillo et al. 2021. Using the multiwavelength scorecard and the X-ray selection criteria described in [2], we selected 213 CV candidates with low-mass donors. Following the first follow-up confirmation of a period-bouncer with SDSS-V ([3]), the full sample is currently undergoing detailed vetting. Here, we present the eROSITA-selected candidate sample, the newly confirmed CVs based on their SDSS optical spectra, orbital period determinations from TESS data, and the detection of very late-type donors through spectral energy distribution analysis. In addition, we present a new diagnostic to distinguish period-bouncers from pre-bounce CVs using the Balmer decrements ([4]).

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How the LMC star-formation history formed the current population of HMXBs

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The Magellanic Clouds are our closest star-forming galaxies with low Galactic foreground absorption. This makes them a unique laboratory to study the population of high-energy sources. The SMC hosts a large population of Be/X-ray binaries associated with high star formation activity 25-40 Myr ago. It has been proposed that the HMXB population in the LMC is associated with more recent star formation. However, due to the large angular extent and the resulting insufficient coverage of the LMC, this association with SFR is not yet well established.

An essential asset for studying the HMXB population in the entire LMC was the launch of eROSITA. eROSITA scanned the sky in great circles crossing at the ecliptic poles. Due to the proximity of the south ecliptic pole, sources in the LMC are monitored for up to several weeks during each all-sky survey, leading to deep total exposure and the possibility of studying long-term temporal behaviour. This allowed us to discover several new HMXBs, verify candidate HMXBs and construct a complete, flux-limited catalogue. During my presentation, I will first focus on the classification scheme we adopted, based on the multi-wavelength properties of all objects in the catalogue. Then I will discuss the properties of the HMXB population in the LMC, with a focus on its tight connection to star-formation history.

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Multiwavelength search for supernova remnants in the Circinus constellation

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Supernova remnants (SNRs) are key drivers of the interstellar medium and Galactic chemical evolution, yet the observed Galactic SNR population remains highly incomplete due to observational biases. As a result, many remnants, particularly faint and extended ones, are still missing from current catalogs. We present recent results demonstrating the power of a multiwavelength approach that combines eROSITA X-ray observations with radio, optical, and infrared data to study SNRs in a selected region of the Circinus constellation. This joint analysis yields improved constraints on the morphology and spectral properties of known remnants in the region, including MSH 15-52 and G320.6−1.6. In addition, we identify a new SNR candidate, G320.2−3.6, and report likely X-ray counterparts to the candidate SNR G320.0−1.7 and the known SNR G321.9−1.1.

New X-ray Supernova Remnants in NGC 7793

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We investigate the population of X-ray emitting supernova remnants (SNRs) in the nearby spiral galaxy NGC 7793 using archival Chandra observations spanning nearly two decades. A systematic search for X-ray counterparts to optically identified SNRs reveals five sources spatially coincident with known remnants, four of which are identified here as new X-ray SNRs. Their X-ray emission is soft (<1.2 keV), non-variable, and consistent with thermal plasma emission from shock-heated gas. Spectral analysis of the brightest remnants indicates temperatures of a few million kelvin and prominent O and Ne line emission, characteristic of evolved SNRs interacting with the interstellar medium. In addition, we identify two candidate X-ray SNRs lacking confirmed optical counterparts but exhibiting similarly soft spectral properties. We further investigate correlations between the X-ray and optical properties of the SNR population. We find a linear correlation between X-ray luminosity and electron density as inferred from the [S II] λ6717/λ6731 ratio, indicating that X-ray bright remnants preferentially reside in denser environments. In addition, all X-ray detected SNRs exhibit strong [O III] λ5007 emission. These results indicate a close association between X-ray emission and optical line diagnostics of the ionized gas, pointing to environmental or evolutionary conditions that favor detectability in both bands.

Unveiling the Hot Interstellar Medium in Nearby Galaxies with eROSITA

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The eROSITA all-sky survey (eRASS:4) provides sensitive X-ray data for studies of the diffuse emission in nearby galaxies. We aim to characterize the physical conditions of the hot phase of the interstellar medium (ISM). We obtained the properties of a statistically complete sample of 105 nearby galaxies from the *Catalog of Neighboring Galaxies* and the HECATE v2.0 catalog. The sample is volume-limited to a distance of $d < 20\,\mathrm{Mpc}$; the star formation rates (SFRs) span a range of $\sim 10^{-4}$–$4\,\mathrm{M_\odot\,yr^{-1}}$, extending well below the SFR range covered by past X-ray studies. The galaxies were grouped by morphology into early-type and star-forming systems, and further divided according to specific star formation rate (sSFR). For each of these subsamples, we stacked the counts to obtain high signal-to-noise composite spectra. From the resulting spectral fits we determined the diffuse X-ray luminosities and, for the star-forming subsamples, derived an $L_\mathrm{X} - \mathrm{SFR}$ relation. The eROSITA spectra are well described by a combination of power-law and thermal components and show systematic differences: high-sSFR galaxies exhibit stronger soft thermal emission ($kT \sim 0.7\,\mathrm{keV}$), while low-sSFR systems have a harder X-ray spectrum and are dominated by point-source emission. Early-type galaxies show temperatures of ~ 0.2–$0.3\,\mathrm{keV}$, but a higher fraction of thermal emission compared to low-SFR systems. We found a correlation between the thermal X-ray luminosity L_X and the SFR, described by $\log L_\mathrm{X} \sim 38.6 + 1.1 \log \mathrm{SFR}$, with an intrinsic scatter of 0.3 dex.

A newborn spider system at the core of a radio shell: Evidence of a low-energy supernova

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Observations with the Australian Square Kilometre Array Pathfinder (ASKAP) have revealed a faint radio shell (G289.6+5.8) surrounding the γ-ray and X-ray source IGR J11187–5438, spatially coincident with an M-type star [1]. At the Gaia DR3 distance, the source exhibits an unusually low X-ray luminosity, inconsistent with the previously proposed low-mass X-ray binary interpretation. We instead propose that the radio shell represents the remnant of a low-energy supernova that produced a neutron star now interacting with its stellar companion. In this scenario, the system may represent a newly formed spider binary, offering a rare glimpse into the earliest stages of spider-system evolution. This discovery also highlights the power of next-generation radio surveys such as the ASKAP Evolutionary Map of the Universe (EMU) to uncover low-surface-brightness structures and provide new insight into previously known objects.

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Probing Type Ia Supernova Progenitors with Supernova Remnants in the Milky Way and Nearby Galaxies

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We find that the dominant explosion mechanisms of Type Ia supernovae (SNe Ia) in nearby galaxies may differ from those in the Milky Way, and that these differences are reflected in the observed properties of their supernova remnants (SNRs). This raises a fundamental question: how can variations in SN Ia explosion mechanisms improve our understanding of the physics and the Universe?

Type Ia SNRs reveal their nature through their geometric and physical structures across different environments and wavelengths. Some remnants exhibit similar structures in multi-wavelength observations, while others show significant discrepancies (e.g., N103B in the LMC and Kepler in the Milky Way). In some cases, the X-ray emission appears relatively symmetric, whereas the optical emission is significantly asymmetric. Comparisons of optical and X-ray structures in Galactic and nearby extragalactic SNRs offer important constraints on both the explosion physics and the interaction with the surrounding medium, providing new insights into the nature of Type Ia SNe across different galactic environments.

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Transition to the quiescent state in the accreting magnetised neutron star: no propeller required?

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The final stages of transient X-ray pulsars outbursts, characterized by a significant drop in observed flux, offer valuable insights into the physics of the accretion disc and its interaction with the magnetic field of the neutron star (NS). In particular, the "propeller effect" has been proposed as determining the onset luminosity of the rapid transition to quiescent state. On the other hand, the decrease in the incoming mass accretion rate is governed by processes occurring in the accretion flow at larger distances from the NS. In this study, we present the results of the first comprehensive high-cadence monitoring campaign that tracks the entire transition to quiescence in the transient XRP 4U 0115+63, utilizing NICER observations, see the figure. We show that the observed fast drop of the light curve is the result of the evolution of the viscous accretion disc. We successfully model the light curve of XRP 4U 0115+63 using the public code “Freddi” [1,2,3] and further apply this model to another three sources. This result suggests that estimates of the NS magnetic field obtained from alleged propeller turn-ons are highly uncertain for disc-fed outbursts.

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Why Supernova Remnants look the way they do: multiwavelength insights from 3D simulations

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Supernova remnants (SNRs) are the main laboratories for studying the radiative cooling of shock-heated plasma and its interaction with the multiphase interstellar medium. Radiative losses strongly influence the morphology, emission properties, and dynamical evolution of SNRs, but interpreting these effects remains challenging without a multiwavelength framework that directly connects simulations to observations.
This work presents 3D high-resolution magnetohydrodynamic simulations of SNRs evolving in a complex interstellar medium [1]. We post-process the simulations to produce synthetic emission maps in Halpha, Hbeta, [N II], [O III], and [S II] lines and find that the optical emission originates in thin, shock-compressed cooling layers. Because these layers are highly sensitive to projection effects, their observed brightness can bias standard emission-line diagnostics [2].
Our statistical analysis demonstrates that variations in the ambient density at the site of the supernova explosion dominate the resulting remnant morphology and optical brightness, while magnetic fields have a weaker influence [3]. Apart from that, we can track how the dominant cooling channels change over the lifetime of the SNR. In a separate simulation, we compute synthetic X-ray emission of a SNR, which traces hotter gas phases and highlights evolutionary stages that are not captured by optical diagnostics. As a result, such simulations allow us to better constrain SNR parameters and understand the observed morphology, suggesting practical approaches for comparing simulations with multiwavelength observational data.

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Isolated neutron star candidates from the fourth generation XMM-Newton catalogues

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X-ray thermally emitting isolated neutron stars (XINSs) provide crucial insights into neutron star cooling and Galactic demographics. Using over two decades of data from XMM-Newton, we searched the fourth-generation serendipitous source catalogues for absorbed XINS candidates, focusing on sources with soft X-ray spectra and no optical/infrared counterparts. The brightest candidates were followed up with XMM-Newton fulfil programmes, Chandra snapshot observations, deep imaging with Gemini, and radio searches with FAST. Our analysis revealed five sources with stable, moderately absorbed X-ray emission, consistent with distant XINSs at distances up to 7 kpc. These sources are primarily located in the Galactic plane, with possible associations to open clusters and a SNR/PWN system. Population synthesis models suggest that many softer, more absorbed, and distant XINSs are still hidden below our selection threshold. These sources are likely present in the 4XMM-DR12 catalogue but are difficult to identify due to source confusion and catalogue cross-matching limitations. Ongoing and future follow-up will enable the detailed study of these faint, distant populations.

Simulations of Elongated Supernova Remnants

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Recently, individual supernova remnants with highly elongated morphologies have been reported from XMM-Newton and eROSITA X-ray observations. These remnants exhibit strong X-ray emission predominantly in the 0.7–1.1 keV band, suggesting that the dominant emission arises from iron-rich ejecta. Such characteristics are consistent with Type Ia progenitors, though core-collapse events may also produce asymmetric structures. Understanding the physical origin of elongated supernova remnants requires connecting remnant morphology to asymmetries in the explosion and the surrounding circumstellar medium. Type Ia explosions can develop asymmetries through mechanisms such as gravitationally confined detonation and double detonation, which naturally produce off-centre or collimated ejecta. The interaction of these asymmetric ejecta with the surrounding medium can further shape the remnant, with dense or high-pressure regions channelling the material into elongated structures.

In this talk, I present results from two-dimensional hydrodynamic simulations of asymmetric explosions expanding into a uniform circumstellar medium. We explore how the ejecta morphology depends on the explosion geometry, specifically varying the half-opening angle of the explosion. The simulations show that velocity shear within the ejecta leads to adiabatic stretching, producing collimated, elongated structures, while the surrounding shocked medium maintains higher pressure that can compress and guide the ejecta along preferred directions. Over time, this results in remnants with highly elongated morphologies.

Synthetic X-ray surface brightness maps derived from these simulations show enhanced elongation in the 0.7–1.1 keV band, highlighting the iron-rich emission. These results are broadly consistent with observations and provide supporting evidence for the connection between explosion asymmetries and the morphology of elongated supernova remnants.

From stellar birth to stellar death: tracing high energy processes in Sh2-284/G213.0-0.6 complex

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G213.0-0.6 is a Galactic supernova remnant previously estimated to lie at a distance of ~ 1 kpc, with a reported angular extent of $\sim 2.3° \times 2.7°$, and a debated interaction with nearby molecular material, namely the Sh2-284 HII region.
Using eROSITA observations, we detect thermal X-ray emission across most of the remnant and revise its extent to $2.6° \times 4.0°$. X-ray spectral analysis indicates significant absorption ($N_{\mathrm{H}} = 2.4 - 4.6 \times 10^{21}\ \mathrm{cm}^{-2}$), implying a distance of 1.7-3.9 kpc, significantly larger than previously assumed.
At this revised distance, the angular extent implies a physical size exceeding 100 pc, placing G213.0-0.6 among the largest known Galactic supernova remnants.
Analysis of Fermi-LAT data reveals gamma-ray emission from the remnant area, with particularly enhanced emission from the region between its northwestern boundary and the adjacent HII region Sh2-284.
The combined X-ray morphology, absorption-derived distance, and gamma-ray spatial distribution disfavor a cosmic-ray illumination scenario for the gamma emission near the northwestern boundary, instead supporting an origin associated with active star formation embedded within the HII region.

Investigation of supernova remnant IC 443 and G189.6+3.3 with *LAMOST*

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Abstract

We present an analysis of the optical emission associated with the supernova remnants (SNRs) G189.6+3.3 and IC 443, based on spectroscopic data obtained with the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (*LAMOST*). All available spectra covering these regions were utilized in the study. Characteristic emission lines of SNRs, including prominent H α, [S II] and other forbidden lines, were identified and measured from stellar spectra exhibiting low continuum levels (S/N< 10). In the regions northeastern (NE) and east (E) of IC 443, we derive an average [S II] $\lambda\lambda$6716/6731Å to H$\alpha\lambda$6563 ratio of [S II]/H α= 0.59±0.12, consistent with moderate shock activity. Within and just beyond the visible boundaries of IC 443, the ratio increases significantly to [S II]/H α=1.25±0.31, with values reaching up to 1.33 in areas outside the bright filaments, suggesting that the optical extent of IC 443 may be larger than previously estimated. This interpretation aligns with the explosion site inferred from the identification of the pre-supernova binary companion, which is significantly offset from the geometrical center of the SNR. Electron densities ($N_{\rm e}$) across the observed region range from 4 to 1257 cm^{-3}, supporting the presence of shock-heated ionized gas. Additionally, we estimate shock velocities, reddening, and interstellar extinction coefficients, and compare these with theoretical predictions. The physical conditions and optical characteristics of the environments surrounding SNR G189.6+3.3 and IC 443 are discussed in detail.

The Supernova remnant candidate HESS J1614-518 seen with eROSITA

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We report new soft X-ray observations of the TeV-emitting supernova remnant (SNR) candidate HESS J1614-518, using eROSITA. X-ray data were retrieved from the first four completed full-sky eRASS surveys. An X-ray counterpart is identified in eRASS data, in good agreement with the TeV source, above a softer and more extended X-ray component which is likely unrelated to the object. The findings agree with the SNR identification hypothesis of HESS J1614-518.

eRASSU J043115.8-711730: Discovery of the first symbiotic super soft X-ray source in the Magellanic Bridge

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Abstract

The stellar population and compact remnants in the Magellanic Bridge provide insight into the tidal interaction between the Magellanic Clouds. Systematic X-ray surveys enable their detection, while deeper follow-up is required for their characterization. We present follow-up observations of the candidate supersoft X-ray source eRASSU_J043115.8-711730, discovered by eROSITA in the Magellanic Bridge. We carried out a multi-wavelength study using eROSITA, XMM-Newton, and Swift, along with optical spectroscopy from SALT. Long-term optical and infrared photometry was obtained from OGLE, ASAS-SN, ATLAS, and WISE. We performed Bayesian X-ray spectral analysis, searched for periodicity using the Lomb-Scargle periodogram, analyzed the optical spectrum, and constructed color–magnitude diagrams to constrain the evolutionary state of the system. The X-ray spectrum is well described by a single blackbody with a temperature of $kT \sim 0.03$ keV. The inferred unabsorbed luminosity of 0.1–1.0×10^{37} erg s^{-1} is consistent with thermonuclear burning on a white-dwarf surface. The optical continuum is consistent with an M-type giant, placing the source on the red giant branch of the GAIA color–magnitude diagram. The optical spectrum shows strong Balmer lines, HeII λ4686, and the [Fe X] coronal line. The optical light curve shows a periodicity of ~ 500–560 days, consistent with a long-period symbiotic binary. The source lies in the Magellanic Bridge near the periphery of the LMC ($\sim 90\%$ confidence boundary), with proper motion consistent with the drift of the old stellar population toward the LMC (GAIA Collaboration 2021). We identify eRASSU_J043115.8-711730 as a super-soft X-ray S-type symbiotic system with a late-type companion and a white-dwarf accretor, and the first of its kind discovered in the Magellanic Bridge. Its position and proper motion suggest that it is either part of the old Bridge population near the LMC or part of the systematic drift of stars toward the LMC.

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Seeing Through the ISM: Recovering Intrinsic X-ray Emission in Metal-Poor Dwarf Galaxies

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X-ray binaries (XRBs) are expected to play a major role in shaping the interstellar medium (ISM) of extremely metal-deficient (XMD) galaxies, yet their intrinsic X-ray spectra and physical nature remain poorly constrained due to strong and uncertain absorption, particularly at soft X-ray energies ($<$2 keV). Limited soft X-ray photon statistics introduce significant degeneracies in spectral modeling, leading to large uncertainties in the inferred hydrogen column density, intrinsic luminosity, and spectral shape. We present a multiwavelength study aimed at constraining the intrinsic X-ray properties of compact sources in local XMD dwarf galaxies by combining far-ultraviolet (FUV) absorption measurements with ISM diagnostics. Our sample consists of $\sim$50 nearby XMD local dwarf galaxies hosting XRBs, most of which have FUV spectroscopy from FUSE and X-ray observations from *Chandra* and/or *XMM–Newton*. Many targets also have *HST* COS and STIS data, enabling a detailed characterization of both neutral and ionized ISM phases. We compare hydrogen column densities derived from FUV H I absorption with those inferred from X-ray spectral modeling, and examine their dependence on metallicity, ISM emission-line properties, and source environment. Spatial correlations between X-ray sources and HST-resolved OB stellar populations are used to assess the association of XRBs with star-forming regions and to probe the distribution of absorbing material toward compact objects. Direct measurements of H I column density from Lyβ absorption, together with indirect constraints from O I, S II, and metallicity tracers, provide independent constraints on the absorbing medium. We present the results on how ISM-constrained absorption affects source classification and discuss implications for identifying ultraluminous X-ray sources (ULXs) and potential intermediate-mass black hole (IMBH) candidates in low-metallicity environments. For a small but valuable sub-sample, we directly compare the absorbing column densities required by X-ray models with far-UV measurements to assess whether X-ray sources are embedded within, or spatially offset from, their associated stellar clusters. We also demonstrate that H I column densities derived from FUV absorption toward OB stellar clusters provide robust priors on the intrinsic X-ray spectral shape and luminosity, assuming the X-ray source lies within or close to the young stellar population. This approach improves physical source classification and is directly applicable to future *JWST* studies of metal-poor galaxies at high redshift, as similar excitation mechanisms are expected to operate in the dwarf galaxies of the early Universe.

Evidence of Persistent Obscuration in Stellar Mass Black Hole GRS 1915+105.

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1 Abstract

Since its discovery, the stellar mass Black hole GRS 1915+105 remained active for 25 years. During early 2019 the high-luminosity X-ray emission of GRS 1915+105 has declined and the source went into an obscured state. GRS 1915+105 is famous for its structured variability pattern of 16 different light curve classes. In this work, we report the spectral properties of a NICER observation (MJD 56658), an obscured state observation of the η light curve class. This light curve class has been recently discovered before the source transitioned to the obscured state. The emission spectrum shows the two Fe XXV He-α and Fe XXVI Ly-α emission lines, indicating the presence of highly ionized gas. The best fit for the observation data was obtained for the model consisting of comptonization emission, partial absorber for neutral gas, partial absorber for ionized gas and photoionization emission. The spectral properties from this fitting reveal the existence of obscuration. These results support the current obscured state of GRS 1915+105 and indicate that the source of obscuration could be thick dense gas or a clumpy accretion disk.

Isolated Neutron Stars and other soft-sources in eROSITA super-soft X-ray catalog

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eROSITA onboard the "Spectrum-Roentgen-Gamma" (SRG) mission provides a much higher sensitivity, better spatial and spectral resolution compared to its predecessor ROSAT, and has boosted the number of detected X-ray sources[1] by a factor of about 25. This provides us with a unique opportunity to unveil, among other soft X-ray emitters, X-ray dim isolated neutron stars (XDINS)[2]. XDINS are classified as neutron stars, powered predominantly by cooling. These are nearby (< 1 kpc) sources, known for their soft blackbody-like spectra with X-ray-to-optical flux ratios in excess of 10^3 and without signs of non-thermal emission.
The current source detection scheme for eROSITA All-Sky Survey (eRASS) in the 0.2-2.3 keV band is optimized to detect mildly hard X-ray sources as completely as possible and with least possible contamination of spurious sources[3]. It misses, however, extremely soft sources. The new approach presented here is based on extensive X-ray simulations[4], aimed at optimizing the energy bands for detecting XDINS and other (super-) soft sources.
The new processing is applied to both the eRASS data and the calibration performance verification phase (CalPV) data to develop a new catalog of eROSITA soft sources that have so far been undetected in the standard processing. Various source classes will benefit from the super-soft catalog: XDINS, white dwarfs, cataclysmic variables, and NLS1 AGNs.

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eROSITA X-ray Census of the Young Nearby Stellar Moving Group Tucana Horologium

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Observations of young nearby moving groups provide valuable laboratories of pre main sequence stars, and for the search of exoplanets around young stars. A marked property of young stars is enhanced X-ray activity. The Roentgen Survey with an Imaging Telescope Array (eROSITA) all sky survey (eRASS) provides the area coverage required to probe this radiation with a sensitivity 20 times larger than the ROSAT all sky survey.

We have established a membership list of the 40 Myr old Tucana Horologium association (THA) from the Montreal Open Cluster Association (MOCA) database. THA (d~45 pc) is one of the largest stellar associations within 100 parsecs. Using updated kinematics and radial velocities, we created a 'clean' list of high probability members using the BANYAN Σ algorithm.

The 'clean' catalogue includes 175 stars, out of which 151 are found to have an eRASS:5 X-ray counterpart. Using spectral fitting of X-ray spectra, energy conversion factors were obtained for 10 representative stars of various spectral types. These were used to obtain the X-ray luminosities of fainter stars. Combining this with the upper limits for the undetected THA members, the X-ray luminosity function is constructed. Moreover, the L_X/L_{bol} ratio is used to compare the X-ray activity level of the THA to that of other field star samples observed with eROSITA.

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Multi-Mission Broadband Spectral–Timing and High-Resolution X-ray Spectroscopy of GX 339-4 During the 2023 Outburst

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We present a multi-mission spectral–timing study of the black hole low-mass X-ray binary GX 339-4 during its 2023 outburst using coordinated observations from XMM-Newton, NICER, NuSTAR, AstroSat, and INTEGRAL. Three representative epochs are selected from eight observations to trace the spectral evolution across different accretion states. The broadband spectra are well described by a combination of multi-temperature disk emission, thermal Comptonization, and relativistic disk reflection. The first two epochs, corresponding to intermediate states, show strong Comptonized emission together with an increase in inner disk temperature toward the outburst peak. The second epoch, near the peak and simultaneously observed by NICER, AstroSat, NuSTAR, and INTEGRAL, provides broadband coverage of ~0.6–200 keV, enabling tight constraints on the continuum and reflection properties. Power spectral analysis using NICER, AstroSat/LAXPC, and NuSTAR reveals a persistent ~4.6 Hz low-frequency QPO during this epoch. NICER energy-dependent lag measurements indicate evolving coronal geometry and disk–corona coupling. In the final epoch, improved soft X-ray sensitivity from XMM-Newton reveals a disk-dominated spectrum with a strongly reduced coronal contribution, consistent with the soft state. In addition to the broadband analysis, we perform high-resolution spectroscopy using the XMM-Newton RGS, where several narrow features are detected in the soft X-ray band, providing further insight into the accretion environment.

Accretion from massive stars: unravelling the spectrum from radio to X-rays

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Roughly half of the population of known X-ray binaries are High-mass X-ray binaries (HMXBs): systems where the compact object accretes from the wind of a massive companion star. This mode of mass transfer differs fundamentally from the Roche-lobe overflow that dominates in systems with a low mass donor star, leading to distinct characteristics in their X-ray emission. The same is the case in other observing bands. However, while low-mass X-ray binaries have been explored extensively across their entire SED, large swats of HMXB SEDs remain poorly characterized. In this poster, I will present our current views of the emission from HMXBs from radio, via (sub-)mm, optical and UV, to the X-rays. I will discuss the challenges in successfully observing and interpreting HMXBs at the lowest frequencies, and show why we now believe that these bands are fully dominated by stellar wind emission. I will also show how the complete multi-wavelength picture can provide completely new views of the stellar wind parameters and fundamental accretion properties, such as the accretion efficiency in Supergiant Fast X-ray Transients. Finally, this poster will focus on future research directions and discuss how upcoming facilities in the next decades can move these studies from the edge of feasibility to the mainstream.

Long Term Star Formation in M82 with e-MERLIN and the EVN

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Centimetric-wavelength observations open a uniquely unobscured window onto compact radio sources such as supernova remnants (SNRs), bypassing the severe dust extinction that limits optical and infrared studies. Radio observations enable long-term monitoring of SNRs as their expanding shells interact with the interstellar medium (ISM). Notably starburst galaxy, M82 (SN rate 10 times that of the Milky Way) provides the ideal landscape (dist=3.6 Mpc, linear scale=0.017 pc/mas) to study a large population of radio SNRs.

M82 has been extensively monitored across almost 5 decades with high-resolution radio interferometers including e-MERLIN and the EVN, which has identified unusual sources, such as a potential radio counterpart to intermediate black hole candidate (IMBH) and ultra-luminous X-ray source M82 X-1 [1] and a vast collection of SNRs, HII regions and transient sources.

I present new high-resolution (~50 mas) e-MERLIN imaging of M82's central region from 2015-2016 at 5 and 6 GHz, reaching a sensitivity of ~6 μJy beam. Combined with an archival flux catalogue of known SNRs and compact radio sources, these data reveal short- and long-term variability across five decades of monitoring. I will also be developing an archival Chandra X-ray catalogue of compact sources in M82 to enable systematic radio and X-ray comparisons. This will help constrain objects such as the IMBH candidate M82 X-1 and improve our understanding of how compact remnants influence feedback and star formation.

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Assessing the Effects of Comptonization on Black Hole Spin Estimates for LMC X-1

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The black hole candidate LMC X-1 is a persistently soft-state high-mass X-ray binary that exhibits an unusual luminosity–temperature relationship, and its inferred spin is strongly model-dependent due to assumptions about disk structure. To investigate the role of Comptonization in shaping its thermal continuum, we analyze 10 Chandra-High Energy Transmission Gratings (HETG) observations of LMC X-1 using the Comptonization model `eqpair` as our primary spectral description. The model provides good fits to the broadband continuum (we include absorption and emission features to model narrow features detected by the HETG) while also reproducing the unusual normalization–temperature trend. This suggests that scattering in a warm, optically thick layer may play an important role in this system. To further assess the presence of a warm scattering layer, we explore whether the spectra can be jointly described with a Comptonized disk model with a consistent set of parameters (e.g., black hole spin) by fitting spectra with a `thcomp` $\times$ `kerrbb` model. These models yield a moderate spin ($a^* \approx 0.5$) and a variable color-correction factor ($f_c \approx 1.7$–2.0), highlighting the extent to which the inferred disk properties depend on the adopted treatment of Comptonization. As a data cross-check, we further apply these models to XMM-Newton observations of LMC X-1 to test whether the same Comptonization-based interpretation remains consistent across instruments.

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A framework for the characterization of Galactic and extragalactic X-ray binaries

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The characterization of X-ray binaries in terms of their donor star, compact object and accretion state is important for studies of their populations and compact-object demographics. We present a framework for the classification of X-ray binaries in Galactic and extragalactic environments based on their multi-wavelength counterparts, the stellar populations in their vicinity, and their X-ray emission. For the characterization of the compact objects and the accretion state we develop a machine-learning tool that is trained on an extensive set of X-ray observations of Galactic X-ray binaries covering accreting black holes, pulsars and lower magnetic-field neutron stars in different accretion states. We explore combinations of X-ray hardness ratios and/or luminosities in different bands. In addition, for the characterization of the accretion state we develop a general set of prescriptions based only on X-ray spectroscopic data which we then use to train our machine-learning classifier. The combination of the two classifiers (one for the classification of the compact object and one for the accretion state) gives excellent performance (more than 90% recall rate). The use of hardness ratios allows the classification of faint X-ray sources observed in other galaxies. These diagnostic tools together with multi-wavelength information fully characterize the X-ray binaries and hence they can be used for X-ray binary demographics, studies of their evolution, and formation rate in different stellar environments.

The soft X-ray all-sky map and supernova remnants observed with the lobster-eye focusing wide-field telescope onboard the Einstein Probe

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The Einstein Probe Wide-Field Telescope (WXT), leveraging lobster-eye optics, reinvigorates the second generation of soft X-ray imaging all-sky surveys. With an angular resolution of 5 arcmin and nearly one order of magnitude improvement in GRASP (effective area x FOV) compared to earlier all-sky survey missions in the soft X-ray band, WXT is an efficient instrument for observing the X-ray sky and mapping hot diffuse gas in our Galaxy. We will introduce the WXT X-ray all-sky map and highlight several intriguing large-scale structures. We will more focus on the study of a few large supernova remnants (SNRs) and SNR candidates identified with the EP-WXT and the EP-FXT (follow-up X-ray telescopes).