MAX PLANCK INSTITUTE
FOR EXTRATERRESTRIAL PHYSICS

Press Release

EMBARGOED UNTIL **APRIL16** 2026 **8PM CET**

Space Telescope Studies Solar System X-ray Glow

SRG/eROSITA reveals how our Solar System modifies the appearance of the X-ray sky

Isolating the Solar System's X-ray Signature

MPE scientists have been able to disentangle the X-ray glow originating in our Solar System from similar emission reaching us from deep space, using data from the SRG/eROSITA space telescope. Four sky maps obtained between 2019 and 2021 from a vantage point ~1.5 million km from Earth—approximately four times the Moon's distance—enabled the extraction of solar-wind charge exchange (SWCX) emission.

This achievement provides the clearest view to date of the soft X-ray sky (below 1 keV). It also redefines the SWCX glow, previously considered just a signal interference, as an observational tool that enables studies of the heavy ion content of the solar wind across all latitudes, its variation with solar activity, and its interaction with the interstellar medium.

The Source of the Soft X-ray Glow

The X-ray glow arises when highly charged solar wind ions like carbon and oxygen capture electrons from neutral atoms, which are present in Earth's upper atmosphere (the so-called geocorona) and in the whole Solar System (the heliosphere). The result is a ubiquitous foreground signal that affects virtually every study of the diffuse soft X-ray sky, from the hot plasma surrounding the solar neighbourhood (the Local Hot Bubble) and the halo of our Milky Way to the outskirts of distant galaxy clusters, where it can skew temperature and density measurements—key data for cosmological models. An accurate determination of the SWCX glow is therefore critical, and until now has been only partly successful.

eROSITA's Observational Advantage

The space telescope SRG/eROSITA has enabled this fundamental advance through two distinctive observational capabilities. First, its unique location around the second Lagrange point (L2) avoids the X-ray glow of the geocorona that affected previous observations. Second, it has conducted four complete sky surveys, spanning from solar minimum through rising solar activity, enabling researchers to track changes in the X-ray sky over time. By comparing observations across varying solar activity levels, the team led by Konrad Dennerl isolated the heliospheric component and reconstructed the soft X-ray sky as it would appear when observed from outside the Solar System. Yet eROSITA's achievements extend beyond merely

removing contamination: the SWCX emission itself could be utilized as a valuable signal.

Tracking Solar System X-ray Emission Across the Solar Cycle

The data reveal a clear evolution of heliospheric X-ray emission across the solar cycle. During solar minimum, emission is weak and confined to low latitudes. As solar activity increases, emission intensifies and expands to higher latitudes. This confirms what earlier spacecraft measurements had indicated: a polar hole, a region of reduced X-ray emission at high latitudes caused by less ionized fast solar wind, should be present near solar minimum and then gradually close. “This is like watching the Solar System breathe in X-rays,” explains Gabriele Ponti, who had first noticed the time-varying emission in a specific sky field.

A Stationary X-ray Source Near Earth’s Orbit

Further analysis revealed a localized region of enhanced X-ray emission near Earth’s orbit that does not revolve around the Sun—seemingly defying orbital mechanics. The explanation lies in an interstellar breeze. As our Solar System moves through the Galaxy, gas containing helium atoms flows through it. The Sun's gravity bends their trajectories, creating a concentrated stream on the downwind side—the helium focusing cone, predicted since the 1970s. Previous evidence came from spacecraft measurements of interstellar helium and ultraviolet observations, but X-ray detection attempts had not yet yielded unambiguous results. With eROSITA, scientists mapped the cone without prior assumptions about its location, just by analyzing X-ray emission patterns from different vantage points.

Modeling the Spatially and Temporally Variable X-ray Glow in Three Dimensions

Using solar wind measurements and interstellar matter data, researchers modeled the three-dimensional, time-resolved SWCX volume emissivity. This enabled computation of the expected X-ray glow as seen from eROSITA's perspective, showing good overall agreement with observations. The modeling revealed that the emission at any moment predominantly originates from spiral structures created by varying solar wind speeds, primarily within Mars' orbit. We see them as X-ray enhancements projected onto the sky, exhibiting distinct temporal signatures ranging from hours to days, depending on viewing direction. Only when averaged over multiple days does the helium focusing cone become clearly visible.

A Paradigm Shift in Soft X-ray Astronomy

The findings represent a paradigm shift in soft X-ray astronomy, redefining what was considered a contaminating nuisance into a powerful diagnostic tool. “Tracking how the solar wind modifies the appearance of the X-ray sky over time not only allows us to clean up observations of the distant universe but also provides unprecedented insights into solar physics and heliospheric dynamics,” notes Konrad Dennerl, one of the discoverers of cometary X-ray emission in 1996, which provided the explanation of the soft X-ray glow. “Understanding our Solar System’s X-ray emission is the key to properly interpreting observations of the diffuse X-ray sky.”

The findings underscore the importance of considering Solar System processes when analyzing X-ray data, and highlight eROSITA’s role in advancing both heliophysics and astrophysics.

Contact:

Dr. Konrad Dennerl | +49 89 30000-3862 | kod@mpe.mpg.de

Dr. Gabriele Ponti | +49 89 30000-3572 | ponti@mpe.mpg.de

Dr. Xueying Zheng | +49 89 30000-3527 | zhengxy@mpe.mpg.de

About MPE:

The Max Planck Institute for Extraterrestrial Physics (MPE) investigates physical and chemical processes in the universe – from the formation of stars and planets to the origins of life.

This press release is also available at: www.mpe.mpg.de/.../press_releases

The research paper appears in Science:
https://www.science.org/doi/10.1126/science.adt914

Media Contact:

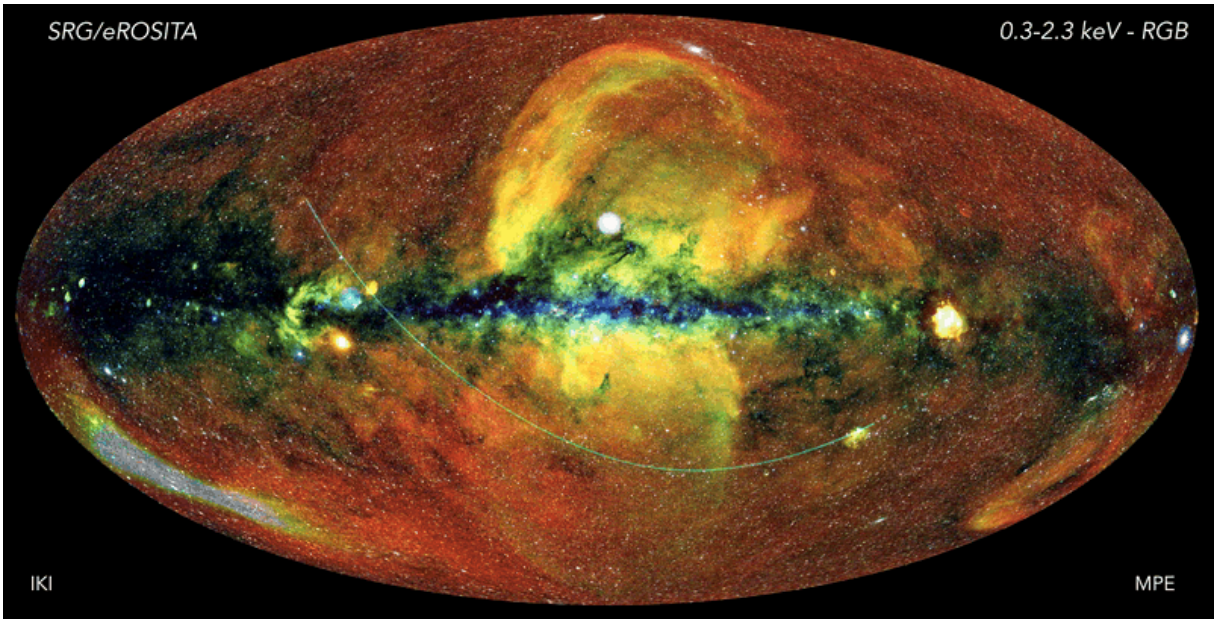
Isabelle Kessler

Press Officer

Phone: +49 (0)89 30000 - 3980

E-Mail: pr@mpe.mpg.de

Max-Planck-Institute for Extraterrestrial Physics
Giessenbachstrasse 1
85748 Garching
Germany
www.mpe.mpg.de



Reconstruction of how the diffuse X-ray sky should have appeared to eROSITA from May to October 2021. At any given moment, eROSITA has observed only a 1° wide field along its

scanning direction, which is indicated by a cyan curve. Each 360° scan took 4 hours and was done approximately perpendicularly to the direction of the Sun, which is located in the overexposed moving region. See https://www.mpe.mpg.de/7461950/erass1-presskit for information on the underlying sky image. © K. Dennerl, J. Sanders, H. Brunner & the eSASS team (MPE); E. Churazov, M. Gilfanov (IKI)