



# XMM-Newton survey of the SMC: The point source catalog



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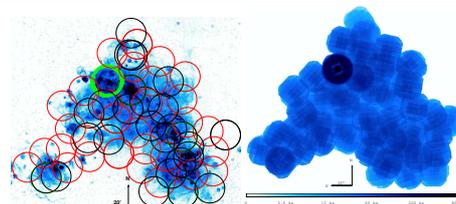
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## Summary

The XMM-Newton large-program survey of the Small Magellanic Cloud (SMC) [1,2] in combination with archival observations, reveals more than 3000 sources [3] in a field of 5.7 deg<sup>2</sup> covering the SMC main body (the bar and eastern wing). This is a significant improvement compared to the 70 sources detected by Einstein in the 1980s and 563 by ROSAT in the 1990s. The SMC offers a unique possibility to investigate the X-ray source population of a galaxy as whole. The small distance of ~60 kpc and the low Galactic foreground absorption of the SMC enables us to study complete X-ray source populations, like supernova remnants (SNRs), high mass X-ray binaries (HMXBs) and super soft X-ray sources (SSSs) in a low metallicity environment. This is contrary to the Galaxy, where most sources are obscured by large amounts of absorbing gas and where uncertainties in distances complicate the determination of luminosities, or to more distant galaxies, where spatial confusion of individual X-ray sources becomes complicated and only the brightest X-ray sources can be detected (e.g. for M31,  $L_X \gtrsim 10^{35}$  erg s<sup>-1</sup>).

## The Data

- SMC survey data  
33 observations (1100 ks)
- Archival data  
34 observations (750 ks)
- Calibration observations  
28 observations (850 ks)



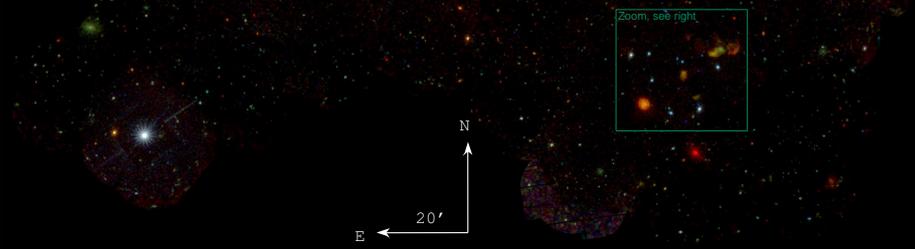
Left: H $\alpha$  image of the SMC overlaid with observed fields. Credit: F. Winkler/Middlebury College, the MCELS Team, and NOAA/AURA/NSF  
Right: Combined EPIC exposure map. EPIC MOS is weighted by 0.4 to account for the smaller effective area.

## XMM-Newton EPIC colour image of the SMC

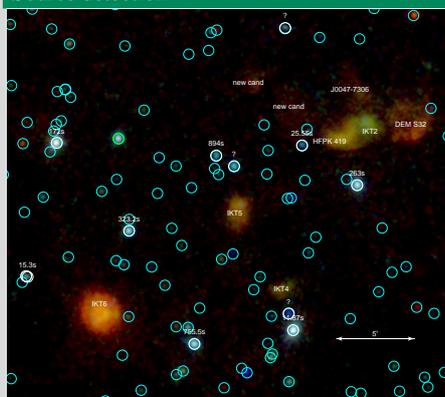
The mosaic EPIC colour image of the SMC reveals more than 3000 point sources. In addition several supernova remnants, clusters of galaxies, and diffuse emission is seen. In the zoom-in on the right, detected point sources are marked by blue circles and pulsars and SNRs are labelled in white. The moon demonstrates the size of the field.



- (0.2–1.0) keV
- (1.0–2.0) keV
- (2.0–4.5) keV



## Source detection

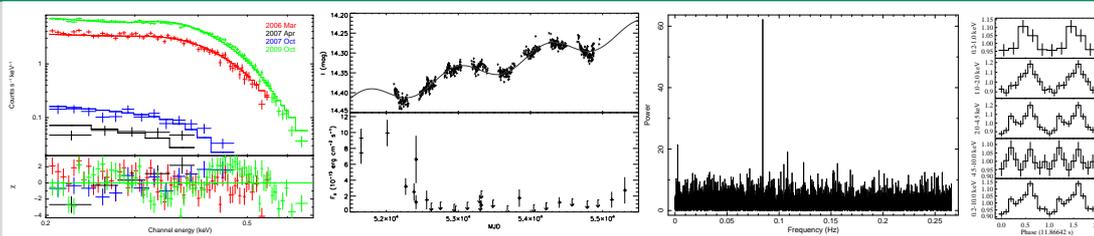


## Source classification

Class	identified	classified
HMXB	55	27
SSS	4	7
AGN	46	1771
fg-star	3	93

- HMXB are remarkably frequent in the SMC [5,6]. The survey enables us to study a complete population. HMXB can be used to estimate the star formation rate [7].
- SSS are explained by thermonuclear burning on the surface of a white dwarf. The low foreground absorption enables the study of these sources in the SMC.
- AGN behind the SMC provide a reference frame for proper motion studies and might be used to probe the absorption by the interstellar medium of the SMC.

## Examples for data analyses of individual sources

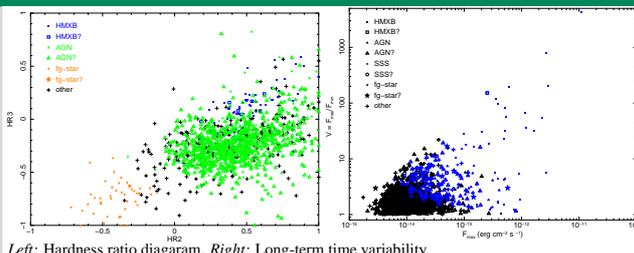


Examples for different types of source products. Left: Spectral analysis of the symbiotic nova SMC3 at 4 different epochs [8]. Middle: Long-term X-ray light curve (lower panel) of a new discovered SSS compared with the 1-band light curve of the optical counterpart from OGLE III [9]. Right: Power density spectrum and folded pulse profile of the new discovered Be/X-ray binary pulsar with 11.86642(17) s spin period [10].

## Catalog characterisation

- 5236 detections of 3053 individual X-ray sources
- 927 sources are detected more than once
- Some sources are detected up to 34 times
- ~ 500 detections have sufficient statistics for detailed spectral and timing analysis
- position accuracy: 1.42'' (using astrometric correction)
- 6433 upper limits for non-detections
- exposure: ~10–30 ks (average), ~600 ks (maximum)
- complete to 10<sup>-14</sup> erg s<sup>-1</sup> cm<sup>-2</sup> in the (0.2–4.5) keV band corresponding to 4.3 × 10<sup>33</sup> erg s<sup>-1</sup> for the SMC

## General characteristics of the dataset



Left: Hardness ratio diagram. Right: Long-term time variability.

## References

- [1] Haberl & Pietsch 2008, in X-rays From Nearby Galaxies
- [2] Haberl et al. 2011, in preparation
- [3] Sturm et al. 2011, in preparation
- [4] Pietsch et al. 2004, A&A 426, 11
- [5] Haberl et al. 2008, A&A 489, 327
- [6] Coe 2005, MNRAS 358, 1379
- [7] Antoniou et al. 2010, ApJ 716L, 140
- [8] Sturm et al. 2011, A&A 529, 152
- [9] Sturm et al. 2011, in preparation
- [10] Sturm et al. 2011, A&A 527, 131