EXTraS
Exploring the X-ray Transient and variable Sky

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The EXTraS project

• Submitted in response to FP7-Space call for proposal, area SPA.2013.2.1-01 - Exploitation of science and exploration data
• Currently in Negotiation phase
• Expected Start of the project: 2014, January
• Duration: 36 months
• Coordinator: A. De Luca
• Consortium:
  – INAF (coordinator) – IASF-Mi, OA-Rm, OAB, OA-Ct, OA-Ts, IASF-Bo, OA-Pa
  – IUSS Pavia
  – CNR-IMATI Genova
  – University of Leicester (UK)
  – MPE Garching (Ge)
  – Erlangen Center for Astrophysics (Ge)
The project in two sentences

• The EXTraS project will harvest the temporal domain information buried in the serendipitous data collected by the EPIC instrument onboard the ESA XMM-Newton, characterize it and release it to the community in an easy-to-use form.

• A catalog of variable sources will be compiled, spanning more than eight orders of magnitude in time scale and six orders of magnitude in flux.
Rationale

• At soft X-ray energies (0.2-10 keV) narrow-field imaging telescopes are ways more sensitive than all-sky monitors

• dim X-ray variable srcs can be better spotted by systematic searches in their archival data

• Huge databases have been accumulated, time domain largely unexplored
Why XMM-Newton/EPIC

The powerful tool to study faint sources in the soft X-ray energy range (0.2-10 keV) due to its unprecedented combination of high sensitivity, large field of view, and good temporal and spectral resolution.

<table>
<thead>
<tr>
<th></th>
<th>pn</th>
<th>MOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>E range</td>
<td>0.1-12 keV</td>
<td>0.2-12 keV</td>
</tr>
<tr>
<td>FOV</td>
<td>R=15’</td>
<td>R=15’</td>
</tr>
<tr>
<td>Aeff @ 1 keV</td>
<td>1500 cm²</td>
<td>550 cm² (x2)</td>
</tr>
<tr>
<td>Δθ (FWHM)</td>
<td>5”</td>
<td>5”</td>
</tr>
<tr>
<td>Time res</td>
<td>73 ms</td>
<td>2.6 s</td>
</tr>
<tr>
<td>ΔE @ 1keV</td>
<td>85 eV</td>
<td>70 eV</td>
</tr>
</tbody>
</table>
Why XMM-Newton/EPIC

Slew speed is 90 degrees / hour
Exposure time on a source is ~10 s (max),
7 secs (average)
The EPIC database (13+ yr)

• Pointed observations

<table>
<thead>
<tr>
<th>instrument</th>
<th># obs</th>
<th>Total time</th>
<th>Ωtot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pn</td>
<td>9405</td>
<td>225 Ms</td>
<td>&gt;700 sqdeg</td>
</tr>
<tr>
<td>MOS</td>
<td>9405</td>
<td>232 Ms</td>
<td>&gt;700 sqdeg</td>
</tr>
</tbody>
</table>

• Slew data

>65% of the sky, growing
>20% of the sky with at least 2 scans
Ongoing EPIC serendipitous science efforts

• XMM-Newton serendipitous source catalog
  – 3XMM – to be released in 2013
  – Data up to Oct 2012 (6500 Obs, 650 sqdeg)
  – >340,000 unique srcs
  – typical (deepest) sensitivity limits
    • $f_X (0.5-2 \text{ keV}) \sim 3 (1) \times 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$
    • $f_X (2-10 \text{ keV}) \sim 1.5 (0.8) \times 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$
  – 83,000 srcs >300 cts
    • light curves (20 cts/bin, 10s min bin),
    • basic variability test,
    • FFT on binned light curve
Ongoing EPIC serendipitous science efforts

• XMM-Newton slew survey catalog
  
  – Release 6 (current)
  – data up to mid-2012, 61.8% of sky
  – >18,250 clean sources
  – typical sensitivity limits
    • $f_X (0.5-2 \text{ keV}) \sim 6 \times 10^{-13} \text{ erg cm}^{-2} \text{ s}^{-1}$
    • $f_X (2-10 \text{ keV}) \sim 3 \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$
  
  – No systematic characterization/cataloguing of variability
The EXTraS project

• Systematic search for transients down to the instrument time resolution
• Search and characterization of variability in about 150,000 srcs
• Search for pulsations down to P=0.2s in about 150,000 srcs
• Search for long-term variability in all srcs with multi-epoch observations

• MWL characterization of all new srcs
• Phenomenological classification based on spectral/temporal/MWL properties
• Compilation of a variable source catalog
• Release of new tools
Discovery space of EXTraS

- Explored in 3XMM
- Not explored in 3XMM
- Strong variability
- 3XMM: too few counts
- Impossible (pn time resolution)
Sensitivity (pn only)