Introducing XGA and DAXA, Two Python Modules to Streamline X-ray Astronomy

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With the imminent public release of eRASS-1 in September 2023, an unprecedented volume of X-ray sources are soon to be available for scientific exploits. Conducting science with such volumes can fast become unmanageable when dealing with the tedious intermediate processing steps in telescope specific software, switching between multiple programming languages, and keeping track of necessary files. Democratising Archival X-ray Astronomy (DAXA) and X-ray: Generate and Analyse (XGA) aim to shield the user from these troublesome commands in X-ray product generation and analysis from multi-mission X-ray data. These modules thereby make X-ray astronomy accessible to non-specialists, whilst also maintaining enough freedom for experts to make sophisticated choices about their data processing, all through these open source Python modules.

DAXA: Democratising Archival X-ray Astronomy

DAXA controls the generation of processed, multi-mission, and science-ready X-ray archives. Users may specify coordinates, ObsIDs and timeframes to obtain all available X-ray data for certain objects of interest, or simply acquire every observation for every compatible X-ray mission. DAXA provides a consistent interface to conduct cleaning processes for each telescope in the archive, with default arguments available, so that users may regulate these functions to their level of understanding.

Currently: DAXA supports XMM, eROSITA Early Data Release (EDR), and Chandra data acquisition, and XMM cleaning. ***Cleaning for eROSITA EDR will become available by July.***

In the Future: Full DAXA compatibility for XMM, eROSITA (EDR and eRASS), Chandra, NuSTAR, and ROSAT

XGA: X-ray: Generate and Analyse

XGA is the one stop module for all things X-ray product generation and analysis. For a known source, XGA will create images, exposure maps, rate maps, spectra, and annular spectra in a matter of a few lines of Python. High level analysis may also be conducted via XGA. For instance, XGA can obtain a hydrostatic mass for a galaxy cluster in less than 10 lines of Python. Similar to DAXA, XGA's functions contain a multitude of default arguments, allowing non-specialists access to high level data products, whilst simultaneously enabling experts the freedom to make more sophisticated choices in their analysis.

Currently: XGA supports XMM-Newton product generation and analysis, with most high level analysis relevant to galaxy clusters. ***We aim for eROSITA EDR compatibility by October.***

In the Future: XGA compatibility for as many X-ray Missions as possible, enabling multi-mission analysis. More analysis products available for other X-ray Sources

EXAMPLES OF CURRENT CAPABILITIES:

Acquire all eROSITA Early Data Release observations with DAXA

```
import daxa
from daxa.mission.erosita import eROSITACalPV
from daxa.archive import Archive

mission = eROSITACalPV()
archive = Archive(mission, name='all_eROSITA_EDR')
```

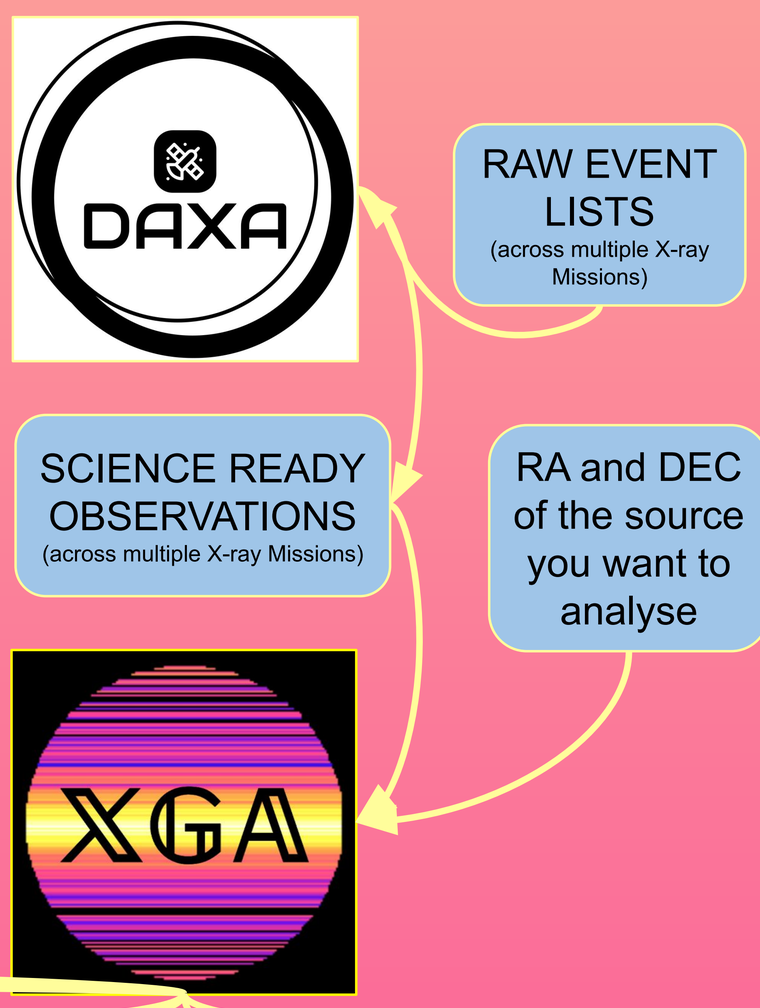
A Hydrostatic Mass of a Galaxy Cluster in 10 lines of Python with XGA

```
from xga.sources import GalaxyCluster
from xga.sourcetools.temperature import min_snr_proj_temp_prof, onion_deproj_temp_prof
from xga.sourcetools.density import ann_spectra_apec_norm
from xga.products.profile import HydrostaticMass

from astropy.units import Quantity, Unit

demo_src = GalaxyCluster(149.59209, -11.05972, 0.16, r500=Quantity(1200, 'kpc'), r200=Quantity(1700, 'kpc'),
                         name="A907")
deproj_temp = onion_deproj_temp_prof(demo_src, min_snr=35, outer_radii=demo_src.r500*1.2)[0]
dens_prof = ann_spectra_apec_norm(demo_src, min_snr=35, outer_radii=demo_src.r500*1.2)[0]
hym_prof = HydrostaticMass(deproj_temp, 'simple_vikhlinin_temp', dens_prof, 'simple_vikhlinin_dens',
                           deproj_temp.radii[1:], deproj_temp.radii_err[1:], deproj_temp.deg_radii[1:],
                           num_steps=40000)
mass_val, mass_dist = hym_prof.mass(demo_src.r500)
```

OUR FINAL GOAL:



Interested in trying XGA and DAXA? Visit https://github.com/DavidT3 for the repositories, and links to XGA tutorials.
Want to get involved? We are currently looking for people comfortable with Chandra cleaning to implement this into DAXA. We are also looking for astronomers to add analysis methods for AGN, and X-ray point sources into XGA. If you would like to offer your expertise, please don't hesitate to contact David at: turne540@msu.edu or Jessica at: J.Pilling@sussex.ac.uk