Detecting faint rapid transient sources with *Athena*

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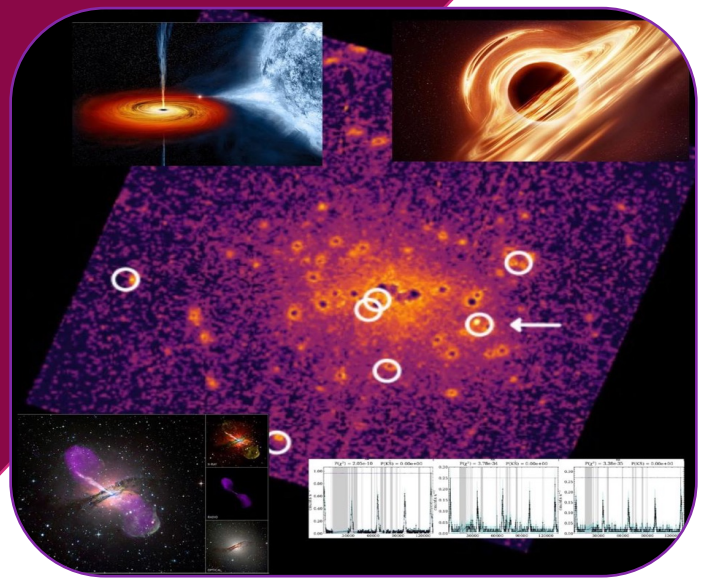

EXOD program output identifying the fast transients in a field of view. (credits: NASA/CXC/M.Weiss.; Getty Images.; NASA/CXC/CfA/R.Kraft et al.; NSF/VLA/Univ.Hertfordshire/M.Hardcastle; ESO/WFI/M.Rejkuba et al.)

The dynamic sky is a treasure trove of information, though it is relatively unexplored compared to the static sky. Variability in the X-ray band is one part of multiband time-domain astronomy that focuses on this transient sky. Searching for X-ray variability on the shortest possible time scales allow us to identify rare variable phenomena such as Quasi-Periodic eruptions (QPE), identify previously undetected compact objects, and help find variable AGN and even X-ray counterparts for events in other bands, such as Fast Radio Bursts (FRBs). To search for faint, short term variable sources we have developed the EPIC XMM-*Newton* outburst detector (EXOD) algorithm.

Though XMM-*Newton* was not built as a transient detector, the high sensitivity and time resolution of its European Photon Imaging Cameras (EPIC) allow it to record fast X-ray transients. Nevertheless, the detection of these transients and potential follow-up with other instruments depends on the sensitivity and performance of the variability detection pipeline.

Traditionally variable sources were identified by generating the lightcurves of all sources detected by the data processing pipeline. This is a very computationally intensive process, which sometimes fails to detect faint, short term variable sources.
In our algorithm, we compute the variability of the whole field of view of the detector. Since this process works independently of the source detection pipeline, we can detect very faint, short term variable sources which can be missed by the detection pipeline. Our algorithm computes the variability over the entire field of view and is much faster than generating light curves for each individual source.

The EXOD algorithm can be seamlessly extended to work on images produced by the ESA's Athena X-ray observatory WFI (Wide Field Imager) instrument. The WFI instrument is one of two complementary focal plane cameras, with a large 40' x 40' field of view and an excellent high count-rate capability. This will provide unprecedented simultaneous high-time resolution for the observation of bright sources with low pile-up and high efficiency. Similar to XMM, we will use EXOD in Athena to detect faint rapid transient sources for which time series would not otherwise be generated due to low counts, or whose source may, if generated, be drowned in background noise and thus not be identified by the pipeline. EXOD will also help identify objects whose variability timescales are shorter than the bin sizes, as they would otherwise be disregarded by the $\chi 2$ test which is generally used in the pipeline to identify variability. Employing EXOD will thus help identify new and exciting sources with Athena.

Founded by EU´s Horizon 2020 research and innovation programme GA nº 101004168