

# AGN accretion disks under the X-ray scanner

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**Parent Program: X-TrA** (PI: E. Nardini, 11 co-Is)  
*X-ray Emission and Absorption Transients in AGNs*

## Scientific Context

X-ray observations represent the best (and often unique) means to probe the conditions of matter in the innermost regions of AGNs. In particular, the various X-ray emission and absorption features imprinted on the intrinsic AGN continuum have a huge diagnostic value, as they typically arise very close to the central SMBH and they are thus expected to vary in strength, shape, and/or energy on timescales of the order of a few hours. However, these features are generally weak and/or unresolved, so that not only the analysis of their variability, but even their very detection is often challenging for current X-ray telescopes.

## Activities and Aims

The grant request was intended to support a specific and well-defined working package within the X-TrA program consisting of spectral simulations and analysis to verify the capabilities of *Athena*, whose official adoption by ESA was expected in 2023. An accompanying special issue of *Astronomy & Astrophysics* on *Athena* was planned with about 80 accepted contributions, three of which led by X-TrA team members:

- *AGN accretion disk fluorescence at high spectral and temporal resolution with Athena* (**WP1**, Nardini)
- *Accretion disk tomography using X-ray eclipses with Athena* (**WP2**, Kammoun)
- *Blueshifted absorption lines in AGN: disk or wind?* (**WP3**, Matzeu)

## Status of the project

The period leading to the start of the project saw a radical change of circumstances, with the decision by ESA to subject the *Athena* mission to further budget and performance assessment. This inevitably affects the development of the simulation work and publication output as foreseen in the original plan. For each of the aforementioned topics, several adjustments were made in due course as detailed in the following.

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## Spectral simulations

*Athena*-related simulations have been mostly performed as planned for both WP1 and WP2. Some of the results have been presented by the PI at international meetings (<https://zenodo.org/records/7357609>). As the A&A special issue will not be resumed in the short term, the work carried out so far is currently being converted to the newly launched X-ray satellite *XRISM*, which will provide for the first time a high spectral resolution in the Fe-K band and is still undergoing the performance verification phase. The objective is to obtain a publication dealing with the prospects of *XRISM* in this field in the next few months.

A simulation-based analytical effort that was not anticipated in the proposal has been devoted to explore the capabilities of the mission concept *HEX-P* (High Energy X-ray Probe), to be submitted in response to the NASA 2023 Astrophysics Probe Explorer Announcement of Opportunity. Specifically, given the larger effective area of *HEX-P* compared to the current *XMM-Newton*+*NuSTAR* synergy, the possibility to probe the variability of ultra-fast accretion disk winds on timescales of hours has been studied as a function of the instrument design. Preliminary results were shown at the HEAD meeting ([2023HEAD...2010801W](#)).

Most X-TrA members met for two days at INAF/IAPS to discuss possible strategies for *eXTP* in May.

## Critical Aspects

While a rescope version of *Athena* has just been endorsed by ESA, a major drawback this project has to face is the departure of the only co-I, G. Matzeu, who recently joined a private company, *Quasar Science Resources*, for a job with *XMM-Newton*-related duties in partnership with ESA. The PI has taken over the lead of the WP3 simulations, with the prospect of a publication independent on a specific X-ray mission.

## Publications

In the context of WP3, the search for overlooked targets in the public archives delivered a paper in press on A&A, [Disc wind or disc line? The extraordinary Fe-K feature of Mrk 1513](#): the first four authors (Middei, Nardini, Matzeu, Bianchi) are X-TrA members. Three other refereed papers closely related to the activities of the X-TrA program have been published in 2023.