爱因斯坦探针
einstein probe

EP Performance Verification (PV) Targets Recommendation Form

Submission Due Date: 27th October 2023

NOTE: Please do not change or delete the words marked in blue.

1. TITLE

Using Changing-look AGNs to verify the detection limit and energy resolution of FXT

2. ABSTRACT *(< 250 words)*

The discovery of "changing-look" Active Galactic Nuclei (CLAGNs) has recently deepened our understanding of AGN behavior. These CLAGNs exhibit correlated changes in X-ray flux corresponding to alterations observed in the optical spectrum. Furthermore, certain CLAGNs exhibited notable variations in their X-ray spectra, characterized by a pronounced increase in soft X-ray emission during periods of optical "turn-on" phase. Long-term monitoring of specific CLAGNs revealed an unexpected harder-when-brighter trend. These connections suggest that the physical property of the corona is related to the accretion flow of AGNs, impacting our understanding of AGN accretion physics. To verify the capability of EP in AGN research, we propose studying three bright CLAGNs with significant variability recently: NGC4151, Mrk6, and 3C390.3. By integrating subsequent X-ray monitoring with optical spectra and ZTF light curves, our approach aims to analyze these intriguing CLAGNs' accretion states comprehensively.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
*Recommender' Name	Xue-Bing WU
*Recommender' Email Address	wuxb@pku.edu.cn
*Recommender' Expertise	Xue-Bing WU is an expert of the observational study of AGNs
*Recommender' STP(s)	STP1
Co-Recommenders	
*Recommenders' Names	Bing Lyu
*Recommenders' Email Addresses	lyubing@pku.edu.cn

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***Recommenders' Expertise**	Bing Lyu is an expert of X-ray data analysis of AGNs.
***Recommenders' STP(s)**	STP1

4. TARGET FORM

- **TARGET 1 *(mandatory)***

***Target Name**	NGC 4151			
***Target Type**	AGN			
***Target Coordinates**	***RA:**	12:10:32.579	***DEC:**	+39:24:20.63
***Expected Flux in 0.3-10 keV**	2.01e-10 erg/cm^2/s			
***Primary Instrument**	FXT			
FXT Configuration ***(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)***	**FXT-A**	window mode: Full-frame filter: Thin	**FXT-B**	window mode: Full-frame filter: Thin
***Exposure Time**	1200s			
Suggest Joint Observation with Other X-ray Telescopes	e.g. joint observation with Insight-HXMT, XMM-Newton, INTEGRAL, Swift			
Other remarks	Visible from March 1st to March 31st			
*Note: * mandatory items*				

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- **TARGET 2 and more…**

***Target Name**	3C 390.3			
***Target Type**	AGN			
***Target Coordinates**	***RA:**	18:42:08.99	***DEC:**	+79:46:17.127
***Expected Flux in 0.3-10 keV**	2.28e-11 erg/cm^2/s			
***Primary Instrument**	FXT			
FXT Configuration *(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)*	**FXT-A**	window mode: Full-frame filter: Thin	**FXT-B**	window mode: Full-frame filter: Thin
***Exposure Time**	1200s			
Suggest Joint Observation with Other X-ray Telescopes	e.g. joint observation with Insight-HXMT, XMM-Newton, INTEGRAL, Swift			
Other remarks	Visible from March 1st to March 12th			
*Note: * mandatory items*				

***Target Name**	Mrk 6			
***Target Type**	AGN			
***Target Coordinates**	***RA:**	6:52:12.251	***DEC:**	+74:25:37.46
***Expected Flux in 0.3-10 keV**	3.2e-11 erg/cm^2/s			

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***Primary Instrument**	FXT			
FXT Configuration *(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)*	**FXT-A**	window mode: Full-frame filter: Thin	**FXT-B**	window mode: Full-frame filter: Thin
***Exposure Time**	1200s			
Suggest Joint Observation with Other X-ray Telescopes	e.g. joint observation with Insight-HXMT, XMM-Newton, INTEGRAL, Swift			
Other remarks	Visible from March 1st to March 26th			
*Note: * mandatory items*				

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5. SCIENTIFIC AND TECHNICAL JUSTIFICATION
(< 2 pages in total for this session, including figures, tables and references)

- **Scientific Motivations and Values**

Active Galactic Nuclei (AGN) are highly energetic and compact regions at the centers of galaxies. Recently, a group of certain AGNs has been discovered, known as "changing-look" AGNs (CLAGNs), which undergo rapid shifts in their appearance within just a few years or even months, challenging our conventional understanding of AGN behavior. So far, hundreds of these CLAGNs have been identified, with potential causes including instabilities in the accretion disc (Ricci & Trakhtenbrot 2022) or rare events like tidal disruption events.

The X-ray observations are crucial to determine the origin of CLAGN events and understand the physical properties of the hot X-ray corona. Unlike the changing-obscuration events, which derived temporal variations in the line-of-sight column density (Risaliti et al. 2022), no significant changes in the line-of-sight NH were observed during most optical CL events. Instead, most CLAGNs exhibit correlated changes in X-ray flux corresponding to alterations observed in the optical spectrum. Some CLAGNs exhibited notable variations in their X-ray spectra, characterized by a pronounced increase in soft X-ray emission during periods of optical "turn-on" phase (Hirofumi & Chris 2018). Intriguingly, long-term monitoring of specific CLAGNs (e.g., Mrk 1018) revealed an analogy between the structure of accretion flows AGNs and X-ray binaries (Ruan et al. 2019), traced by the evolution of X-ray photon spectral index (Γ) and optical-UV to X-ray spectral index (α_{OX}) with luminosity. These connections suggest that the variation of the broad line region is related to the physical property of hot corona and the accretion flow of AGNs, impacting our understanding of AGN accretion physics. Besides, we could further study the mechanisms and associations between soft excess and the variation of broad emission lines using these extremely variable CLAGNs.

To conduct a detailed study of these optical CLAGNs, we have gathered data on around 300 confirmed cases with robust ZTF lightcurves (MacLeod et al. 2010; Runco et al. 2016). Our plan involves continuous optical spectroscopy monitoring for sources with violent variability using the 2.16-meter telescope. Here, we propose three AGNs of different types with large optical variability and sufficient brightness to acquire reliable X-ray data using EP. Two of these AGNs are radio-quiet, with distinct trends in their ZTF light curves: NGC 4151 has recently become brighter, while Mrk 6 has become fainter. 3C 390.3 is a well-known radio-loud AGN. Successful observation of these sources could verify the capability of EP in AGN research. By combining subsequent X-ray monitoring with optical spectra and ZTF light curves, we aim to analyze these intriguing CLAGNs' accretion states comprehensively.

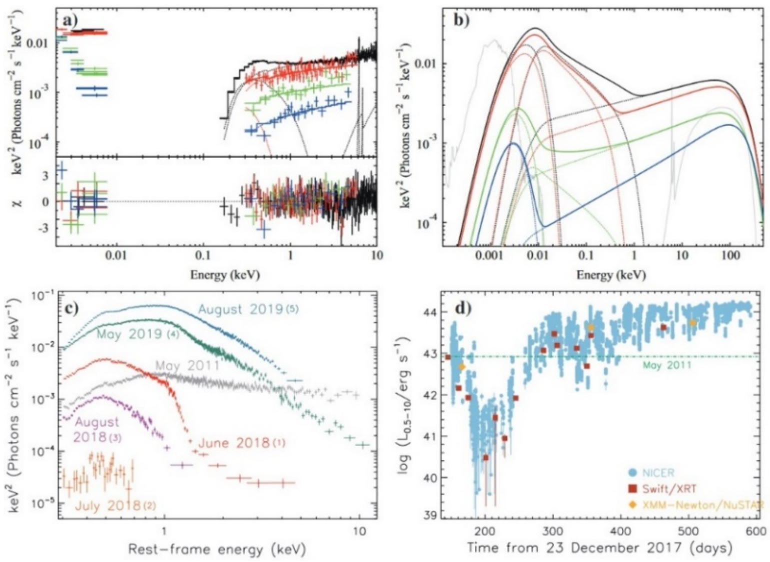

Figure 1: X-ray spectra and light curve of CLAGN. a) Optical, UV, and X-ray spectra of Mrk 1018 in different epoch. b) Fitting results of optical/UV and X-ray observations show an increasing soft X-ray component for increasing luminosities. c) Spectral evolution of 1ES 1927+654 showing the disappearance and reappearance of the power-law component after the CL event. d) 0.5–10 keV emission of 1ES 1927+654 shows extreme X-ray variability (Figure 5 in Ricci & Trakhtenbrot 2022).

- **EP Capabilities to be Verified**
  Einstein Probe could help us observe plenty of X-ray spectra of turn-on CLAGNs and obtain their corona properties. This proposal gives a good baseline to evaluate the performance of the physical properties of AGN, such as the luminosity variability, the X-ray photon spectral index (Γ), and the column density from the line of sight.
- **Immediate Objectives**
  1. Quantifying AGN Characteristics: Examining the X-ray spectra of AGNs to quantify Γ, α_{OX}, and n_H parameters.
  2. Understanding Accretion and Corona: Combining analysis for X-ray spectra and optical phases.
- **Technical Justification (e.g. target visibility during the PV phase)**
  Our targets are bright CLAGNs with large variability through the ZTF light curves. By assuming a 5100Å to bolometric luminosity and bolometric luminosity to X-ray scaling (Kaspi et al. 2005; Inoue et al. 2007), we estimated the 2-10keV flux of these AGNs, supposing a typical long-term X-ray variability amplitude of 20%–50%, a total time of about 1200s could get a spectrum with enough S/N (>20) for the X-ray phase analysis.
- **References**

Risaliti, G., Elvis, M. & Nicastro, F., 2022, ApJ, 571, 234
Ricci, C. & Trakhtenbrot, B., 2022, arXiv e-prints
Hirofumi, N. & Chris, D., 2018, MNRAS, 480, 3898
Ruan, J. J. et al., 2019, ApJ, 883, 76
MacLeod, C. L. et al. 2010, ApJ, 721, 1014
Runco, Jordan N. et al. 2016, ApJ, 821, 33
Kaspi, Shai et al., 2005, ApJ, 629, 61
Inoue, Hirohiko et al., 2007, ApJ, 662,860

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