爱因斯坦探针
einstein probe

EP Performance Verification (PV) Targets Recommendation Form

Submission Due Date: 15th October 2023

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

1. TITLE

Observation of the high mass X-ray binary pulsar GX 301-2 to verify the spectral resolution and energy scale of EP FXT

2. ABSTRACT *(< 250 words)*

GX 301-2 is a wind fed high mass X-ray binary (HMXB) pulsar with a wind fed donor thus exhibiting a plethora of fluorescent lines that can be used to verify the spectral resolution and energy scale of FXT. The neutron star in the binary system also exhibits pulsations which can be used to verify the timing capabilities of the source (which could be further endorsed by a near simultaneous XMM Newton observation to check the consistency between the spin periods). Study of the source during the peri-periastron flare passage when the source brightens, would allow one to study both the timing and spectral properties of the source and verify all the capabilities of EP FXT in a pointed observation.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
***Recommender' Name**	Chandreyee Maitra
***Recommender' Email Address**	cmaitra@mpe.mpg.de

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

***Recommender' Expertise**	Chandreyee Maitra is an expert of the observational study of XRBs and pulsars
***Recommender' STP(s)**	STP4
Co-Recommenders	
***Recommenders' Names**	
***Recommenders' Email Addresses**	
***Recommenders' Expertise**	
***Recommenders' STP(s)**	

4. TARGET FORM

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

***Target Name**				
***Target Type**	GX 301-2			
***Target Coordinates**	***RA:**	12:26:37.56	***DEC:**	-62:46:13.16
***Expected Flux in 0.3-10 keV**	1.e-9 erg/cm^2/s			
***Primary Instrument**	FXT			

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FXT Configuration ***(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)***	**FXT-A**	Full-frame *medium* filter	**FXT-B**	*Full-frame* *medium* filter
***Exposure Time**	40 ksec			
Suggest Joint Observation with Other X-ray Telescopes	XMM-Newton			
Other remarks	A 40 ks (near) simultaneous observation with XMM will be beneficial but not essential			
*Note: * mandatory items*				

- **TARGET 2 and more…**
  (optional, if there are more than one target in this recommendation, copy the entire target form above to the empty space below; note that this is only for the case that one observing proposal includes multiple targets; for targets of a different proposal with distinct technical and scientific goals, please submit them in separate proposals.)

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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**

The object of our study is a HMXB GX 301-2. GX 301–2 (also known as 4U 1223−62) is a high mass X-ray binary system (HMXB) containing an XRP with a period of ~680 s, one of the longest observed (White et al. 1976). In this system, accretion is normally fed by the wind from the hypergiant donor star, Wray 977. Spectral classification of the donor was used by Parkes et al. (1980) to measure the distance to the system of 1.8 kpc, however, Kaper et al. (1995) later obtained 5.3 kpc and latest distance estimates from Gaia indicate a distance of 3.5 kpc (Bailer-Jones et al. 2018).

The orbital period of the system is 41.482 ± 0.001 d (Doroshenko et al. 2010) with the orbit characterized by a high eccentricity of $e \sim 0.46$ (Koh et al. 1997). The regular and bright X-ray flares of GX 301−2 were found to occur ~1.4 d before the periastron passage, i.e., before the neutron star reaches the densest part of the stellar wind. The model to explain this indicates that the neutron star is trailed by an accretion stream, which it overtakes shortly before periastron. The source brightens close to 1 Crab during that part and produces a plethora of fluorescence lines of Fe, Ni, S, Ar, Ca, Cr (between 2-8 keV) due to the interaction of the neutron star with the dense accretion stream (Fürst et al. 2021). This makes it an ideal target to verify the spectroscopic capabilities of FXT with high S/N (since it is a bright state).

Moreover search for pulsations and determination of the spin period and the pulsed profile will help to verify the timing capability of FXT. No significant pile-up is expected from the source (< 10%).

- **EP Capabilities to be Verified**

1. Spectral resolution of FXT
2. Energy scale of FXT
3. Timing capabilities of FXT by searching for pulsations. In case a near simultaneous XMM Newton observation is scheduled, the absolute timing can be verified by comparing the spin period measurement and the precision.

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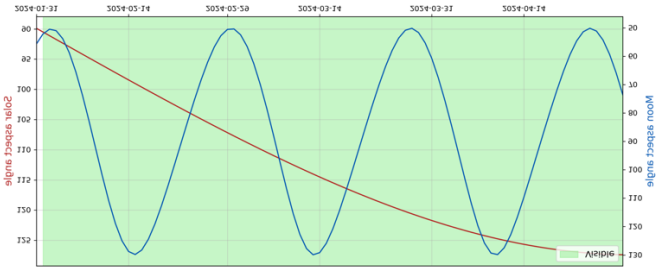
- **Immediate Objectives**
  (listed the main objectives of the recommended targets and observations)
  1. Extract spectrum from the source, verify flux calibration (favourable in case of near simultaneous XMM Newton), verify energy resolution and energy scale
  2. Extract light curve, power spectrum and search for pulsations

- **Technical Justification (e.g. target visibility during the PV phase)**

  Assuming a spectral shape from a previous XMM Newton observation (Fürst et al. 2010) and an observed flux of 1e-9 erg/cm2/s we predict an average FXT count rate of 2.8 c/s which is <7% of the pile-up limit in full-frame mode and medium filter. No optical loading is expected from the optical counterpart and there are no other bright sources in the field of view. A 40 ks observation is sufficient to achieve a very high signal to noise ratio (of comparable quality to the existing XMM Newton observation, Fürst et al. 2021) and will be ideal to achieve all the goals of the PV target.



The source is visible during the entire PV phase

- **References**

Fürst et al. 2021, 2011, A&A, 535A, 9F, Study of the many fluorescent lines and the absorption variability in GX 301-2 with XMM-Newton

Doroshenko et al. 2010, 2010, A&A, 515A, 10D, Is there a highly magnetized neutron star in GX 301-2?

White at al. 1976, ApJ, 209L, 19W, Periodic modulation of three galactic X-ray sources

Parkes at al. 1980, MNRAS, 191, 547P, A spectral study of Wray 977, the optical counterpart of the binary X-ray pulsar 4U 1223-62.

Koh et al. 1997, ApJ, .479, 933K, Rapid Spin-Up Episodes in the Wind-fed Accreting Pulsar GX 301-2

Kaper et al. 2006, A&A, 457, 595K, VLT/UVES spectroscopy of Wray 977, the hypergiant companion to the X-ray pulsar GX 301-2

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