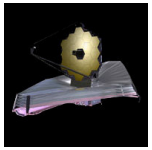

6980 - Probing dense matter with XMM and JWST observations of a neutron star in binary

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1		NIRCam Imaging	(1) NGC6397_QuiescentLMXB

ABSTRACT

Neutron stars (NSs) are unique sources to determine the dense matter equation of state (EoS). One method to do this consists in modelling the spectra of NSs in quiescent low-mass X-ray binaries (qLMXBs) in globular clusters (GCs). XMM-Newton can spatially resolve a few GC qLMXB and provide good spectra to measure the NS mass Mns and radius Rns. While known analysis assumptions may cause systematic biases (up to 40%), the development of new tools can now include these systematics in the error budget. To compensate for the resulting larger uncertainties, we propose deep XMM observations for the qLMXB in NGC 6397. Furthermore, observations of the binary companion with JWST will also constrain its type,

star or white dwarf, as needed to further reduce the uncertainties on Mns and Rns by ~50%.

OBSERVING DESCRIPTION

We propose to use JWST NIRcam to image the central part of the globular cluster NGC 6397. In particular, we are targetting the binary companion to the neutron star in a quiescent low-mass X-ray binary to determine the nature of this companion as it informs on the composition of the neutron star atmosphere (a key point to infer NS properties, such as its radius). The proposed JWST observations are designed to determine whether this binary companion with R=26.2 is a main sequence star or a white dwarf, the two possibilities mentioned in a previous work with HST (which barely detected the counterpart in the R band). The proposed JWST observation will also have an important legacy value, prompting us to wave our 12-month Exclusive Access Period.

The imaging will be done in two pairs of short+long wavelengths broad filters, F090W+F277W and F150W+F356W, with respective exposure times 3435 sec and 1889 sec, respectively. The BRIGHT2 readout mode was chosen for the first pair of filter, as a compromise between sensitivity to faint sources (including our target) and not saturating bright sources (to maintain the legacy value of the program - sources fainter than F090W=18 will not be saturated). For the 2nd pair of filters, we chose a BRIGHT1 readout was chosen to keep the data volume below the allowed limit, and because this was not changing the scientific goals.

We opted for 4 INTRAMODULEBOX with 4 SMALL-GRID-DITHER dither frames (total of 16 dithers). This will produce deep images for nearly the whole field and will sample the point spread functions well. The F090W+F277W set of filters will be exposed with 3 groups/integration and 3 integrations per exposure, again a choice to compromise between faint and bright sources. The F150W+F356W will be observed with 2 groups/integration and 3 integration per exposures.

A special requirement to offset the target's coordinate by X = -5" and Y = 15" is made to 1) ensure that the target will not fall in the chip gaps during the dither patternm and 2) to cover the globular cluster core without the chip gaps. There is no need for dedicated background observations as the total integration time is achieved by stacking multiple dithers and integrations, not by single long exposure. There is no requirement for the observations to be done in a particular time frame.

There is no requirement to perform the JWST observations simultaneously with the XMM observations.

Proposal 6980 - Targets - Probing dense matter with XMM and JWST observations of a neutron star in binary

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	NGC6397_QuiescentLMXB	RA: 17 40 41.4700 (265.1727917d)	Proper Motion RA: +3.5 mas/yr	
		Dec: -53 40 4.43 (-53.66790d)	Proper Motion Dec: -18.3 mas/yr	
		Equinox: J2000	Epoch of Position: 2005.6	

Comments: Location of the quiescent low-mass X-ray binary in the globular cluster NGC 6397. The position and uncertainties are known from the Chandra X-ray observations aligned to HST images obtained in June 2005 (Cohn et al. 2010). The proper motion has been determined from the GAIA proper motion of 2 stars within 2 arcsec of the target.
Category=Star
Description=[X-ray binary stars]
Extended=NO

Observation

Proposal 6980, Observation 1

Wed Apr 09 13:00:15 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 1:1) Warning (Form): Data Excess over lower threshold

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 1:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

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(1)	NGC6397_QuiescentLMXB	RA: 17 40 41.4700 (265.1727917d)	Proper Motion RA: +3.5 mas/yr	
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Category=Star
Description=[X-ray binary stars]
Extended=NO

Template

Module	Subarray
B	FULL

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	SMALL-GRID-DITHER		4

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F090W	F277W	RAPID	6	3	48	16	3435.766	
2	F150W	F356W	RAPID	3	3	48	16	1889.672	

Special Requirements

Aperture PA Range 300.05262691 to 325.05262691 Degrees (V3 300.0 to 325.0)
Offset 58.0 arcsec, 63.0 arcsec