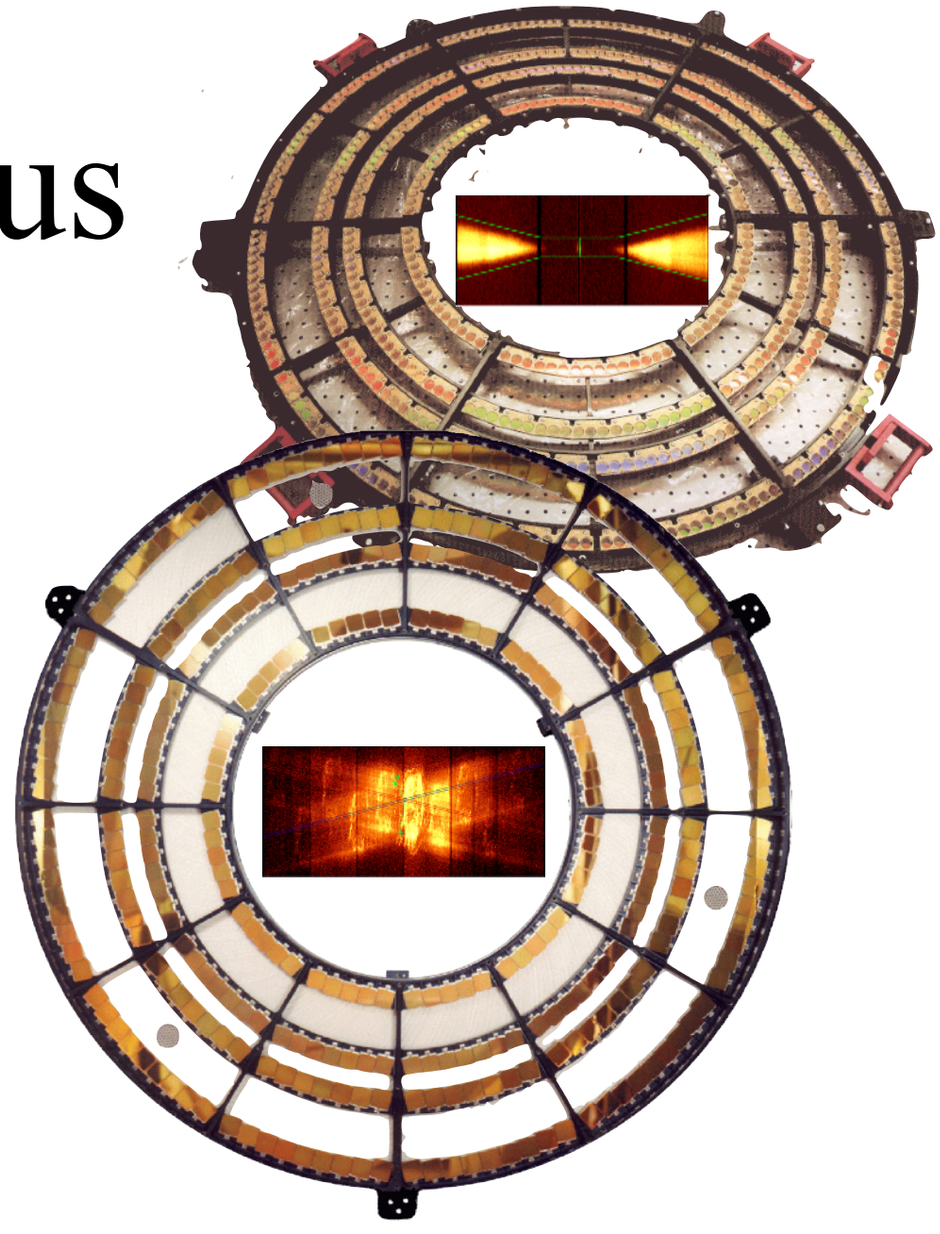
MIT KAVLI INSTITUTE

CHANDRA X-RAY OBSERVATORY

HETG/LETG — Status

Chandra Quarterly Review No. 55
16 May 2023

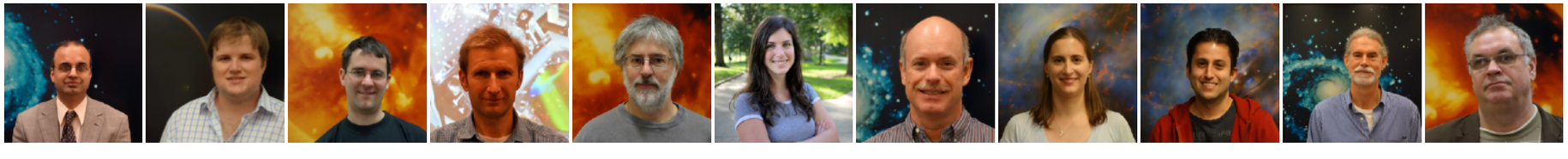
David Huenemoerder
dph@space.mit.edu



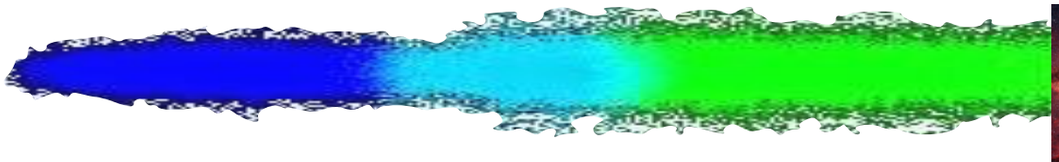
HETG IPI: Prof. Claude R. Canizares
MIT Kavli Institute

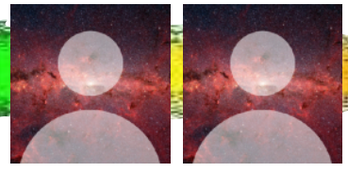
LETG IPIs: Dr. Peter Predehl
Max Planck Institute

Dr. Jelle Kaastra
SRON

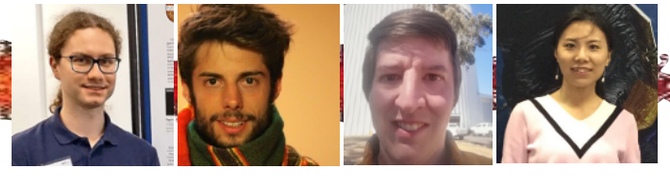


faculty, staff;





New 1 New 2



postdocs

... moving on ...

HETG GTO Science Program

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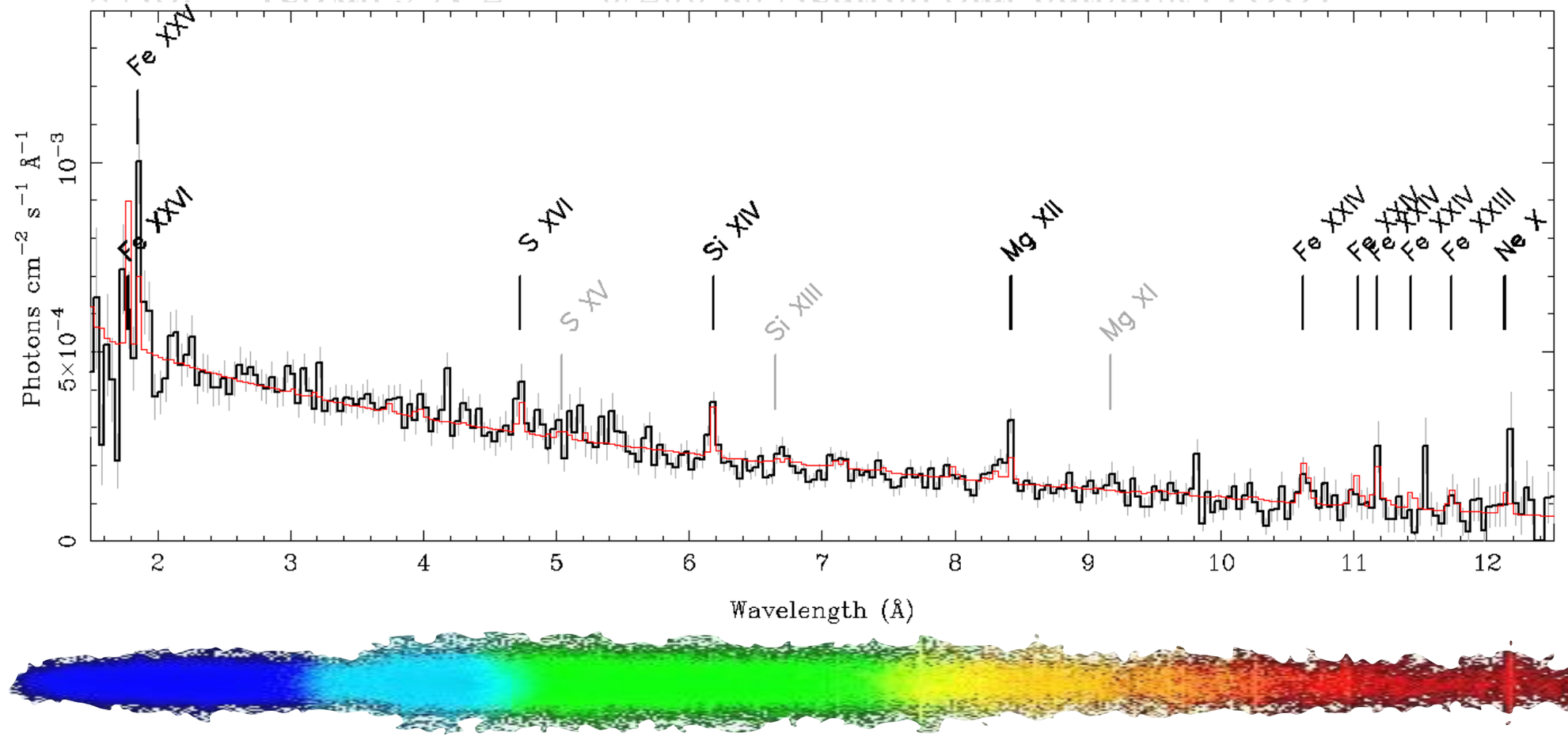
CHANDRA X-RAY OBSERVATORY

Proposal **Cycle 23** (448 / 648 ks)

★Stars:	π Aqr	101 ks	Winds of the hottest stars
★AGN:	Circinus Galaxy	69 ks	Emission lines, morphology, variability (IXPE-coordinated)
★XRB:	Cen X-3	20/62 ks	Eclipsing X-ray pulsar; accretion
★XRB:	4U 1626-67	86 ks	Ultra-compact binary; monitor Fe lines.
★XRB:	GX 1+4	25/90 ks	Low-mass XRB; accretion, Compton shoulder study.
★ISM:	GX 340+0	57/150 ks	Cosmic dust composition
★ULX/NS:	M33 X-8	90 ks	Pulsar wind outflow, absorption
★ULX:	LMC/SMC X-?	0/70 ks	Accretion disk outbursts (TOO)
★NS:	Terzan 5 X-2	0/200 ks	Neutron Star outburst (TOO)



Preview — π Aqr:

B-type giant star, rapidly rotating, binary Period = 84d.

X-ray spectrum: *extremely hot* : >100MK; weak H-like lines, few/no He-like lines, high-ionization Fe lines.

(*Not* a classical stellar wind.)

Jargon list:
AGN: Active Galactic Nucleus
BH: Black Hole
ISM: InterStellar Medium
NS: Neutron Star
SN: SuperNova
ULX: Ultra-Luminous X-ray source
SNR: SuperNova Remnant
XRB: X-ray Binary
LMXB: Low Mass XRB

HETG GTO Science Program (2)

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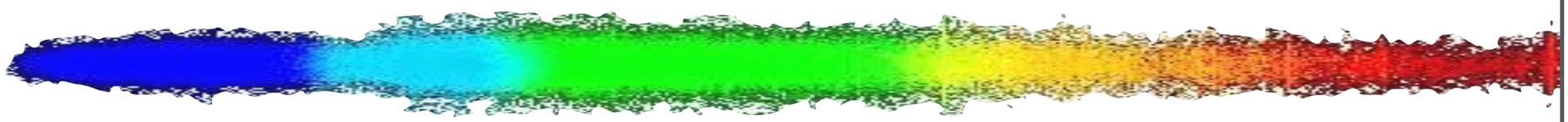
Proposal **Cycle 24** Jan 2023 (77 / 745 ks)

★XRB: 4U 1624-490 29/135 ks Accretion disk structure (with NuSTAR, XRISM)
★XRB: Cen X-3 48 ks Eclipsing X-ray pulsar; accretion (ongoing - low visibility)
★AGN: MCG-6-30-15 0/232 ks Time-dependent photoionisation modeling of outflows
★BH: SS 433 0/60 ks Relativistic jet physics (coordinated with HRC, Swift GO)
★ULX: LMC/SMC X-? 0/70 ks Accretion disk outbursts (TOO)
★NS: Terzan 5 X-2 0/200 ks Neutron Star outburst (TOO)

Proposal **Cycle 25** start Jan 2024 (705 ks)
TBD



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LETG GTO Science Program

MIT KAVLI INSTITUTE

CHANDRA X-RAY OBSERVATORY

Proposal **Cycle 22**: (215 / 354 ks)

★	Stars (Predehl/MPE)	RX J0859.1+0537	60 ks	Accretion onto white dwarfs (LETG/HRC-S)
★	Stars (Predehl/MPE)	RX J1002.2-1925	0/48 ks	Accretion onto white dwarfs (LETG/HRC-S)
★	AGN (Predehl/MPE)	HSC J092120.56+000722.9	21 ks	Confirmation of faint z=6.56 eROSITA Quasar (ACIS-S)
★	AGN (Predehl/MPE)	2MASX J09325962+0405062	50 ks	Confirmation of eROSITA Compton-thick Seyfert (ACIS-S)
★	AGN (Kaastra/SRON)	MR 2251-178	84/175 ks	Galaxy outflows, absorption line density diagnostics (LETG/HRC-S)

Proposal **Cycle 23**: (243 / 334 ks)

★	Stars (Predehl/MPE)	LTT 1445A	45 ks	High energy environments of terrestrial exoplanets (ACIS-S)
★	Stars (Predehl/MPE)	L 168-9	24 ks	High energy environments of terrestrial exoplanets (ACIS-S)
★	SNR (Predehl/MPE)	Hoinga	30/60 ks	Distance determination (HRC-I, ACIS-I)
★	AGN (Predehl/MPE)	WISEA J202040.85-621509.3	0/30 ks	Confirm eRosita detection of a z=5.9 quasar (ACIS-S)
★	Galaxies (Kaastra/SRON)	Abell 141	144/175 ks	Intercluster temperatures, merger history (ACIS-S)

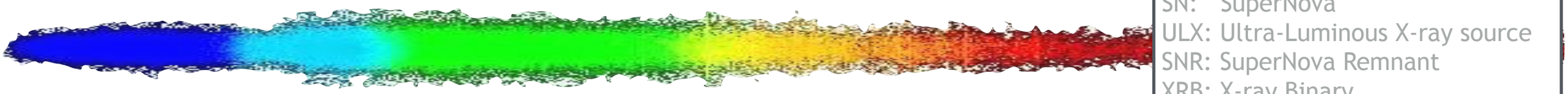
Proposal **Cycle 24**: start Jan 2023 (0 / 338)

★	AGN: (Predehl/MPE)	WISEA J050222.16-341201.6	0/25 ks	Luminous z>5.6 quasars from eROSITA (ACIS-S)
★	AGN: (Predehl/MPE)	WISEA J230341.02-542730.6	0/32	Luminous z>5.6 quasars from eROSITA (ACIS-S)
★	AGN: (Predehl/MPE)	WISEA J050411.92-254959.0	0/26	Luminous z>5.6 quasars from eROSITA (ACIS-S)
★	Galaxies: (Predehl/MPE)	eFEDSJ083933	0/88	Shocks in an eROSITA detected galaxy cluster (ACIS-S)
★	AGN: (Kaastra/SRON)	NGC 3783	0/166	Outflows, variability (with XRISM) (ACIS-S)

(Proposal Cycle 22 and 23 blue entries: now scheduled during 2023, observing cycle 24)

Proposal **Cycle 25** start Jan 2024 (361 ks)

TBD



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HETG/LETG Activities Summary

Performance November 2022 — April 2023

HETG/ACIS-S 462 ks

- 26 observations on 12 targets (15 GO, 9 GTO, 1 TOO, 1 DDT)

LETG 237 ks, 14 observations,

- 6 LETG/HRC-S observations, 2 targets (68 ks; 5 GO, 1 GTO)
- 8 LETG/ACIS-S observations, 1 target (169 ks; 8 Cal)

Grating performance is nominal.

http://tgcat.mit.edu

TGCat has 2630 extractions for 515 objects, in 2514 ObsIDs.
(1791 HETG, 839 LETG (549 HRC-S, 290 ACIS-S))
Total volume: 620 GB
Downloads (11/2022–4/2023): 147 packages, 111 GB; 2364 single-file, 450 MB

Maintenance: port to modern infrastructure (PHP, MySQL), new server continuing.

Calibration Updates

HETG 2nd and 3rd order efficiencies: in progress. Some oddities found in revised efficiencies (non-physical steps). Looking for a cause, e.g., possible bugs in CIAO high-order handling of cross-dispersion regions and lookup of CALDB enclosed energy fractions. (*Line spread functions* for high orders are fine; *fluxes* may have ~5% systematic errors.)

Line-spread-function parameters for HETG/HRC-I and off-axis pointings: in progress. CIAO code ("mkgrmf" has been updated and test CALDB files ("lsfparm") constructed. (HETG/HRC-I has been used for 0.5 keV lines like O VII, for which ACIS-S filter contamination is severe. Some serendipitous sources are >= 2 arcmin off-axis where the PSF grows rapidly.)

LETG/ACIS-S PSF anomaly: below 0.5 keV, the PSF FWHM has grown with time. Under investigation. This is independent of gratings, but HETG and LETG grating data are needed for diagnosis, via the ACIS frame-shift zeroth order streak (unpiled) for very bright sources, and via the very bright Mrk 421 dispersed Carbon-edge (0.25 keV) region.

Some Scientific Results Published in the Past 6 Months (1/2)

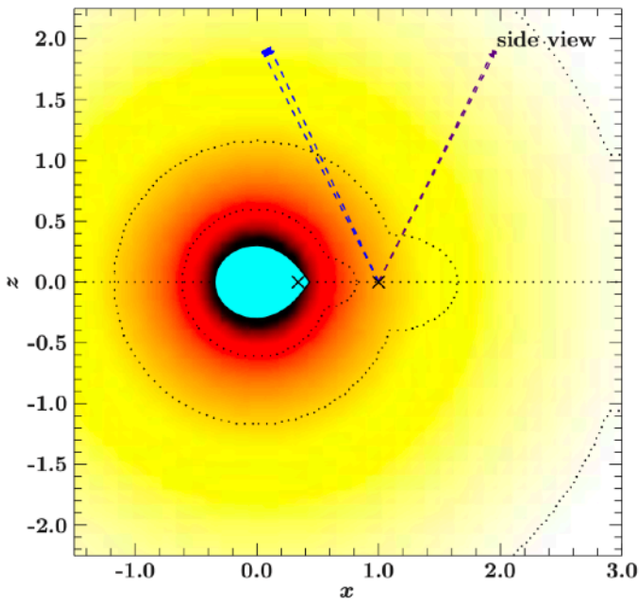
MIT KAVLI INSTITUTE

Stellar wind variability in Cygnus X-1 from high-resolution excess variance spectroscopy with Chandra

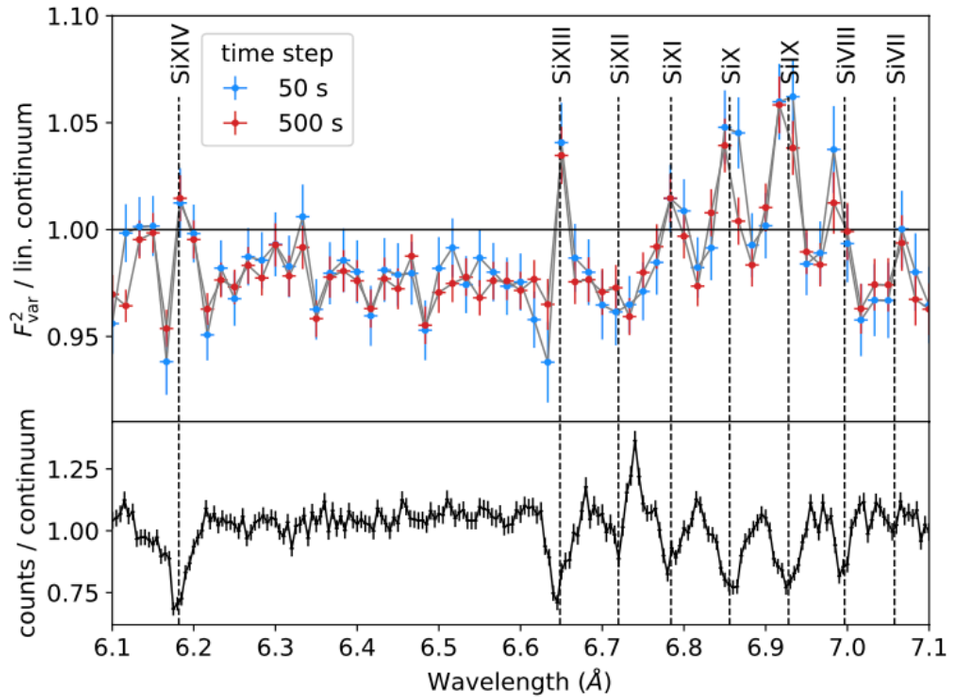
L. K. Härer[1,2,⋆], M. L. Parker[3], I. El Mellah[4,5], V. Grinberg[6], R. Ballhausen[7,8], Z. Igo[9], A. Joyce[1], and J. Wilms[1]

<https://ui.adsabs.harvard.edu/abs/2023arXiv230414201H/abstract>

Phase dependence gives different lines-of-sight through an inhomogeneous wind to the X-ray bright black hole accretion disk.

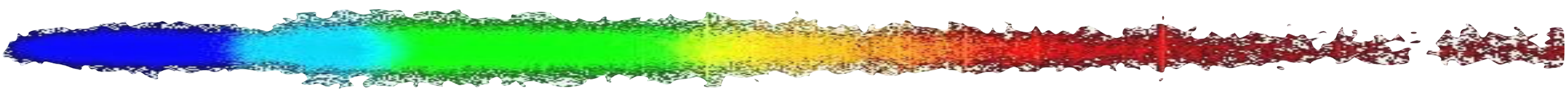


"Excess Variance Spectroscopy" combines spectral and timing information to detect and characterize over-dense clumps of absorbing silicon in the wind.



variance

counts



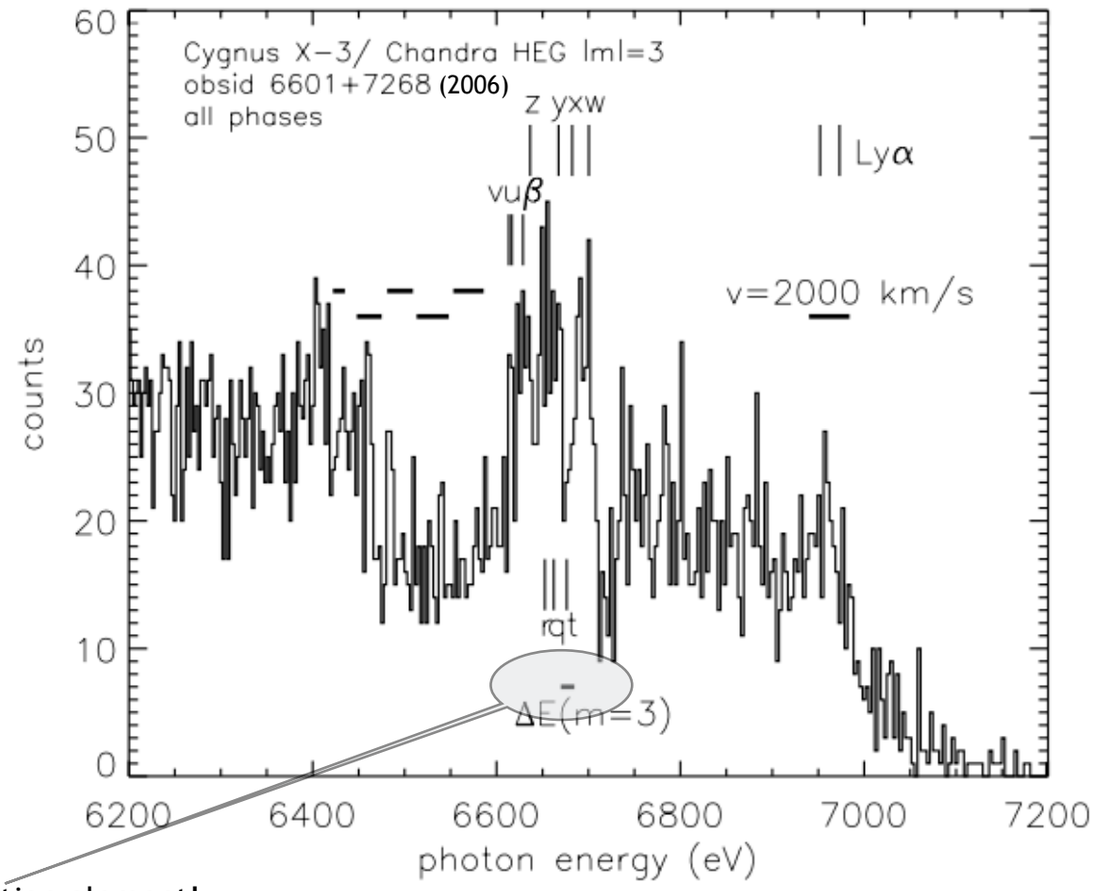
Some Scientific Results Published in the Past 6 Months (2/2)

MIT KAVLI INSTITUTE

The High resolution Fe K Spectrum of Cygnus X-3

ASWATH SURYANARAYANAN,[1] FRITS PAERELS,[1] AND MAURICE LEUTENEGGER[2]

<https://ui.adsabs.harvard.edu/abs/2022arXiv221204165S/abstract>



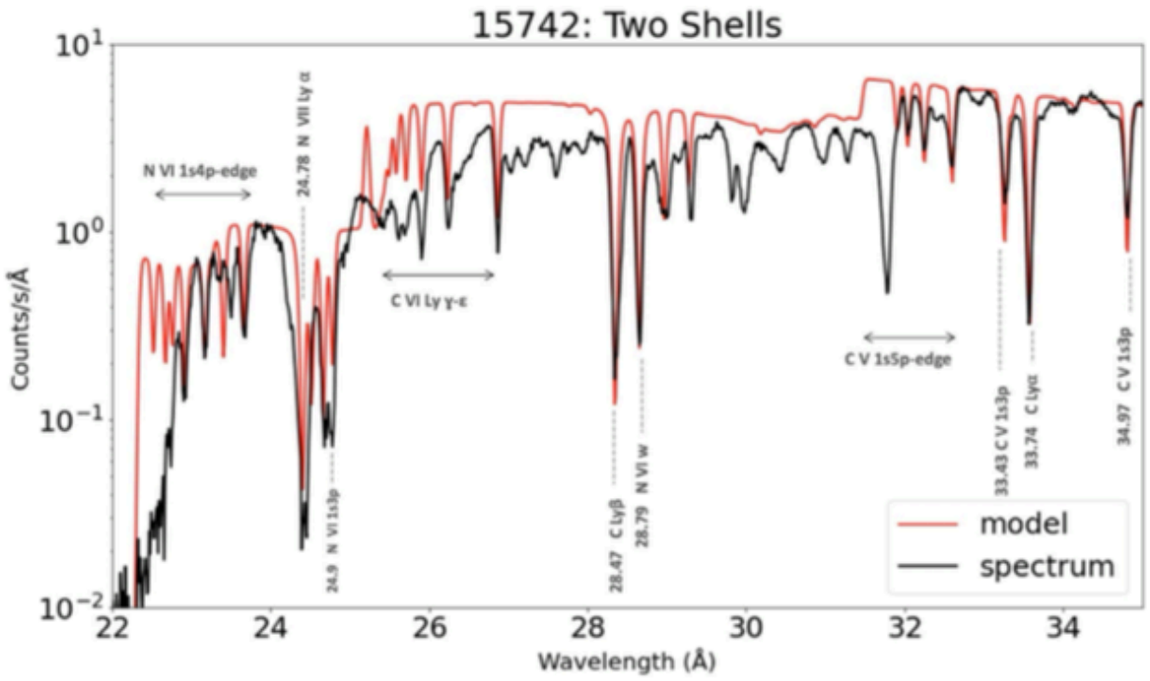
resolution element!

HETGS 3rd order HEG spectrum of the Fe XXV—XXVI region. Probes close to compact object, smaller upper limits on Doppler shifts better constrain component masses, suggesting compact object is a black hole with mass > 7 solar masses.

The High-resolution Soft X-Ray Spectrum of Nova Delphini 2013

Johon Milla and Frits Paerels

<https://ui.adsabs.harvard.edu/abs/2023ApJ...943...31M/abstract>



LETGS spectrum of a nova: blackbody source (white dwarf) absorbed by expanding plasma. Absorption lines of ionized carbon and nitrogen show multiple shells, expanding at 1400 and 4000 km/s. Abundances are non-Solar, indicative of thermonuclear fusion. Estimates of masses suggest systems like this do *not* form Type Ia supernovae.