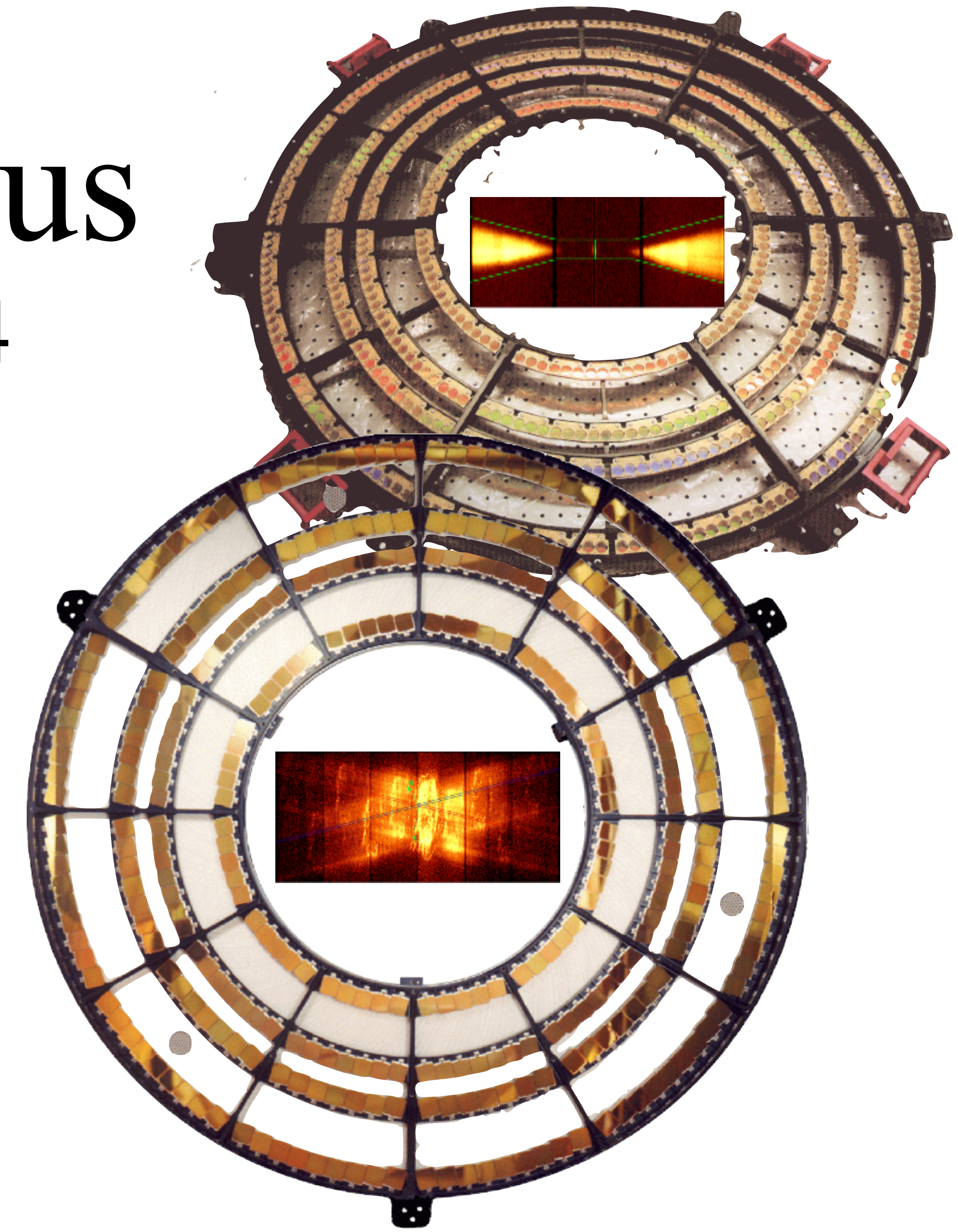
HETG/LETG — Status

Chandra Quarterly Review No. 54

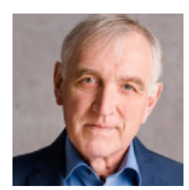
2 November 2022

David Huenemoerder
dph@space.mit.edu

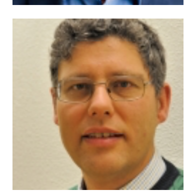


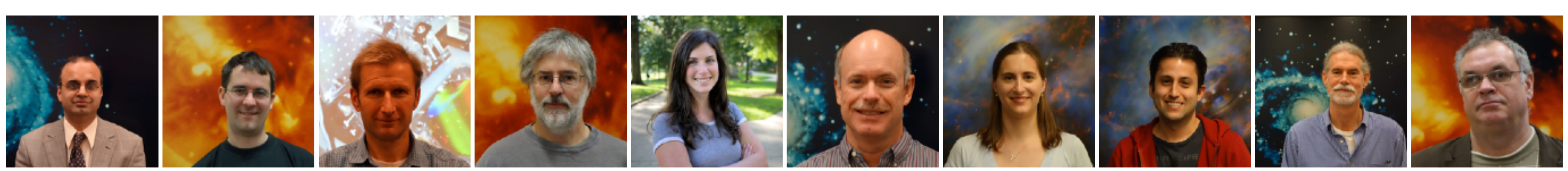
HETG IPI: Prof. C.R. Canizares
MIT Kavli Institute

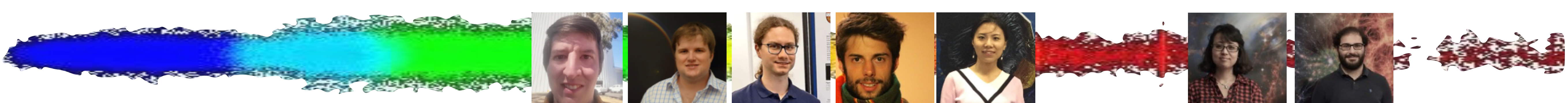
LETG IPIs: Dr. Peter Predehl
Max Planck Institute



Dr. Jelle Kaastra
SRON







HETG GTO Science Program

MIT KAVLI INSTITUTE

CHANDRA X-RAY OBSERVATORY

Proposal **Cycle 22**: completed (1.2 Ms)

★Stars:	ρ Oph A	192 ks	Winds of OB stars; magnetic confinement
★AGN:	Mrk 335	82 ks	Jets, disks, outflows, variability (w/NuSTAR, NICER).
★AGN:	NGC 1365	295 ks	Seyfert 1.8 galaxy; outflow, variability.
★BH:	SS 433	210 ks	Stellar mass black hole; relativistic jets, variability
★NS:	4U 1820-30	175 ks	Neutron Star outburst; gravitational redshift, NS radius (TOO)
★ISM:	GX 3+1	98 ks	Silicon K-edge structure and variability
★ISM:	GX 17+2	87 ks	Silicon gas-to-dust ratio (part of ISM survey)
★XRB:	4U 1626-67	59 ks	Ultra-compact binary; monitor disk line shapes

Proposal **Cycle 23**: in progress (330 / 924 ks)

★Stars:	π Aqr	91/100 ks	Winds of the hottest stars
★AGN:	Circinus Galaxy	69 ks	Emission lines, morphology, variability (IXPE-coordinated)
★XRB:	Cen X-3	0/62 ks	Eclipsing X-ray pulsar; accretion
★XRB:	4U 1626-67	86 ks	Ultra-compact binary; monitor Fe lines.
★XRB:	GX 1+4	0/90 ks	Low-mass XRB; accretion, Compton shoulder study.
★ISM:	GX 340+0	28/150 ks	Cosmic dust composition
★ULX/NS:	M33 X-8	57/92 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)

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 (cont’d)

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Proposal **Cycle 24**: start Jan 2023 (745 ks)

★XRB: 4U 1624-490 0/135 ks Accretion disk structure (with NuSTAR, XRISM)
★XRB: Cen X-3 0/47 ks Eclipsing X-ray pulsar; accretion (ongoing - low visibility)
★NS: Terzan 5 X-2 0/200 ks Neutron Star outburst (TOO)
★AGN: MCG-6-30-15 0/232 ks Time-dependent photoionisation modeling of outflows
★ULX: LMC/SMC X-? 0/70 ks Accretion disk outbursts (TOO)
★BH: SS 433 0/60 ks Relativistic jet physics (coordinated with HRC, Swift GO)

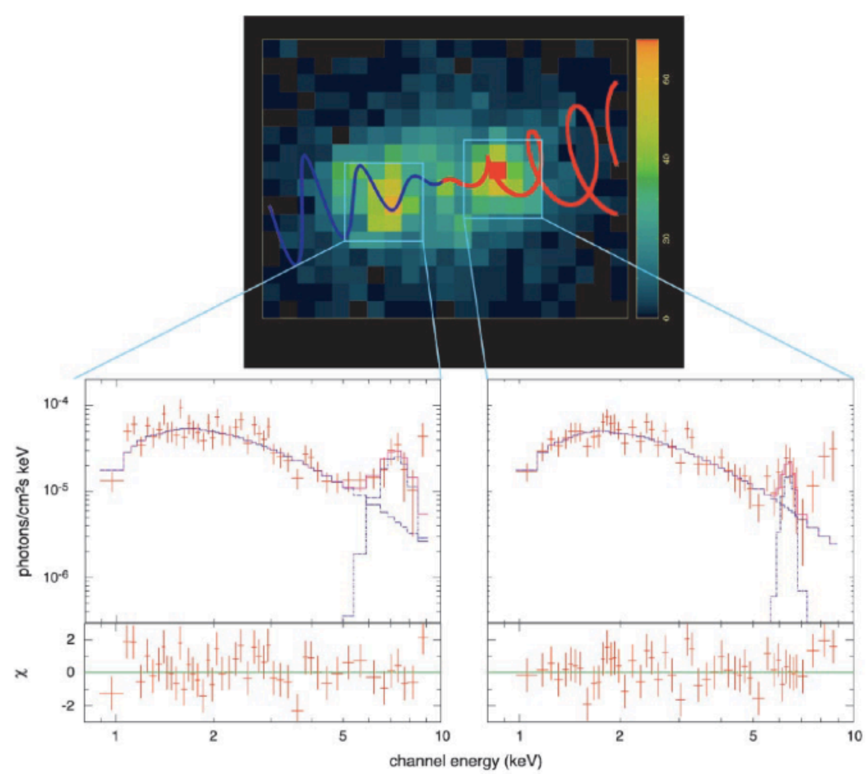

Fig. 1 (left): ACIS-S image of SS 433 taken when the core was faint, clearly showing the extended emission (Migliari et al. 2001). The spectra were fitted with emission lines that they claimed were Doppler shifted to that of the jet. These lines have not been confirmed.

Direct imaging observations (Fig. 1, Migliari et al 2001) were used to support a model that the jet gas is reheated by shocks due to velocity changes along the jet. However, the emission lines are claimed to be detected in only one observation and have not been confirmed in later observations. I looked at the original data and found that there is marginal evidence for emission lines as they claim. HETGS data also do not show evidence for these emission lines but they may be Doppler-broadened.

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LETG GTO Science Program

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CHANDRA X-RAY OBSERVATORY

Proposal **Cycle 22**: (214 / 353 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**: (193 / 340 ks)

★ Stars (Predehl/MPE)	LTT 1445A	19/50 ks	High energy environments of terrestrial exoplanets (ACIS-S)
★ Stars (Predehl/MPE)	L 168-9	0/25 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	0/175 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)

AGN: Active Galactic Nucleus
BH: Black Hole
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NS: Neutron Star
SN: SuperNova
ULX: Ultra-Luminous X-ray source
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LMXB: Low Mass XRB

HETG/LETG Activities Summary

Performance April 2022 — October 2022

HETG/ACIS-S 1754 ks

- 77 observations on 21 targets (39 GO, 29 GTO, 4 Cal, 1 TOO, 4 DDT)

LETG 289 ks, 12 observations, 5 targets

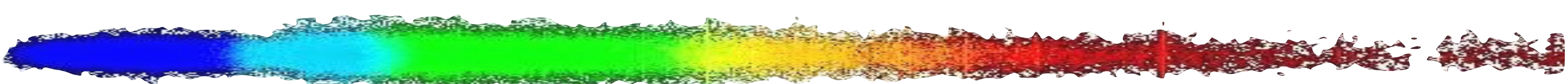
- 2 LETG/HRC-S observations (15 ks; 1 GO, 1 Cal) — ***part of HRC return to operation***.
- 10 LETG/ACIS-S observations (258 ks; 10 Cal)

Grating performance is nominal.

http://tgcat.mit.edu

TGCat has 2575 extractions for 509 objects, in 2459 ObsIDs.
Total volume: 620 GB
Downloads (04/2022-10/2022): 151 packages, 130 GB; 3100 single-file, 120 MB

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



Some Statistics from the Chandra Observations Catalog

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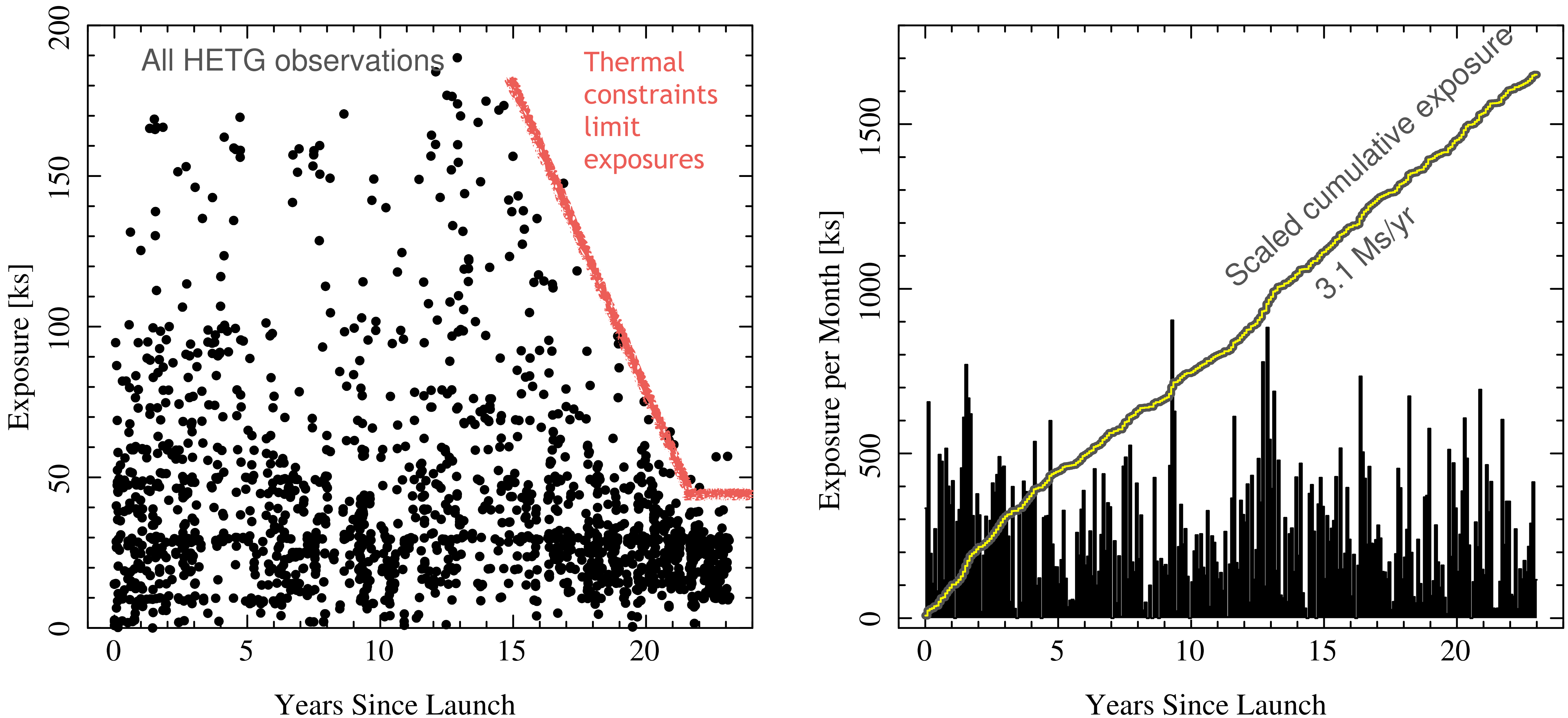
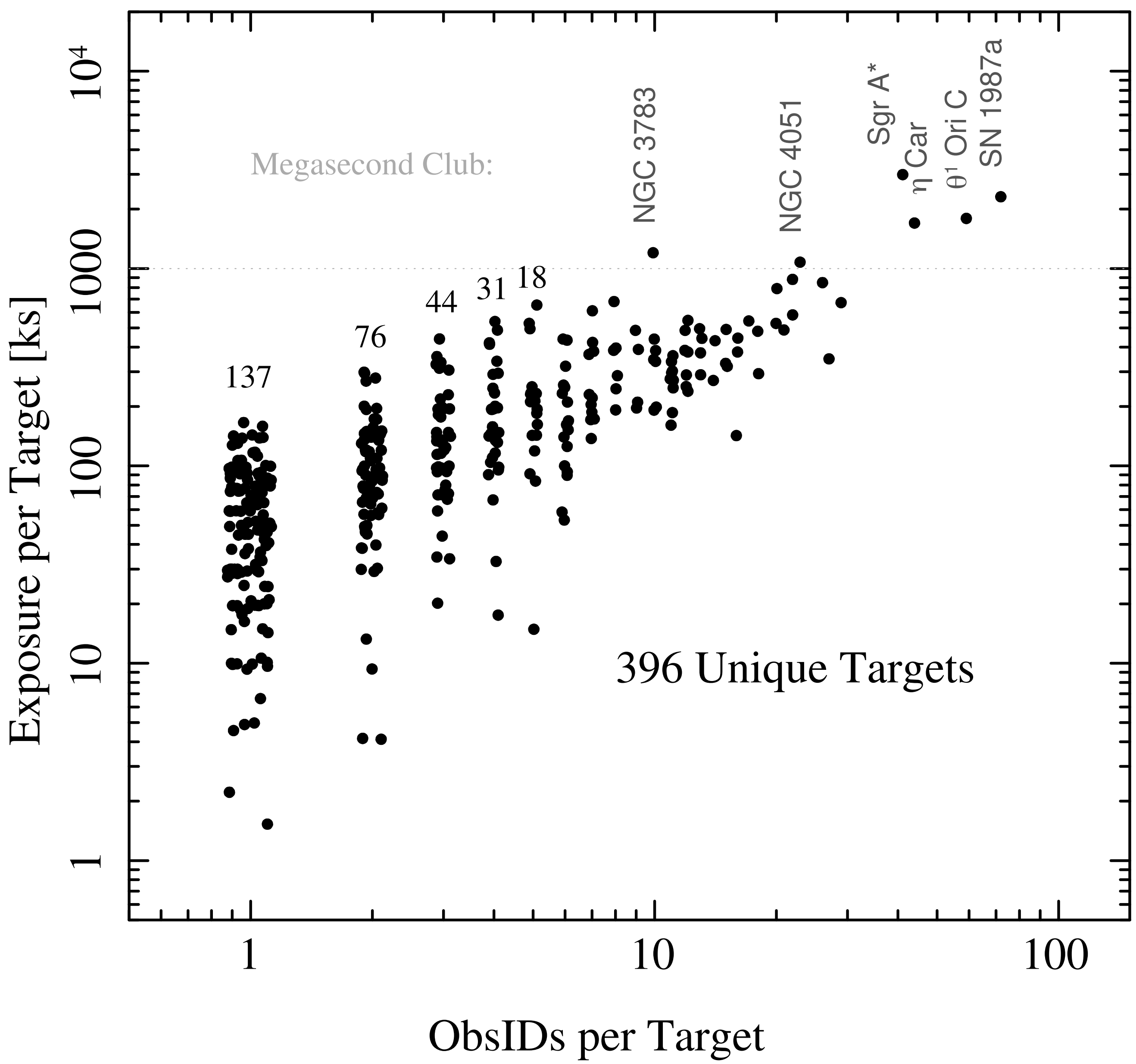
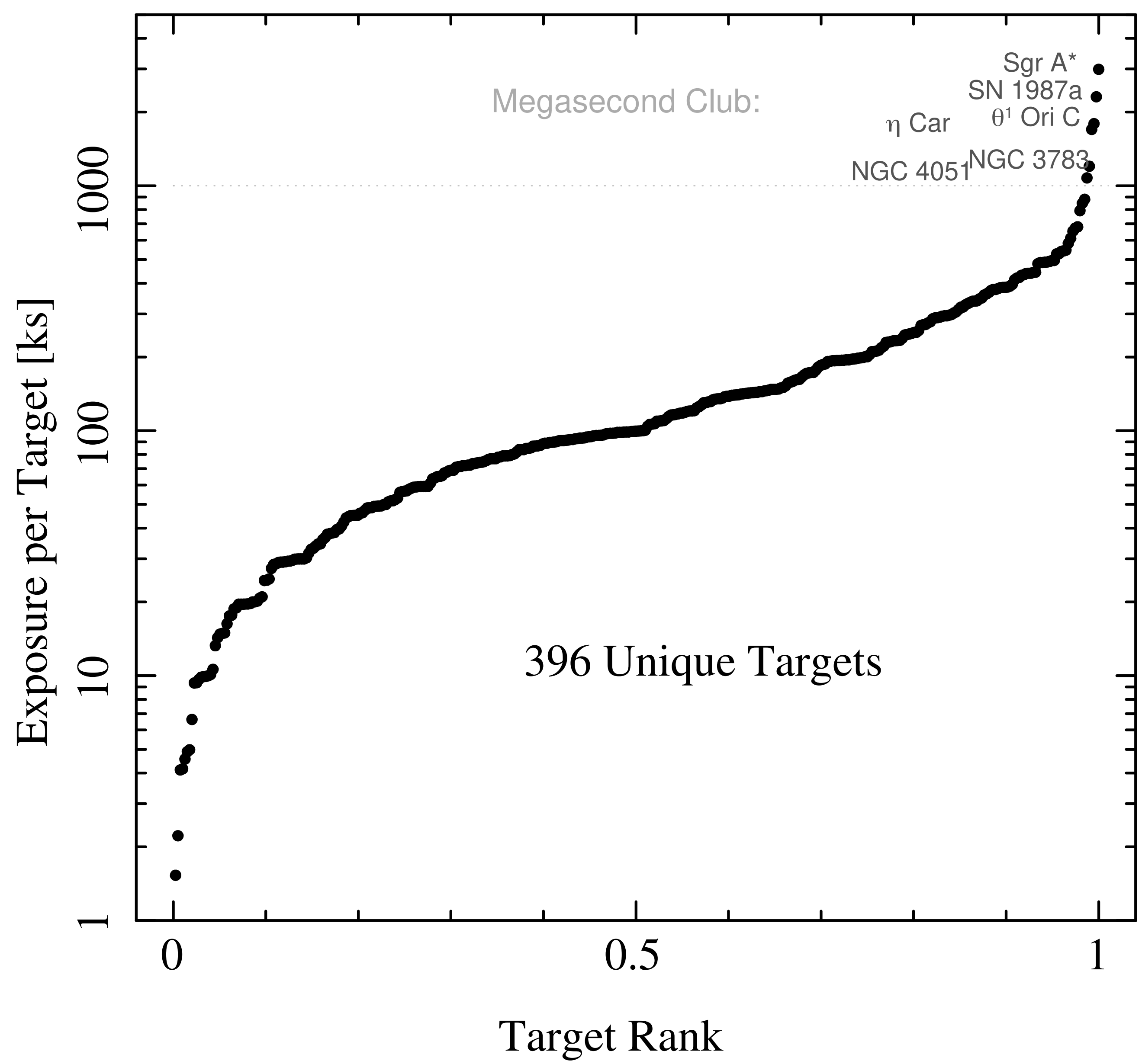


Some Statistics from the Chandra Observations Catalog (2)





Calibration Updates

HETG 2nd and 3rd order efficiencies: in progress. Several datasets analyzed, correction terms derived, and are under review. (*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. MARX will be used to populate important cases with values. (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 seems to have grown with time. This is currently being investigated, and may be related to the filter contaminant (and may be independent of gratings, but can be investigated using dispersed spectra or the zeroth order streak for very bright sources).

Some Scientific Results Published in the Past 6 Months

MIT KAVLI INSTITUTE

The Astrophysical Journal, 936:185 (20pp), 2022 September 10 https://doi.org/10.3847/1538-4357/ac897e
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The Long Stare at Hercules X-1. I. Emission Lines from the Outer Disk, the Magnetosphere Boundary, and the Accretion Curtain

P. Kosec[1], E. Kara[1], A. C. Fabian[2], F. Fürst[3], C. Pinto[4], I. Psaradaki[5], C. S. Reynolds[2], D. Rogantini[1], D. J. Walton[6], R. Ballhausen[7,8], C. Canizares[1], S. Dyda[9], R. Staubert[10], and J. Wilms[11]

MNRAS 513, 1609–1622 (2022) https://doi.org/10.1093/mnras/stac899
Advance Access publication 2022 April 5

Helium-like X-ray line complexes show that the hottest plasma on the O supergiant ζ Puppis is in its wind

David H. Cohen[1★] Ariel M. Overdorff,[1] Maurice A. Leutenegger[2] Marc Gagné,[3] Véronique Petit[4] and Alexandre David-Uraz[2,5,6]

The Astrophysical Journal, 936:66 (15pp), 2022 September 1 https://doi.org/10.3847/1538-4357/ac83ae
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Probing the Extent of Fe Kα Emission in Nearby Active Galactic Nuclei Using Multi-order Analysis of Chandra High Energy Transmission Grating Data

Megan Masterson[1,2] and Christopher S. Reynolds[2]

The Astrophysical Journal, 937:121 (12pp), 2022 October 1 https://doi.org/10.3847/1538-4357/ac8f30
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The 3D X-Ray Ejecta Structure of Tycho's Supernova Remnant

Matthew J. Millard[1], Sangwook Park[1], Toshiki Sato[2], John P. Hughes[3], Patrick Slane[4], Daniel Patnaude[5], David Burrows[6], and Carles Badenes[7]

The Astrophysical Journal, 930:90 (17pp), 2022 May 1 https://doi.org/10.3847/1538-4357/ac5625
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How Do Magnetic Field Models Affect Astrophysical Limits on Light Axion-like Particles? An X-Ray Case Study with NGC 1275

James H. Matthews[1], Christopher S. Reynolds[1], M. C. David Marsh[2], Júlia Sisk-Reynés[1], and Payton E. Rodman[1]

A&A 665, A93 (2022)
https://doi.org/10.1051/0004-6361/202244075
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Astronomy & Astrophysics

Detection of an unidentified soft X-ray emission feature in NGC 5548

Liyi Gu[1,2,3], Junjie Mao[4,5,6], Jelle S. Kaastra[1,3], Missagh Mehdipour[7], Ciro Pinto[8,9], Sam Grafton-Waters[10], Stefano Bianchi[11], Hermine Landt[12], Graziella Branduardi-Raymont[13], Elisa Costantini[1], Jacobo Ebrero[14], Pierre-Olivier Petrucci[15], Ehud Behar[16], Laura di Gesu[17], Barbara De Marco[18], Giorgio Matt[11], Jake A. J. Mitchell[12], Uria Peretz[16], Francesco Ursini[11], and Martin Ward[12]

MNRAS 000, 1–14 (2022) Preprint 4 August 2022 Compiled using MNRAS LaTeX style file v3.0

High resolution X-ray spectroscopy of V4641 Sgr during its 2020 outburst

A. W. Shaw,[1★] J. M. Miller,[2] V. Grinberg,[3] D. J. K. Buisson,[4] C. O. Heinke,[5] R. M. Plotkin,[1] J. A. Tomsick,[6] A. Bahramian,[7] P. Gandhi,[4] and G. R. Sivakoff[5]

MNRAS 514, 2568–2580 (2022) https://doi.org/10.1093/mnras/stac1389

Evidence for a moderate spin from X-ray reflection of the high-mass supermassive black hole in the cluster-hosted quasar H1821+643

Júlia Sisk-Reynés[1★] Christopher S. Reynolds[1] James H. Matthews[1] and Robyn N. Smith[2]

The Astrophysical Journal, 935:70 (11pp), 2022 August 20 https://doi.org/10.3847/1538-4357/ac7eb9
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X-Ray Spectroscopy in the Microcalorimeter Era 4: Optical Depth Effects on the Soft X-Rays Studied with CLOUDY

Priyanka Chakraborty[1,2], Gary J. Ferland[2], Marios Chatzikos[2], Andrew C. Fabian[3], Stefano Bianchi[4], Francisco Guzmán[5], and Yuanyuan Su[2]

The Astrophysical Journal, 933:92 (13pp), 2022 July 1 https://doi.org/10.3847/1538-4357/ac739b
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Detection of Flare-induced Plasma Flows in the Corona of EV Lac with X-Ray Spectroscopy

Hechao Chen (陈何超)[1], Hui Tian (田晖)[1], Hao Li (李昊)[2,3], Jianguo Wang (王建国)[4], Hongpeng Lu (陆洪鹏)[1], Yu Xu (徐昱)[1], Zhenyong Hou (侯振永)[1], and Yuchuan Wu (吴昱川)[1]

The Astrophysical Journal, 934:124 (10pp), 2022 August 1 https://doi.org/10.3847/1538-4357/ac7c6b
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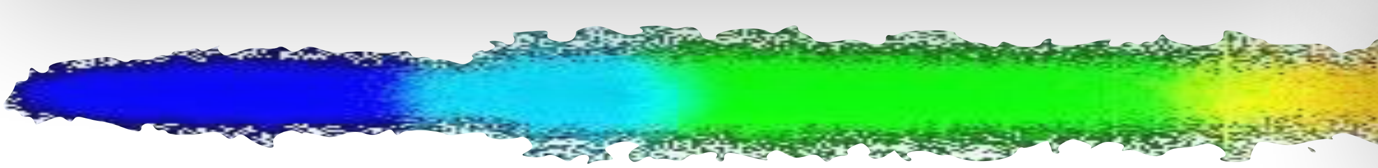
Ionization Distributions in Outflows of Active Galaxies: Universal Trends and Prospect of Future XRISM Observations

Noa Keshet and Ehud Behar



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

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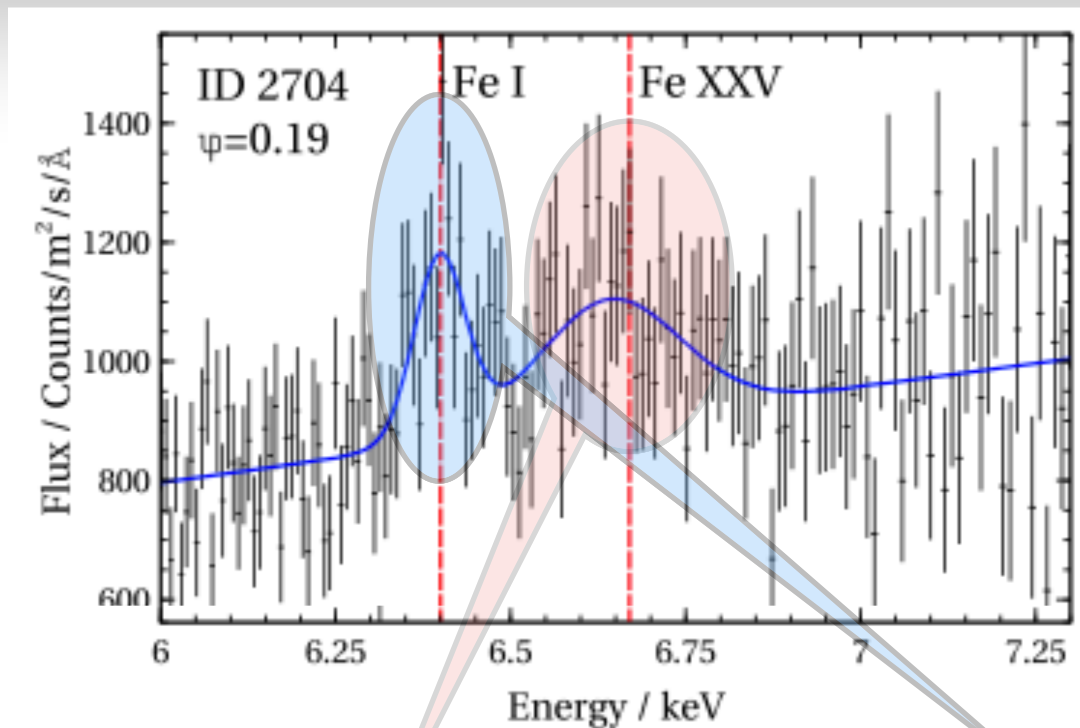
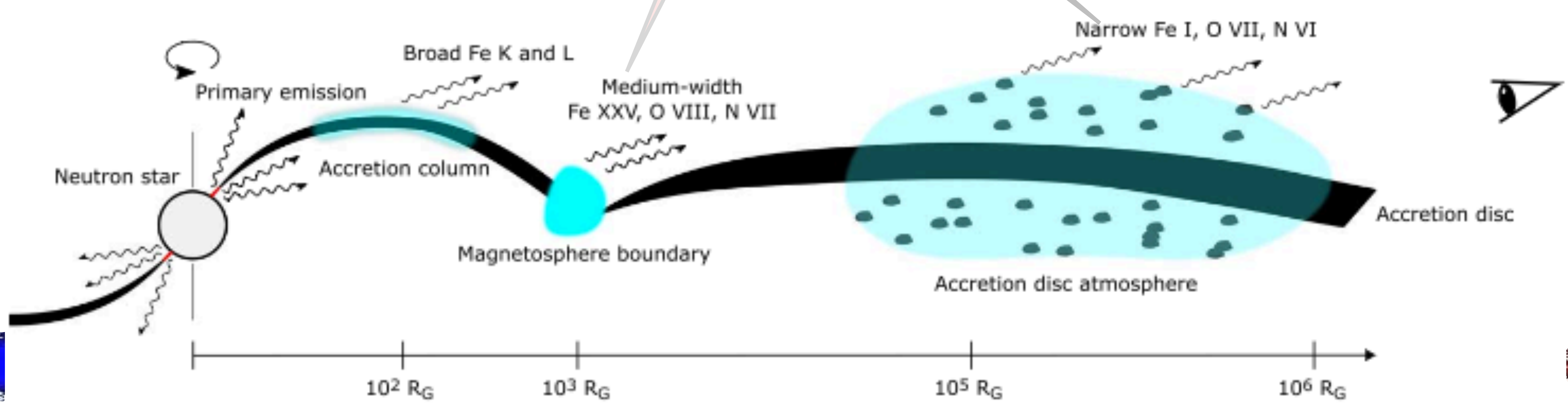
Chandra and XMM-*Newton* observations allow us to separate all the detected emission lines into three groups by origin. First originates in a corona in the outer accretion disk, second one at the magnetospheric boundary and the third from X-ray reflection off the accretion column.



Chandra HETG resolves the Fe K band of Hercules X-1 into a narrow Fe I component (<1000 km/s) at 6.4 keV and a broader Fe XXV component (5000 km/s) at 6.67 keV.



Some Scientific Results Published in the Past 6 Months (3)

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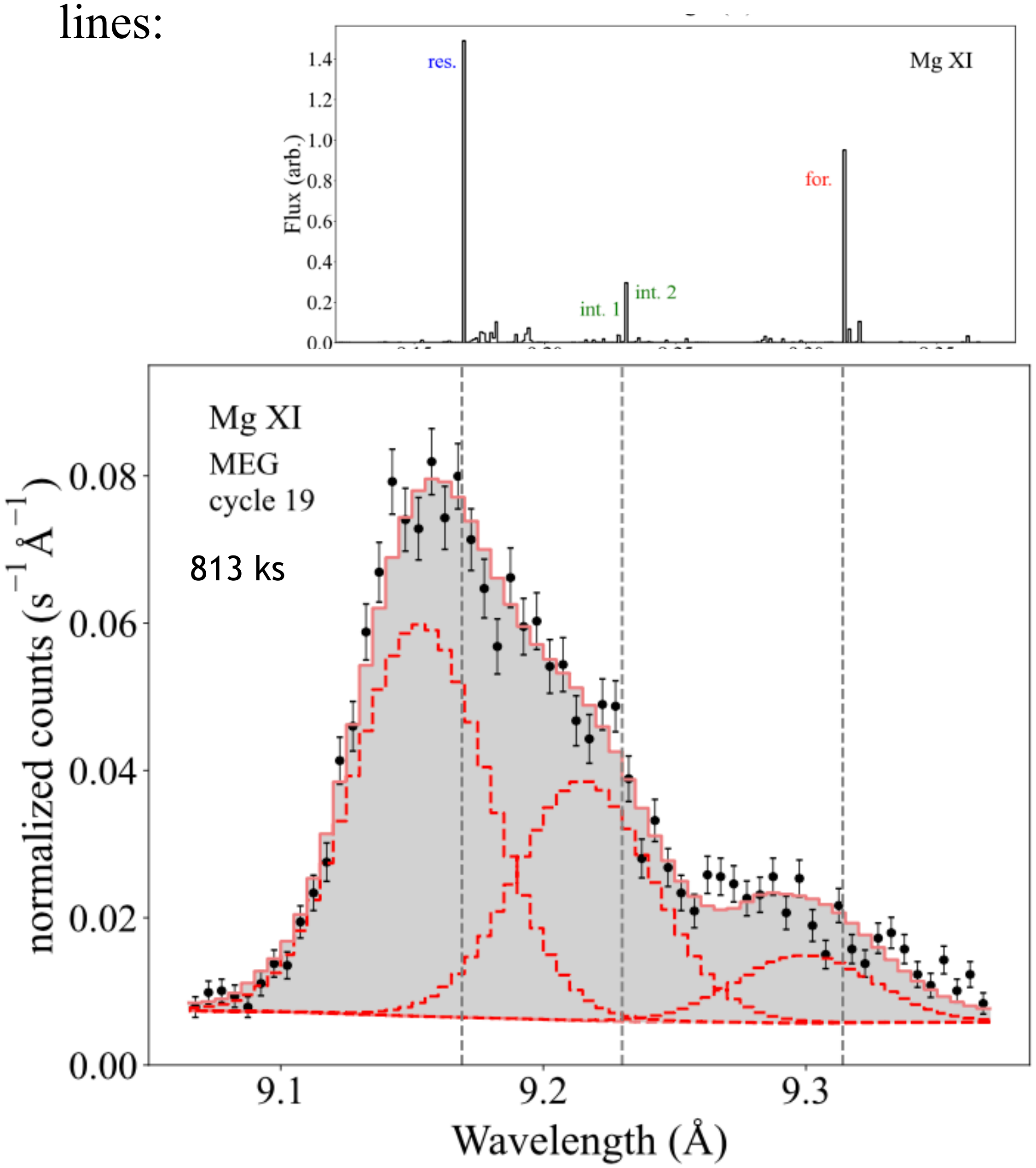
David H. Cohen[1,★] Ariel M. Overdorff,[1] Maurice A. Leutenegger[2] Marc Gagné,[3] Véronique Petit[4] and Alexandre David-Uraz[2,5,6]

Line profile modeling for mass-loss-rate requires high resolution and reliable atomic data to understand contribution of many weak lines:



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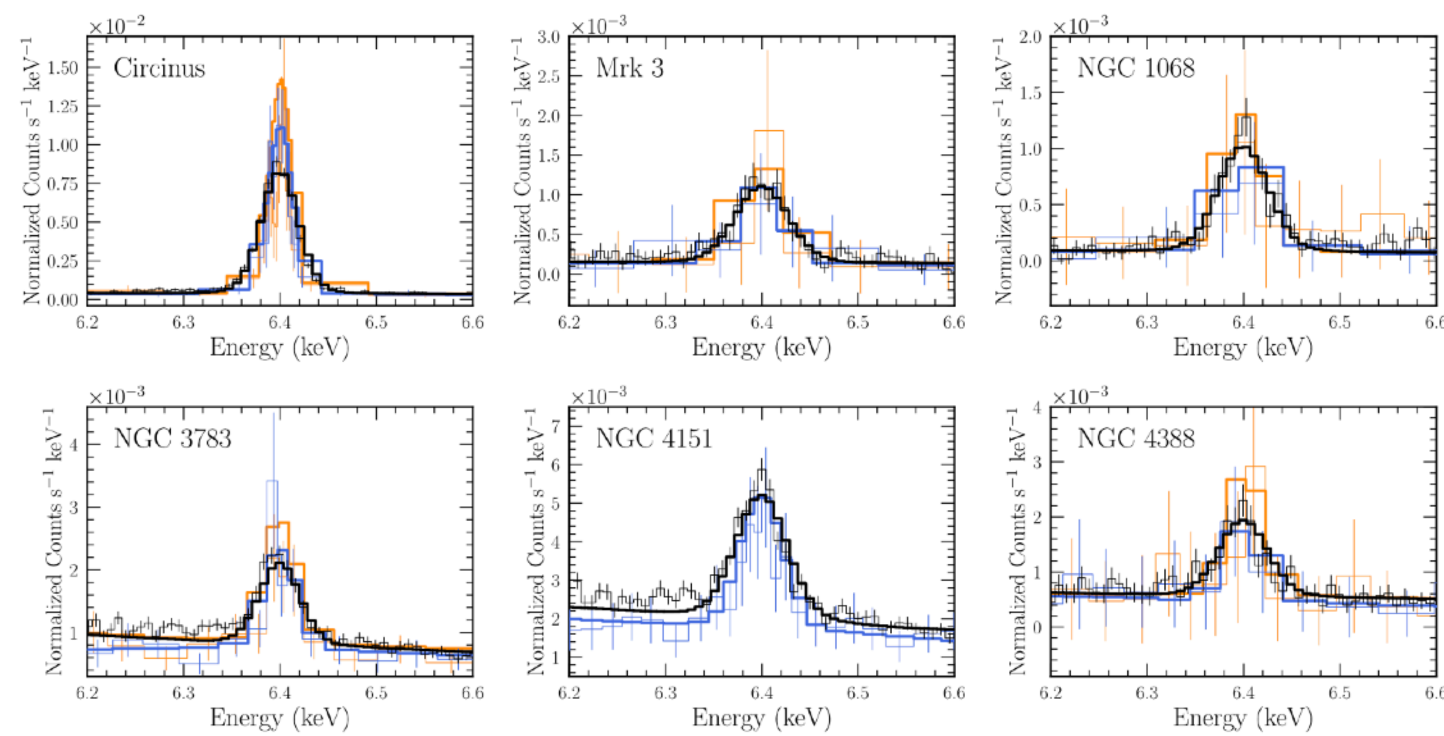
Probing the Extent of Fe Kα Emission in Nearby Active Galactic Nuclei Using Multi-order Analysis of Chandra High Energy Transmission Grating Data

Megan Masterson[1,2] and Christopher S. Reynolds[2]

Use of 2nd and 3rd orders to resolve and separate geometric spatial extent from spectrally resolved velocity width:



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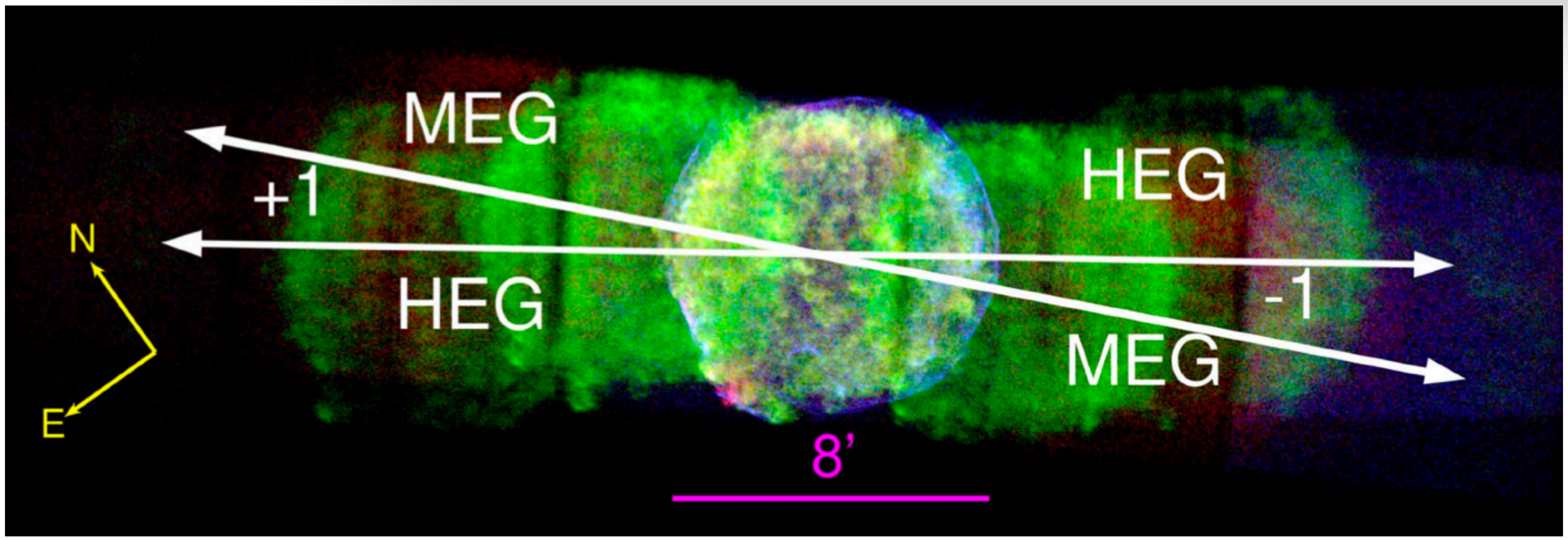

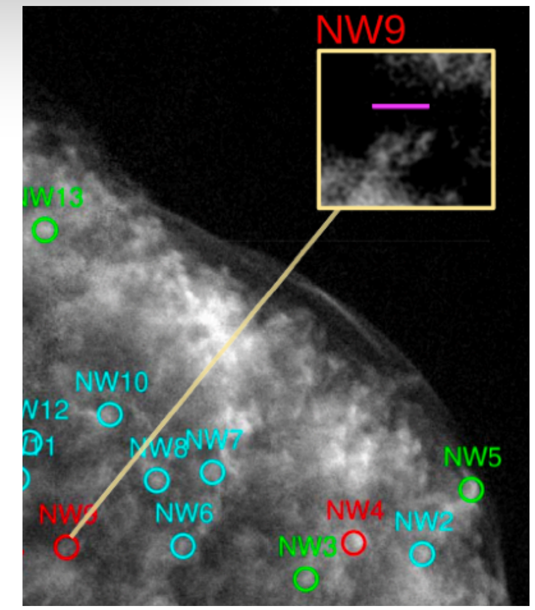

Figure 1. Chandra HETG three-color dispersed image of Tycho. Red: 0.7–1.2 keV. Green: 1.7–2.0 keV. Blue: 4.0–8.0 keV. Our color codes are selected to represent the Fe L line complex (red), He-like Si Kα lines (green), and the continuum-dominated band (blue), respectively. The white arrows show the dispersion directions of the medium and high energy gratings.

450 ks in 13 observations, kinematics from spatial-spectral analysis — expansion up to 5500 km/s.