X-ray Properties of the BHC MAXI J0637-430 during its 2019-20 Outburst

Kaushik Chatterjee
SWIFAR, Yunnan University
(kaushik@ynu.edu.cn)

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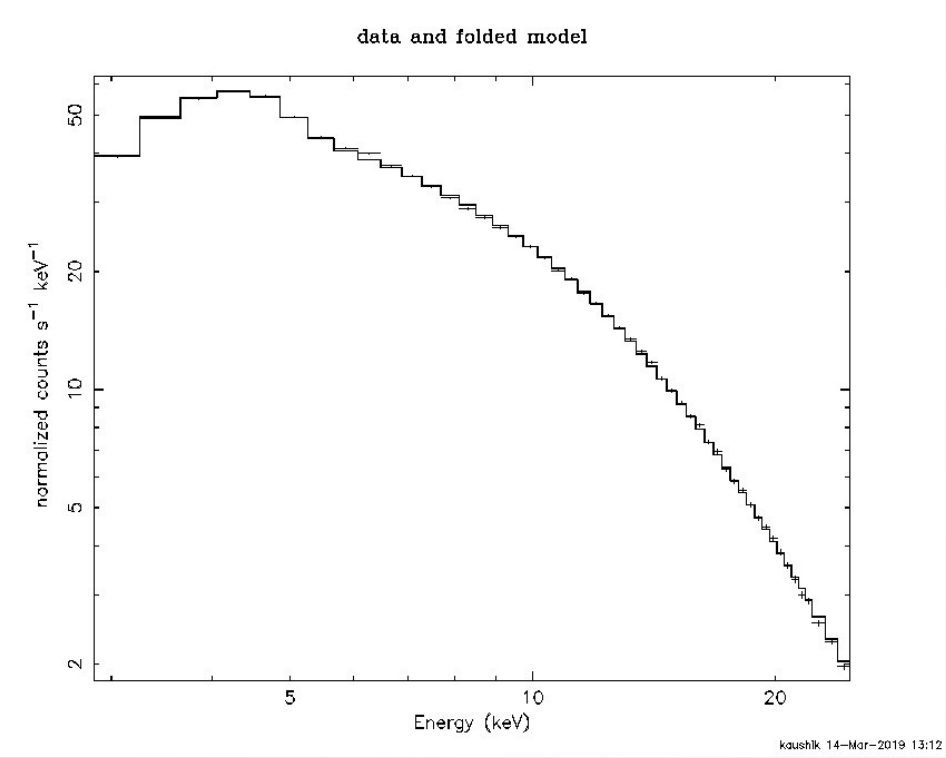
Contents

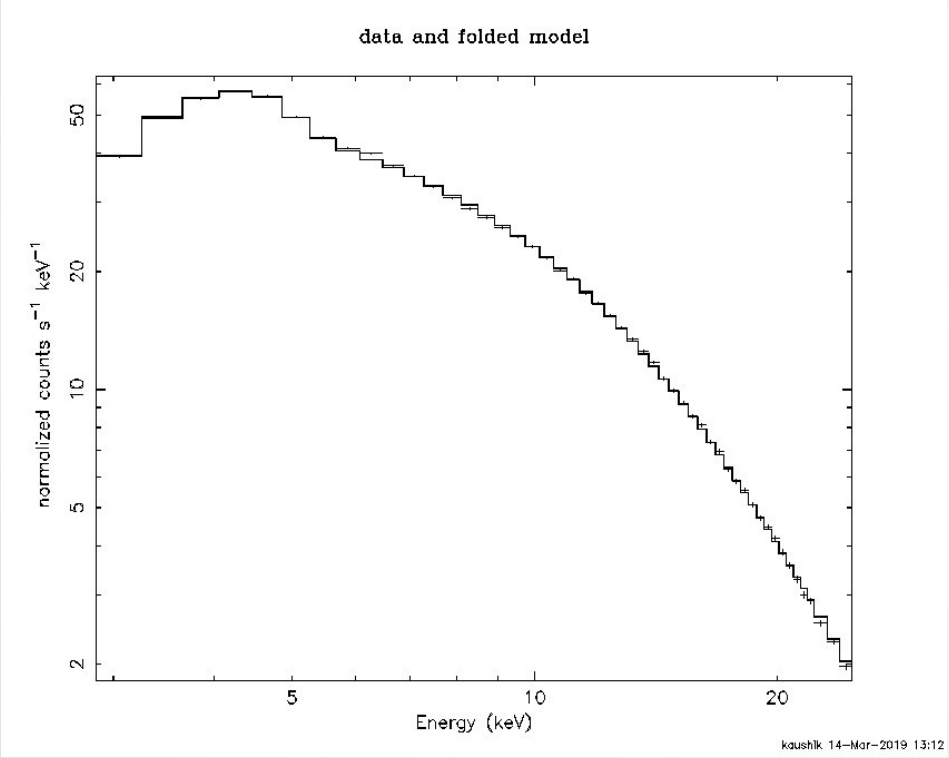
- Radiation Spectra from BHs
- Spectral States and Change of Flux
- Bulk motion Comptonization (BMC)
- MAXI J0637-430 Introduction
- Analysis with Different Combination of Models
- Results
- Conclusions

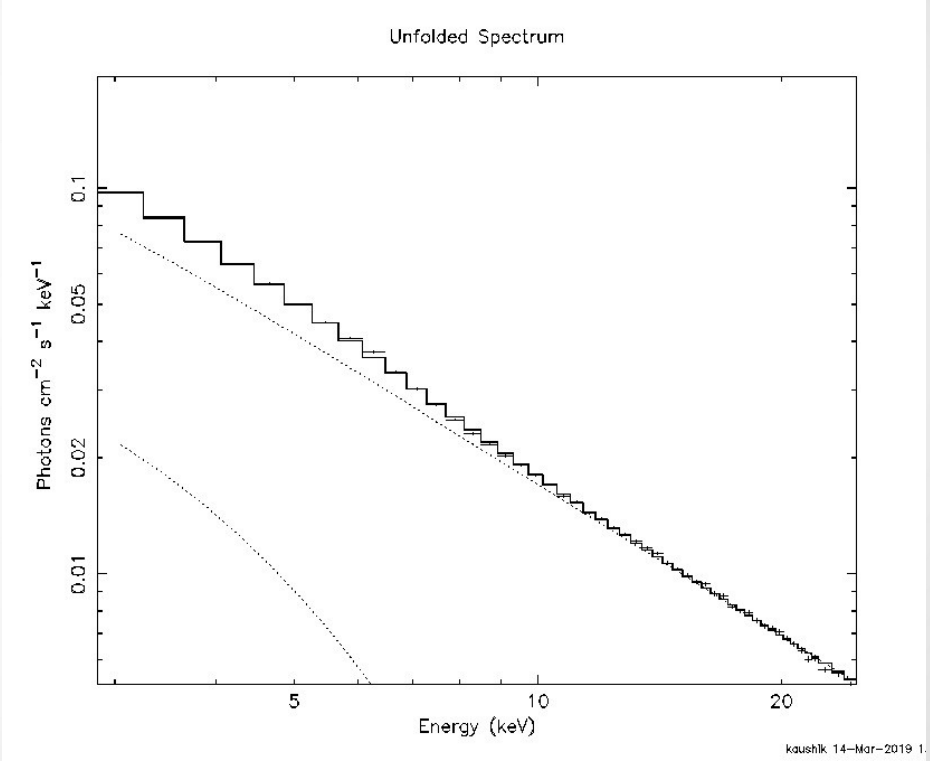
Radiation Spectrum of a BH



Figures taken from the Thesis of Kaushik Chatterjee

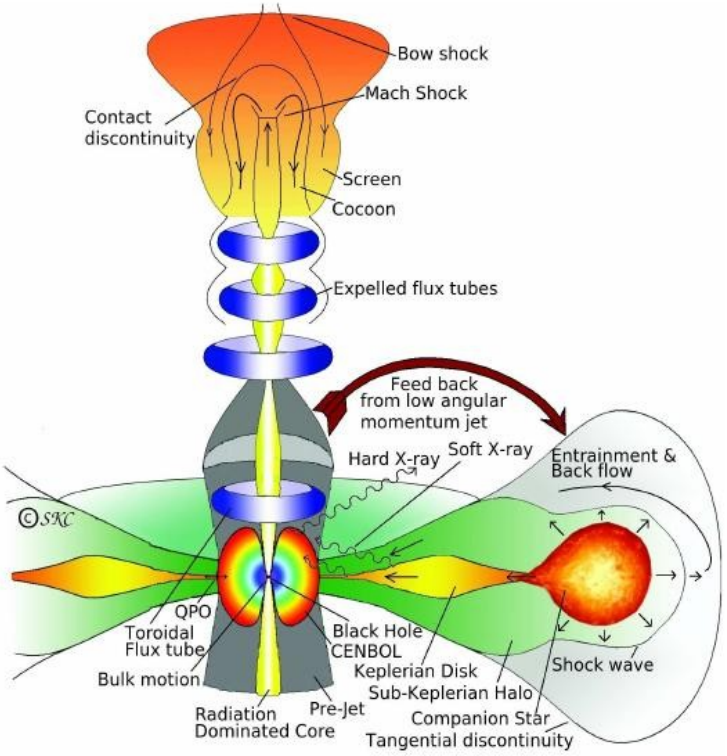
Radiation Spectrum of a BH





Figures taken from the Thesis of Kaushik Chatterjee

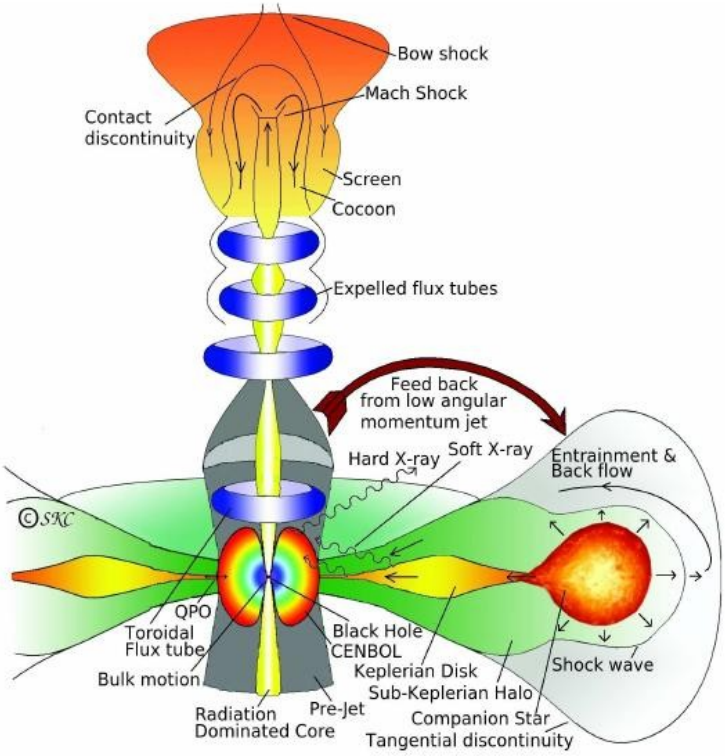
Explanation of Radiation Spectrum



More Theoretical Insight: Dr. Chandra Singh's Talk
Friday, 15th December, 11.50a.m. @ Accretion Processes

Chakrabarti (2013)

Explanation of Radiation Spectrum



Chakrabarti (2013)

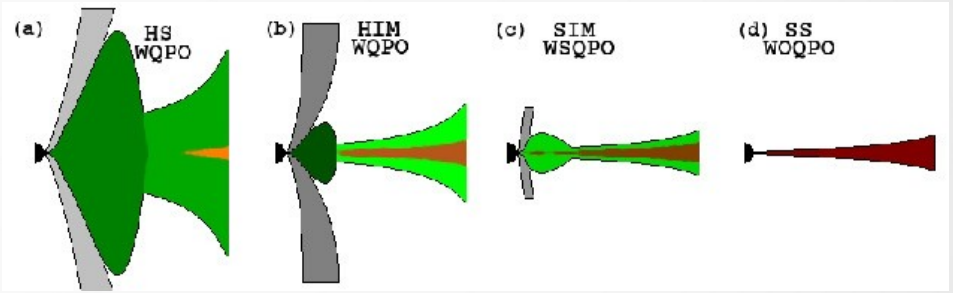


Figure taken from the Thesis of Arghajit Jana

Change of Flux with Spectral States

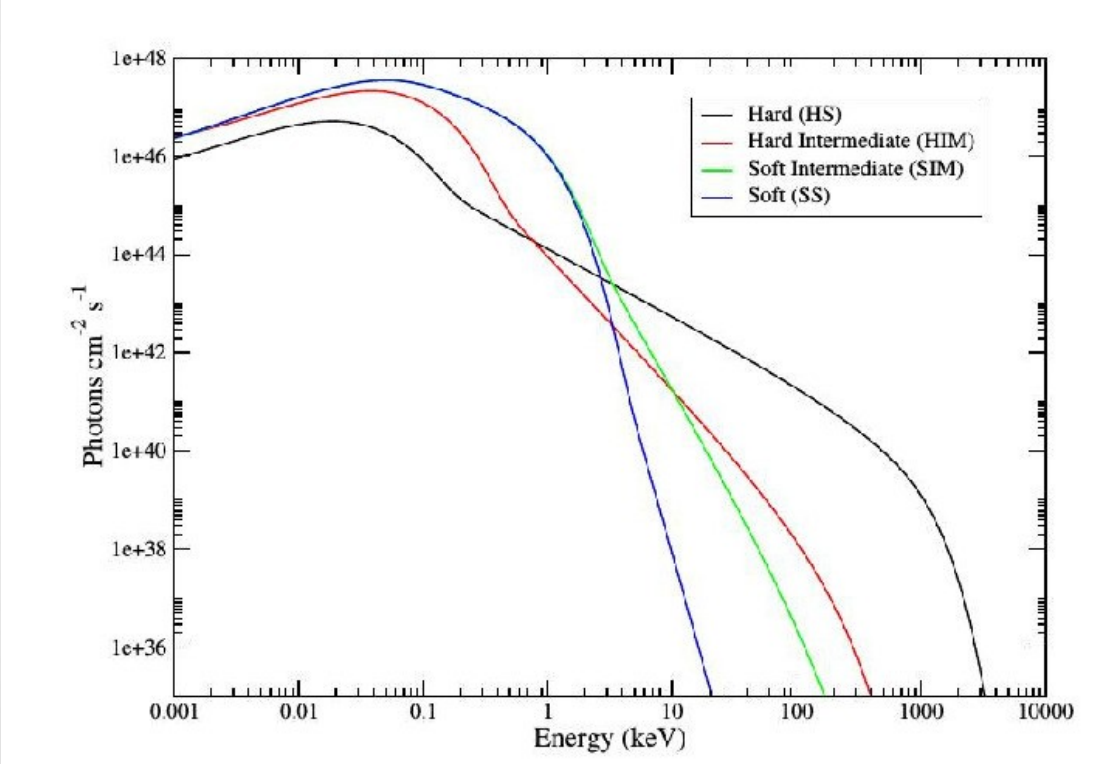


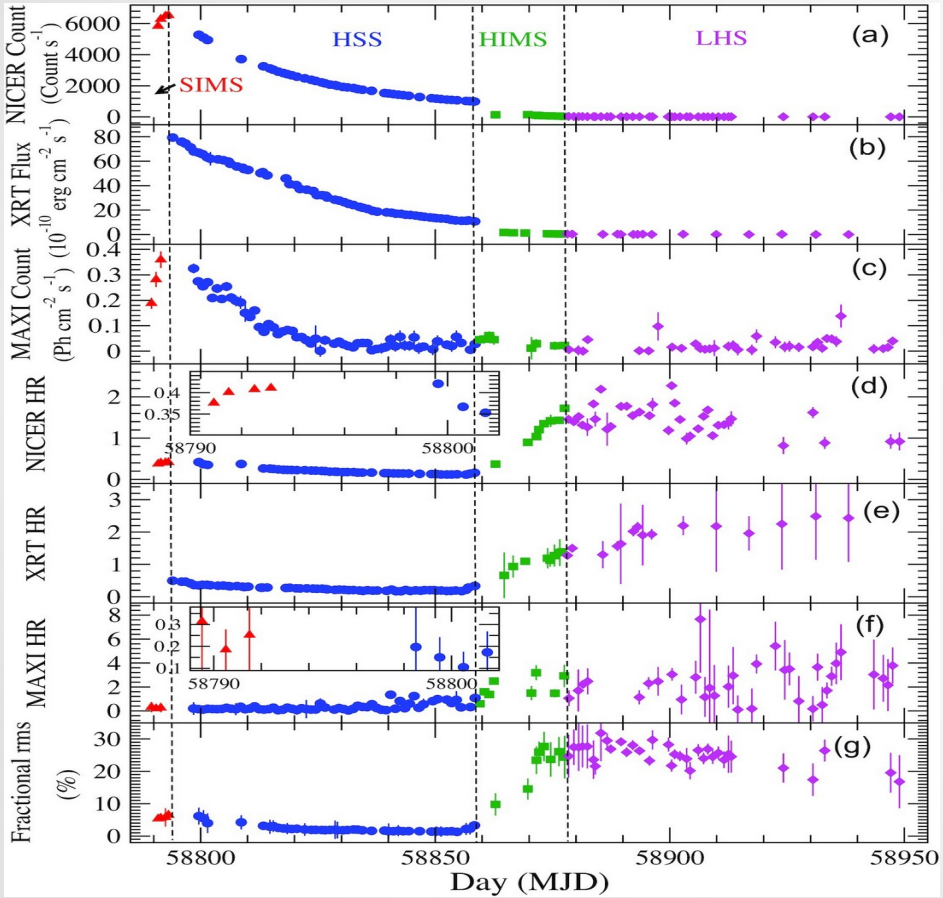
Figure taken from the Thesis of Arghajit Jana

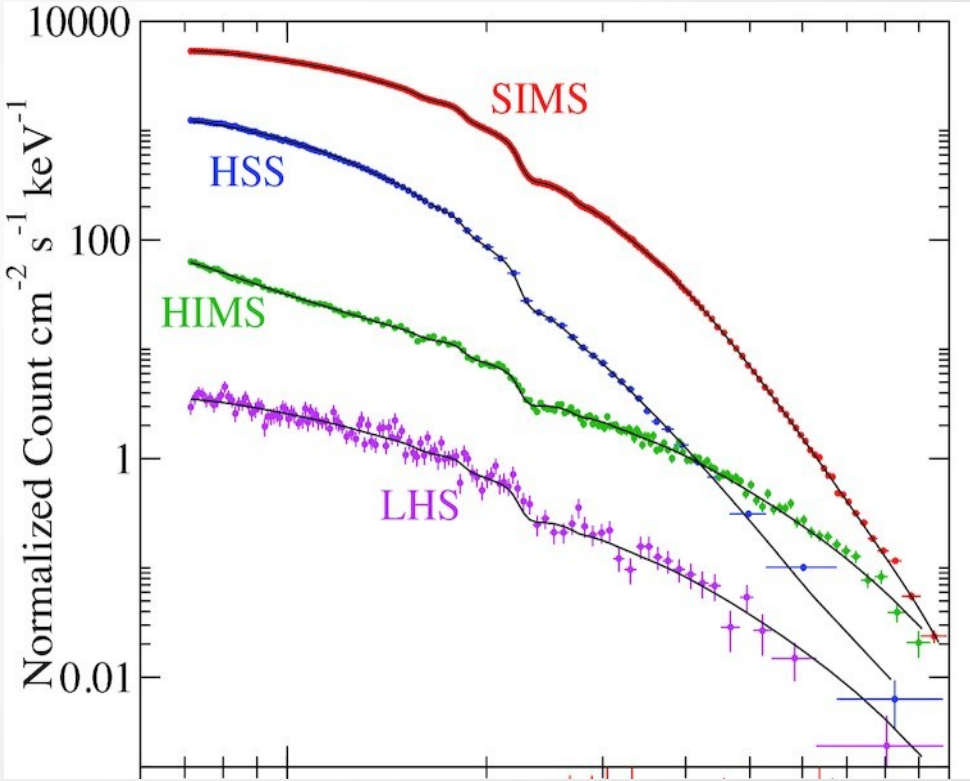
MAXI J0637-430

Source Introduction

- **Discovery: MAXI/GSC on November 2, 2019 (Negoro et al. 2019)**
- **Location: RA= 99.098, DEC= −42.868 (Kennea et al. 2019)**
- **Distance: 8.7 ± 2.3 kPc (Soria et al. 2022**
- **Galocentric Distance: 13.2 ± 1.8 kpc (Soria et al. 2022)**
- **Height from Galactic Plane: 3.1 ± 0.8 kpc (Soria et al. 2022)**
- **Orbital Period: 1.6-3 hrs (Shortest-period BH binary; Soria et al. 2022)**
- **Spin: $a < 0.25$ (Soria et al. 2022)**
- **Mass: 5.1 ± 1.6 $M_{\odot}$ (Soria et al. 2022)**
- **Donor: 0.25 ± 0.07 $M_{\odot}$ (Soria et al. 2022)**

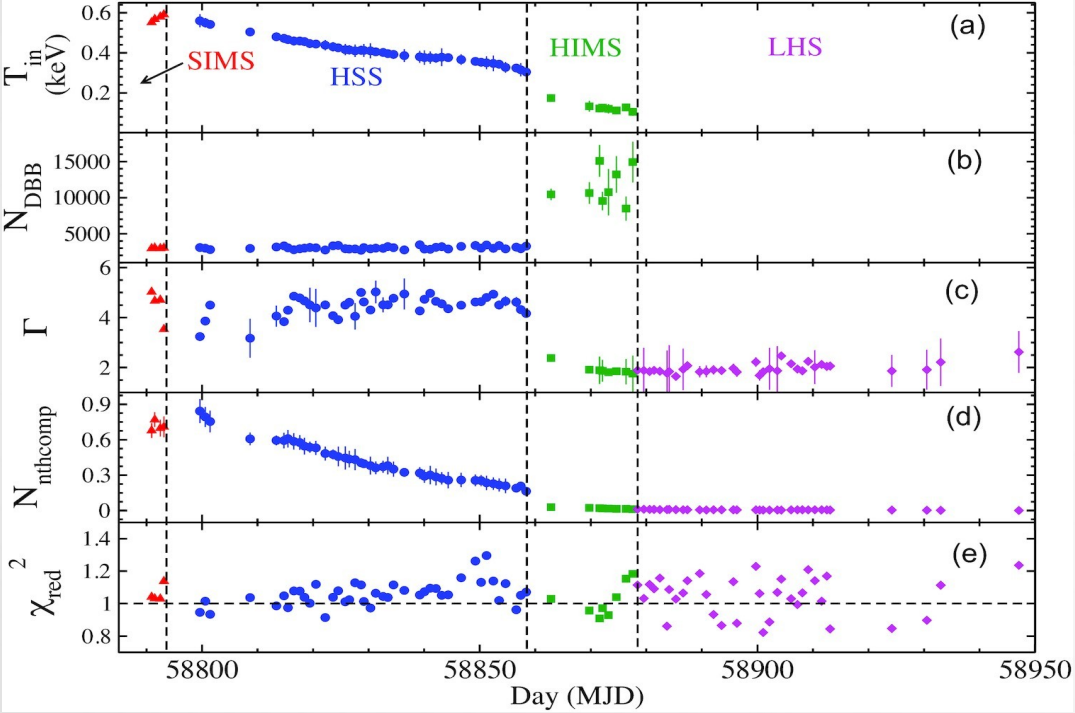
Fluxes and Spectral States

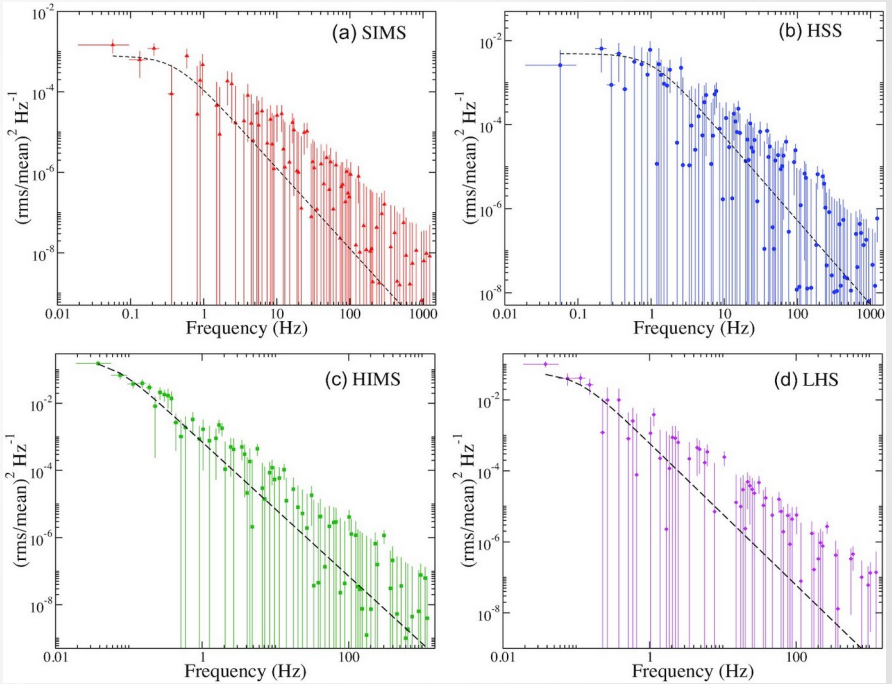




Jana et al. (2021)

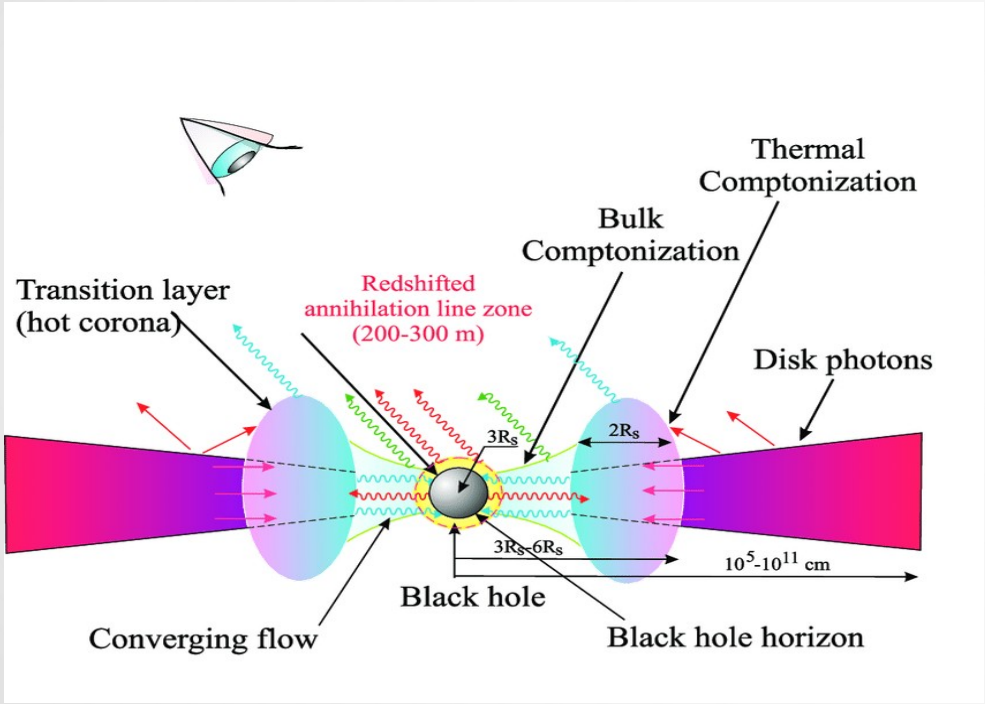
Spectral and Timing Analysis Results





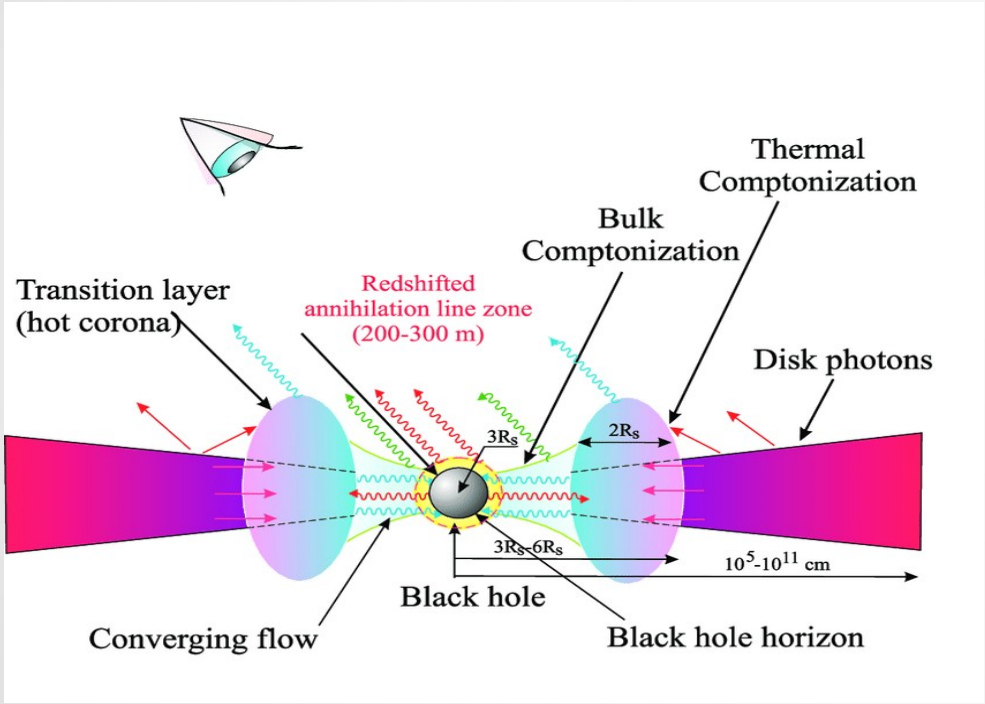
Jana et al. (2021)

Bulk-Motion Comptonization (BMC)



Cartoon Diagram

Bulk-Motion Comptonization (BMC)



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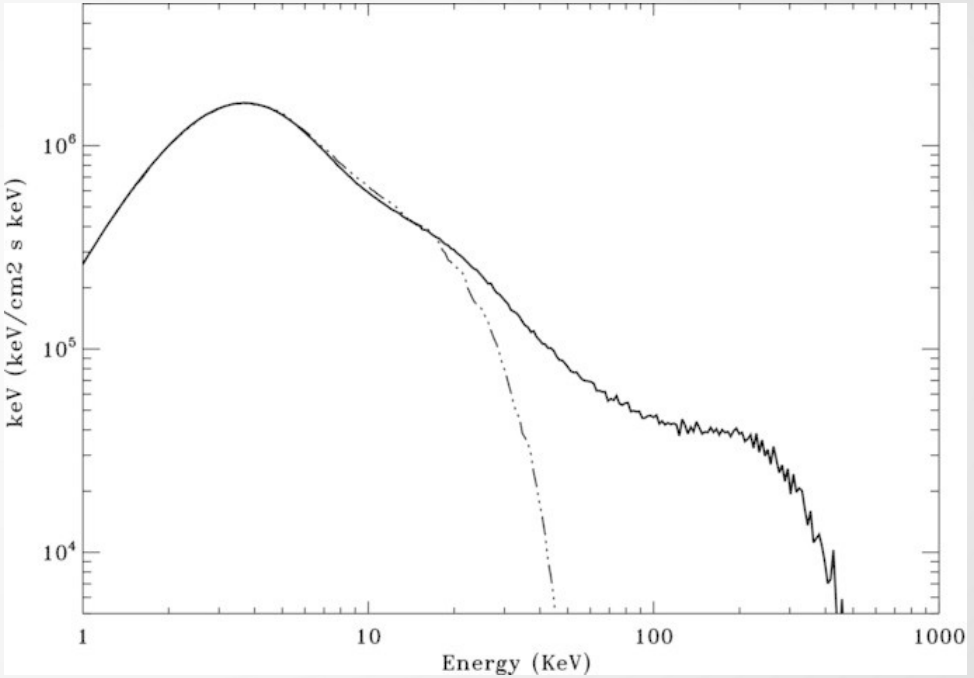
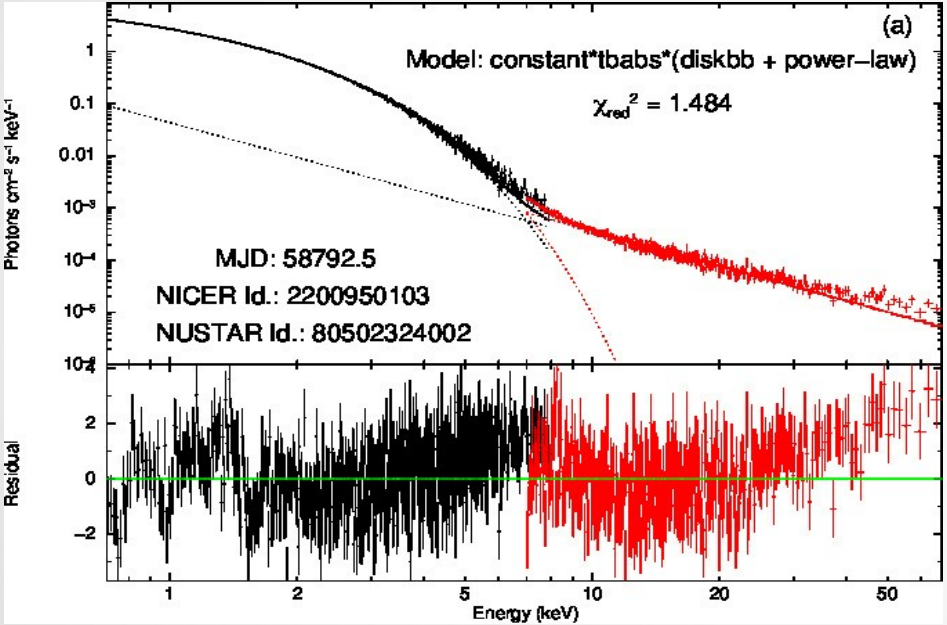


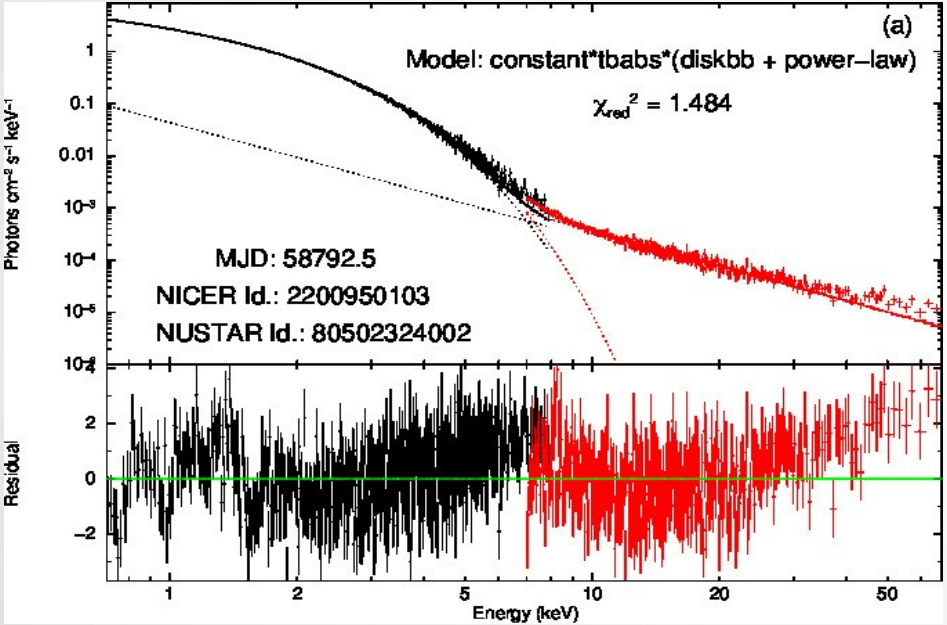
Spectrum

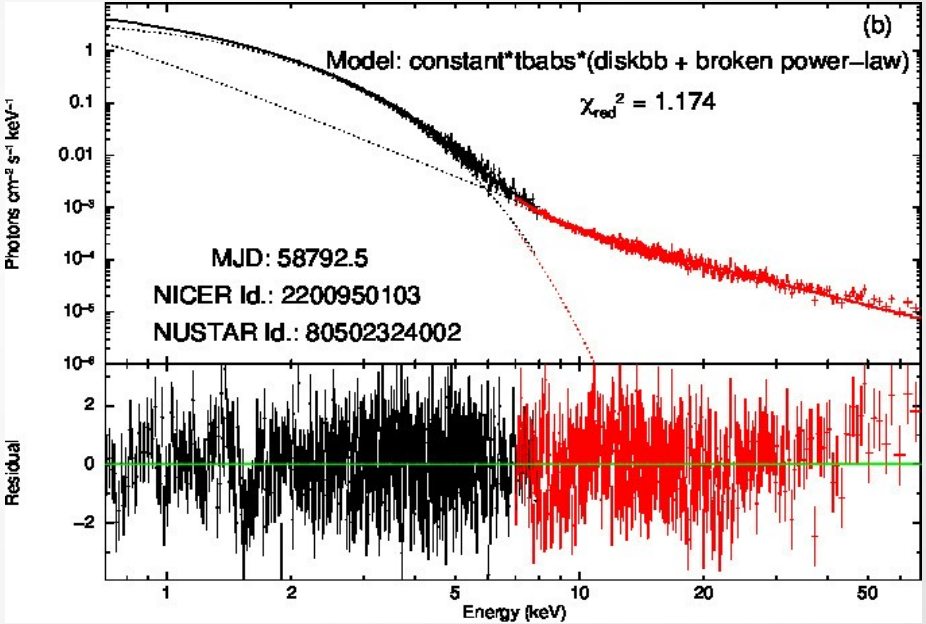
Broadband Spectral Nature (Phenomenological Models)



Chatterjee et al. (2023)

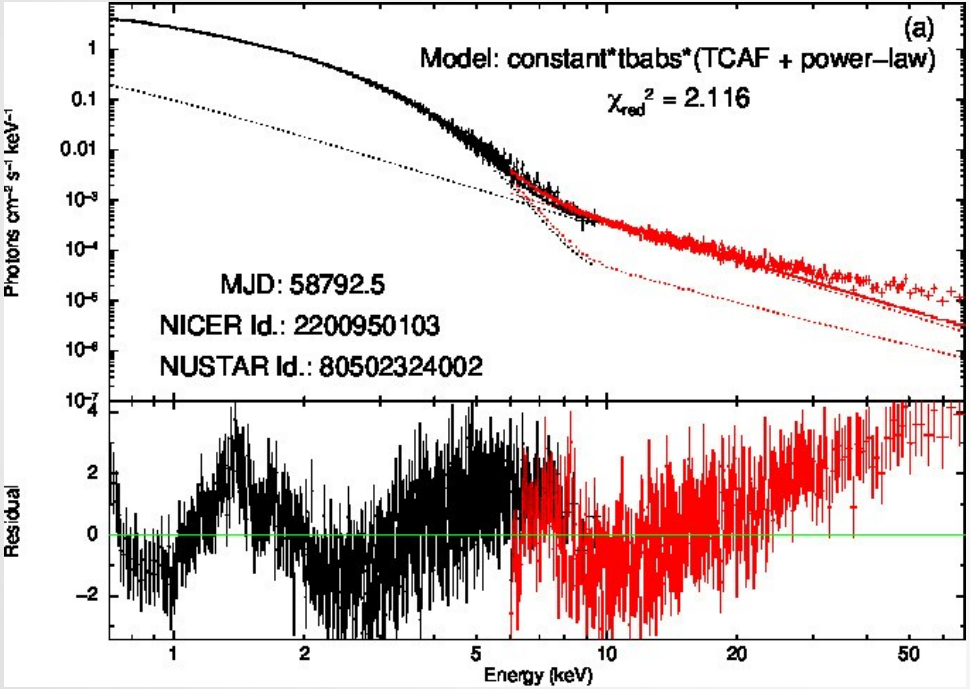
Broadband Spectral Nature (Phenomenological Models)





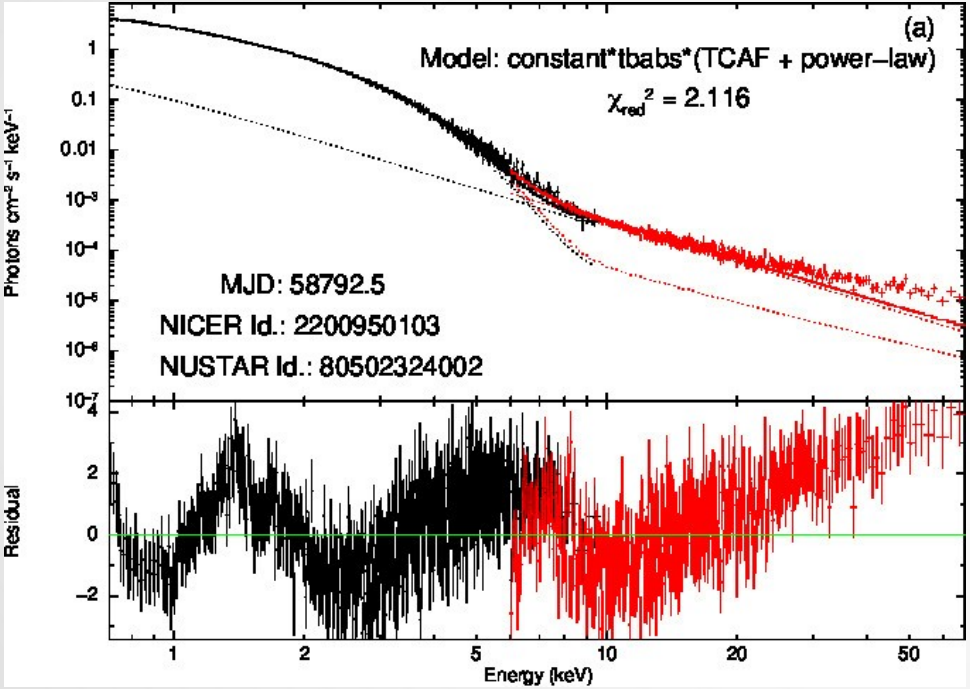
Chatterjee et al. (2023)

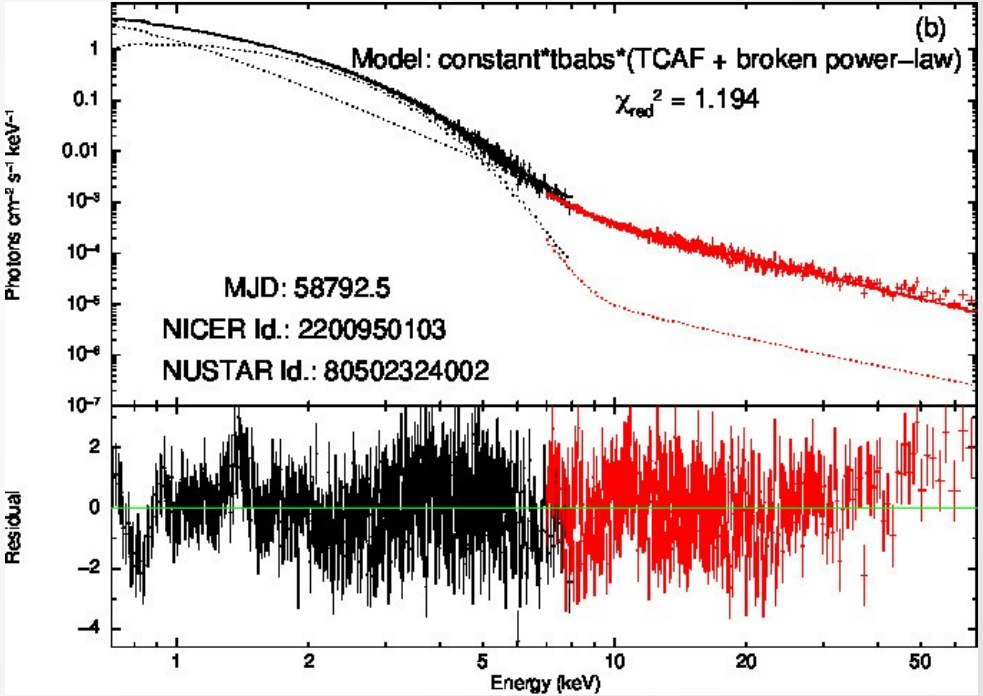
Broadband Spectral Nature (Physical Models)



Chatterjee et al. (2023)

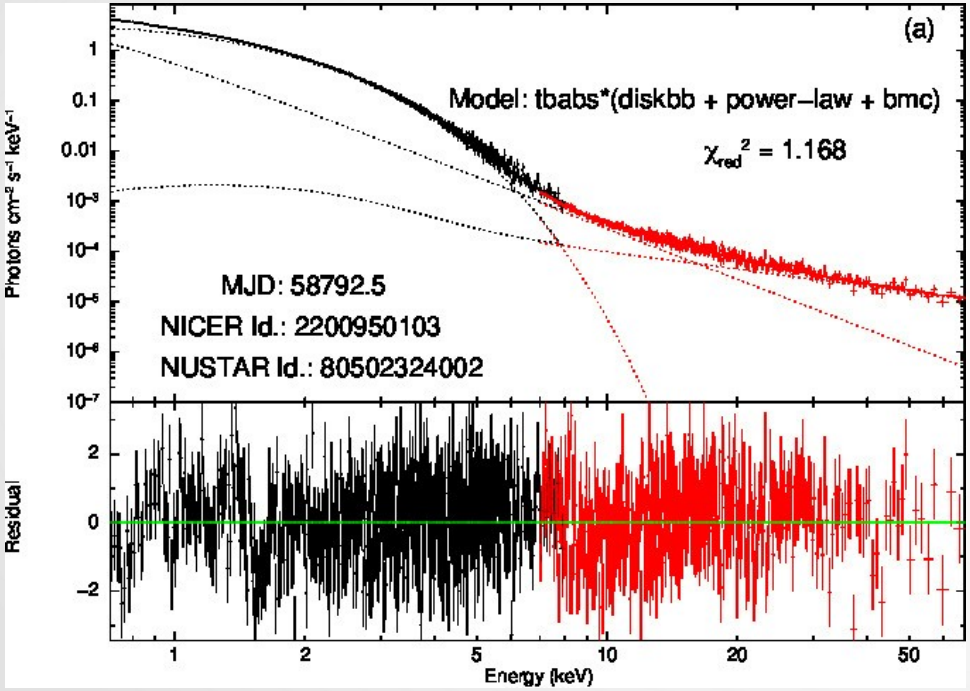
Broadband Spectral Nature (Physical Models)





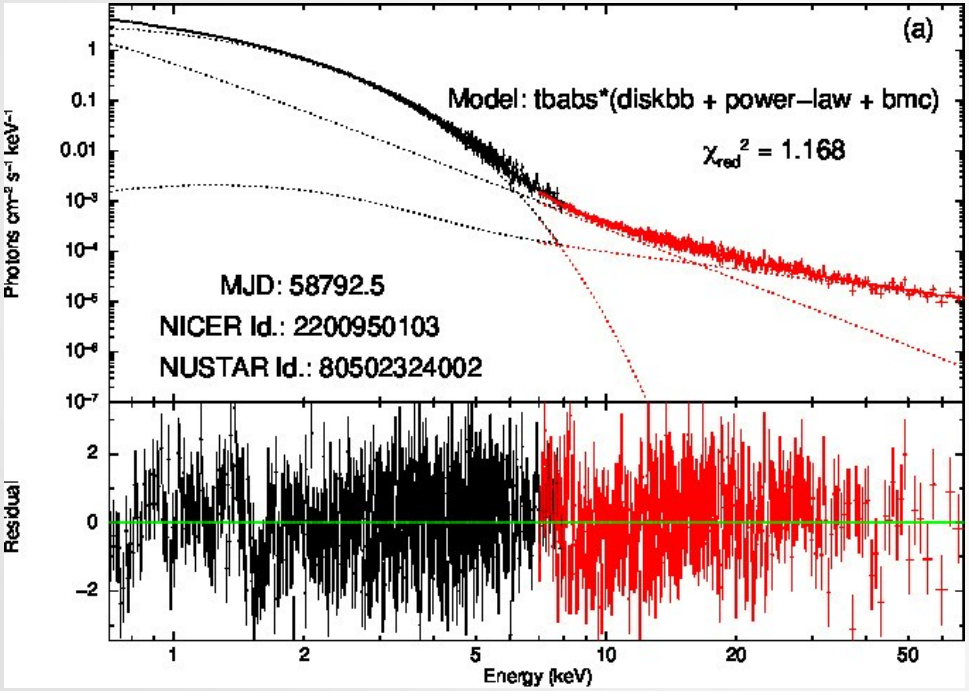
Chatterjee et al. (2023)

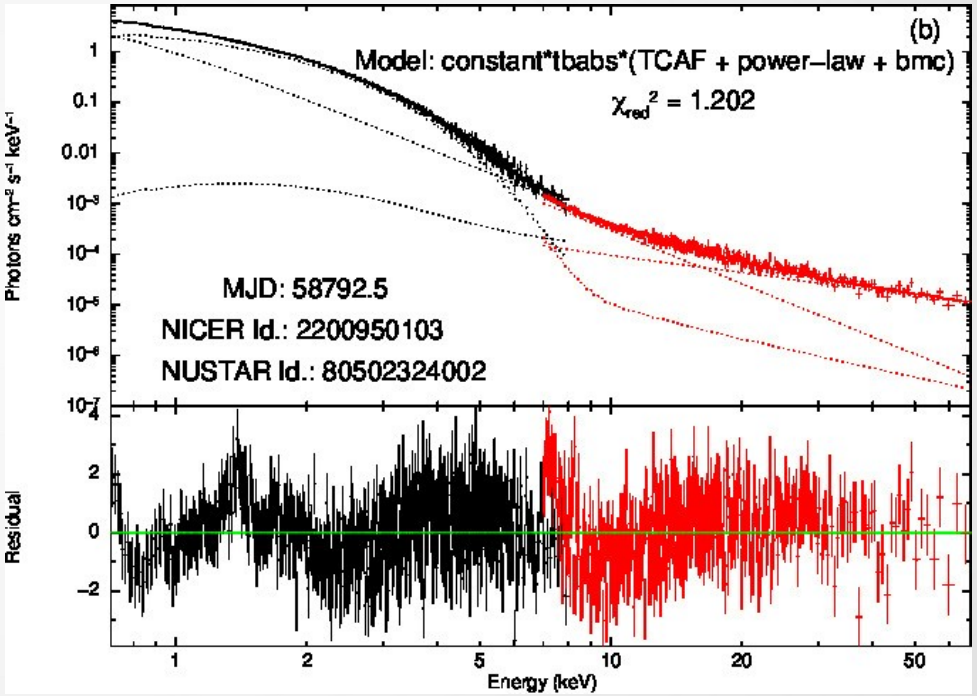
Using BMC Model



Chatterjee et al. (2023)

Using BMC Model





Chatterjee et al. (2023)

Results

Table 2
Spectral Fitting Results for High Soft State (HSS) Epochs

Models	Parameters	E1[a]	E2[a]	E3[a]
	n_H	$6.9E-2 \pm 1.7E-2$	$9.2E-2 \pm 7.9E-3$	$7.0E-2 \pm 8.2E-3$
	T_{in}	$0.61 \pm 8.5E-4$	$0.57 \pm 1.1E-3$	$0.55 \pm 3.0E-3$
DBB	Norm	2982.6 ± 19.4	2676.7 ± 24.7	1114.1 ± 32.1
+	Γ_1	$3.19 \pm 1.3E-2$	$3.09 \pm 9.0E-3$	$3.25 \pm 3.4E-2$
BKNPL	E_{break}	11.39 ± 0.16	$9.44 \pm 8.1E-2$	10.81 ± 0.19
	Γ_2	$1.96 \pm 2.7E-2$	$2.07 \pm 1.2E-2$	$1.92 \pm 3.1E-2$
	Norm	$0.68 \pm 6.6E-3$	$0.89 \pm 7.2E-3$	$0.19 \pm 8.7E-3$
	χ^2/DOF	1066.7/909	1154.6/1204	877.6/695
	n_H	$6.9E-2$	$9.2E-2$	$7.0E-2$
	T_{in}	$0.62 \pm 8.1E-4$	$0.58 \pm 6.8E-4$	$0.56 \pm 2.8E-3$
DBB	Norm	2979.6 ± 18.2	2751.7 ± 14.4	1034.2 ± 25.8
+	Γ	$3.32 \pm 1.3E-2$	$3.02 \pm 7.5E-3$	$3.56 \pm 2.8E-2$
PL	Norm	$0.64 \pm 6.0E-3$	$0.63 \pm 3.3E-3$	$0.19 \pm 6.4E-3$
+	KT (in keV)	$=T_{in}$	$=T_{in}$	$=T_{in}$
BMC	α	$0.14 \pm 4.5E-2$	$0.36 \pm 2.5E-2$	$0.31 \pm 4.9E-2$
	$logA$	$0.41 \pm 4.0E-2$	$0.96 \pm 8.4E-2$	$0.17 \pm 3.5E-2$
	Norm	$4.5E-4 \pm 9.1E-5$	$6.3E-4 \pm 3.4E-5$	$1.2E-4 \pm 7.3E-5$
	χ^2/DOF	1060.7/908	1317.9/1203	897.7/694
	n_H	$0.21 \pm 1.9E-2$	$0.18 \pm 1.6E-2$	$0.12 \pm 3.9E-2$
	$\dot{m}_d$	10.15 ± 0.05	6.06 ± 0.06	4.86 ± 0.24
	$\dot{m}_h$	2.92 ± 0.45	1.71 ± 0.14	1.61 ± 0.10
TCAF	X_s	31.76 ± 0.02	32.39 ± 0.01	32.21 ± 0.10
+	R	1.64 ± 0.44	1.78 ± 0.02	1.64 ± 0.42
BKNPL	Γ_1	$3.68 \pm 4.2E-2$	$3.45 \pm 3.5E-2$	3.64 ± 0.43
	E_{break}	10.66 ± 0.17	$9.01 \pm 8.5E-2$	10.18 ± 2.58
	Γ_2	2.02 ± 0.10	$2.17 \pm 5.2E-2$	3.43 ± 0.56
	Norm	2.46 ± 0.11	1.89 ± 0.10	0.25 ± 0.23
	χ^2/DOF	1080.9/905	1214.04/1200	795.2/690
	n_H	0.21	0.18	0.12
	$\dot{m}_d$	$10.63 \pm 7.7E-2$	$6.26 \pm 3.5E-2$	4.84 ± 0.13
TCAF	$\dot{m}_h$	$3.34 \pm 2.6E-2$	$2.34 \pm 5.8E-2$	$2.42 \pm 9.2E-2$
+	X_s	$32.97 \pm 4.3E-2$	$33.02 \pm 2.6E-2$	30.9 ± 3.93
PL	R	1.89 ± 0.63	$1.42 \pm 7.2E-2$	1.57 ± 0.49
+	Γ	$3.49 \pm 5.7E-2$	$3.21 \pm 3.0E-2$	$3.82 \pm 5.4E-2$
BMC	Norm	1.30 ± 0.12	$1.06 \pm 5.9E-2$	$0.46 \pm 4.1E-2$
	KT (in keV)	0.62	0.58	0.56
	α	0.14	0.36	0.31
	$logA$	0.41	0.96	0.17
	Norm	$5.8E-4 \pm 8.6E-5$	$6.3E-4 \pm 3.5E-5$	$1.2E-4 \pm 4.3E-5$
	χ^2/DOF	1188.9/906	1315.5/1202	803/693

Chatterjee et al. (2023)

- $\Gamma_{bmc} = \alpha + 1$
- $f = A/(A + 1)$
- $N_{bmc} = L_{39} / d_{10}^2$
- f is the fraction of soft disk photons that are inverse Comptonized by the process of BMC.
- f is ~ 0.7, 0.9, and 0.6 for the three Obs. ID
- R_{in} ~ 50 to 70 km during these 3 epochs
- L_{BMC} ~ **0.0003 L_{Edd}**, **0.0004 L_{Edd}**, and **0.0001 L_{Edd}** for the three Obs. ID whereas, L_{total} ~ **0.043 L_{edd}**, **0.03 L_{Edd}**, and **0.011 L_{Edd}** respectively.

Summary

- **This has gone through every spectral states of a BH (LHS, IMS, HSS)**
- **QPO was not found during this outburst**
- **The mass of the source varied between 5.4 and 9.4 $M_{\odot}$**
- **R_{in} ~ very close to ISCO in HSS**
- **In case of HSS, along with thermal and non-thermal radiation, there was contribution from bulk-motion Comptonization (BMC) as matter was very close to the BH**