IACHEC

International Astrophysical Consortium for High Energy Calibration

Galaxy Clusters WG Summary

Eric Miller (MIT)

10 November 2021

WG membership

E. Miller (chair, XRISM, Hitomi, Suzaku/XIS)

A. Beardmore (Swift/XRT)

M. Bonamente

Y. Chen (Insight-HXMT)

Y.-P. Chen (Insight-HXMT)

L. David (Chandra)

J. de Plaa

G. Dewangan (ASTROSAT)

K. Forster (NuSTAR)

C. Grant (Chandra/ACIS)

S. Jia

C. Li

K. Madsen (NuSTAR)

C. Markwardt (NICER)

H. Matsumoto (XRISM/Xtend, Hitomi/SXI, Suzaku/XIS)

N. Ota (XRISM, Hitomi, Suzaku/XIS)

A. Read (XMM-Newton/EPIC-MOS)

G. Schellenberger (XMM-Newton/EPIC, Chandra/ACIS)

S. Snowden (XMM-Newton/EPIC-MOS)

M. Stuhlinger (XMM-Newton/EPIC)

I. Valtchanov (XMM-Newton/EPIC)

N-J. Westergaard (NuSTAR)

H. Zhao (Insight-HXMT)

Mailing list: iachec-clusters@mit.edu
Contact milleric@mit.edu to join

When last we met….

Summary and Future Plans

- CluWG is still useful, will be more so for future missions.
- We have a path forward for the MMS.
  - Assign WG member for each mission. Include additional missions.
  - Identify and gather existing data.
  - Select ~4 clusters to include.
  - Update calibration.
  - Extract spectra and responses, provide to Eric for residual ratio determination.
- Provide data for Calstats WG concordance effort.

- Two CluWG meetings planned before September IACHEC Workshop. If in person, we hope to work real-time on this effort.

19 May 2021 IACHEC 2021 — Galaxy Clusters WG Summary 16

Latest activity

- No WG meetings since May.
- “Asynchronous” meeting started last week to address action items.
- Some activity by members during the last few months.

May 2021 action items

- (A/I Ivan, Larry, Gerrit, Eric, Andy B., Karl, Chen Yong) Update compiled list of available clusters and ObsIDs for your mission that fulfill our criteria. See the table of clusters, the criteria, and the mission assignments on the wiki page.
  ➜ Ivan and Larry have supplied this information. See table.
- (A/I All) Should we add A2199 to the sample? Probably cooler than 6 keV, but also probably observed by many missions. ➜ Yes.
- (A/I Andy) XRT mkarf doesn't flux-weight ARFs, so Andy has to figure out how to do this by hand. ➜ No update.
- (A/I Ivan) Contact Jukka to find out whether he is working on IACHEC cluster related work.
  ➜ Ivan has done this. Jukka is working on a tool and explanatory paper for propagating XMM EPIC pn/MOS cross-calibration uncertainties to spectral fitting. It sounds like this will be done around March 2022, and he is willing to present the idea to the IACHEC and describe how it can be extended to other X-ray missions.
- (A/I Eric) Ask eROSITA team (Konrad and Michael F.) about cluster observations/calibration, interest in cross-calibration. ➜ Not done.
- (A/I Eric) Ask Konrad and Michael F. about someone who can cover ROSAT analysis. ➜ Not done.
- (A/I Eric) Ask Dan Wik and Karl about NuSTAR cluster calibration data. ➜ Not done.
- (A/I Eric) Ask ASTROSAT team about cluster observations/calibration, interest in cross-calibration, contact person.
  ➜ Gulab Dewangan volunteered for this at the May WG presentations.
- (A/I Eric) Ask NICER team about cluster observations/calibration, interest in cross-calibration, contact person.
  ➜ Craig Markwardt volunteered for this at the May WG presentations (TBC).

Cluster data collection

XMM cluster list from Ivan

iachec_clusters_xmm_obs_all

short_name	input_name	input_ra	input_dec	target	observation_id	revolution	ra	dec	duration	distance
A85	Abell 0085	10.4075	-9.3425	Abell 85	65140101	381	10.425	-9.375	13118	2.2
A85	Abell 0085	10.4075	-9.3425	Abell 85	723802201	2477	10.45996	-9.30306	102259	3.9
A85	Abell 0085	10.4075	-9.3425	Abell 85	723802101	2476	10.45996	-9.30306	101400	3.9
A85	Abell 0085	10.4075	-9.3425	A 85 offset	744930301	2662	10.33375	-9.10936	34000	14.7
A119	Abell 0119	14.07	-1.25	A0119	402190501	1194	14.06492	-1.24889	19914	0.3
A119	Abell 0119	14.07	-1.25	A0119	505211001	1391	14.06492	-1.24889	13916	0.3
A119	Abell 0119	14.07	-1.25	LBQS0053-0134	12440101	202	14.06042	-1.30806	34992	3.5
A119	Abell 0119	14.07	-1.25	CGCG 384-028	760340201	2852	13.82833	-1.29167	93000	14.7
A399	Abell 0399	44.485	13.01639	A399	112260101	127	44.47083	13.03333	15409	1.3

IACHEC_Cluster_of_Galaxies_WG .XLSX

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Share

Chandra cluster list from Larry; Google doc for everyone!

A1:L1 | IACHEC - Clusters of Galaxies WG

IACHEC - Clusters of Galaxies WG

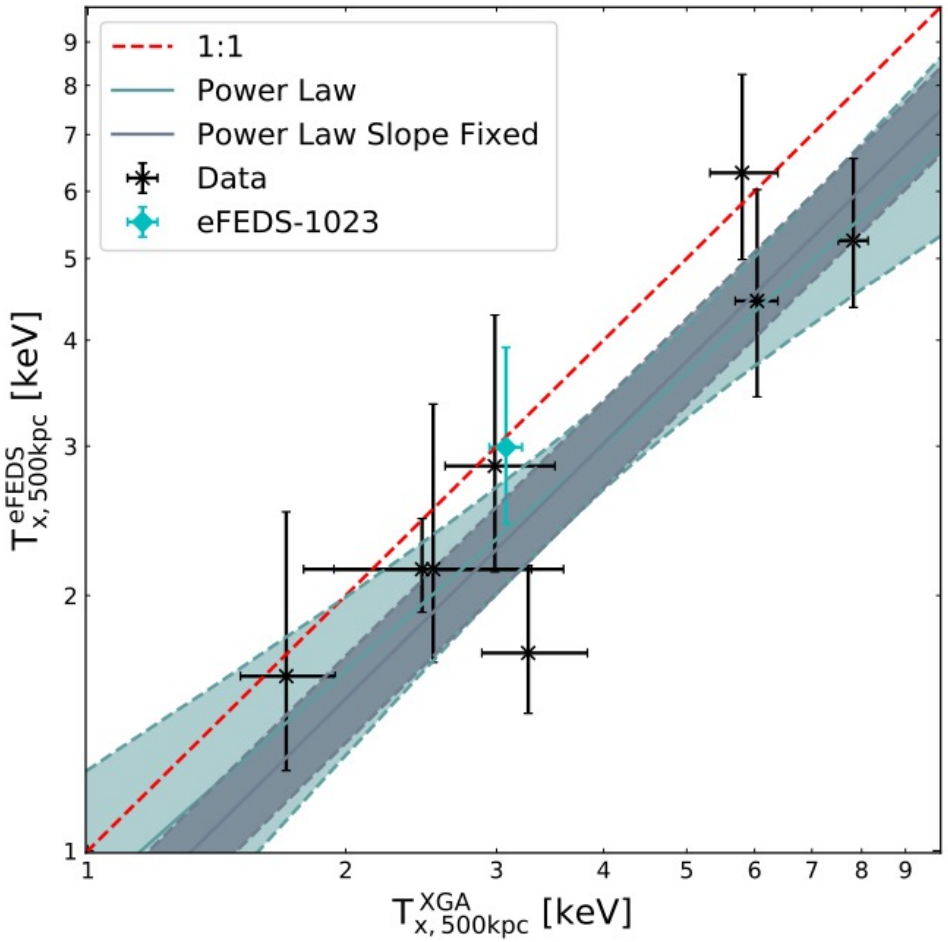
		Chandra		XMM-Newton		Suzaku		NuStar		Swift		ASTROSAT		HXMT		eROSITA		NICER	
	Cluster	ObsID	ACIS-I exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)	Seq no	exp(ks)
4	A85	15173	43																
5	A119	7918	49																
6	A399	3230	50																
7	A401	14024	140																
8	A478	6102	10																
9	A754	577	40																
10	A644	24315	32																
11	A1413	—-	—-																
12	A1650	5823	40																
13	A1651	4185	10																
14	Coma	13996	125																

Multi-Mission Study (MMS) contacts

Instrument	Contact Person	Notes
XMM EPIC MOS & pn	Ivan	
Chandra ACIS	Larry & Gerrit	
Suzaku XIS	Eric	
Swift XRT	Andy B.	
ROSAT PSPC	?	**(A/I Eric)** Ask Konrad and Michael F. about ROSAT cluster person. Kip suggest Steve Snowden.
NuSTAR	Karl and Dan Wik	NuSTAR LP, A2029, A478, A1795, A2199, all completed according to Karl **(A/I Eric)** contact Dan and Karl about NuSTAR data
eROSITA	?	**(A/I Eric)** Ask Konrad and Michael F. about eROSITA cluster person and data set.
ASTROSAT	Gulab	
HXMT	Chen Yong	Only two clusters have been observed: Coma, Perseus
NICER	Craig (TBC)	

eROSITA vs. XMM comparison

https://arxiv.org/abs/2109.11807



The *XMM* Cluster Survey: An independent demonstration of the fidelity of the eFEDS galaxy cluster data products and implications for future studies

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"We compare 8 clusters that have T_X measured by both telescopes, and find that *XMM* temperatures are (on average) 25% larger than the corresponding *eROSITA* temperature…. Very few clusters have both an eFEDS and an *XMM* temperature. However, we have provided evidence of an offset that requires further investigation."

Reminder: Schellenberger+2015 found hot clusters are 25% cooler with XMM than Chandra; here, eROSITA is 25% cooler than XMM.

XGA = *XMM*: Generate and Analyse; a new, open-source, X-ray astronomy analysis module developed by XCS (Turner et al. prep)

Summary and future plans

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  - Identify and gather existing data.
  - Select ~4 clusters to include.
  - Update calibration.
  - Extract spectra and responses, provide to Eric for residual ratio determination.
- Provide data for Calstats WG concordance effort.

- Continue asynchronous work assembling data.
- WG meeting before spring IACHEC meeting to plan spectral fitting.

Multi-Mission Study (MMS) – Review

X: XMM/EPIC

C: Chandra/ACIS

R: ROSAT/PSPC

SW: Swift/XRT

SU: Suzaku/XIS

A1835?

cluster	X	C	R	SW	SU
A85	☺	☺	☺	☹	☹
A119	☺	☺	☺	☹	☹
A399	☺	☺	☺	☹	☹
A401	☺	☺	☺	☺	☹
A478	☺	☺	☺	☹	☹
A754	?	☺	☹	☹	☹
A644	☺	☺	☺	☹	☹
A1413	☺	☺	☺	☹	☹
A1650	☺	☺	☹	☹	☹
A1651	☺	☺	☺	☺	☹
Coma	☺	☺	☺	☺	☺
A1689	☺	☺	☺	☹	☹
A1795	☺	☺	☺	☺	☺
A1914	☺	☺	☺	☹	☹
A2029	☺	☺	☺	☺	☺
A2065	☺	☺	☹	☹	☹
A2142	☺	☺	☺	☹	☹
A2163	?	?	☹	☹	☹
A2204	☺	☺	☺	☹	☹

cluster	X	C	R	SW	SU
A2244	☺	☺	☺	☺	☺
A2255	☺	☺	☺	☹	☹
A2256	☺	☺	☺	☹	☺
A2319	☺	☺	☹	☹	☹
A3158	☺	☺	☹	☹	☹
A3266	?	☺	☹	☹	☹
A3391	☺	☺	☺	☹	☹
A3558	☺	☺	☹	☹	☹
A3571	☺	☺	☺	☹	☺
A3627	?	?	☺	☹	☺
A3667	?	☺	☺	☹	☺
A3827	☺	☺	☹	☹	☹
A3888	☺	☺	☺	☹	☹
Ophiu	☺	☺	☺	4ks	☺
Perse	☺	☺	☺	☺	☺
PKS0745	☺	☺	☺	☺	☺
RXCJ1504	?	?	?	☹	?
Triang	☺	☺	☺	☹	☺
ZwCl1215	☺	☺	☹	☹	☹

34

- Cluster sample is hot HIFLUGCS (+ others) that meet these criteria (plus Perseus), and:
  - Offset btw. the cluster center and pointing FOV center < 3 arcmin
  - Exposure > 10 ks in the available data

Multi-Mission Study (MMS) – Review

- 2017 TASK 4: Compile a list of available clusters and obs. ID:s fulfilling our criteria: Larry (Chandra), Eric (Suzaku), Andy B. (Swift), Steven Snowden (ROSAT), Jukka (XMM) Deadline end of April
- 2017 TASK 5: Extract and process data with May 2017 calibration information. Deadline end of June
- 2017 TASK 6: Jukka will do the stack residuals ratio analysis.

- Only XMM-ROSAT comparison has been done, for ~12 clusters, presented at 2018 IACHEC.

Multi-Mission Study (MMS) – Update

X: XMM/EPIC

C: Chandra/ACIS

R: ROSAT/PSPC

SW: Swift/XRT

SU: Suzaku/XIS

A1835?

cluster	X	C	R	SW	SU
A85	☺	☺	☺	☹	☹
A119	☺	☺	☺	☹	☹
A399	☺	☺	☺	☹	☹
A401	☺	☺	☺	☺	☹
A478	☺	☺	☺	☹	☹
A754	?	☺	☹	☹	☹
A644	☺	☺	☺	☹	☹
A1413	☺	☺	☺	☹	☹
A1650	☺	☺	☹	☹	☹
A1651	☺	☺	☺	☺	☹
Coma	☺	☺	☺	☺	☺
A1689	☺	☺	☺	☹	☹
A1795	☺	☺	☺	☺	☺
A1914	☺	☺	☺	☹	☹
A2029	☺	☺	☺	☺	☺
A2065	☺	☺	☹	☹	☹
A2142	☺	☺	☺	☹	☹
A2163	?	?	☹	☹	☹
A2204	☺	☺	☺	☹	☹

cluster	X	C	R	SW	SU
A2244	☺	☺	☺	☺	☺
A2255	☺	☺	☺	☹	☹
A2256	☺	☺	☺	☹	☺
A2319	☺	☺	☹	☹	☹
A3158	☺	☺	☹	☹	☹
A3266	?	☺	☹	☹	☹
A3391	☺	☺	☺	☹	☹
A3558	☺	☺	☹	☹	☹
A3571	☺	☺	☺	☹	☺
A3627	?	?	☺	☹	☺
A3667	?	☺	☺	☹	☺
A3827	☺	☺	☹	☹	☹
A3888	☺	☺	☺	☹	☹
Ophiu	☺	☺	☺	4ks	☺
Perse	☺	☺	☺	☺	☺
PKS0745	☺	☺	☺	☺	☺
RXCJ1504	?	?	?	☹	?
Triang	☺	☺	☺	☹	☺
ZwCl1215	☺	☺	☹	☹	☹

34

- Swift now has lots of data on PKS0745.
- Chandra has lots of data on A1795.
- Jukka, Ivan et al. worked on chip gap/bad pixel correction on pn using image from MOS
  - Reduces the effect on the ARF to 0.1%
  - TN: https://arxiv.org/abs/2103.01753

Multi-Mission Study (MMS) – Update

- Action items from 2018
  - 2018 TASK 1: Check ROSAT PSPC calibration using one of our clusters (Jukka & M. Freyberg) (Postpone)
  - 2018 TASK 2: Check one cluster with Konrad's methods. Needs isothermal region for simple and accurate modelling. (Postpone)
  - 2018 TASK 3: Swift XRT flux weighting of ARFs **(A/I Andy B.)** XRT mkarf doesn't flux-weight ARFs, so Andy has to figure out how to do this by hand.
  - 2018 TASK 4: Draft ready by next IACHEC (Postpone)
- Where do we go from here?
  - Complete multi-mission study
  - Supply data to the concordance effort (Statistics WG)