# Chandra ACIS Background Modeling

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### IACHEC 2019

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Chandra ACIS Background

IACHEC 2019 1/13

The aim:

templates for ACIS (TE-mode) detector background modeling)

Detector background:

- particle-induced:
  - continuum (particle charge clouds)
  - fluorescent lines (structure in detector FOV)
  - framestore fluorescent lines (framestore cover: Al + Au)
- Four basic combinations:
  - FI vs. BI chip
  - VFAINT **vs.** FAINT **mode**

## Background Features (ACIS "stowed")

- particle-induced background (continuum)
- fluorescent lines (+ framestore lines)



## Background Features (ACIS "stowed")

- particle-induced background (continuum)
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### Background Spatial/Spectral Variation (ACIS "stowed") FI Chips – 10, 12, 13 (no VF cleaning)



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### Background Spatial/Spectral Variation (ACIS "stowed") FI Chips – I0, I2, I3 (with VF cleaning)



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## Background Spatial/Spectral Variation (ACIS "stowed") BI Chip – S3 (with VF cleaning)



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### Not processed by X-ray optics

- particle-induced background (continuum)
  - not real X-rays
  - regular RMF? diagonal RMF?
    no ARF
- fluorescent lines (detector FOV)
  - should be with RMF, detector-only ARF (QE, OBF)
- fluorescent lines (framestore)
  - bypass OBF
  - with RMF, should be detector-only ARF (QE), no OBF
    - Currently: no way to "turn off" OBF in ARF

See also:

- Bartalucci et al. 2014, A&A 566, A25
  - "Chandra ACIS-I particle background: an analytical model"
- ACIS-I only, VFAINT filtered only

My approach:

- Aim for physics-based lines where possible.
- Extend to FAINT mode data
- Extend to S3 FAINT mode and VFAINT filtered data

# Physically Expected Line Complexes

Al	Al K $\alpha$	1.48656	+ framestore line
	Al K $\beta$	1.55745	+ framestore line
Si	Si K $\alpha$	1.73978	
AI	Au M $\alpha_2$	2.118	+ framestore line
	Au M $\alpha_1$	2.1229	+ framestore line
	Au M $\beta$	2.205	+ framestore line
	Au M $\gamma$	2.410	+ framestore line
Ni	Ni K $\alpha_1$	7.4609	
	Ni K $\alpha_2$	7.4782	
Ni	Ni Kβ <sub>1,3</sub>	8.2647	
Au	Au L1	8.4939	+ framestore line
Au	Au L $\alpha_1$	9.7133	+ framestore line
	Au L $\alpha_2$	9.6280	+ framestore line
Au	Au L $\beta_2$	11.5847	+ framestore line
	Au L $\beta_2$	11.4423	+ framestore line

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# Group Physically Expected Lines

- Group the Au M lines; tie norms and widths to Au Mα<sub>2</sub>
- Group Au L $\alpha_1$  and Au L $\alpha_1$ ; tie norm and width to Au L $\alpha_1$
- Au lines have direct and frame store components
  - CTI correction overcorrects
    - (assumes event is actually in imaging array)
  - Frame store component depends on chipy (roughly linear)
- "framestore" version: group as above
  - grouping lines makes modeling framestore component easier
  - allow the Au M $\alpha_2$  and Au L $\alpha_1$  energy to vary
  - allow line width of Au  $M\alpha_2$  and Au  $L\alpha_1$  to vary compensates for variation with chipy
- In principle, Au Lβ<sub>2</sub> and Au Lβ<sub>1</sub>; however, RMF energies don't extend high enough to their framestore lines.
- Also group Al K $\alpha$ , Al K $\beta$ ; framestore lines

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Spectral extractions:

- spectra extracted in four broad regions:
  - chipx: 1:1024
  - chipy: 1:256, 247:512, 513:768, 769:1024
- merge I0+I2+I3 data
- periods D+E+F ACIS-stowed data; ~ 1Ms
- For now, RMF only, no ARF

Particle continuum:

- shallow <code>powerlaw</code> (index  $\sim$  0.08)
- Iow-energy peak: exp model

Fluorescent lines.

- groups of FOV lines: gaussian lines
- groups of framestore lines:
  - single line of a group can vary
  - energies of the rest scaled as for the FOV line group
  - line widths tied to reference line width width allowed to vary (large range of chipy)

# Background Spatial/Spectral Variation (ACIS "stowed") VF cleaned



# Background Spatial/Spectral Variation (ACIS "stowed") VF cleaned



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## Background Spatial/Spectral Variation (ACIS "stowed")

Period D,E,F: ACIS-023: Achipy 513\_768



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# Background Spatial/Spectral Variation (ACIS "stowed") VF cleaned



ACIS-stowed FI data, VF filtered

progress in modeling with physical line energies

More to do:

- I chips
  - no VF filtering case
  - Δchipy=256, background vs. node
  - Δchipy=128
  - as above, individual chips
- ACIS-S3
  - VF filtered, and non-VF filtered