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Chandra X-Ray Data Analysis Overview

$$S_D(\sigma, h, t) = T(\sigma, t) \int d\lambda \int d\hat{p}\, R(\sigma, h, \lambda, \Omega(t), \hat{p}, t)\, S(\lambda, \hat{p})$$

- $S_D(\sigma, h, t)$: counts
- $T(\sigma, t)$: Good-Time, Dead-Time
- $R(\sigma, h, \lambda, \Omega(t), \hat{p}, t)$: Response:
- $S(\lambda, \hat{p})$: Truth

$\sigma \equiv$ detected position
$h \equiv$ detected "wavelength"
$t \equiv$ time
$\lambda \equiv$ incident wavelength
$\hat{p} \equiv$ incident angle

Mirror area
Mirror PSF
Grating effic
Grating LSF
Detector effic
Detector redistribution
Aspect
Coordinate systems

$\therefore$ The 3 most important things are:

1. CALIBRATION

2. CALIBRATION

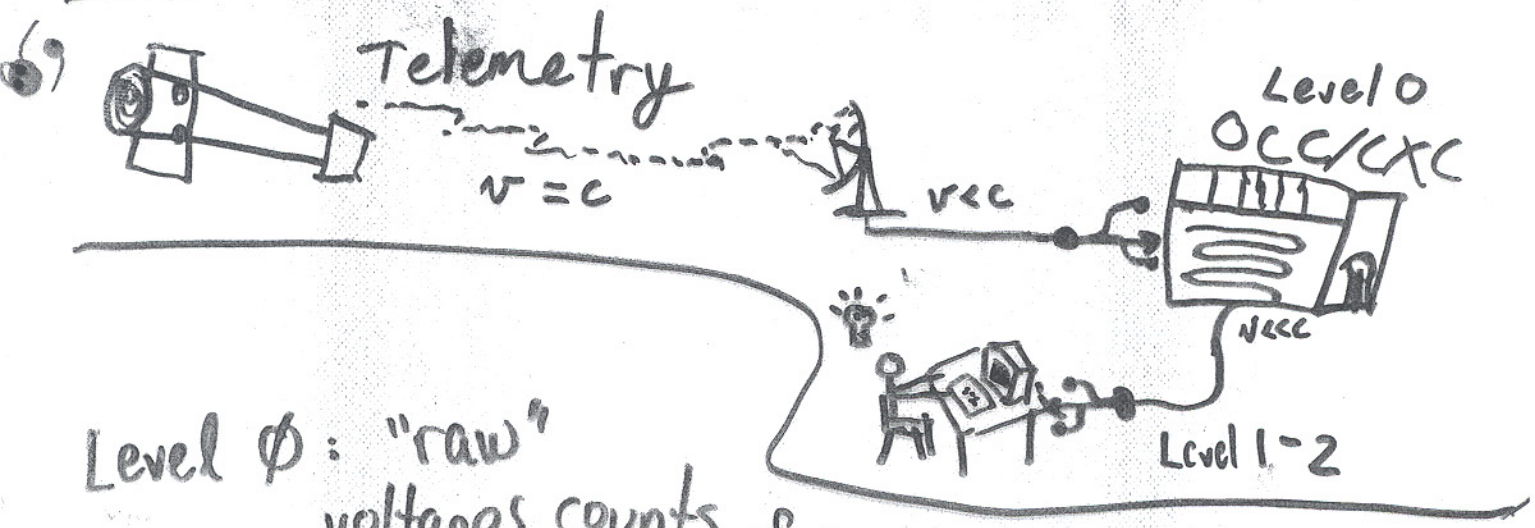
3. CALIBRATION

The rest is

- software
- organization

ANALYSIS

Data Products



Level ∅: "raw"
voltages, counts, frames

Level 1: scaled, calibrated, aspect-corrected
ENERGY = f(chip, gain)

Level 1.5 (a.k.a. "1a"): source dependent coords.
(grating) detect, src
diffraction coor

Level 2 - filtered, concatenated, binned
good grades
good pixels
good aspect...

User Level 2: binning, modeling
images src models
spectra fits
light-curves
responses

ANALYSIS - Preparation

Where to start?

Know your data! "OIF" = Observation Index File

evt2.fits - filtered event list (+GTI)

pha2 - (if grating) binned counts spect
(+REGION)

Check your data:

VV.obsid

Display, e.g. sky x,y vs order, r
det x,y
pha vs time
counts vs channel
vs wavelengt

Check cal files -

ASCDSVER
CALDBVER

vs info on web or chandra-us

Reprocess?

evt1	acis_process_events	tgdetect
evt1a	hrc- " "	tg_create_mask
asol	dmcopy	tg_resolve_events
aoff		tgextract
bpix		

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Analysis - Planning

SPATIAL

Images: (dmcopy)

(dmcopy) ↓↑ point src, extended src

ACIS-I, S3, HRC-I

SPECTRAL

"pha": (dmextract, tgextract)

(dmcopy) ↓↑ low-res

ACIS-I, S3

high-res

HETGS, LETGS

TEMPORAL

Light Curves: (lightcurve)

low-res

ACIS, HRC

high-res

ACIS-CC, HRC-S

→ RESPONSES

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RESPONSES

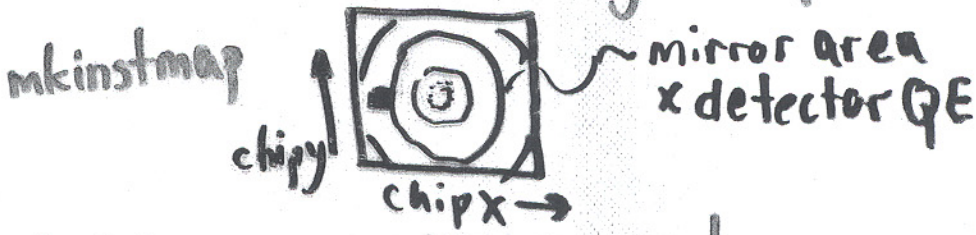
Spatial: Exposure* Map

* [area × time]

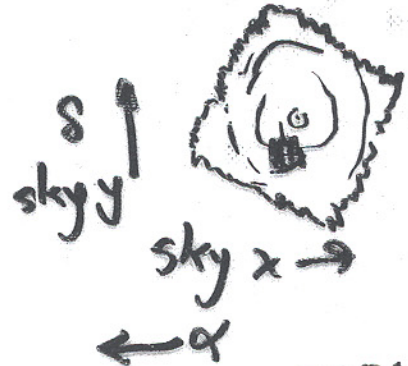
- keeps spatial information at the expense of spectral

$$\int_{\lambda \in \Delta\lambda} d\lambda \, S_{\gamma}(\lambda, \hat{p}) \approx \frac{C(\Delta h, \hat{p})}{E(\Delta h, \lambda, \hat{p})}$$

Instrument map → all calibration info band-integrated



Exposure map → • applies aspect (via aspect histogram)
• applies coordinate x-form



Responses

Spectral - Low Resolution

- keeps spectral information at the expense of spatial

$$C_\Omega(h) = \tau_{eff} \int d\lambda\, D_R(h,\lambda) A_\Omega(\lambda,\hat{q})^{*} s(\lambda)$$

* point source, at location $\hat{q}$ in region Ω.

$D_R(h,\lambda)^{**}$ = Redistribution Matrix Function
"RMF" [File]

$A_\Omega(\lambda,\hat{q})$ = Auxiliary Response Function
"ARF" [File]

= "effective" effective area

* mkarf: applies inverse aspect to map sky to detector vs time

** mkrmf: computes/looks up vs chip + position

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