Timing Analysis with Threads

Outline

I. Using Lightcurve
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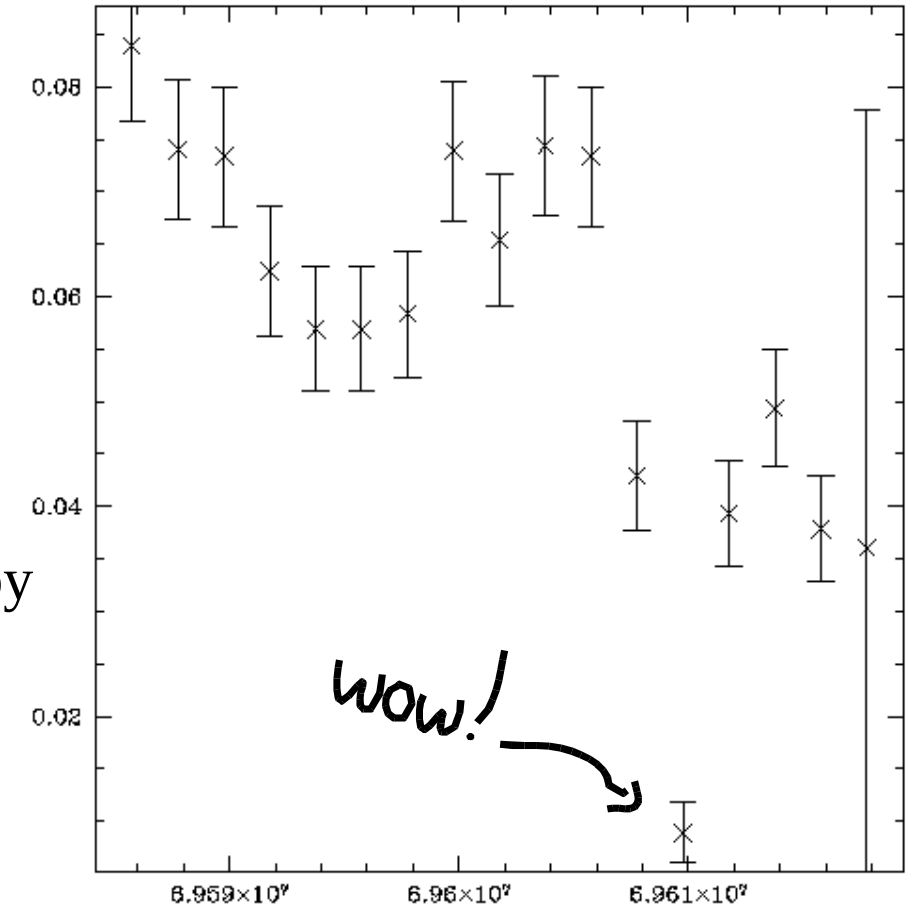
   - B. bugs/caveats
   - C. aliasing
   - D. intrinsic periods

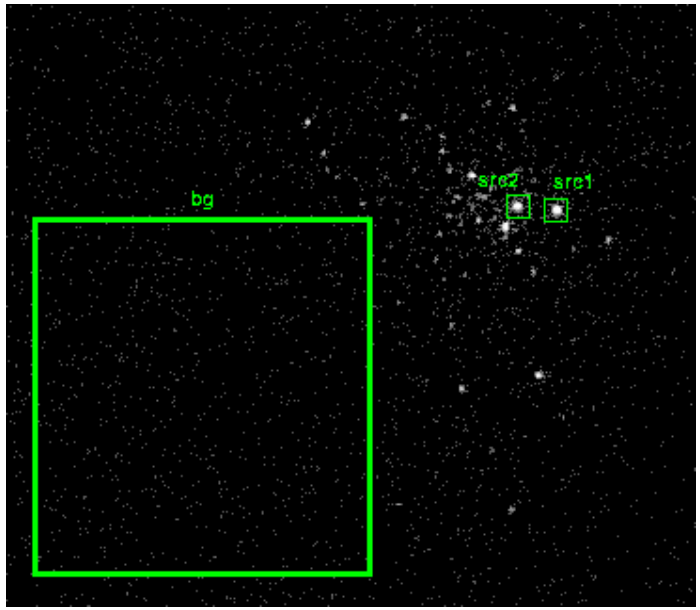
II. Phase−resolved Spectroscopy
   - A. create phase column
   - B. extract and fit data
   - C. caveats



I. Use and Caveats of Lightcurve

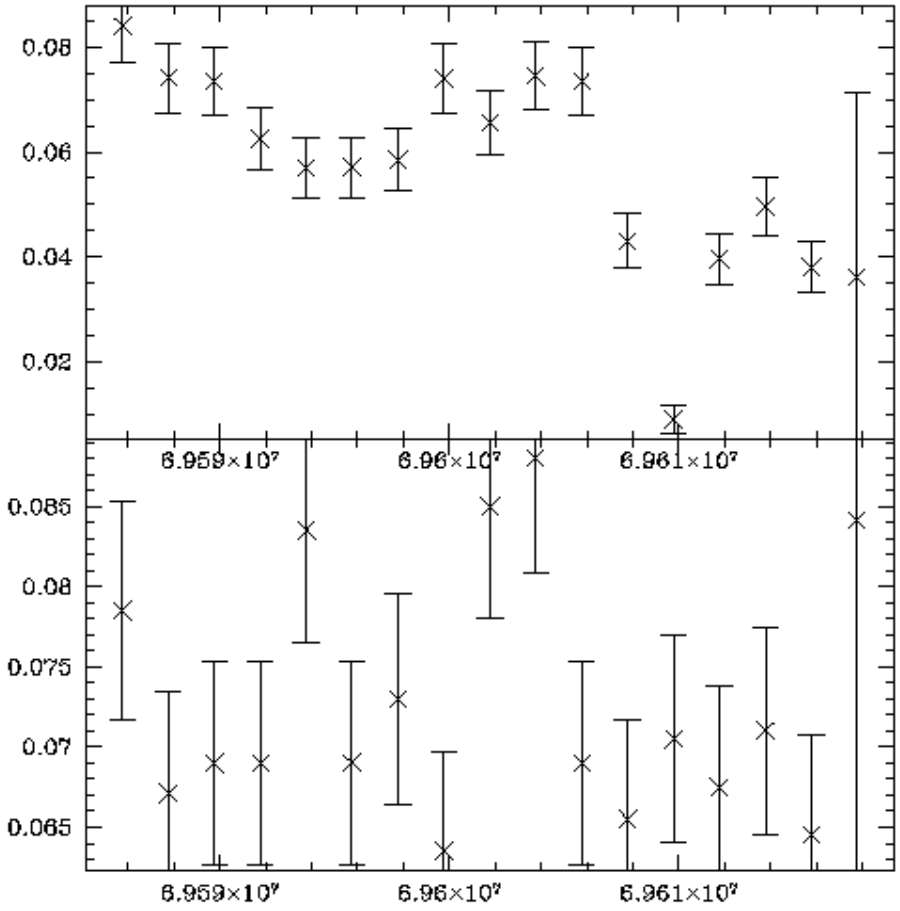
References:
- cxc.harvard.edu/ciao/threads/lightcurve
- ahelp lightcurve
- cxc.harvard.edu/bugs/lightcurve

A. Simple Lightcurve




```
unix%  lightcurve infile="evt2.fits[ccd_id=3,sky=region(src1.reg)]"
bkgfile="evt2.fits[ccd_id=3,sky=region(bg.reg)]"
outfile="lc_bgsub.fits" binlength="2000"
```

... or we can extract two lightcurves for comparison. Simple, no?

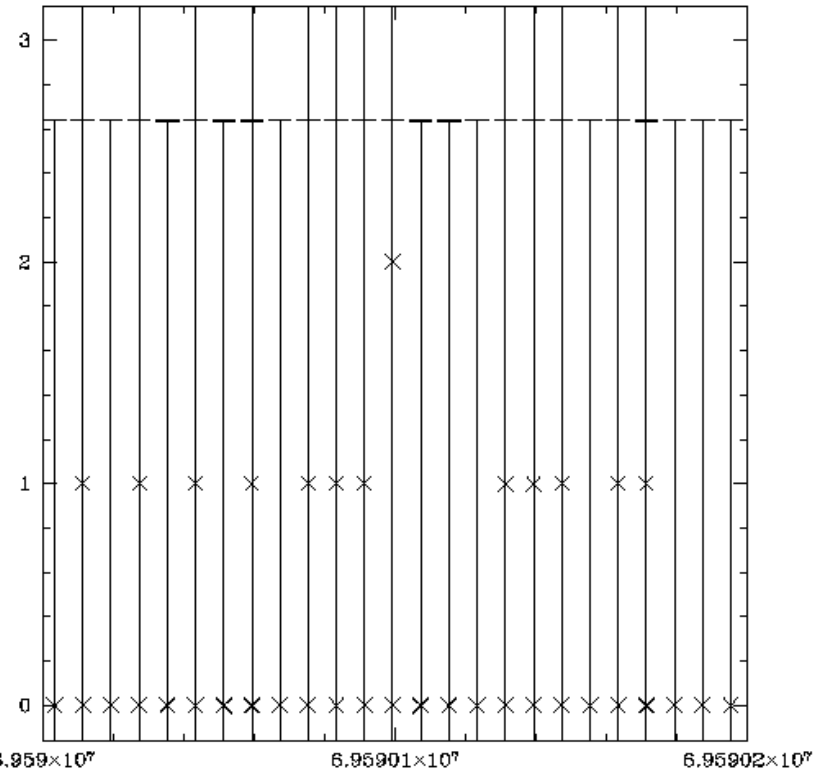


B. Bugs/Caveats
   1. GTIs, [ccd_id=n] filter
   2. area bug, background subtraction

C. Aliasing: the big caveat

> Aliasing is the apparent periodicity formed by the combination of two other periods.

Example 1: Underbinned lightcurve −>
Example 2: Moiré pattern



CXC

- More properly, lightcurve bins should be **integer multiples** of any natural or intrinsic periodicity. Unfortunately, this can be tricky...

Intrinsic Periods

3.2 s, ACIS TE−mode
2.8 ms, ACIS CC−mode
~40 μs, ACIS readout streak
~0.5 s, HRC (new!)

Dither Periods

	HRC	ACIS
Pitch	768.6 s	707.1 s
Yaw	1087.0 s	1000.0 s

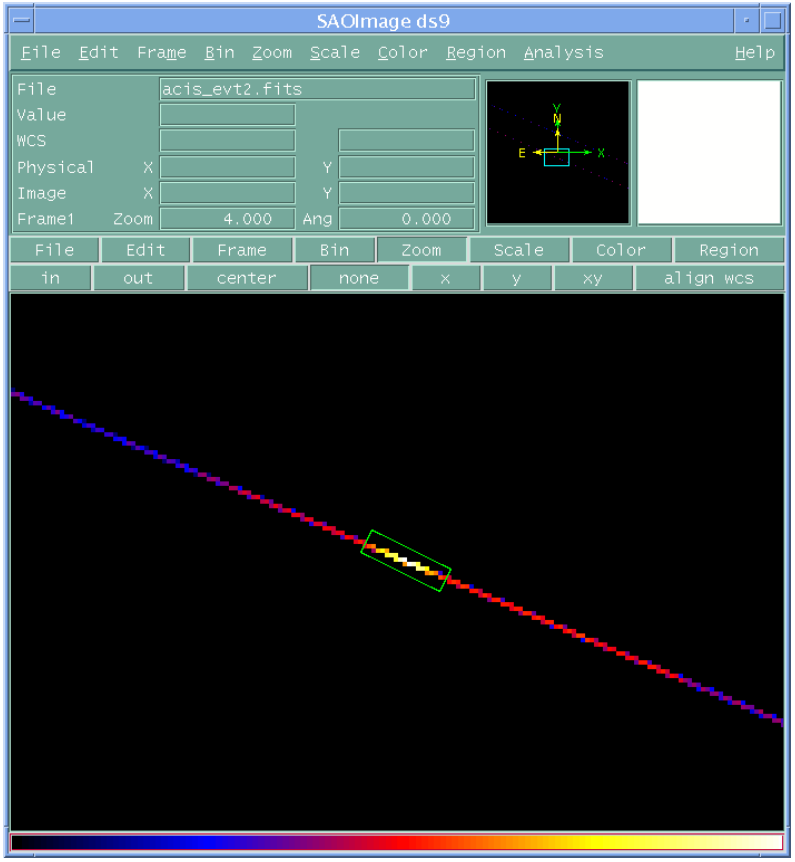
- A good way to verify a suspected period is to rebin the lightcurve with a different resolution. Any aliasing with the lightcurve binsize will change with the binsize.

II. Phase−resolved Spectroscopy

References:
- −cxc.harvard.edu/ciao/threads/phase_bin
- −ahelp dmtcalc
- −see also "faseBin" contributed software

Steps:

1. Apply barycenter time corrections (if necessary, see thread)
2. Use an assumed period (and $\dot{P}$) to convert TIME to PHASE
3. Extract and plot spectrum



PSR B0540−69
(ACIS CC−mode)

use dmtcalc to calculate the PHASE for each event:

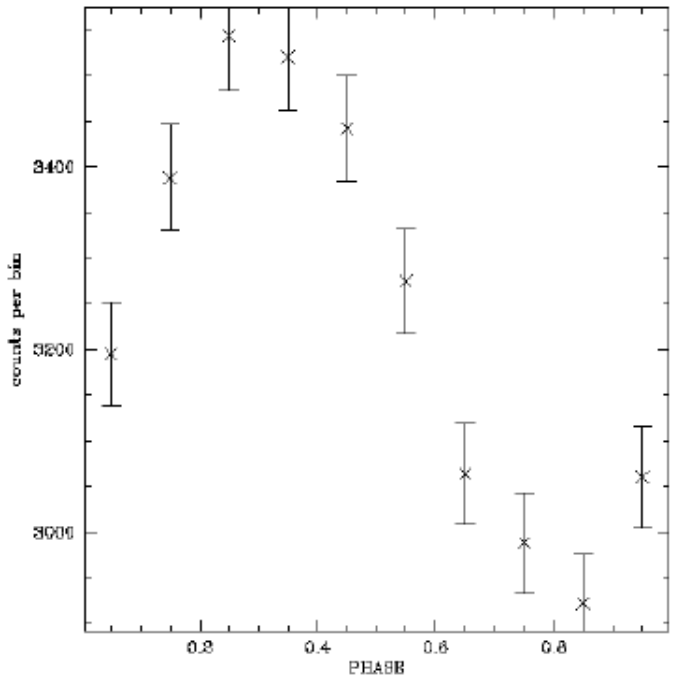
```
dmtcalc infile="evt2.fits" outfile="evt2_phase.fits" expression="@dmtcalc.txt"
```

dmtcalc.txt has the expression. first "phase", then "fold":

```
GPHASE=(time−TSTART)*(19.794885+(−4.79e−13*(time−TSTART)))
PHASE=GPHASE−(int)GPHASE
```

assumed period

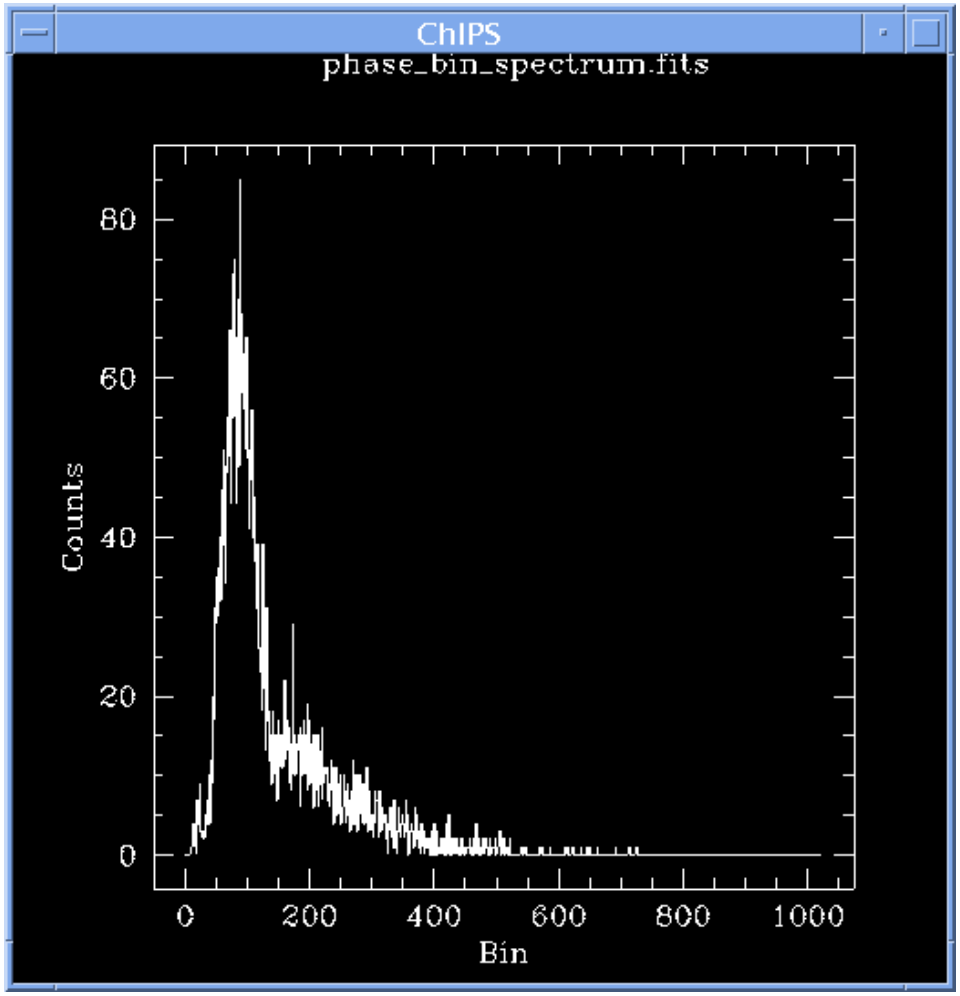
assumed $\dot{p}$



to check shape of oscillation,
use dmextract to "[bin phase=0:1:0.1]"

Now we extract a spectrum and plot...

```
dmextract "evt2_phase.fits[sky=region(source.reg),phase=0.2:0.4][bin pi]"
```



Caveat: no GTIs used