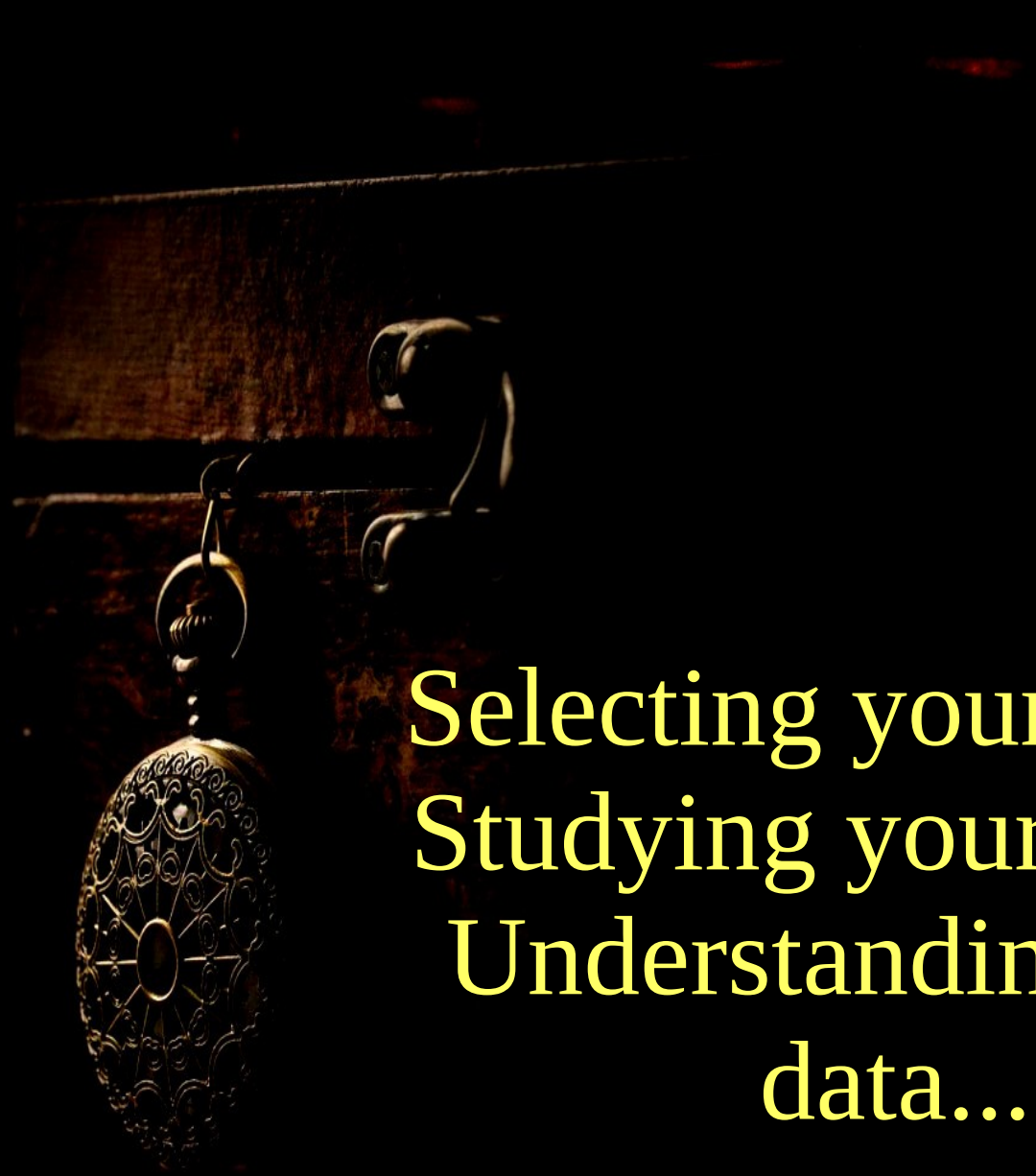
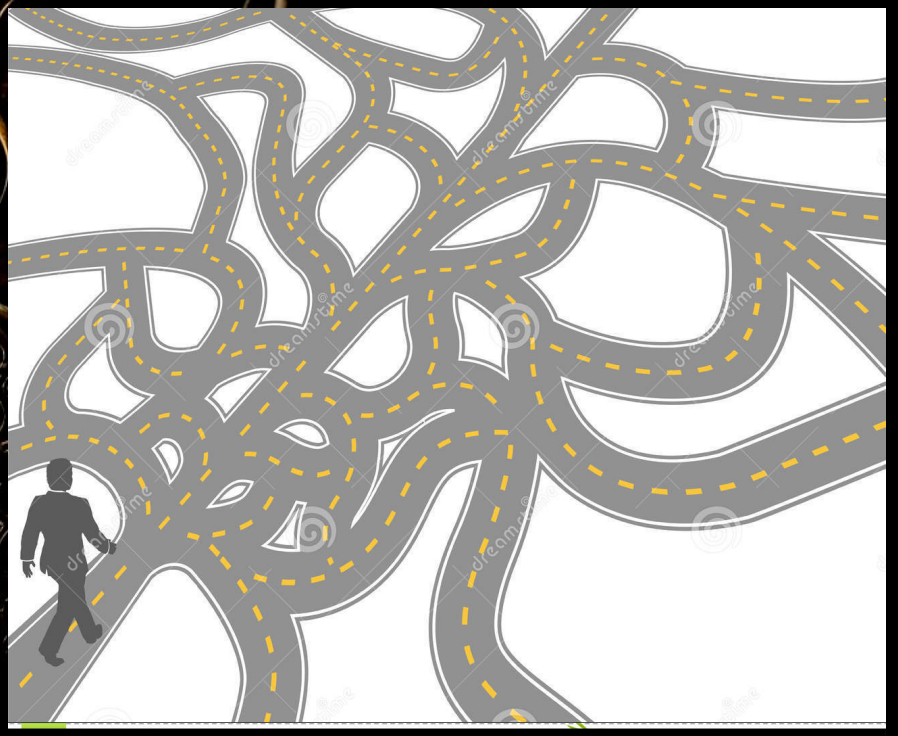
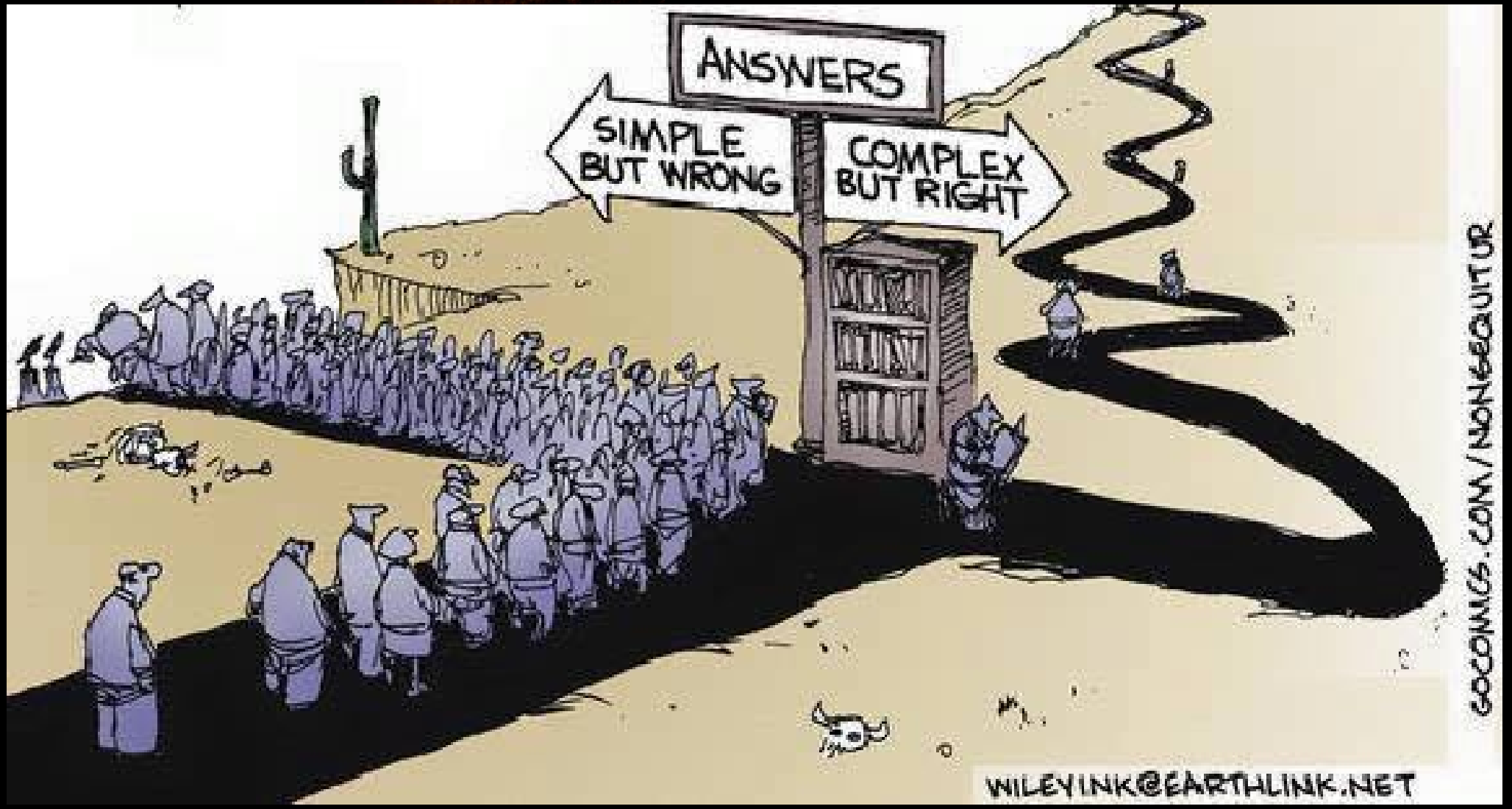


Selecting your data…
Studying your data…
Understanding your data...

Diego Altamirano
THE ROYAL SOCIETY
University of Southampton

What do I do first?



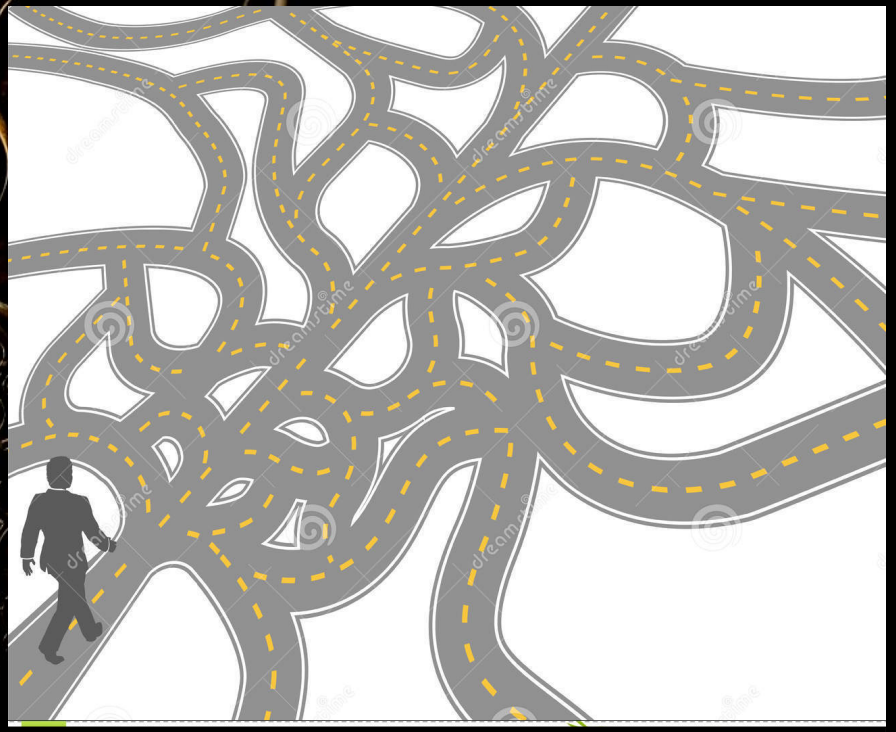

ANSWERS
SIMPLE BUT WRONG
COMPLEX BUT RIGHT
GOCOMICS.COM/NONSEQUITUR
WILEYINK@EARTHLINK.NET

What do I do first?

Energy Spectra?

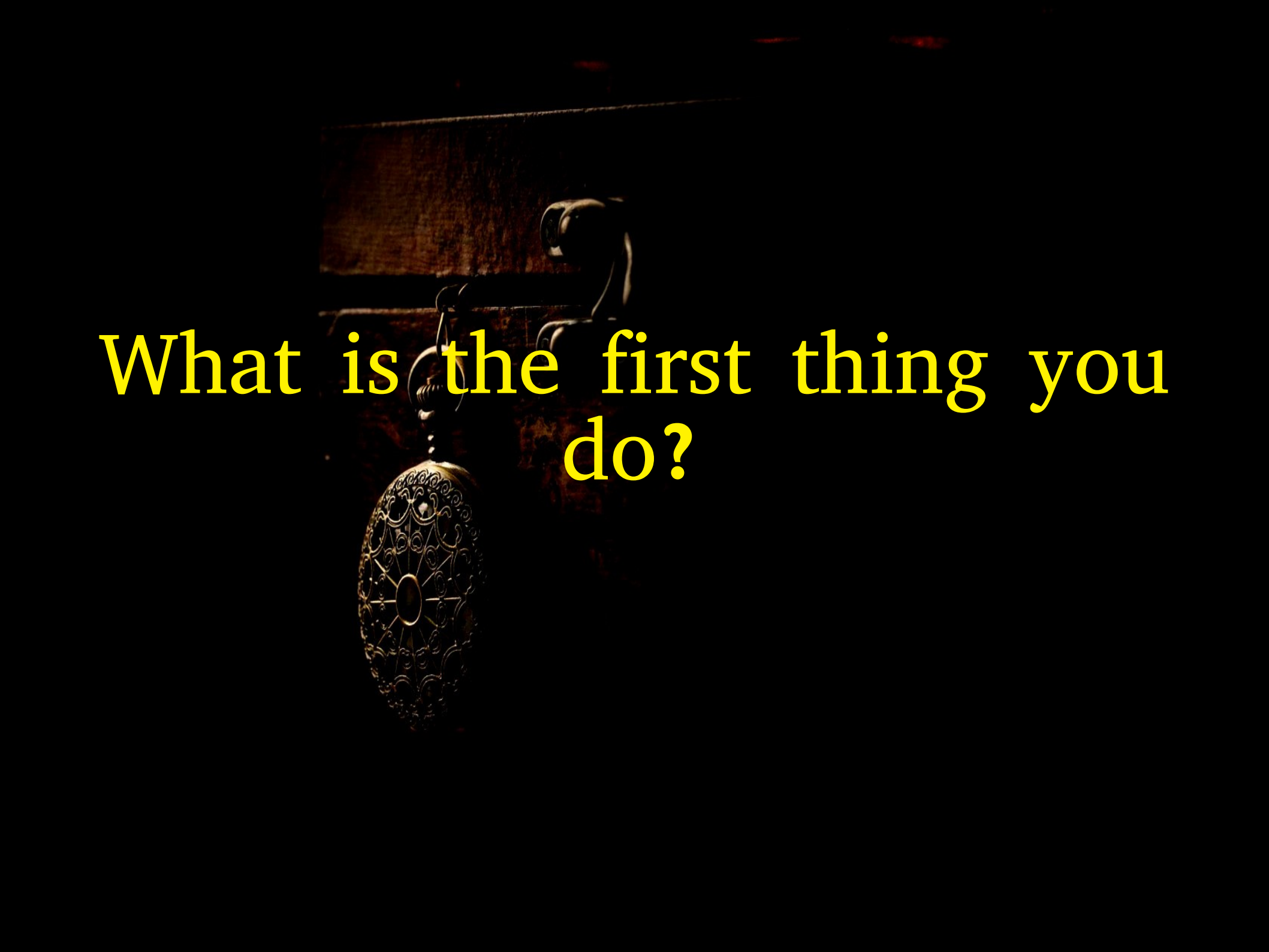
Lots of numbers?

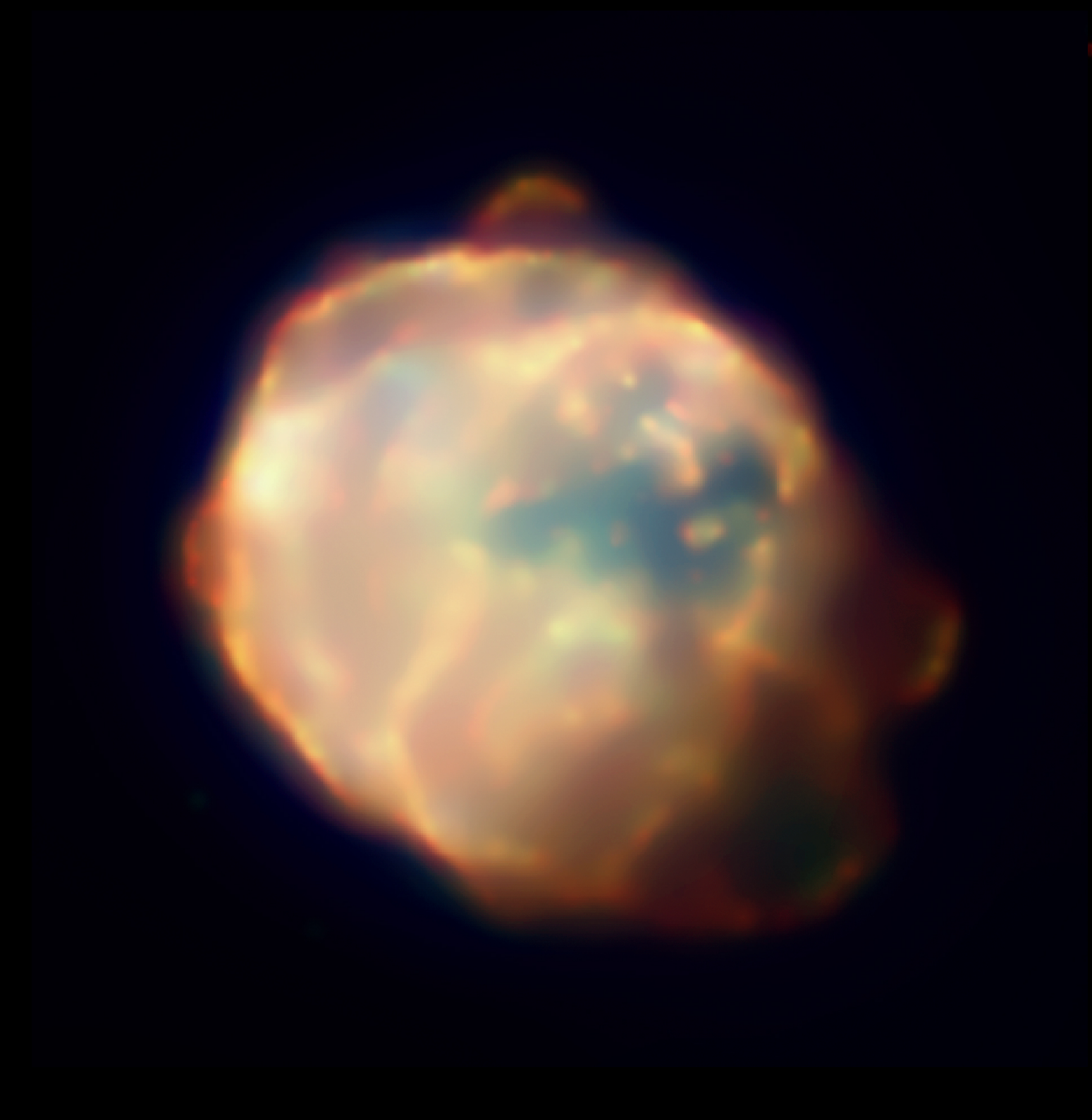
LC? source vs bkg?



Image?

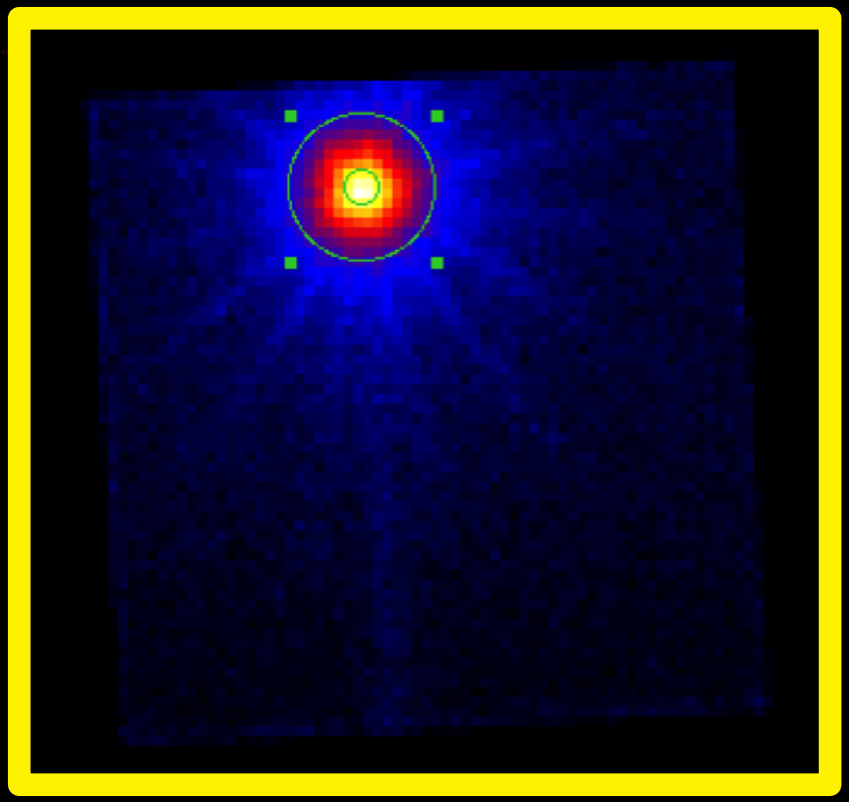
Power Spectra?

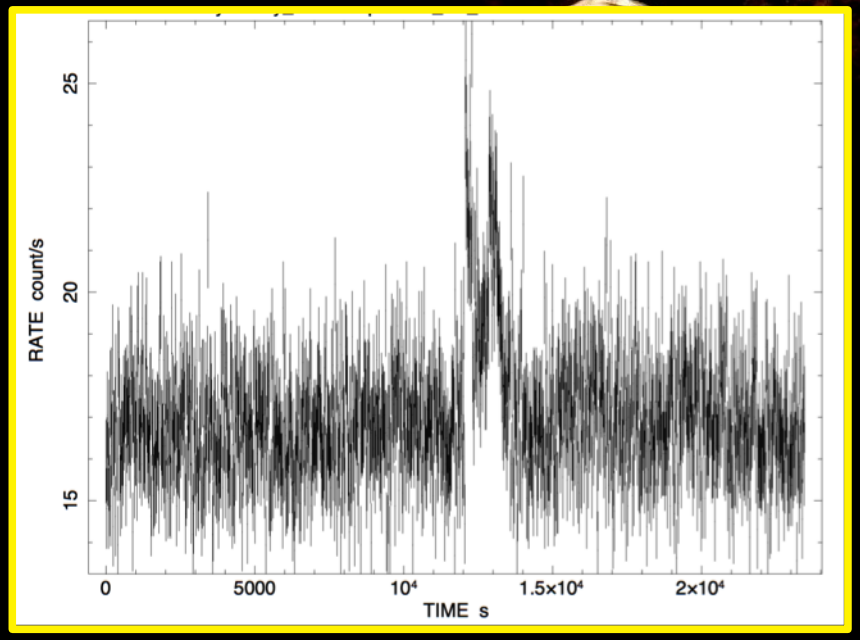

What is the first thing you do?



Chandra 3-Color
X-ray Image of

Rampaging
Supernova
Remnant N63A

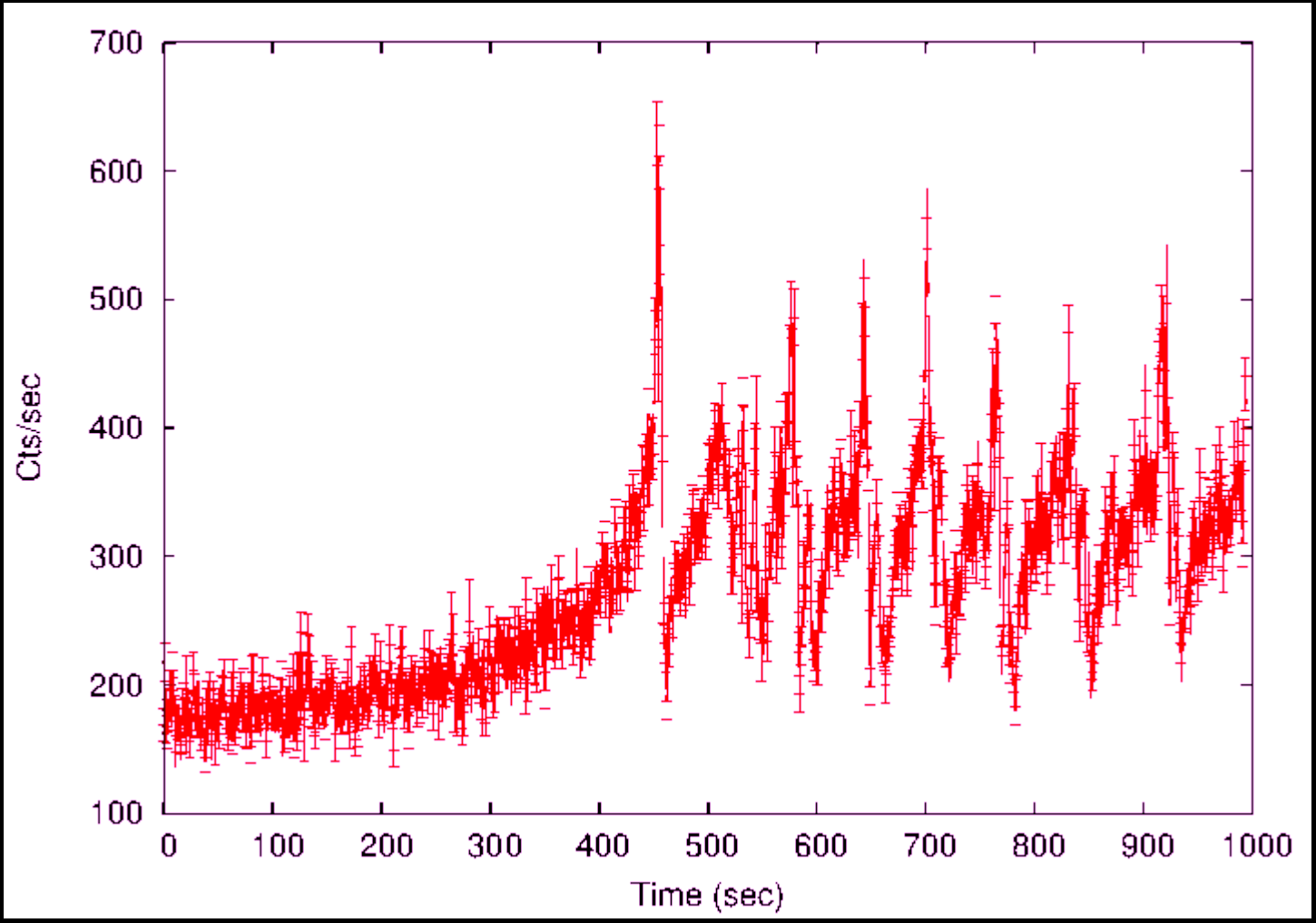




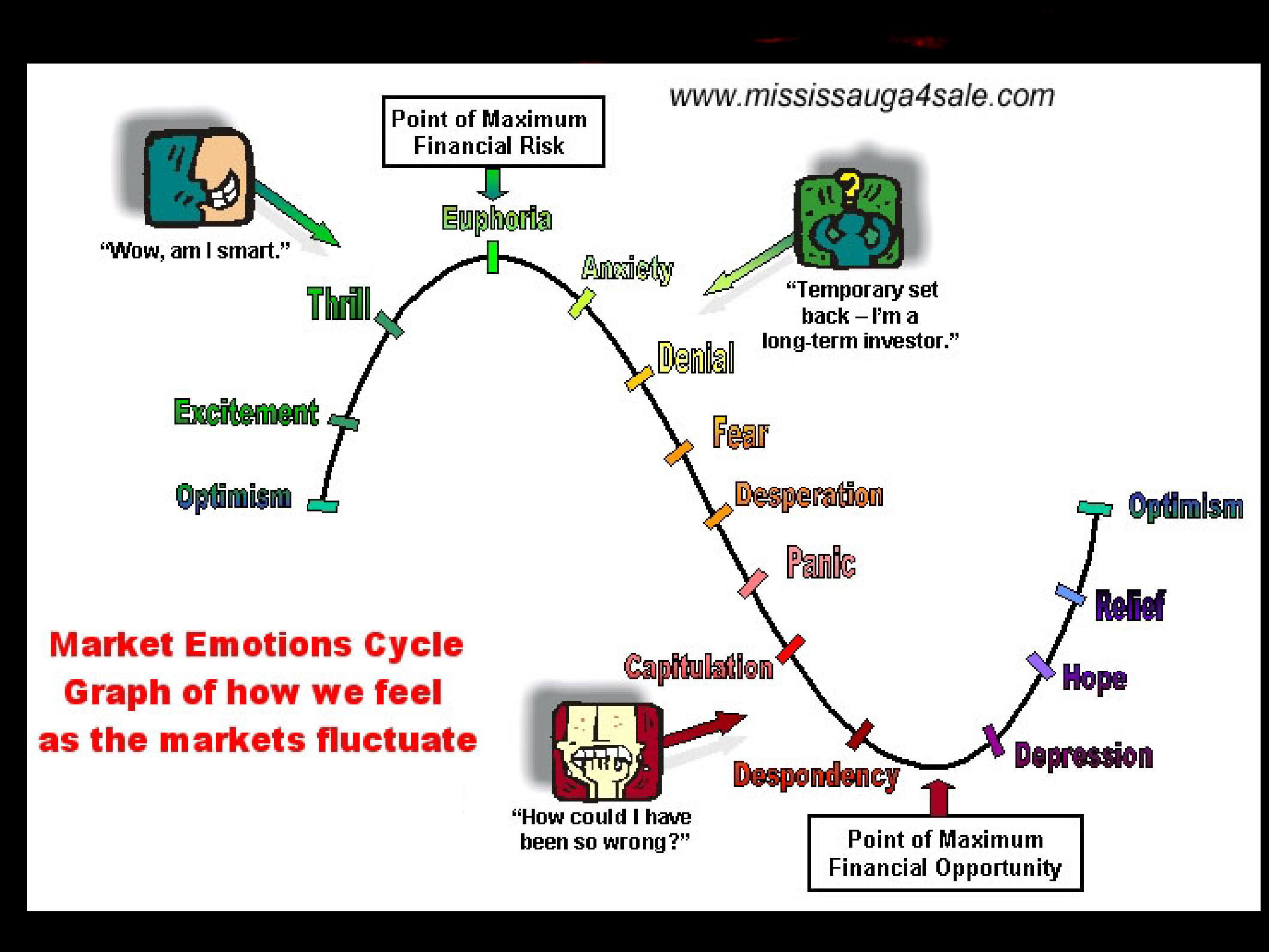
Courtesy of Ozan Toyran

Now what? We take out this Flare because it bothers, right?

For a Light curve, what would you do with a light curve light this?



www.mississauga4sale.com



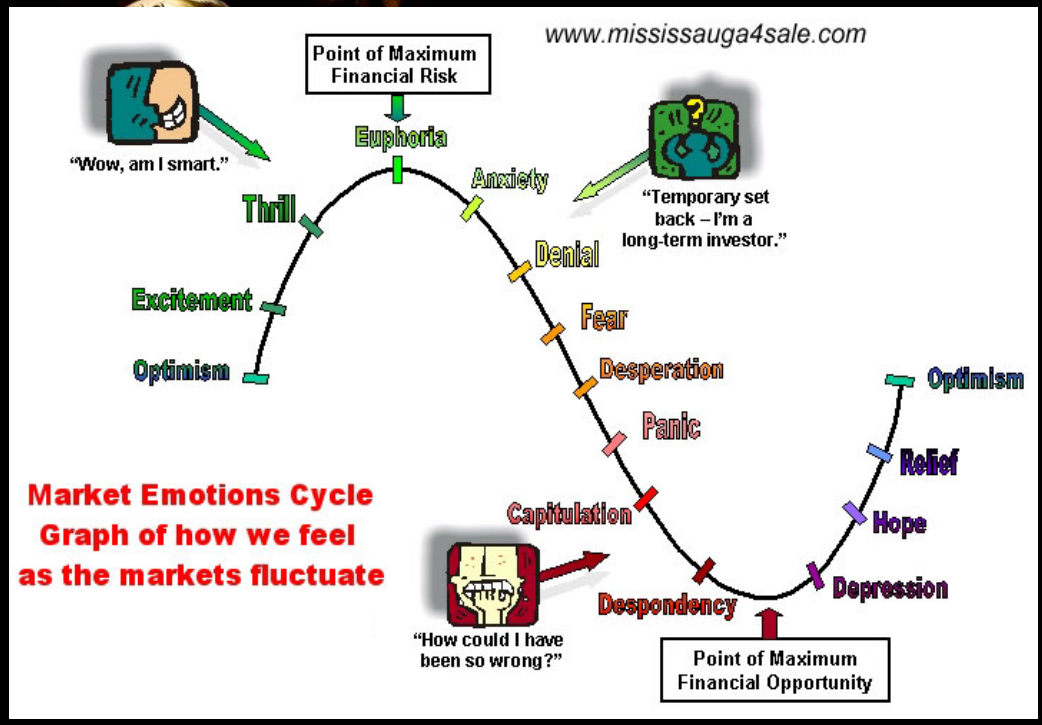
Market Emotions Cycle
Graph of how we feel as the markets fluctuate

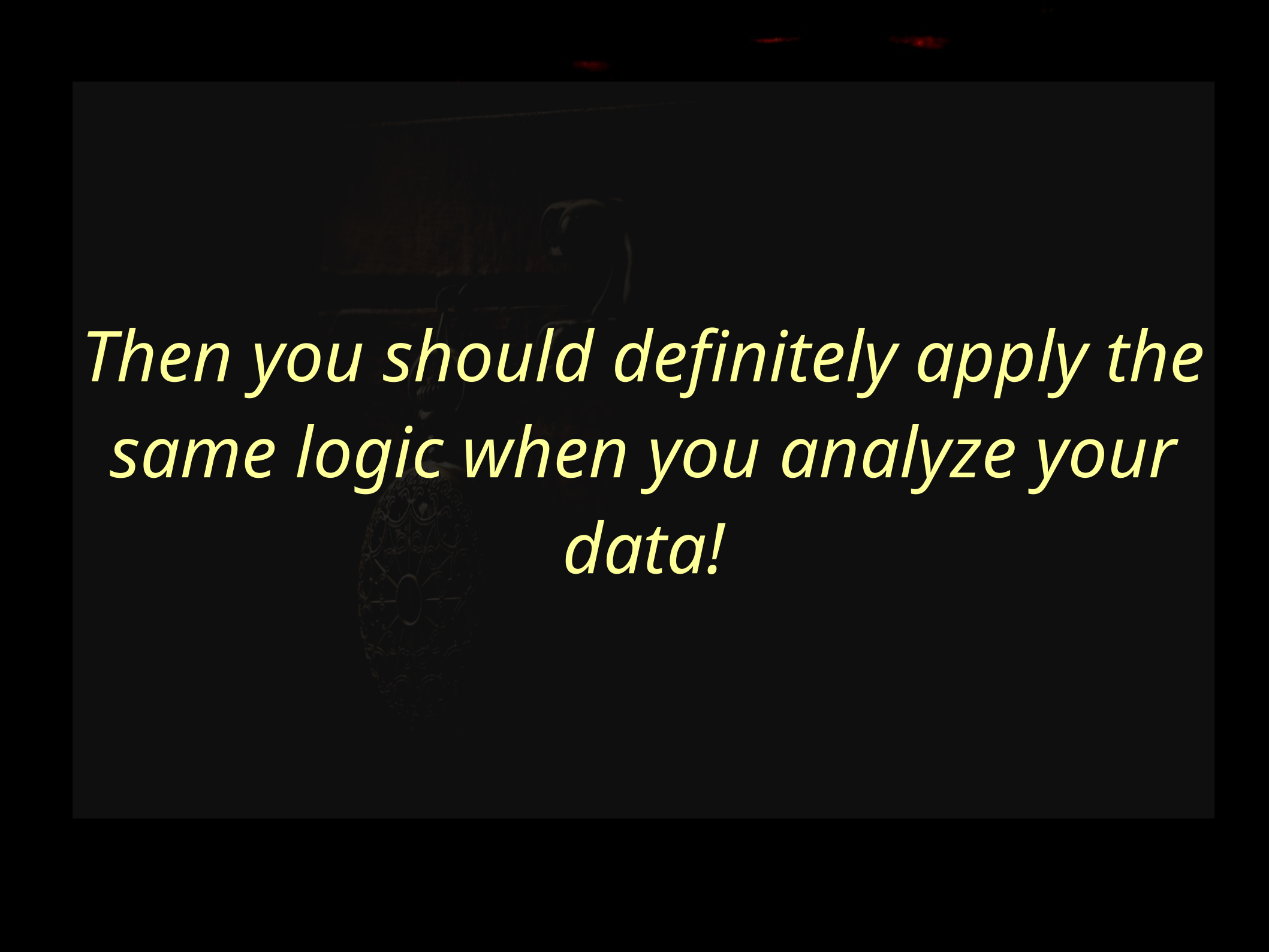
If it is obvious that you would not consider that

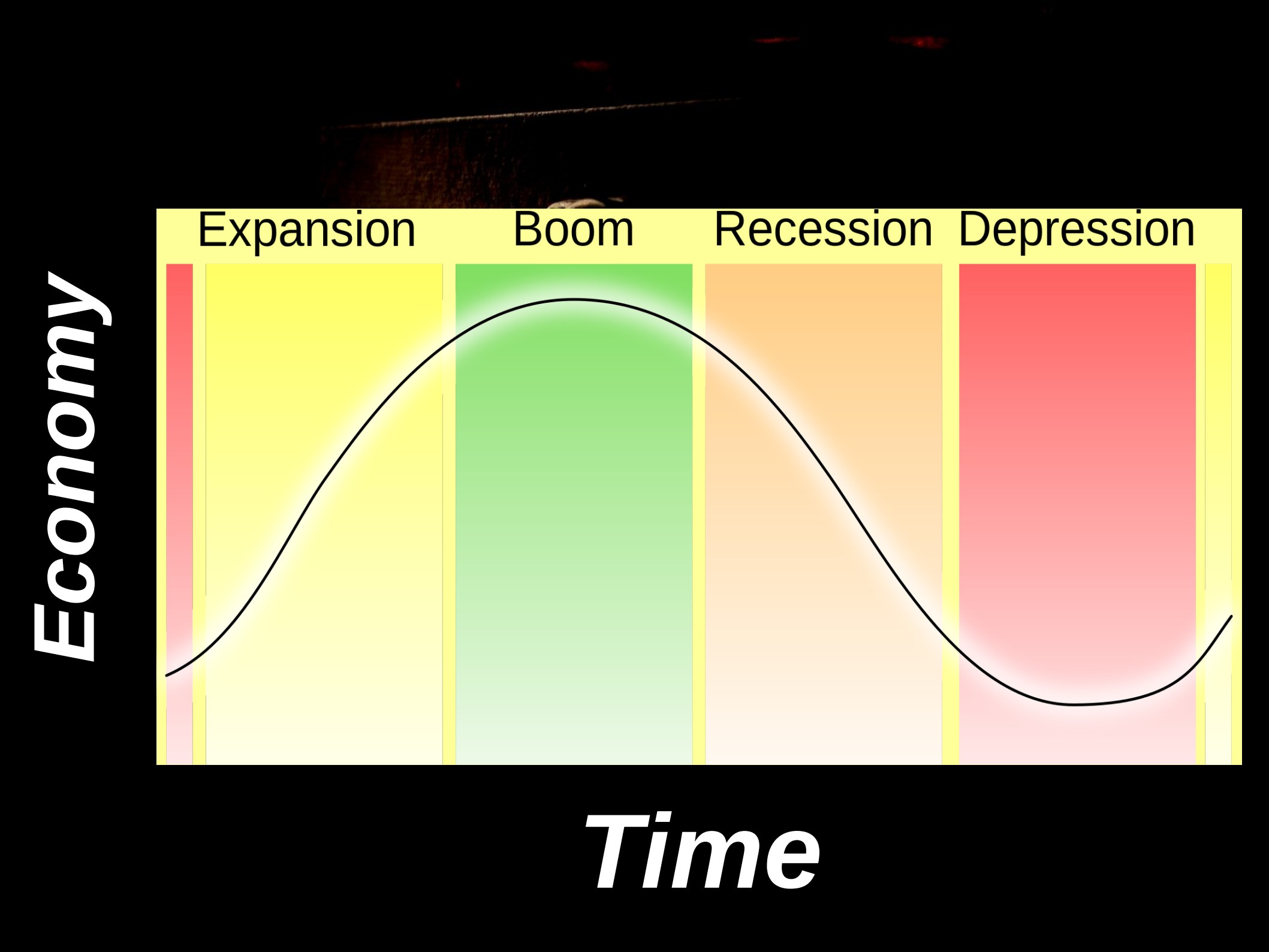
A period of Fear == one of Exciment

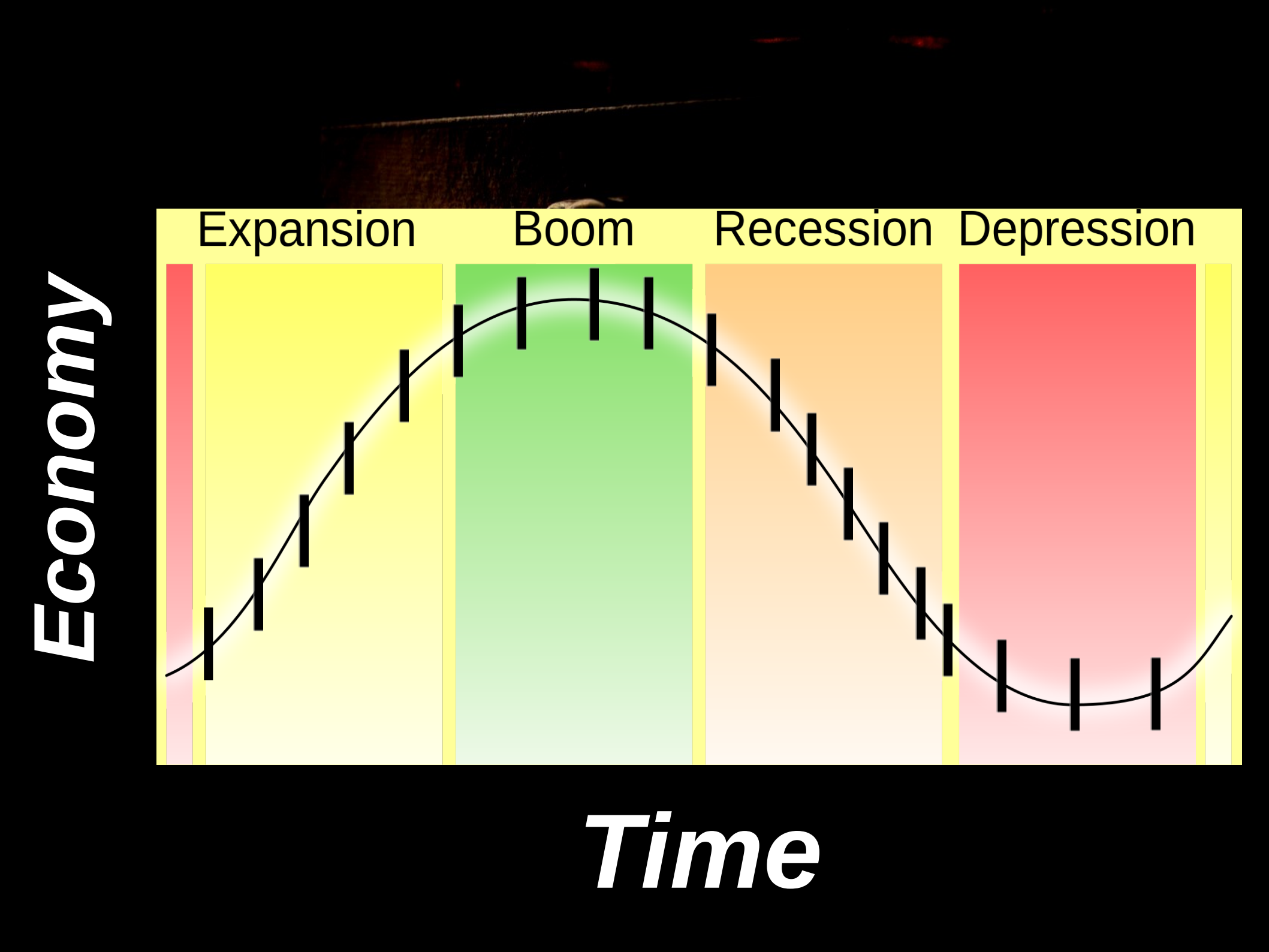
nor

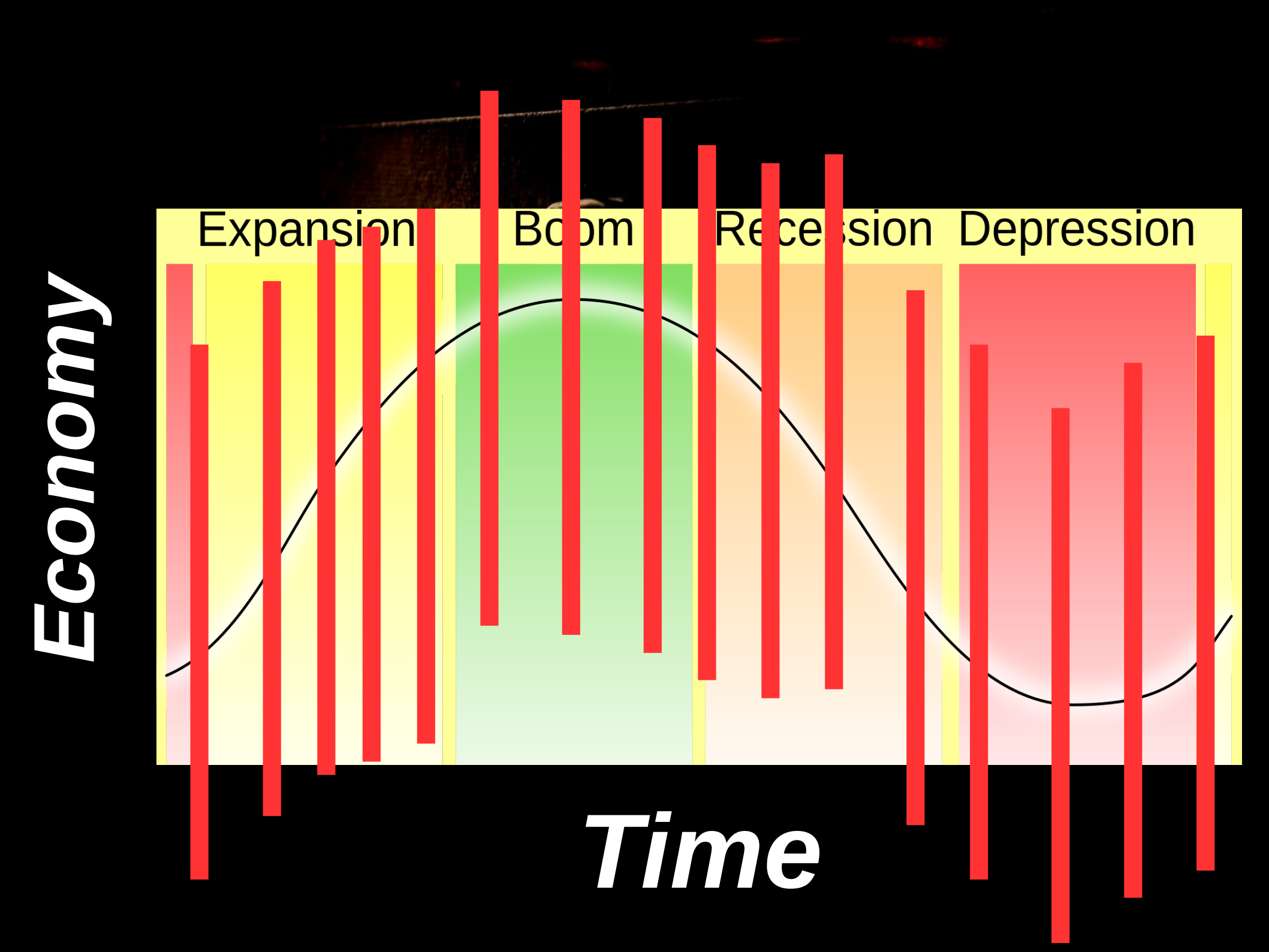
One of Euphoria == one of Depression

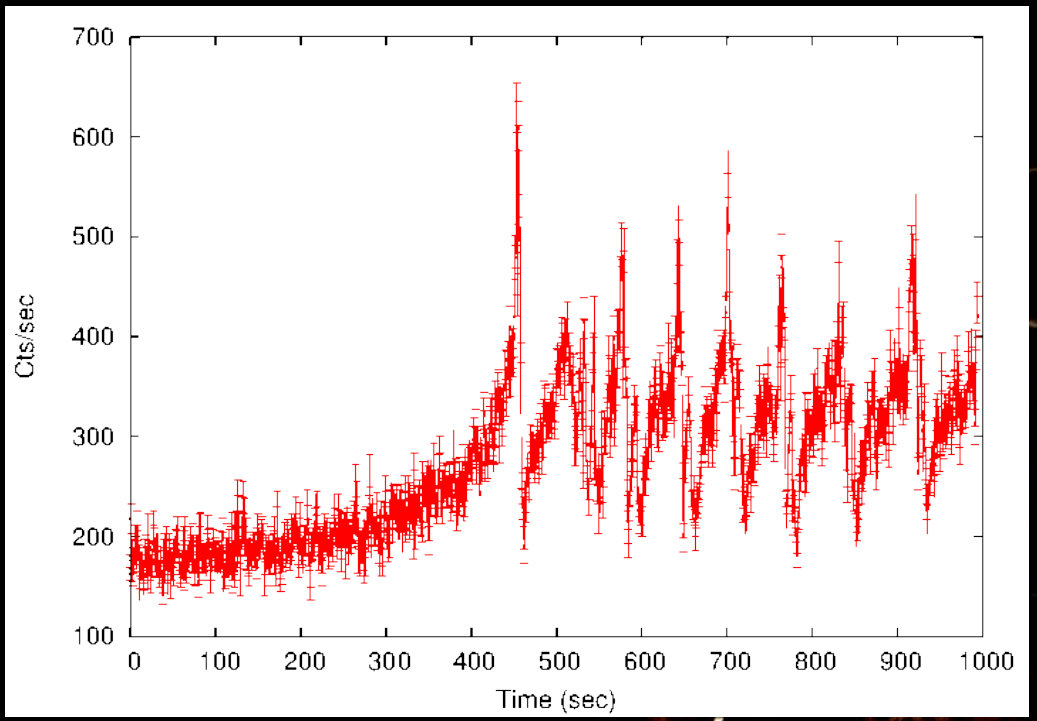


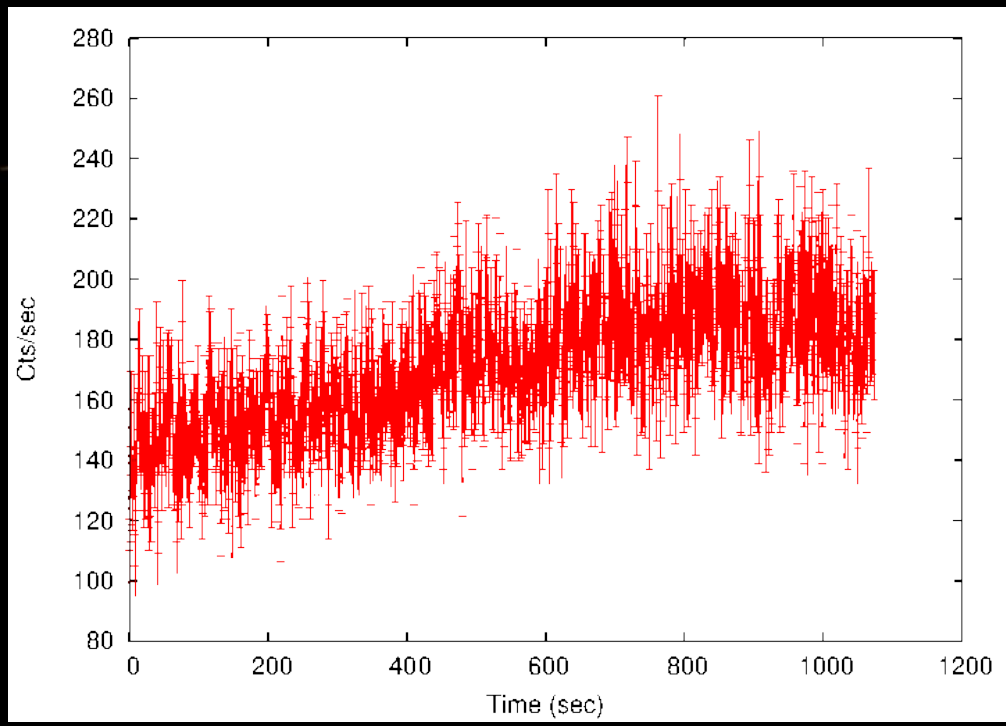

Then you should definitely apply the same logic when you analyze your data!

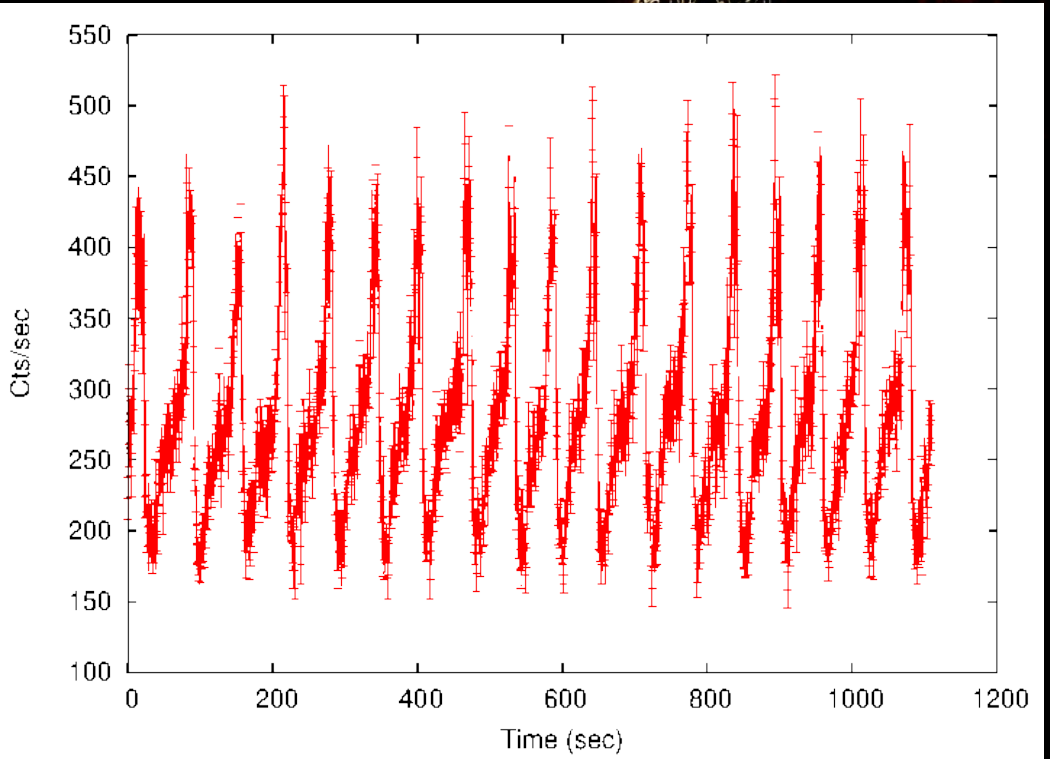

Expansion
Boom
Recession
Depression
Economy
Time

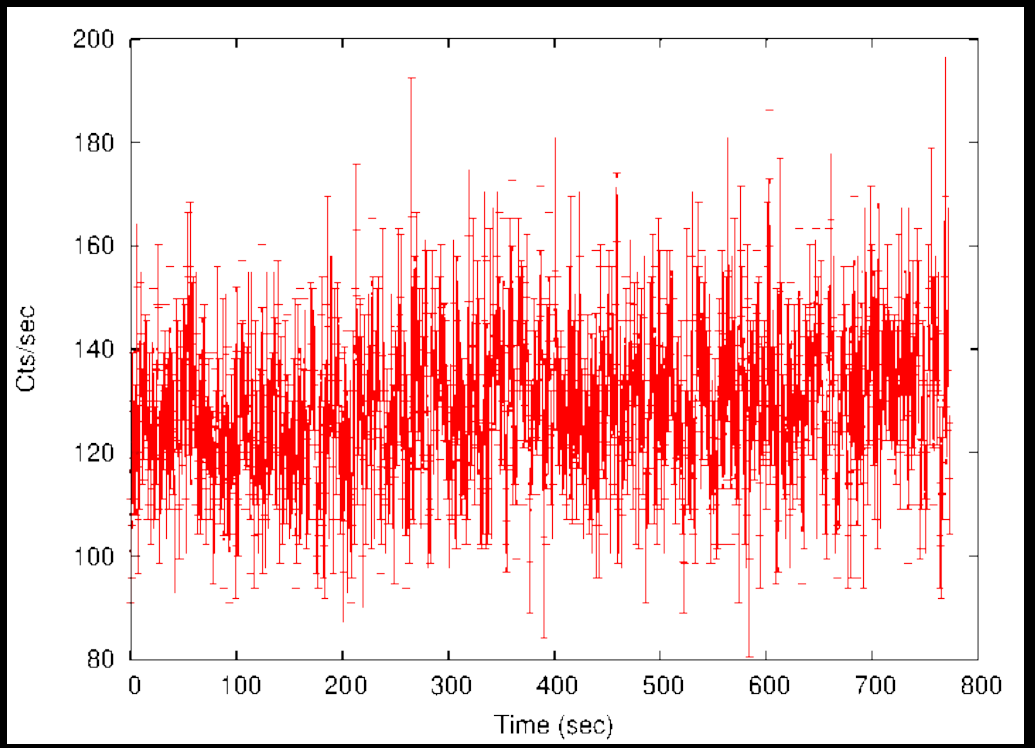

Expansion
Boom
Recession
Depression
Economy
Time

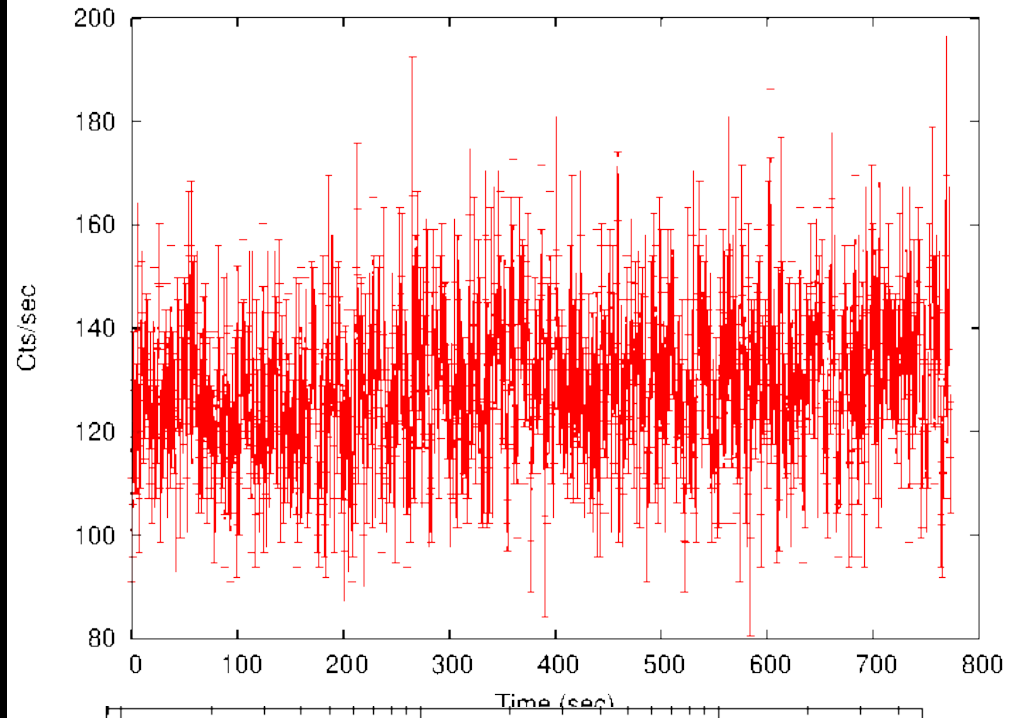

Expansion
Boom
Recession
Depression
Economy
Time

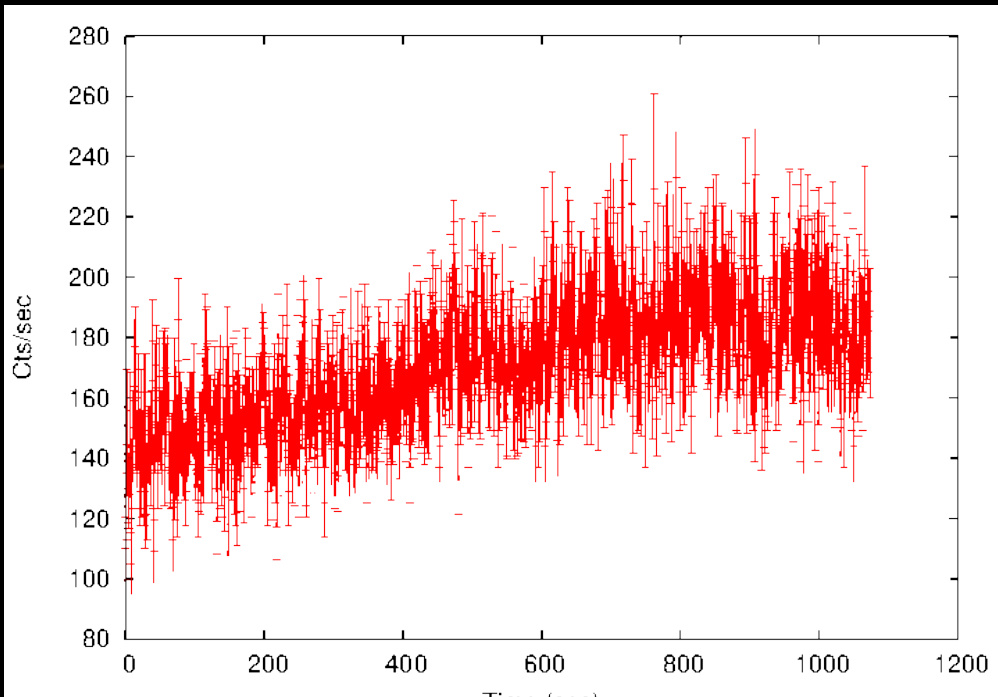

Cts/sec
Time (sec)
700
600
500
400
300
200
100
0
100
200
300
400
500
600
700
800
900
1000

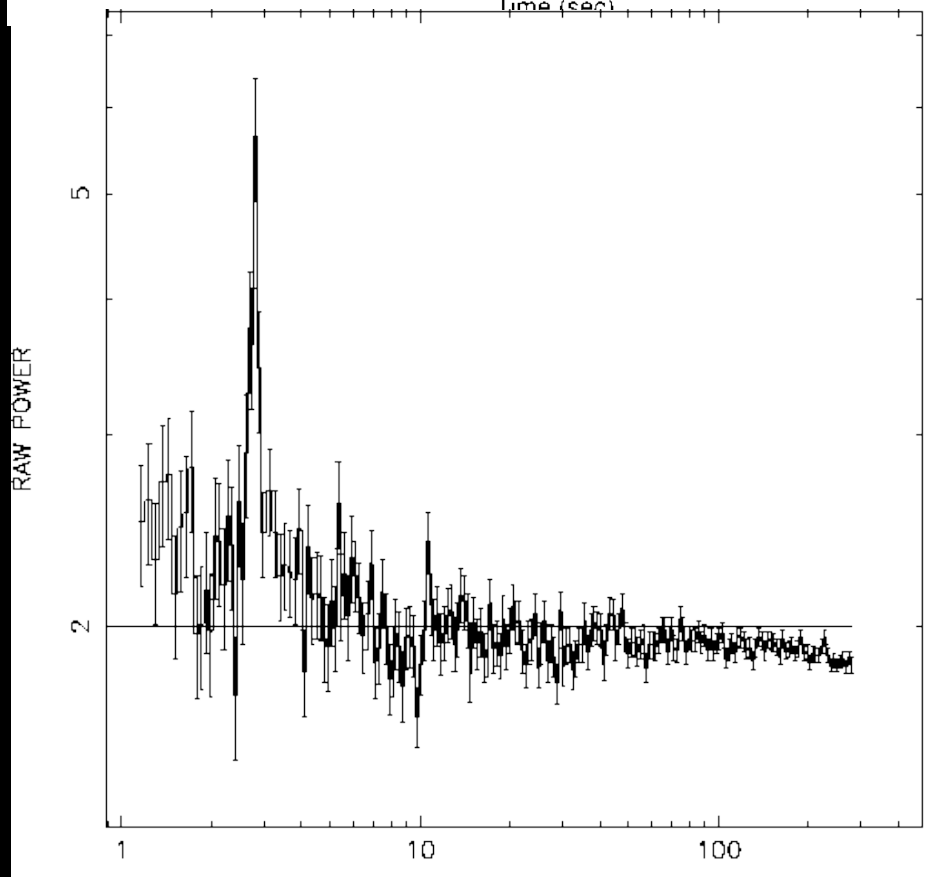

Cts/sec
Time (sec)
280
260
240
220
200
180
160
140
120
100
80
0
200
400
600
800
1000
1200

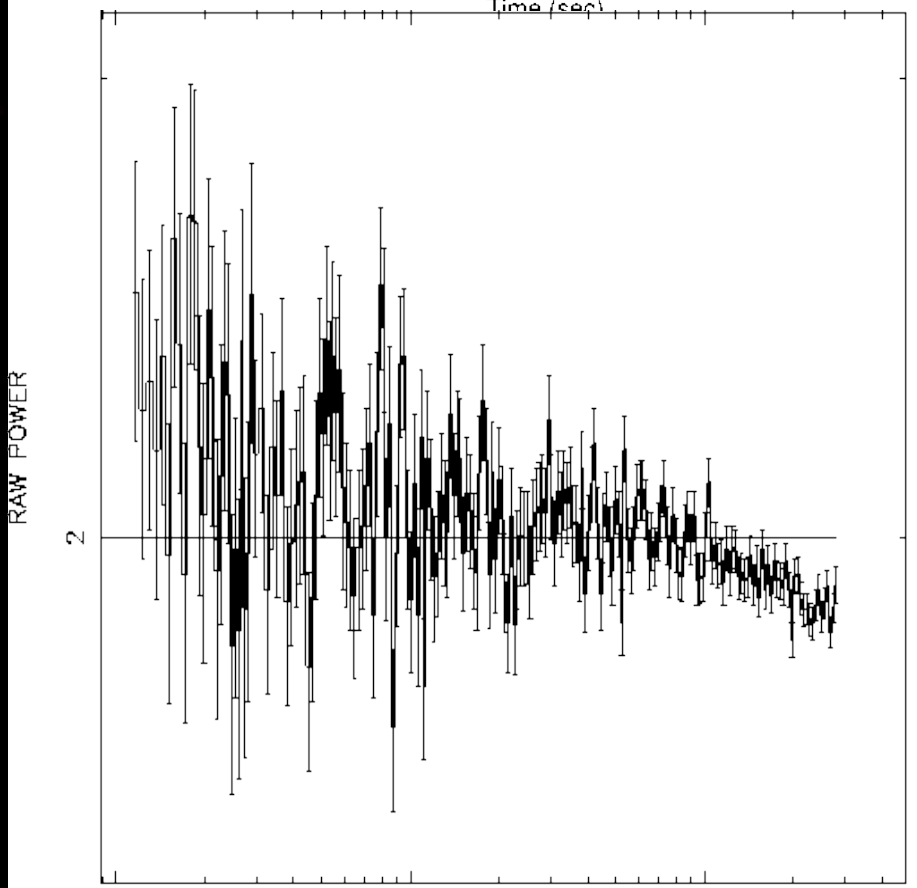

Cts/sec
Time (sec)
550
500
450
400
350
300
250
200
150
100
0
200
400
600
800
1000
1200


Cts/sec
Time (sec)
200
180
160
140
120
100
80
0
100
200
300
400
500
600
700
800

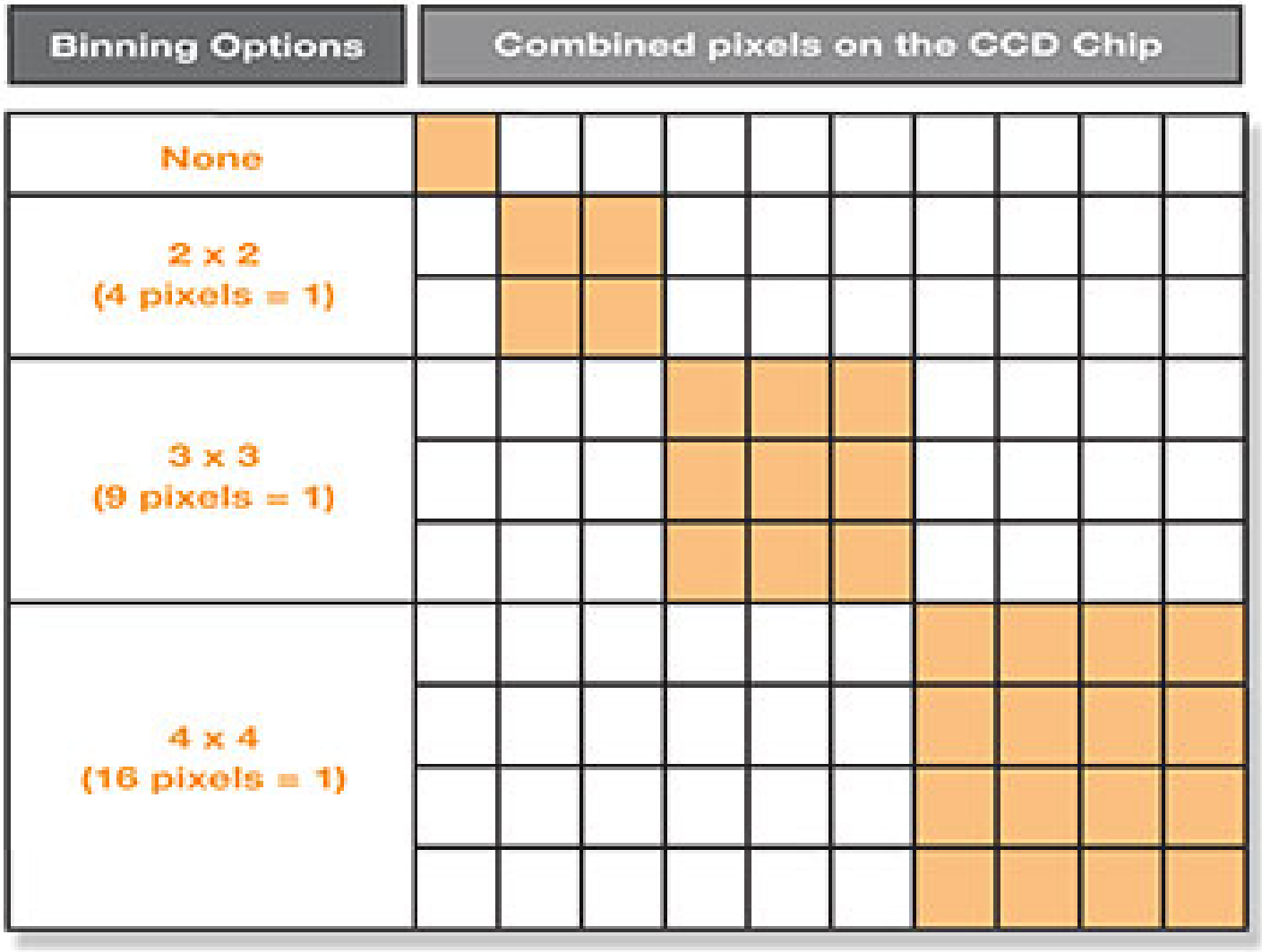

Cts/sec
200
180
160
140
120
100
80
0
100
200
300
400
500
600
700
800
Time (sec)


Cts/sec
280
260
240
220
200
180
160
140
120
100
80
0
200
400
600
800
1000
1200
Time (sec)

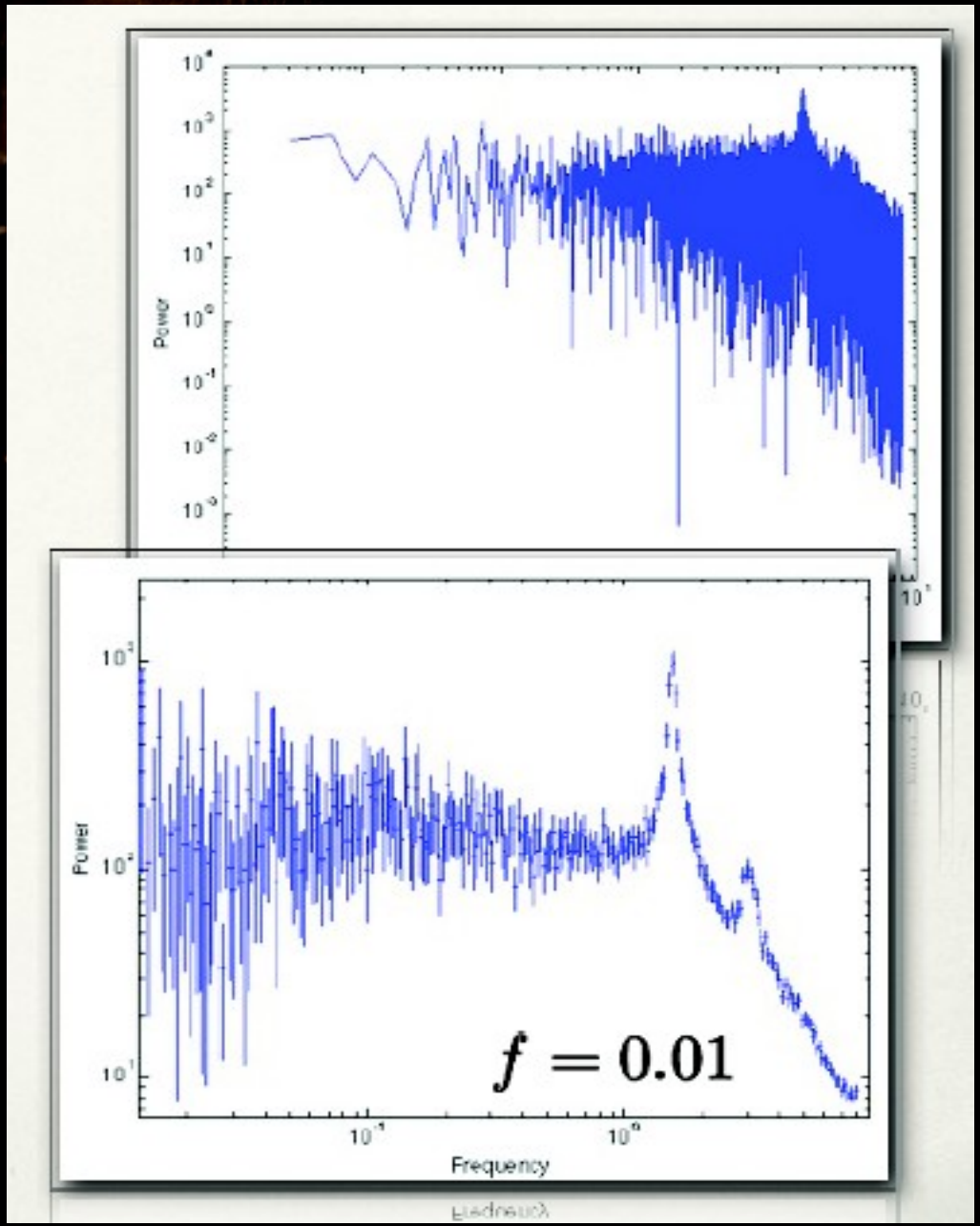

RAW POWER
5
2
1
10
100

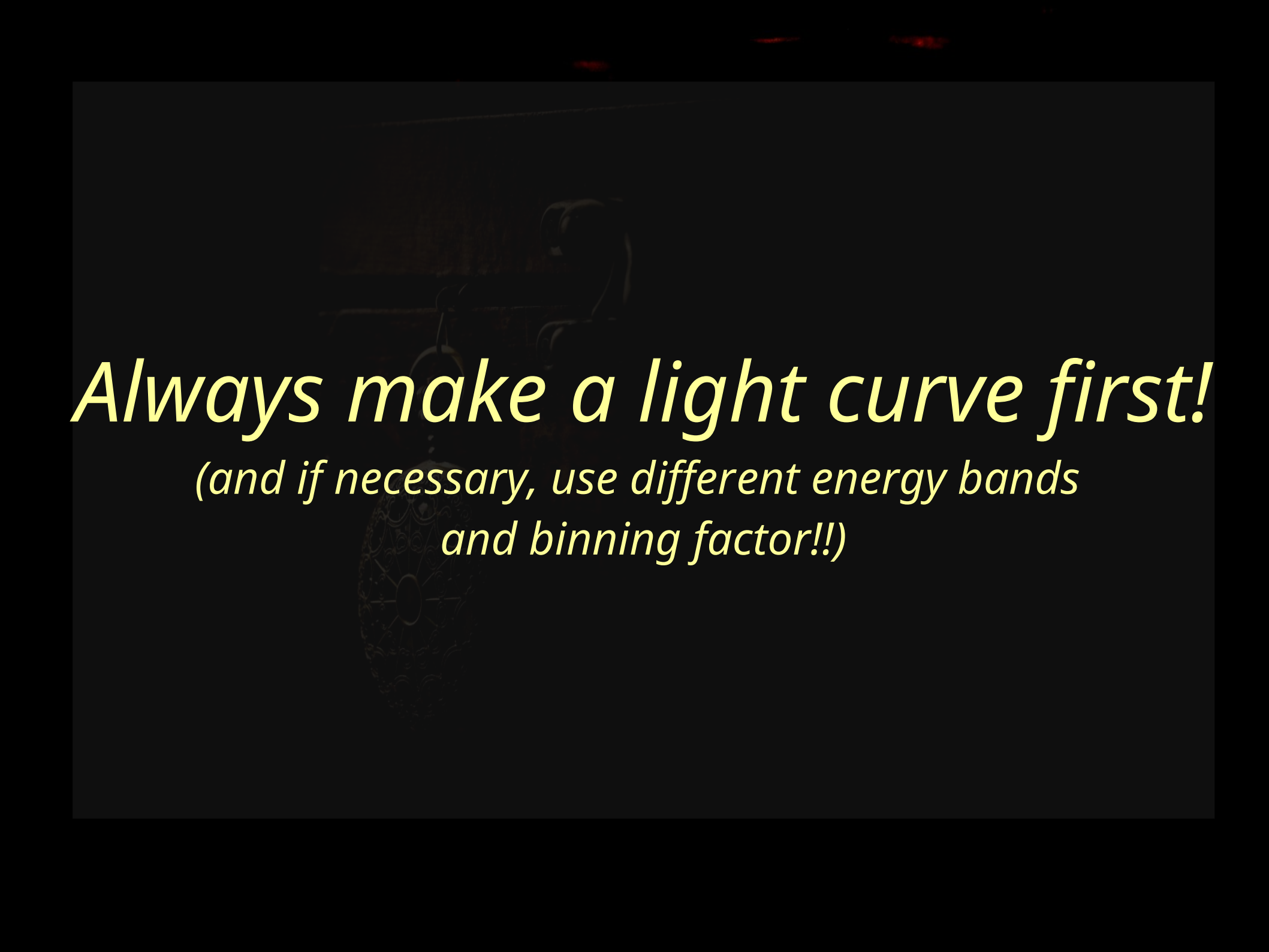

RAW POWER
2

DATA Binning



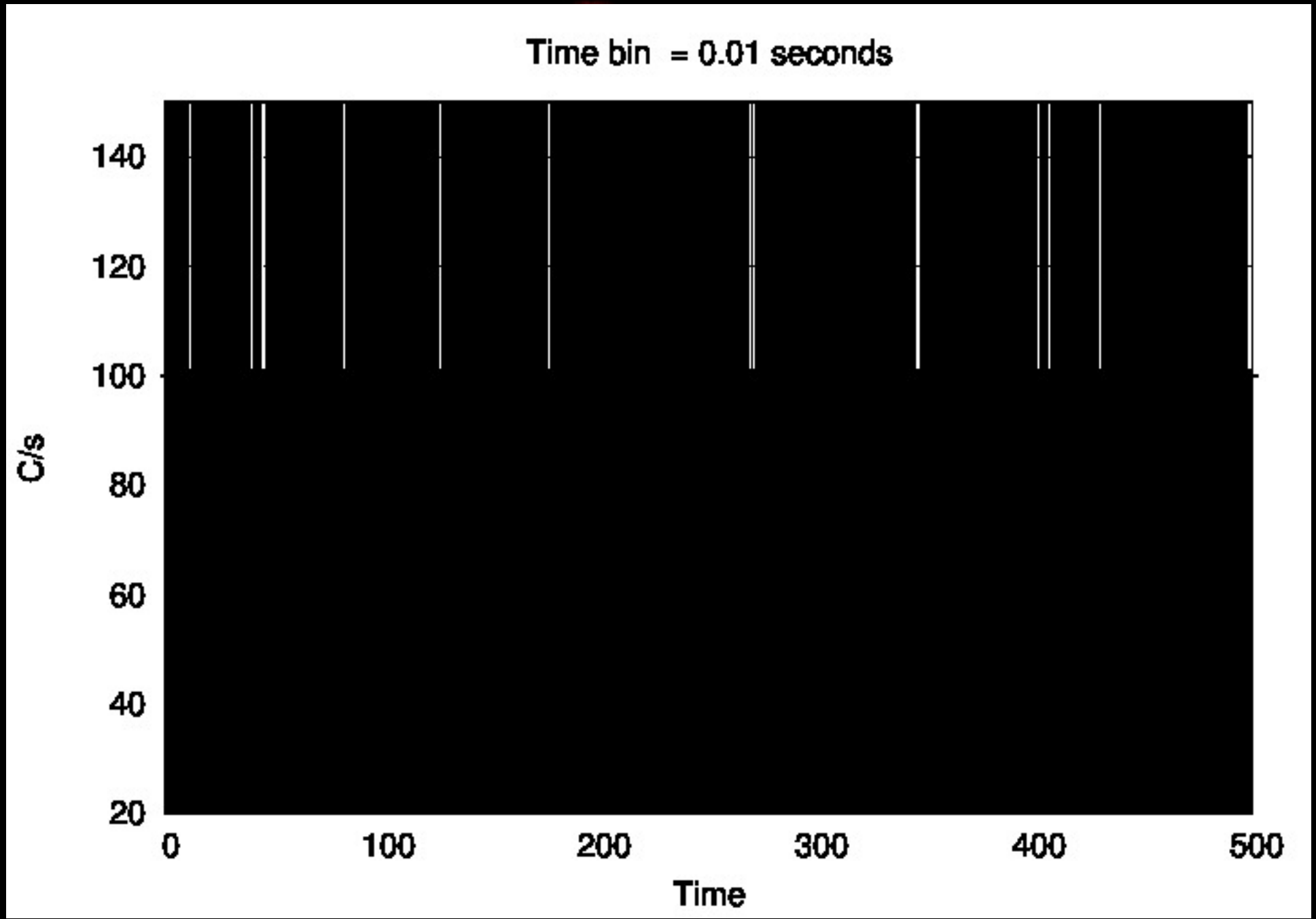
DATA Binning

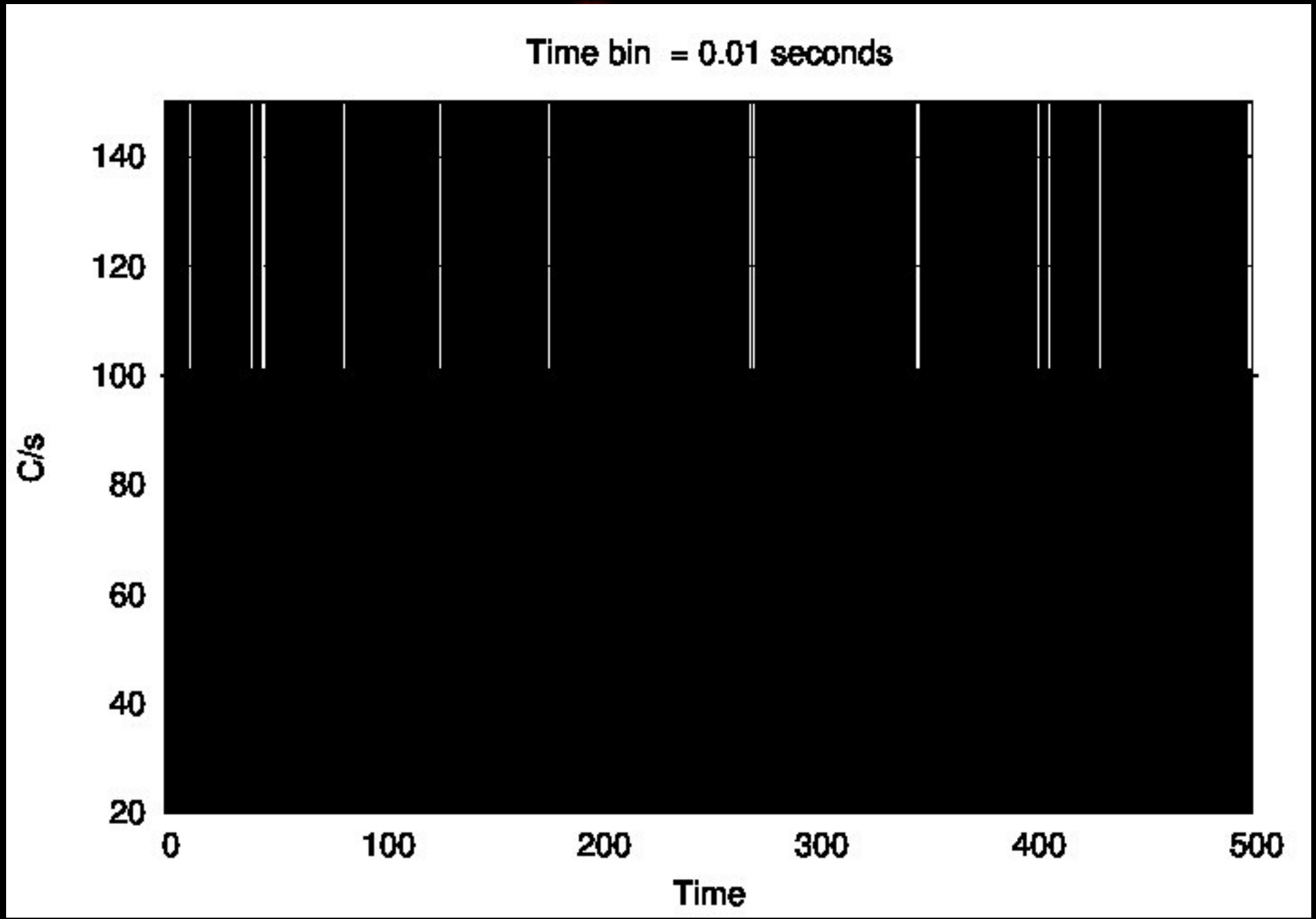



Always make a light curve first!
(and if necessary, use different energy bands
and binning factor!!)

Time Binning!

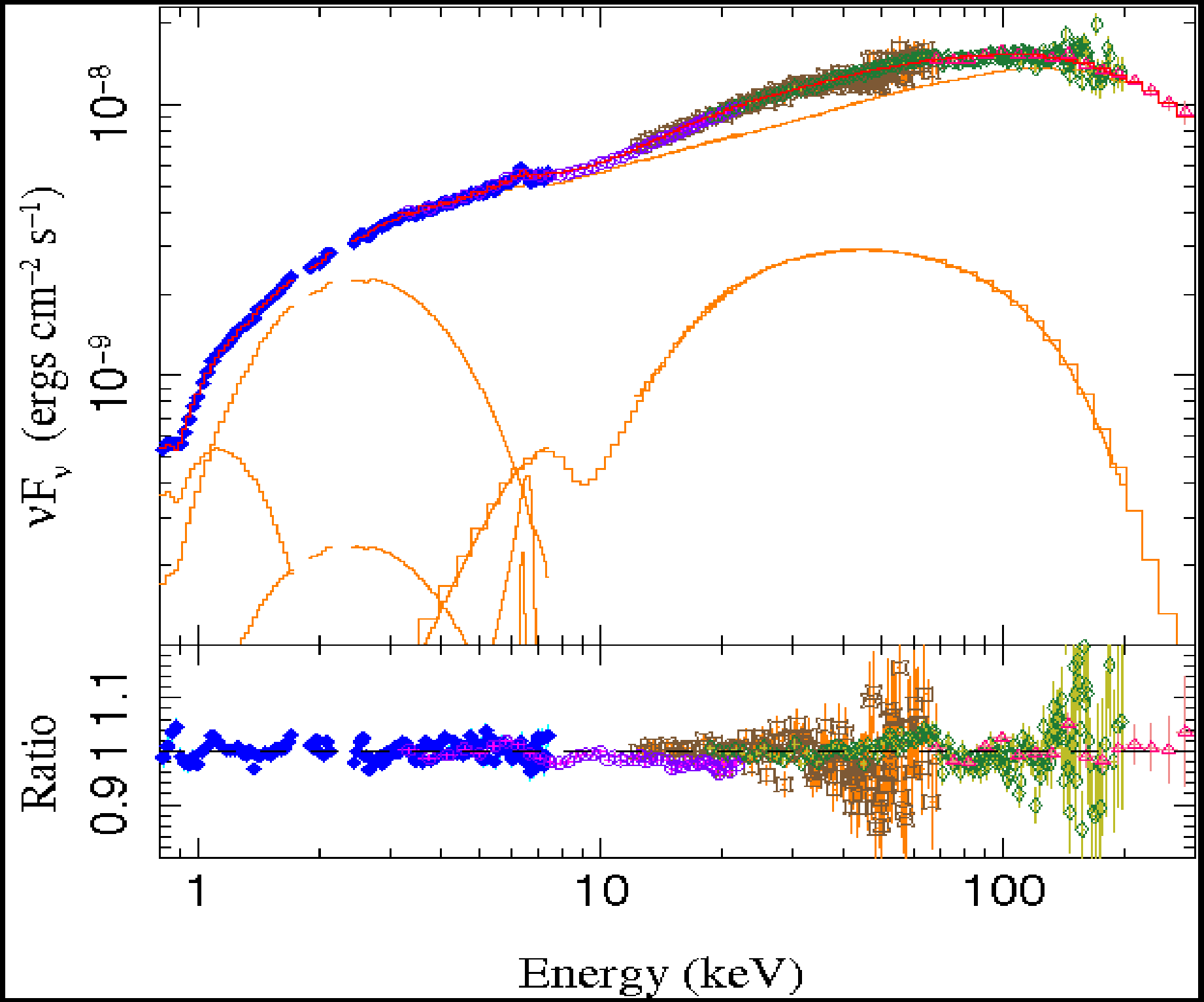
How do things change?

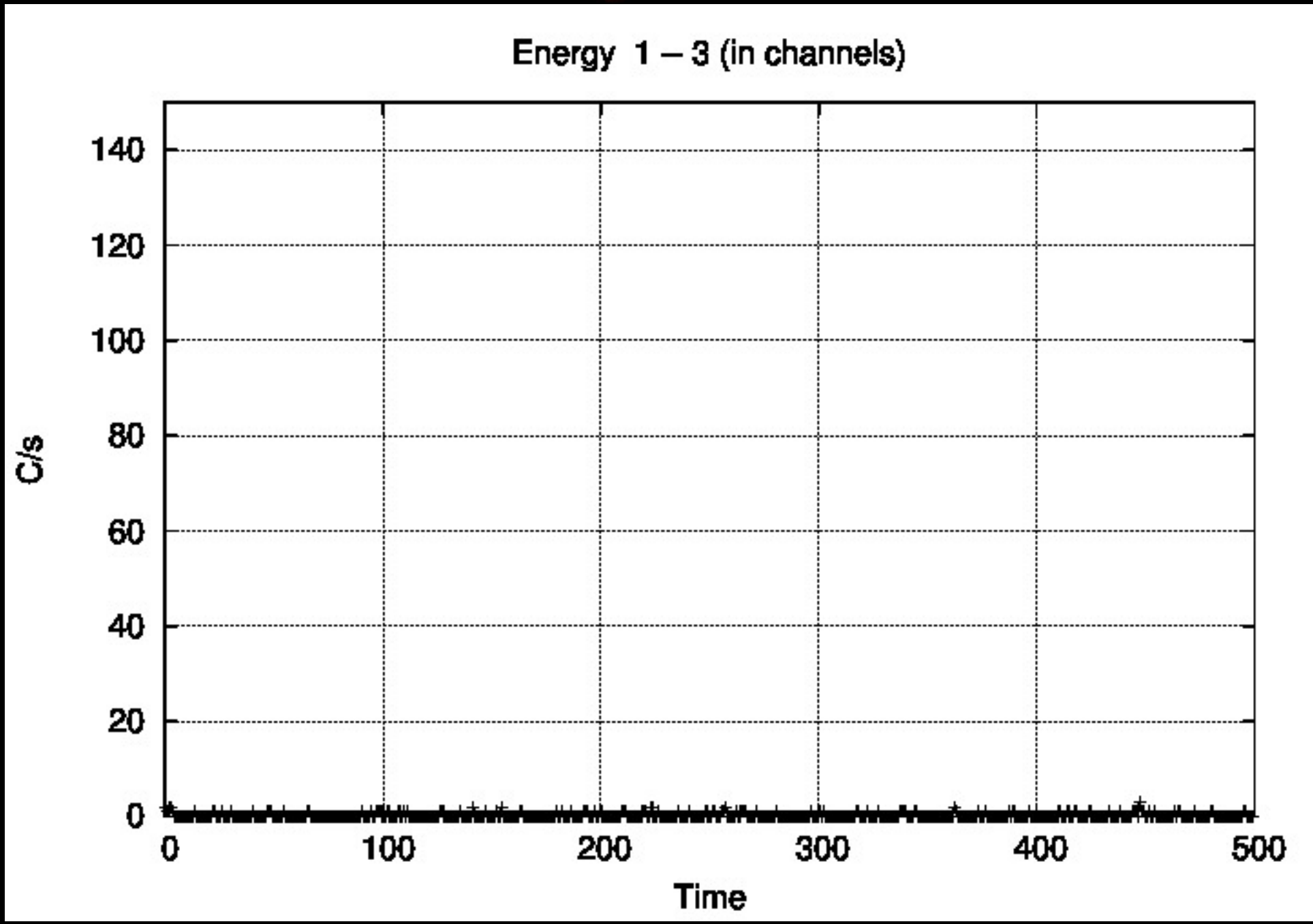

Time bin = 0.01 seconds
140
120
100
80
60
40
20
C/s
0
100
200
300
400
500
Time

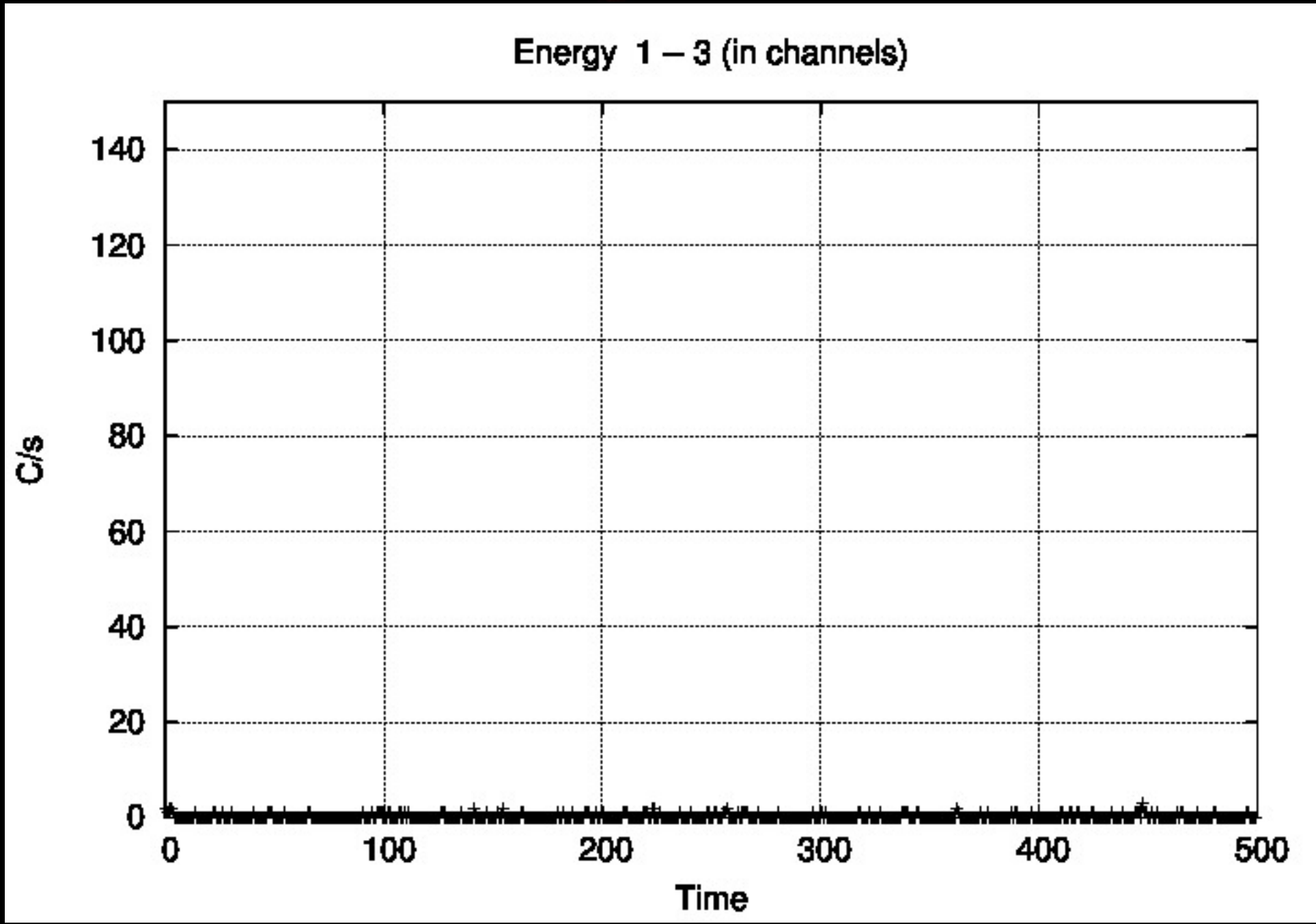

Time bin = 0.01 seconds
140
120
100
80
60
40
20
C/s
0
100
200
300
400
500
Time

Energy selection...

changes my light curve?


10^{-8}
10^{-9}
νF_ν (ergs cm^{-2} s^{-1})
Ratio
0.9
1
1.1
1
10
100
Energy (keV)


Energy 1 – 3 (in channels)
C/s
140
120
100
80
60
40
20
0
0
100
200
300
400
500
Time


Energy 1 – 3 (in channels)
C/s
140
120
100
80
60
40
20
0
0
100
200
300
400
500
Time

Coming back to the talk....


GTI
Good Time Interval

GTI

Good Time Interval

263742929.0000000	263743009.0000000
263743026.0000000	263745778.0000000
263748625.0000000	263751841.0000000

GTI

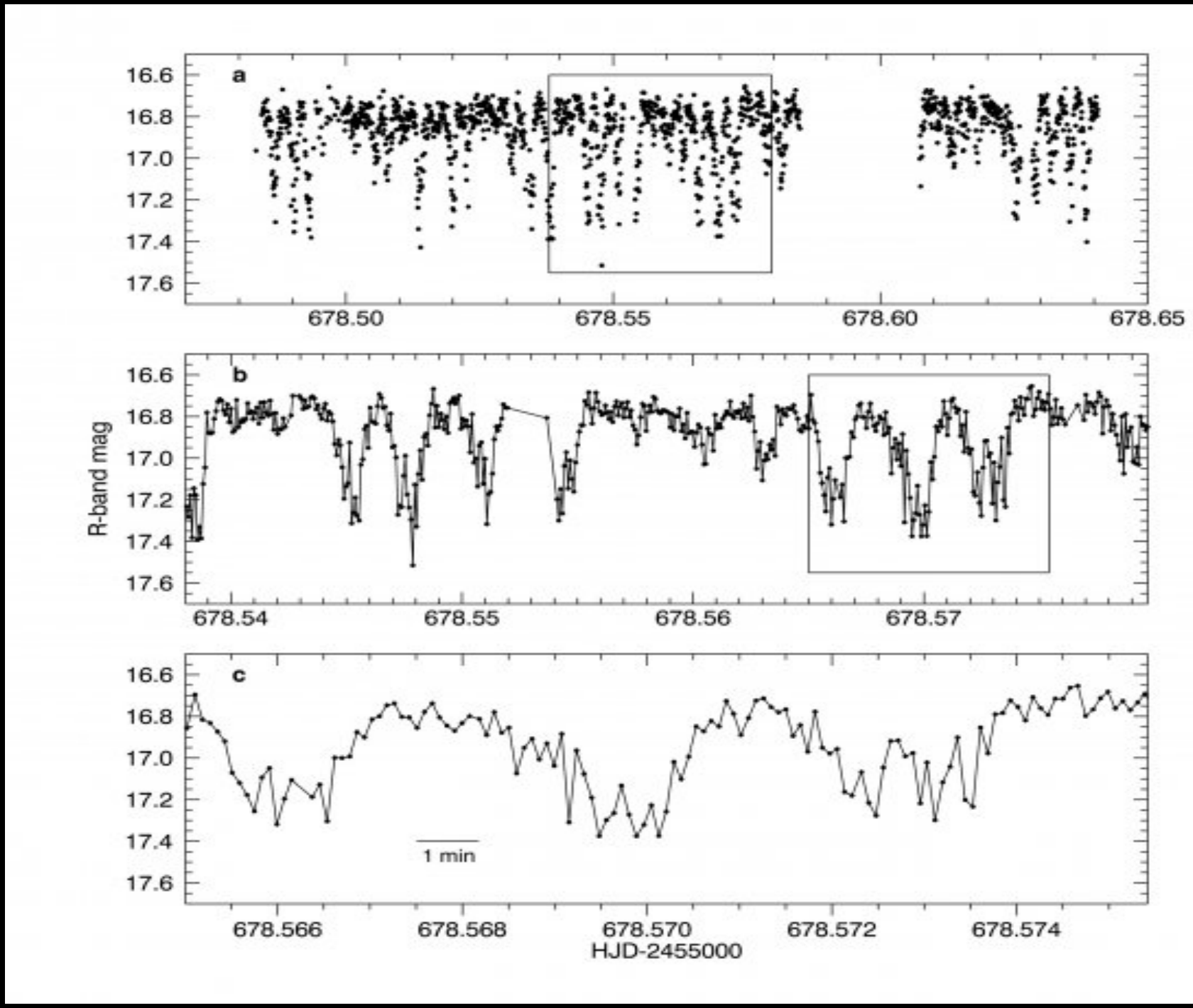
Good Time Interval

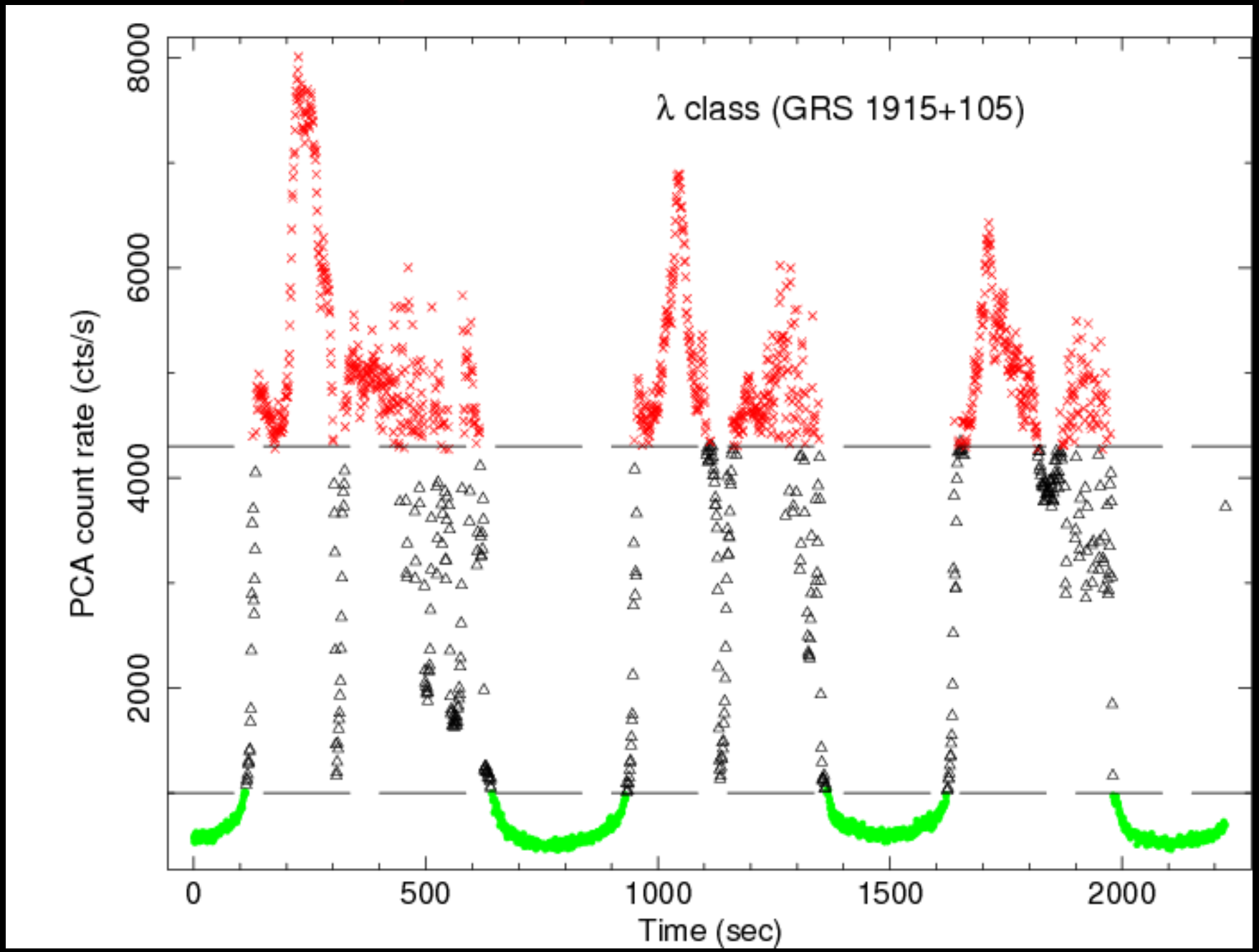
263742929.0000000	263743009.0000000	- offset =	0	80
263743026.0000000	263745778.0000000		97	2849
263748625.0000000	263751841.0000000		5696	8912

GTI

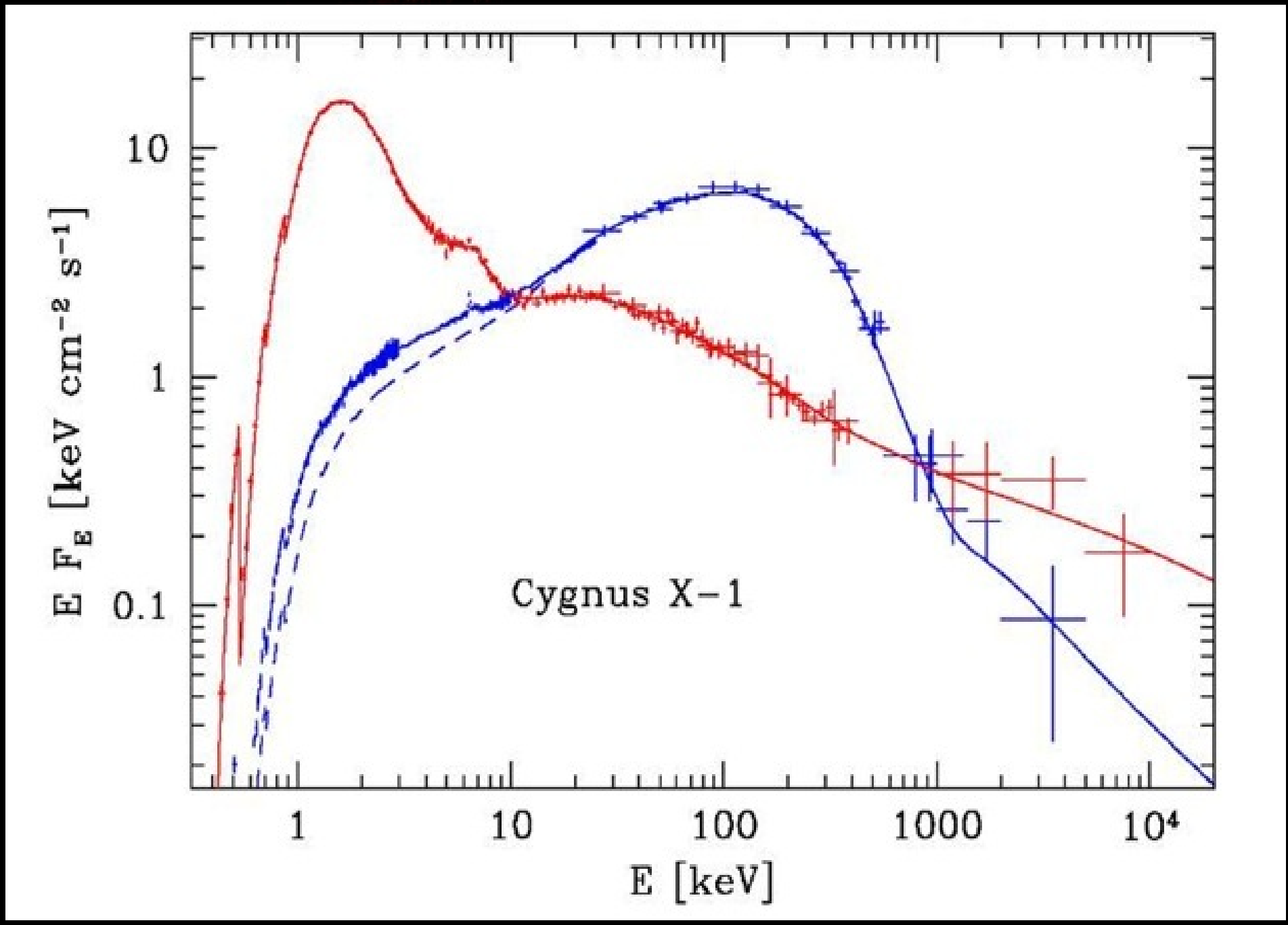
Good Time Interval

There is no standard tool that
you can use for every problem!!

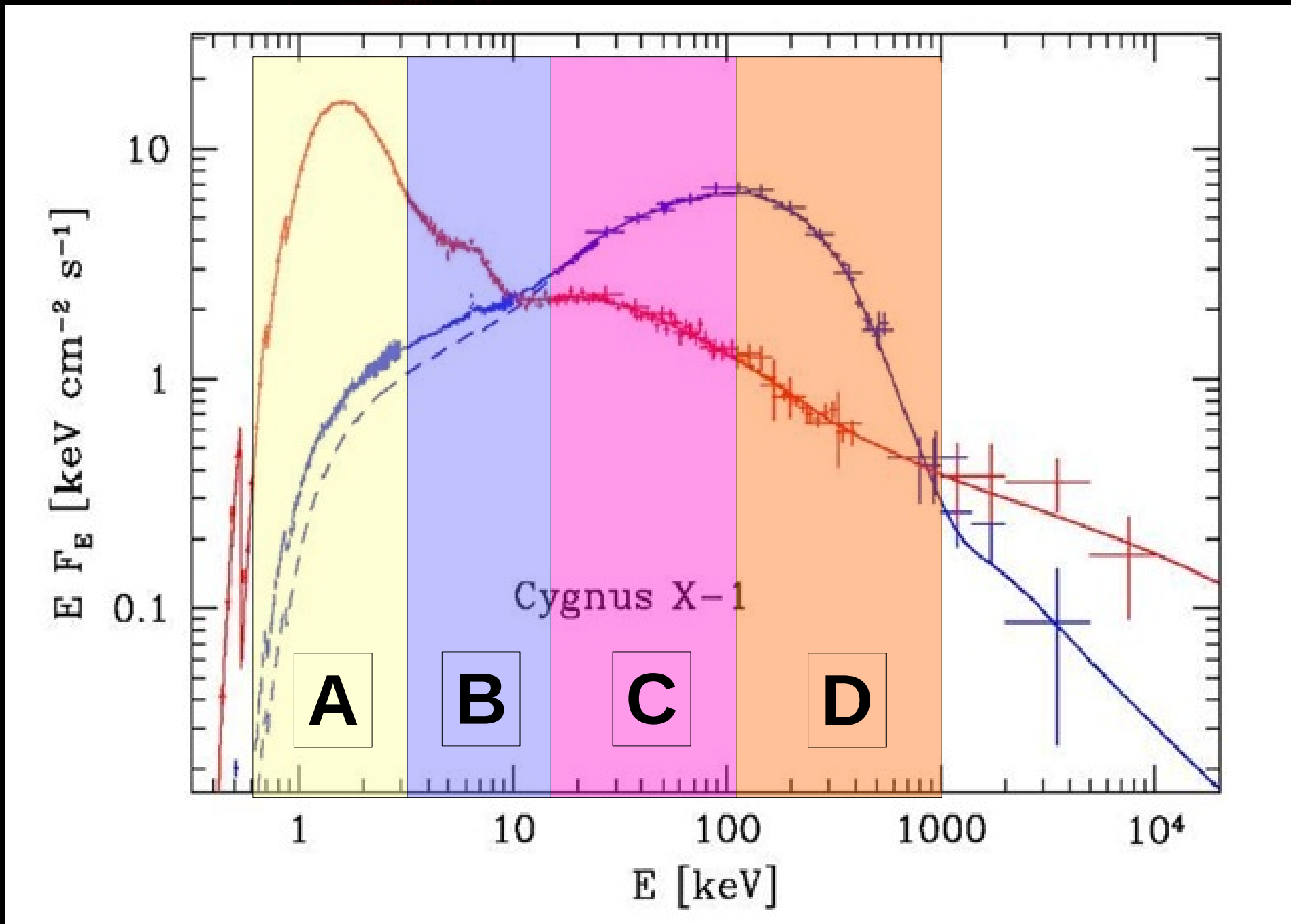

a
b
c
R-band mag
16.6
16.8
17.0
17.2
17.4
17.6
678.50
678.55
678.60
678.65
678.54
678.56
678.57
678.566
678.568
678.570
678.572
678.574
1 min
HJD-2455000


λ class (GRS 1915+105)
PCA count rate (cts/s)
8000
6000
4000
2000
0
500
1000
1500
2000
Time (sec)

X-ray colors -> helping tracing variability

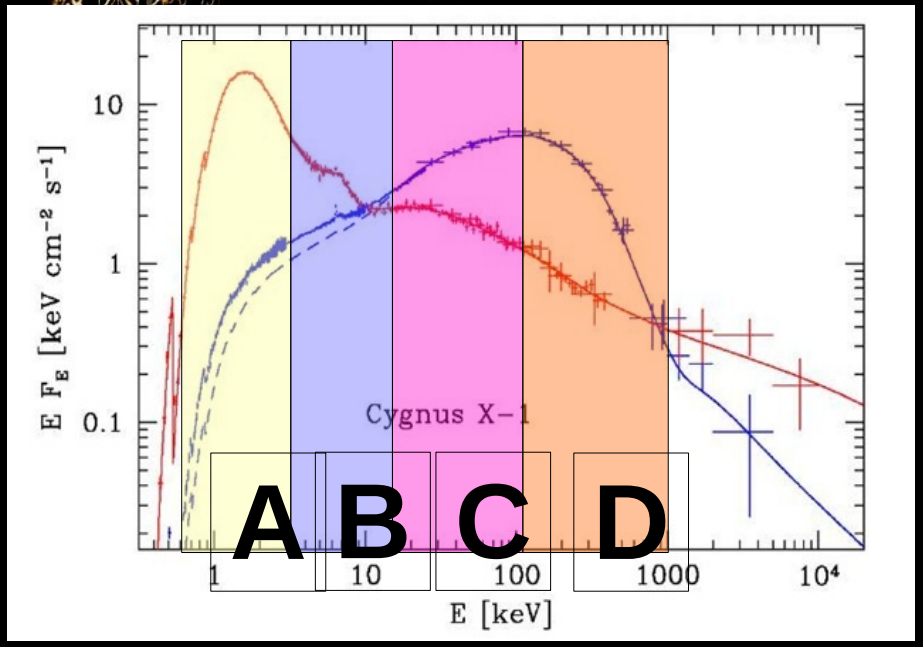


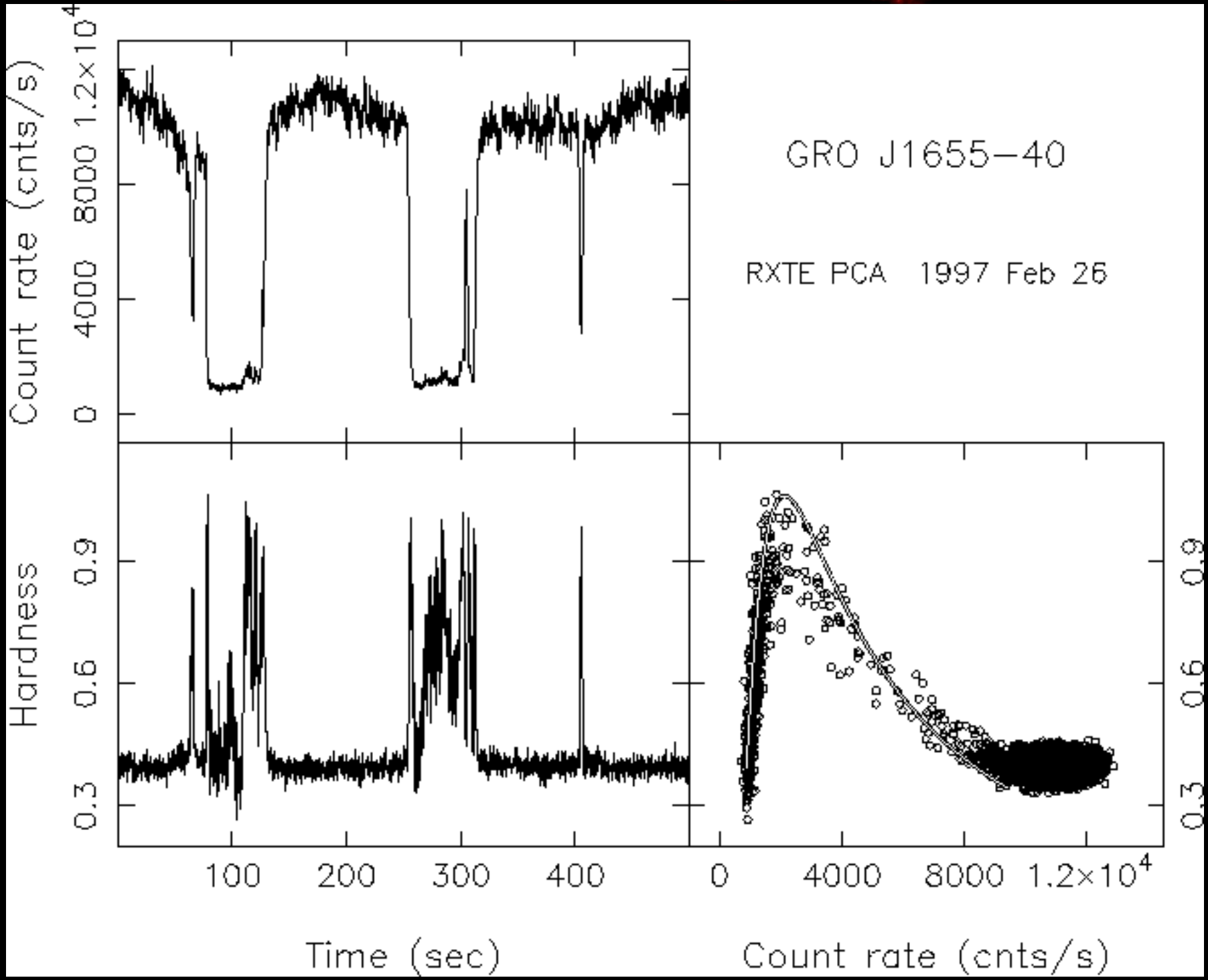
X-ray colors -> helping tracing variability

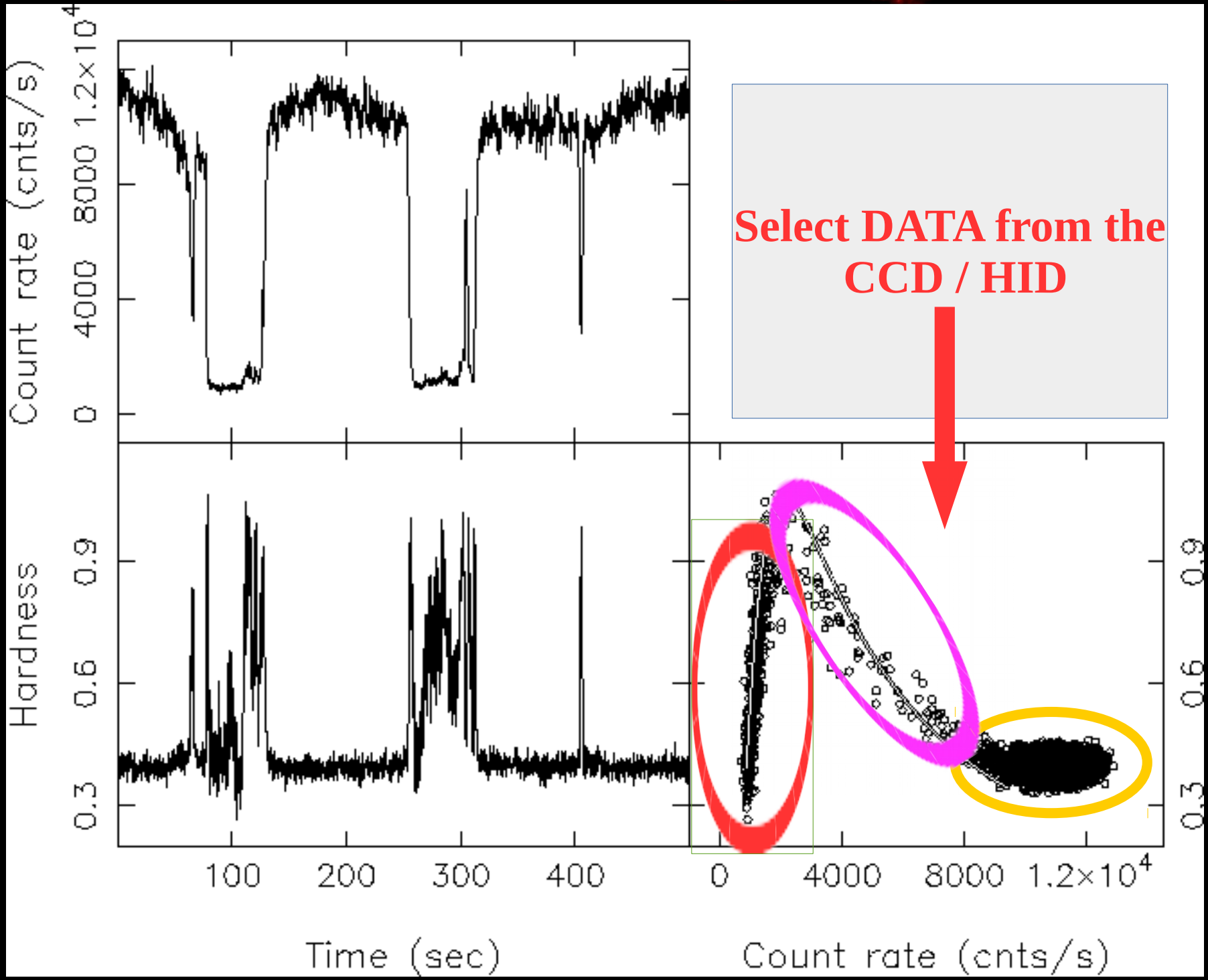


X-ray colors -> helping tracing variability

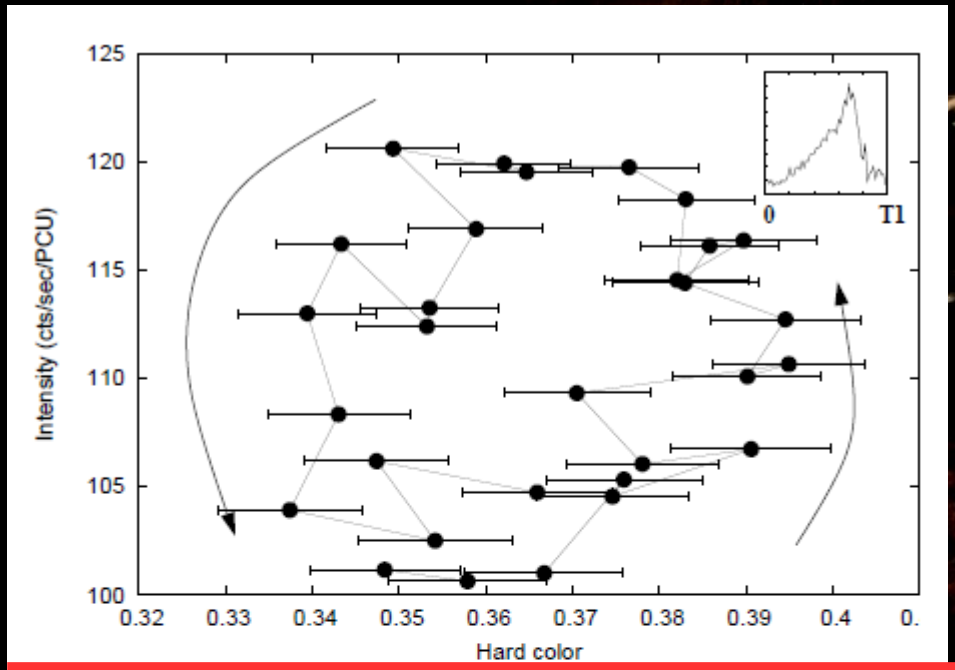
- Color 1 = B/A
- Color 2 = D/C
- Intensity = A+B+C+D

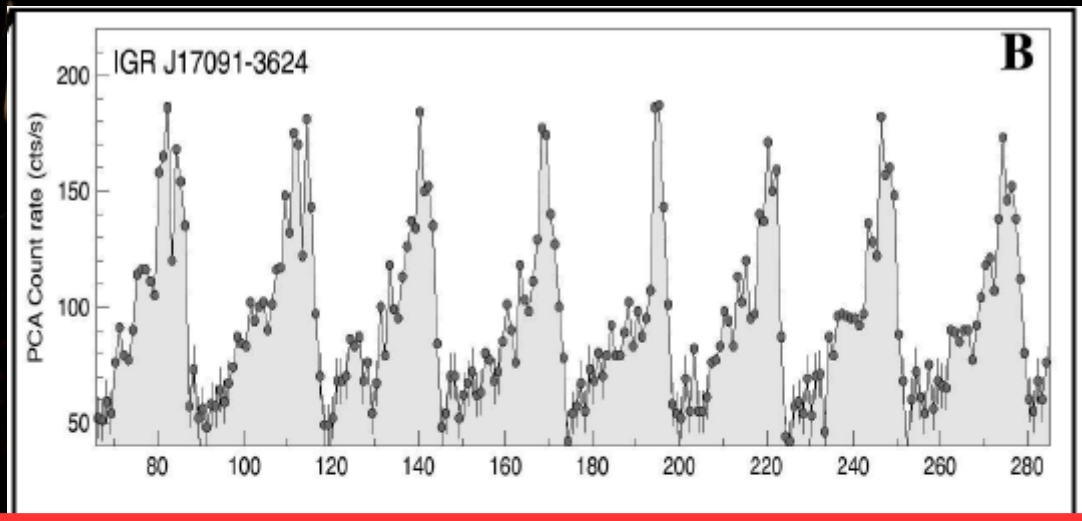


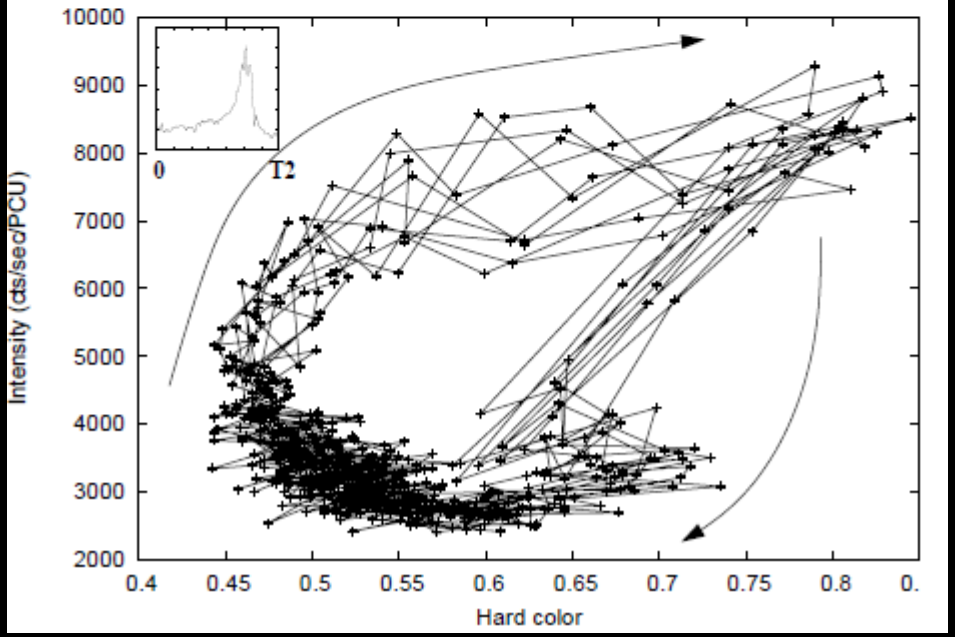

GRO J1655−40
RXTE PCA 1997 Feb 26
Count rate (cnts/s)
0
4000
8000
1.2×10^4
Hardness
0.3
0.6
0.9
100
200
300
400
Time (sec)
Count rate (cnts/s)

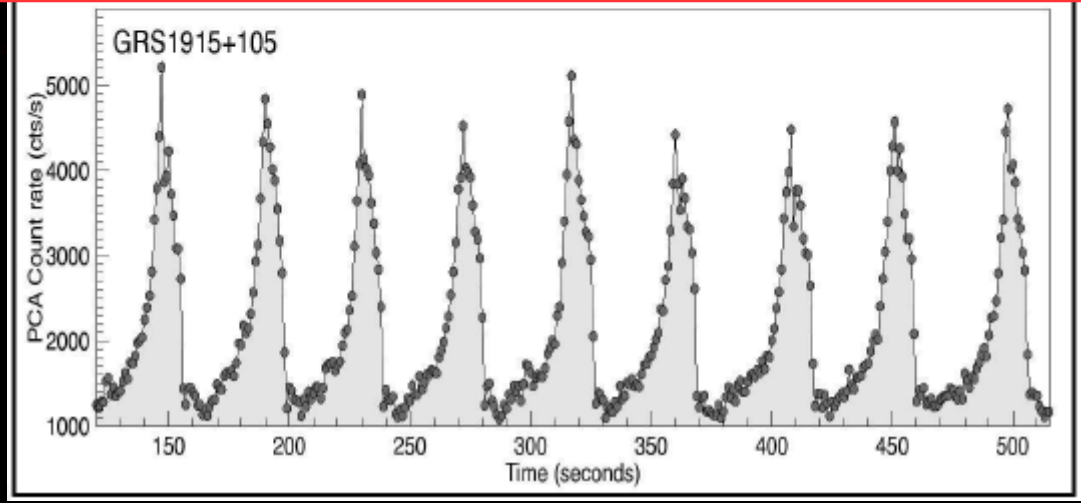

Count rate (cnts/s)
0
4000
8000
1.2×10^4
Hardness
0.3
0.6
0.9
100
200
300
400
Time (sec)
Count rate (cnts/s)
Select DATA from the CCD / HID

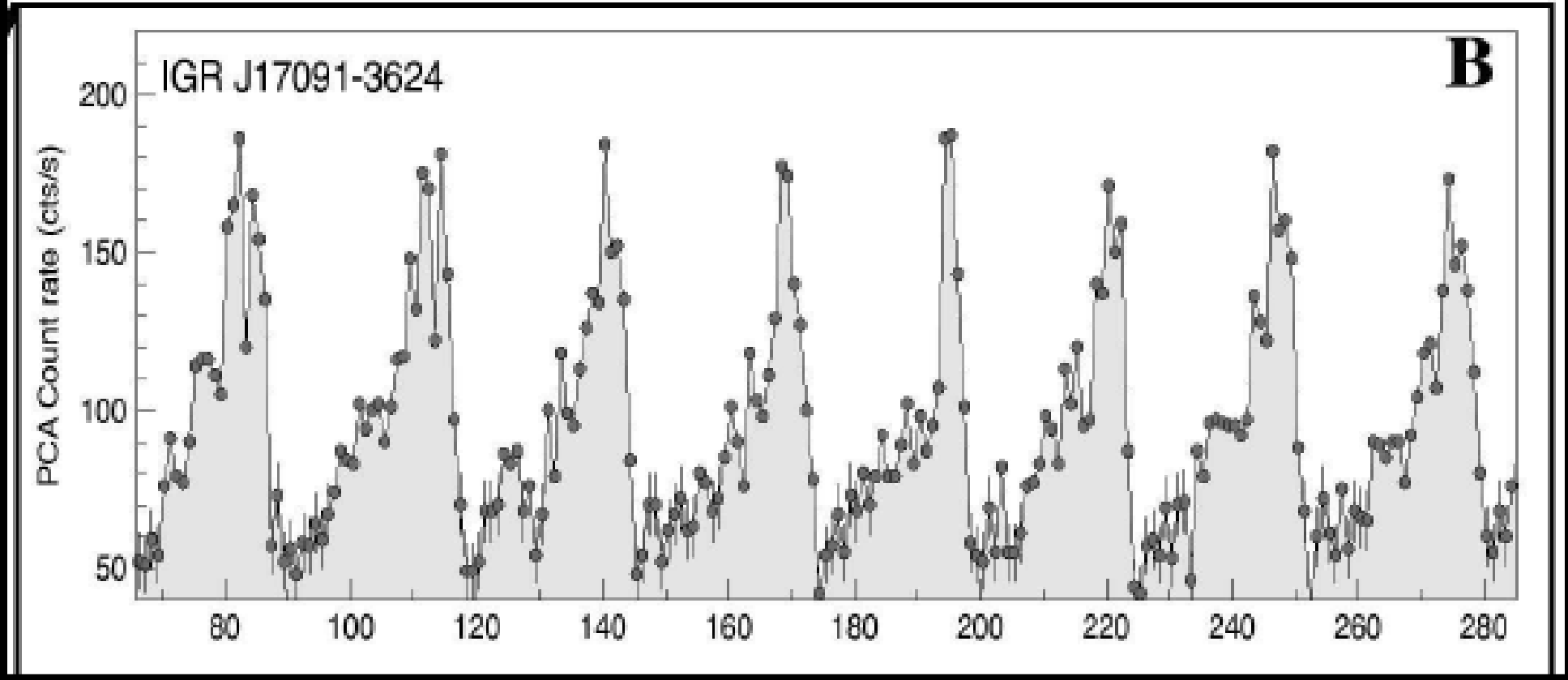
Folding (or similar techniques)!

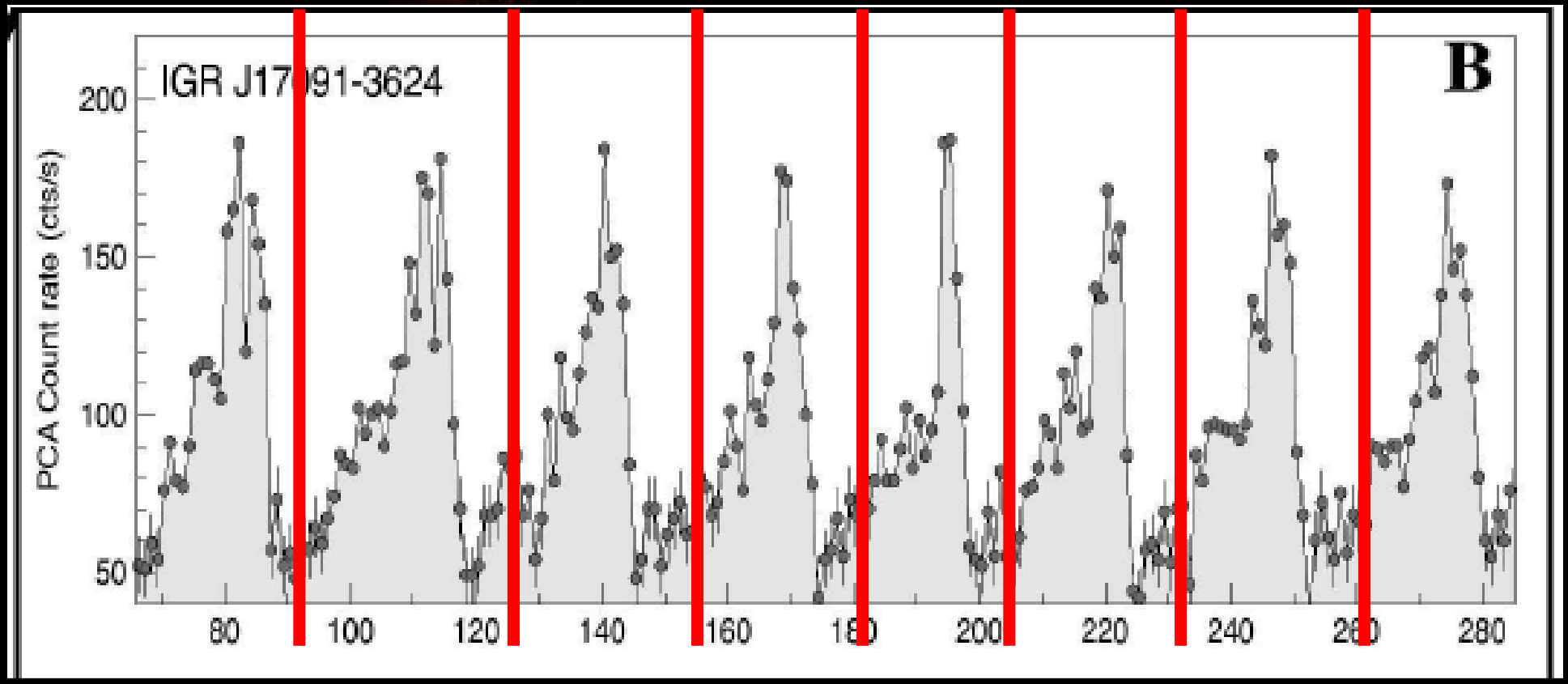


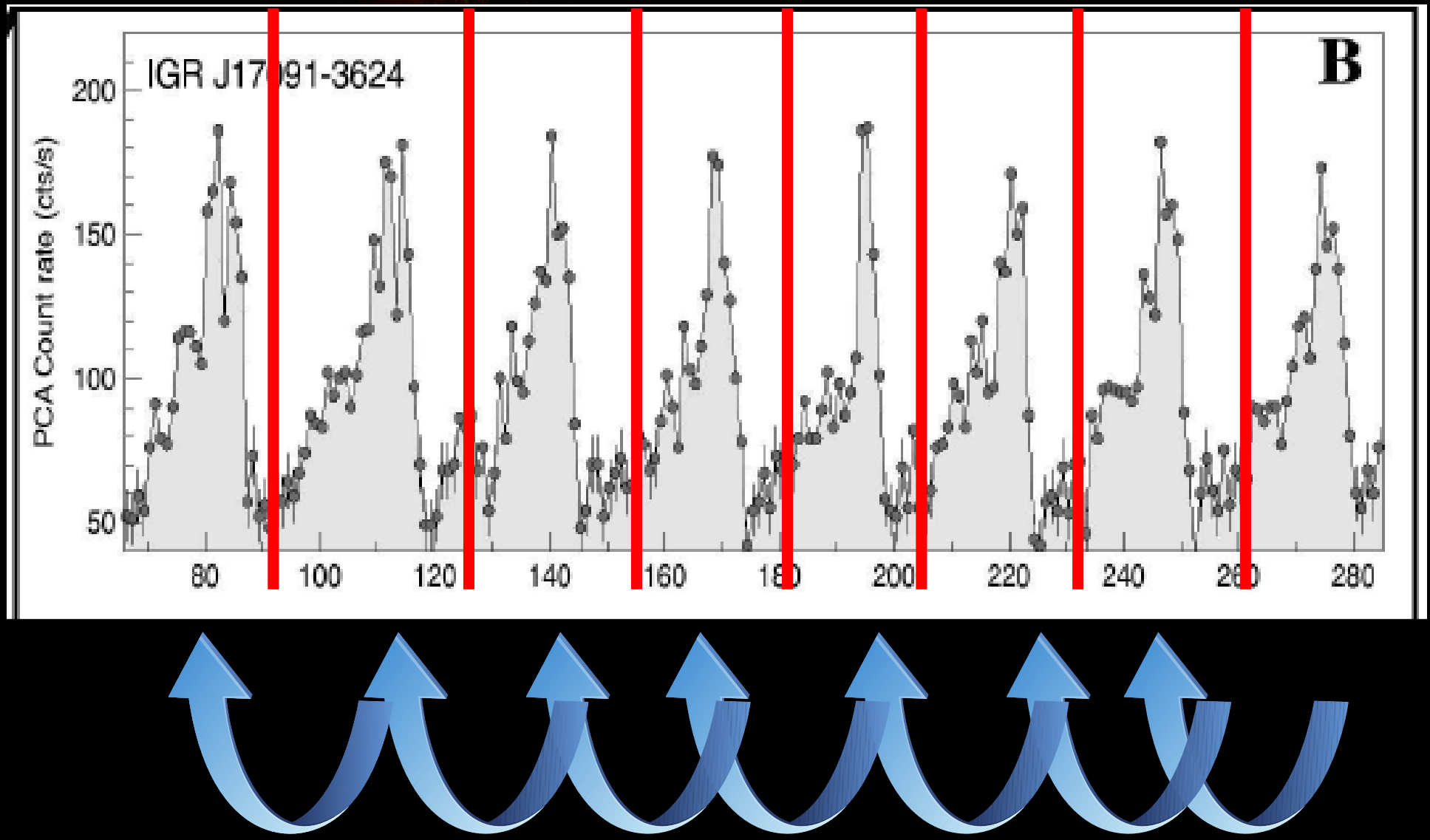


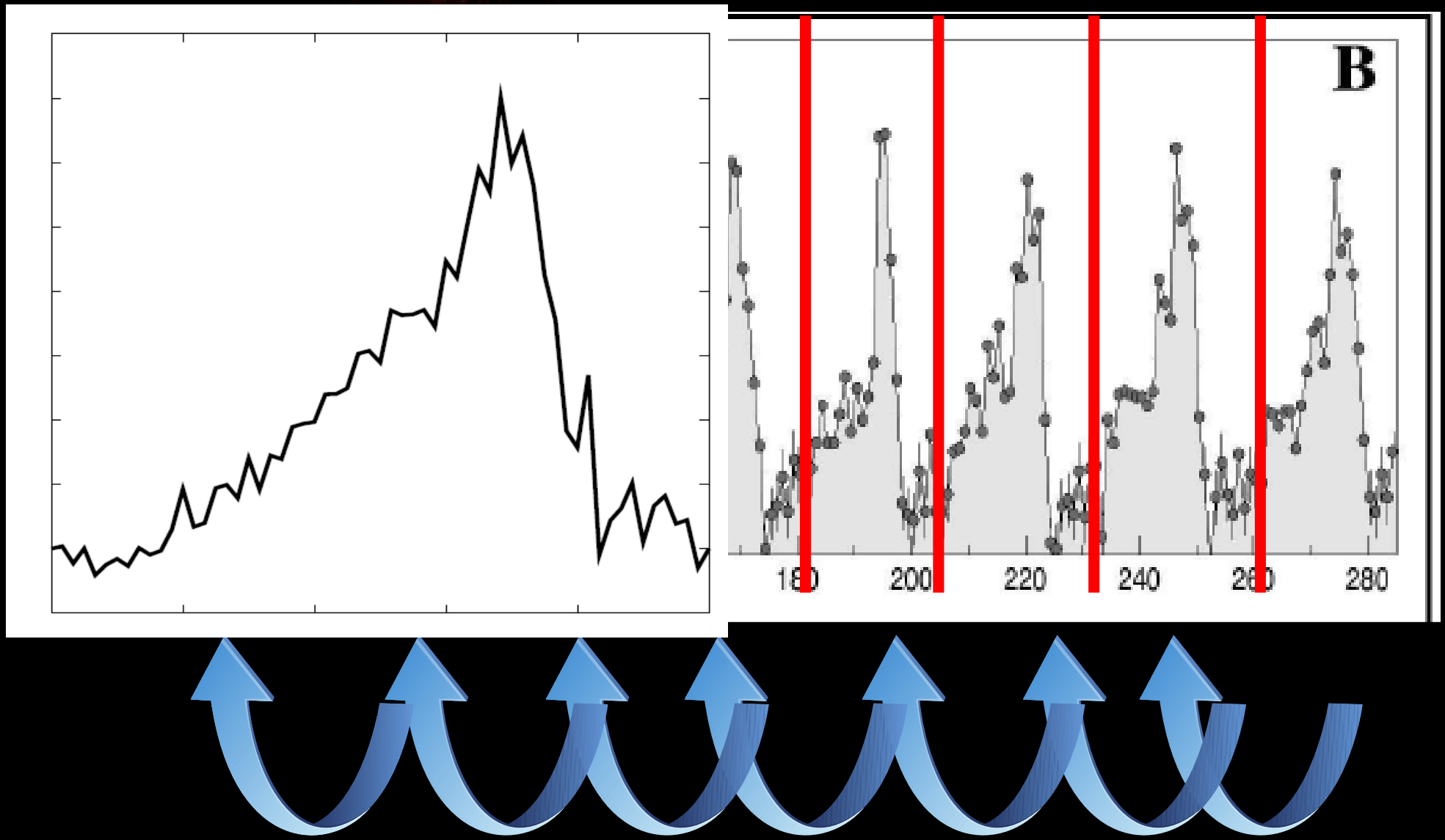




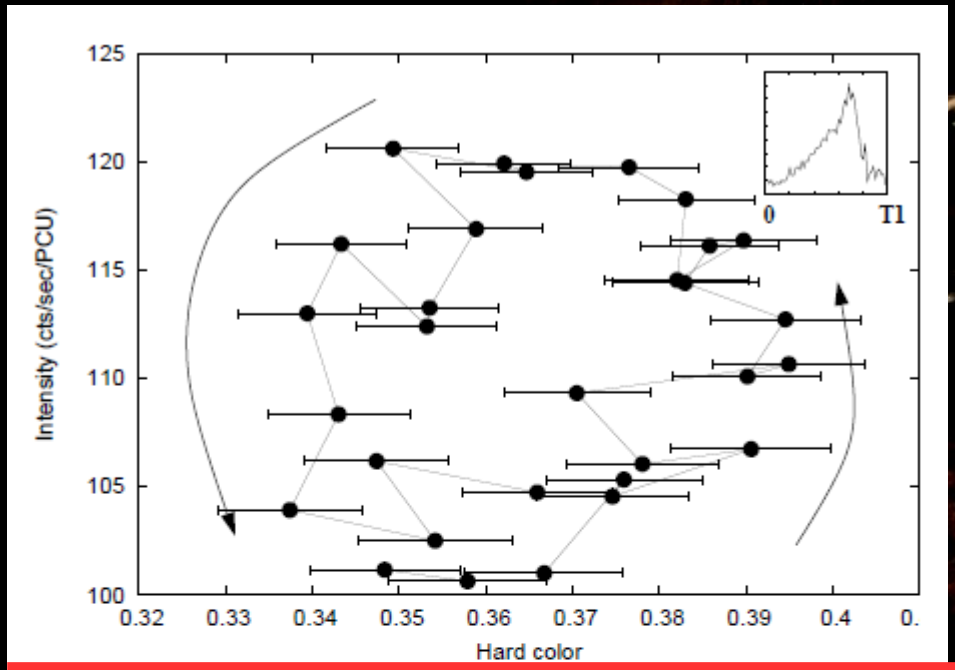

IGR J17091-3624
B
PCA Count rate (cts/s)
200
150
100
50
80
100
120
140
160
180
200
220
240
260
280

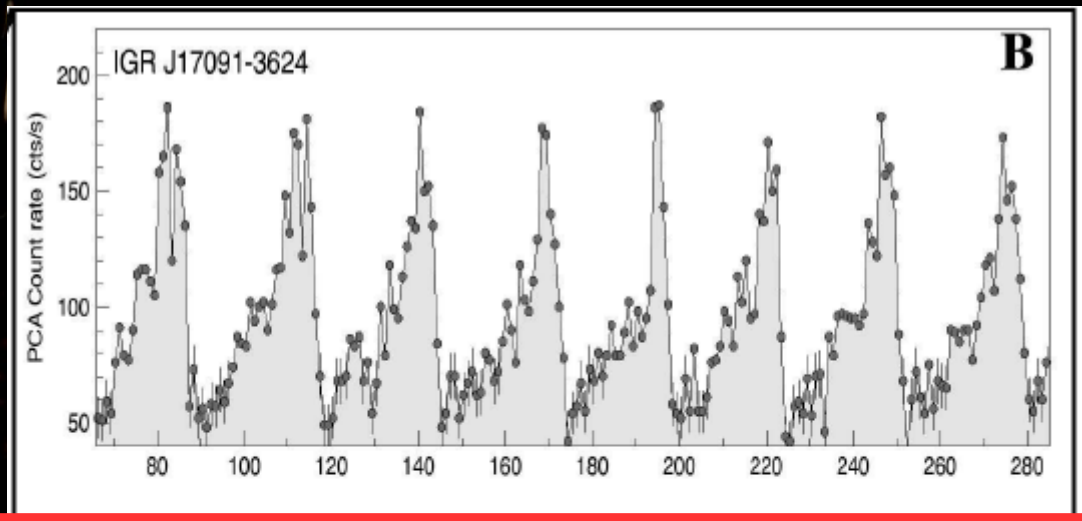

IGR J17091-3624
B
PCA Count rate (cts/s)
200
150
100
50
80
100
120
140
160
180
200
220
240
260
280

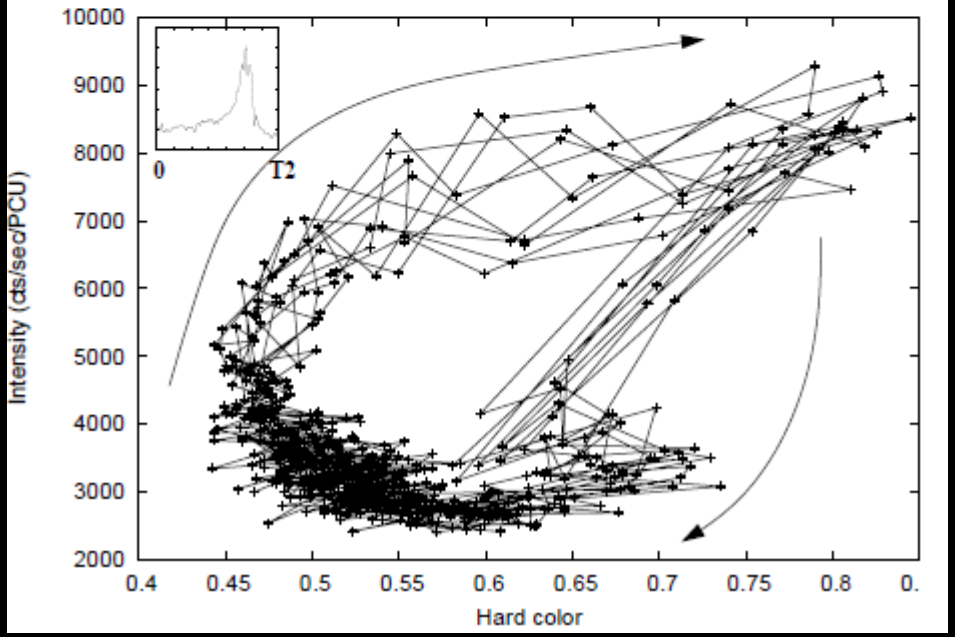

IGR J17091-3624
B
PCA Count rate (cts/s)
200
150
100
50
80
100
120
140
160
180
200
220
240
260
280

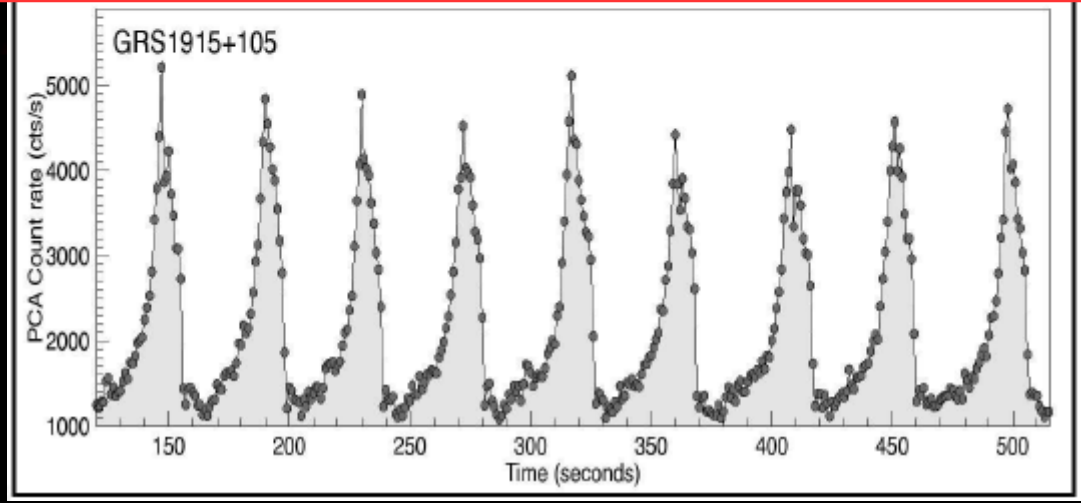

B
200
220
240
280

Folding (or similar techniques)!









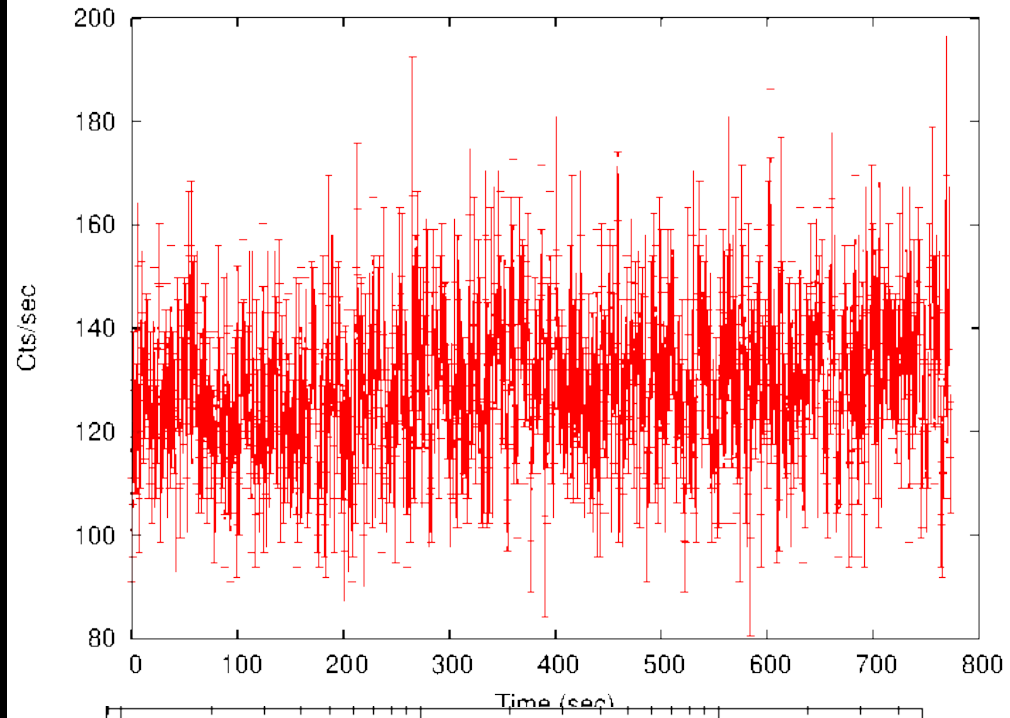
In many cases, we just can't do the selections by eye, or by using spectral colors....

There can be much more variability than that you can see with the naked eye....

In many cases, we just can't do the selections by eye, or by using spectral colors....

There can be much more variability than that you can see with the naked eye....

Statistics some times kill us, but Sir Fourier comes to our help!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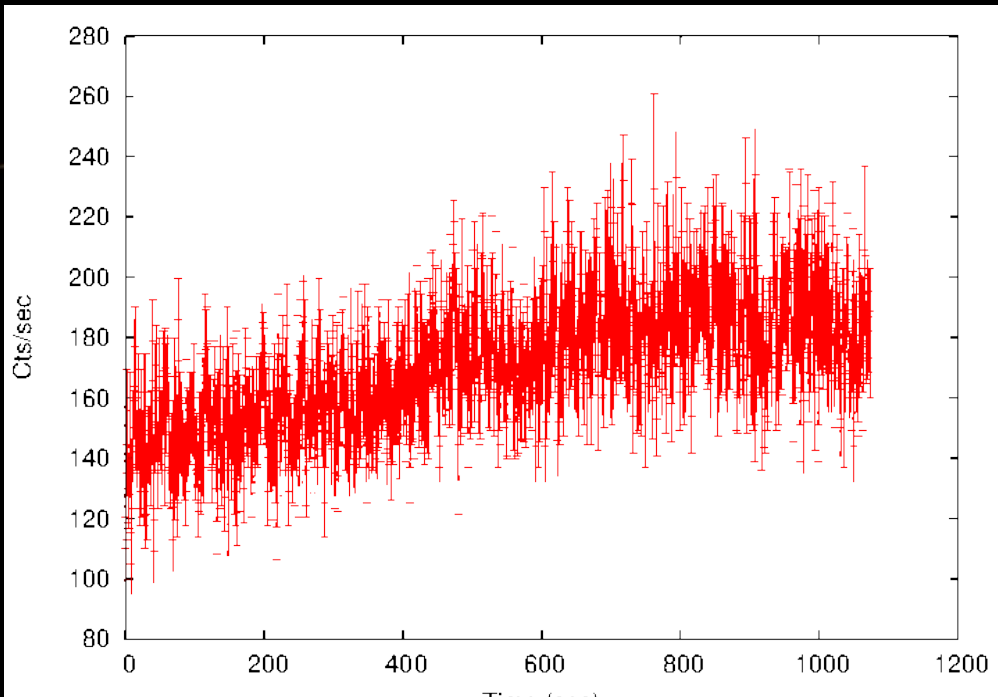
Time (sec)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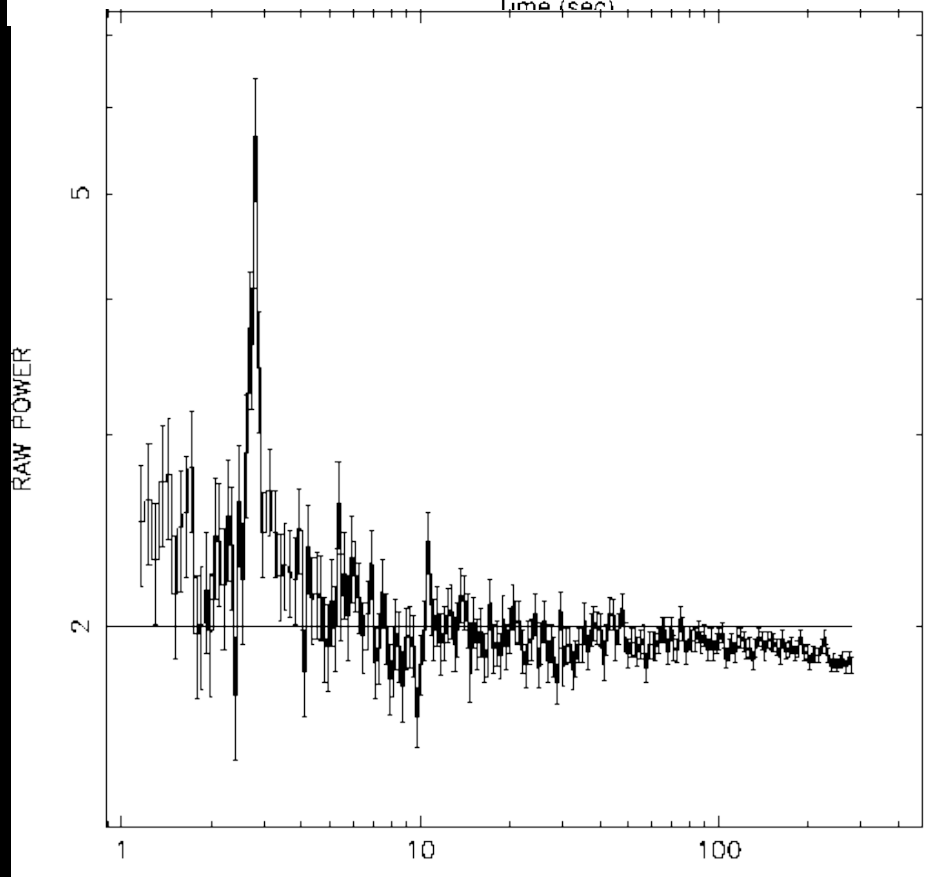
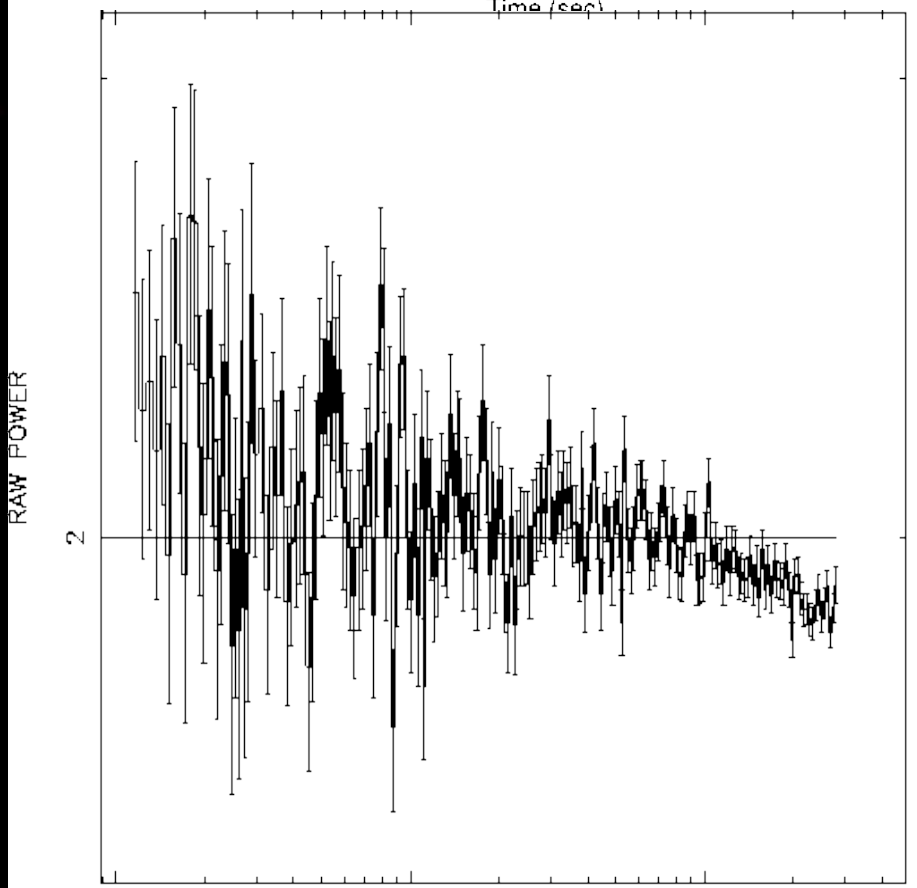
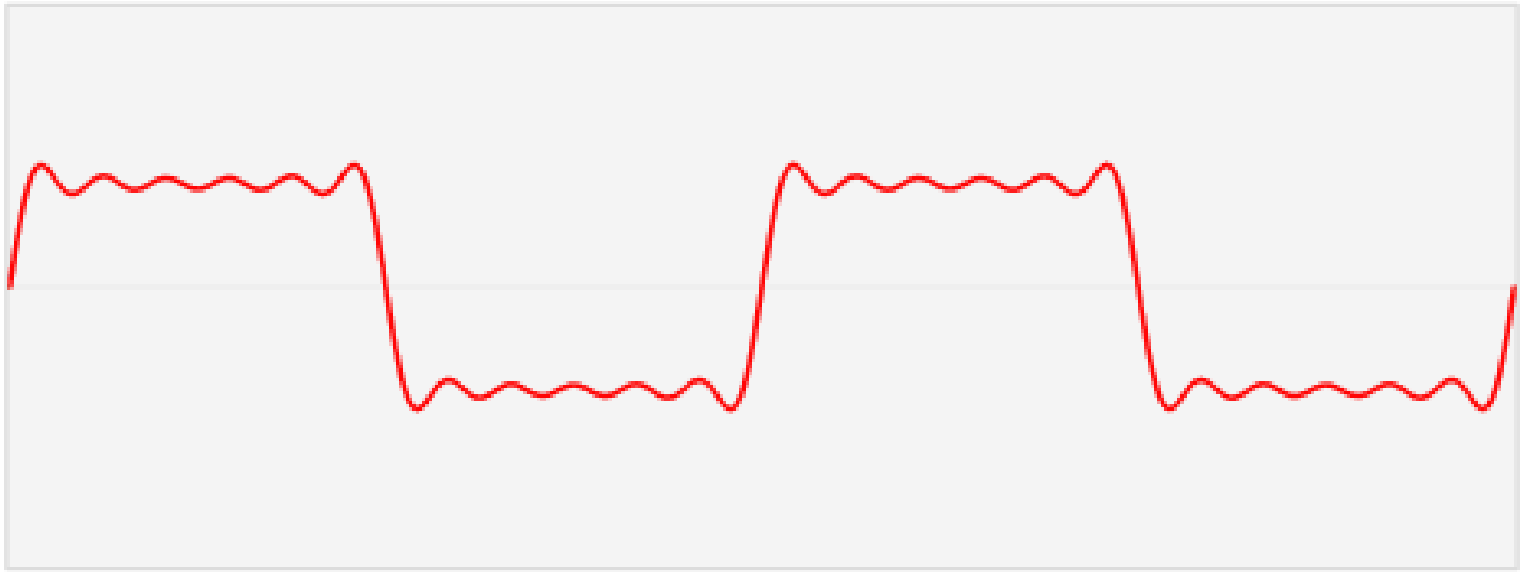
Time (sec)

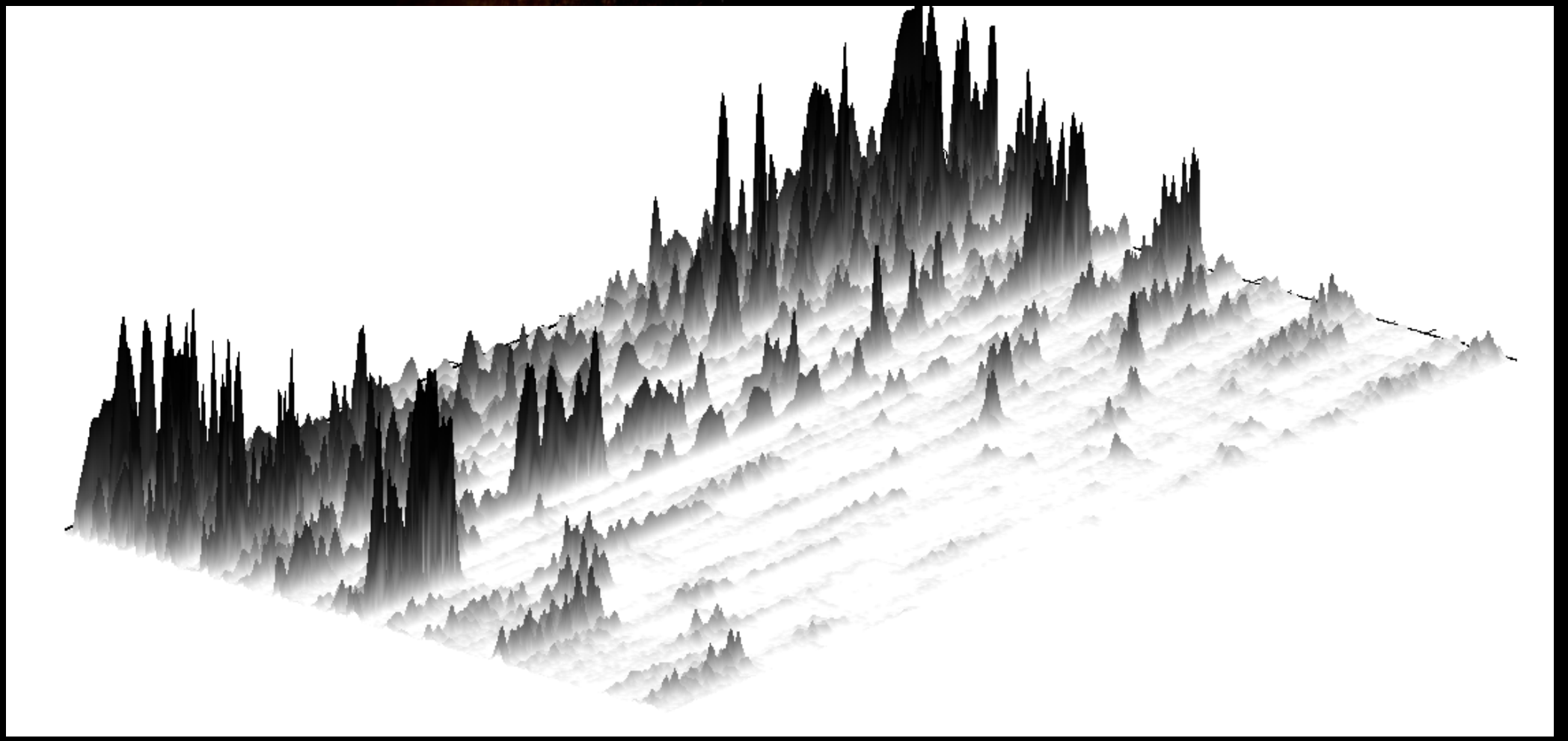

RAW POWER
5
2
1
10
100


RAW POWER
2

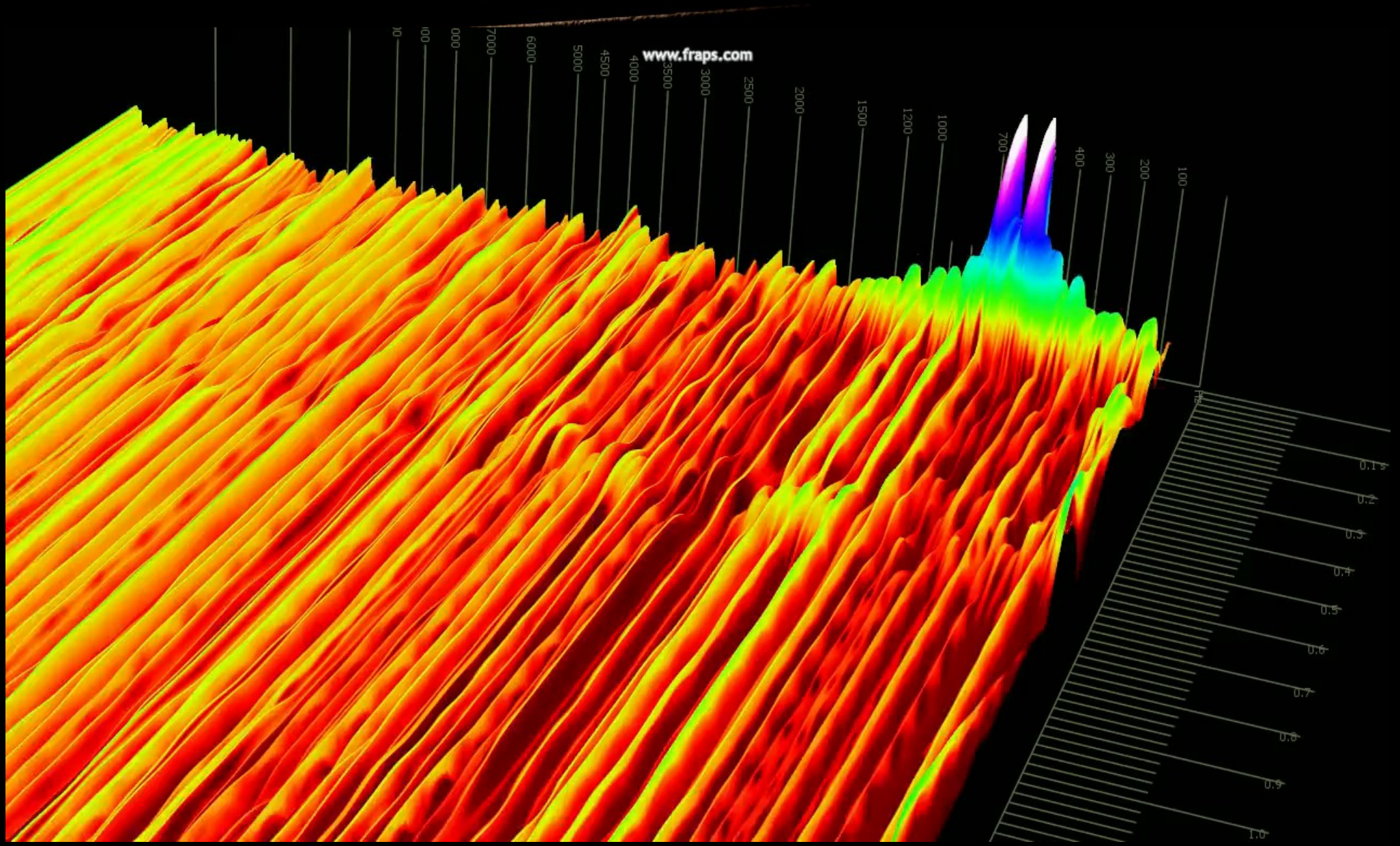
https://www.youtube.com/watch?v=SpzNQOOBeRg

http://commons.wikimedia.org/wiki/File:Fourier_transform_time_and_frequency_domains.gif





https://www.youtube.com/watch?v=vvr9AMWEU-c



System and methods for recognizing sound and music signals in high noise and distortion

US 6990453 B2

ABSTRACT

A method for recognizing an audio sample locates an audio file that most closely matches the audio sample from a database indexing a large set of original recordings. Each indexed audio file is represented in the database index by a set

Publication number	US6990453 B2
Publication type	Grant
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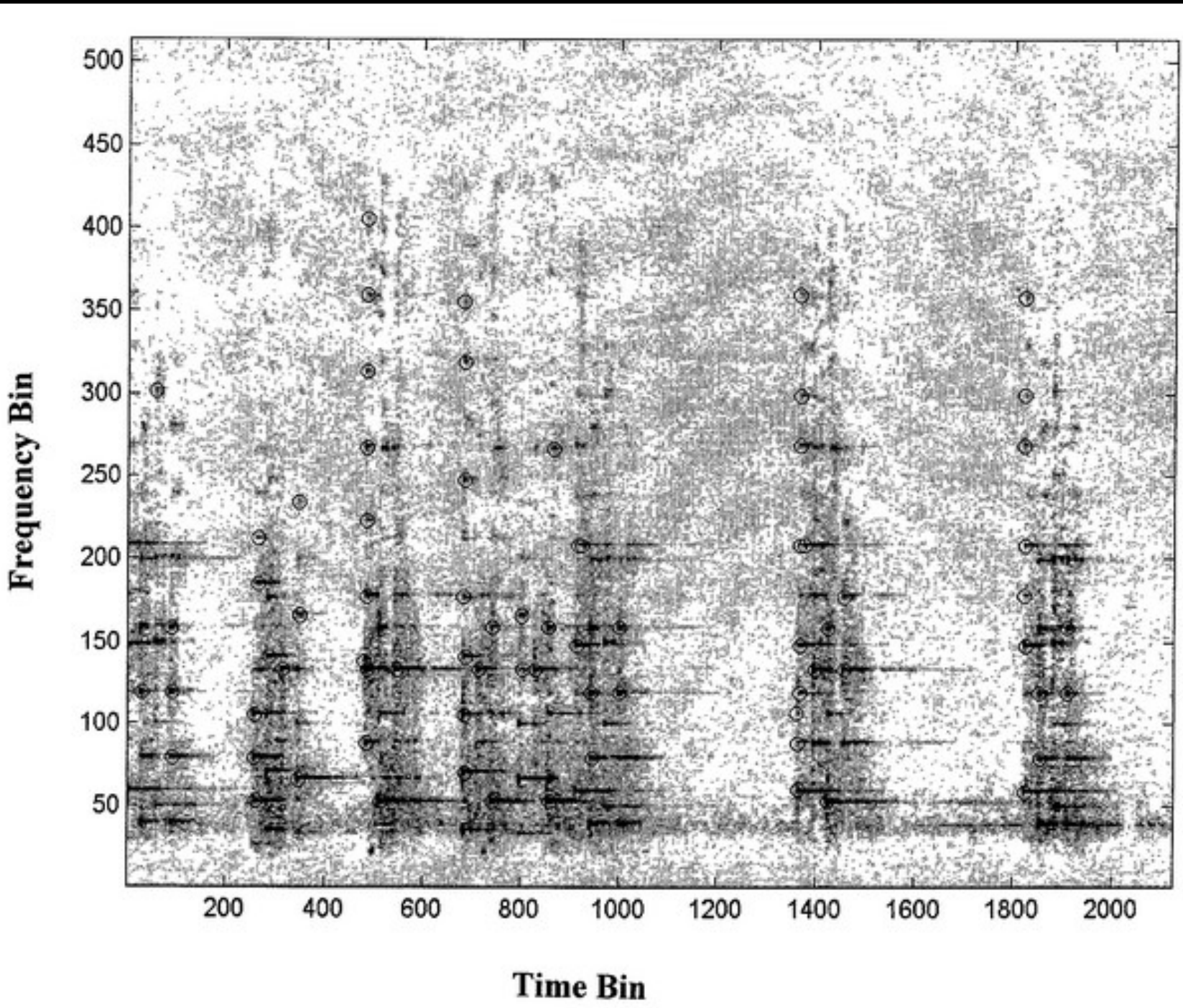
Publication date	Jan 24, 2006
Filing date	Apr 20, 2001
Priority date ⓘ	Jul 31, 2000
Fee status ⓘ	Paid
Also published as	CN1592906A, 18 More »
Inventors	Avery Li-Chun Wang, Julius O. Smith, III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450
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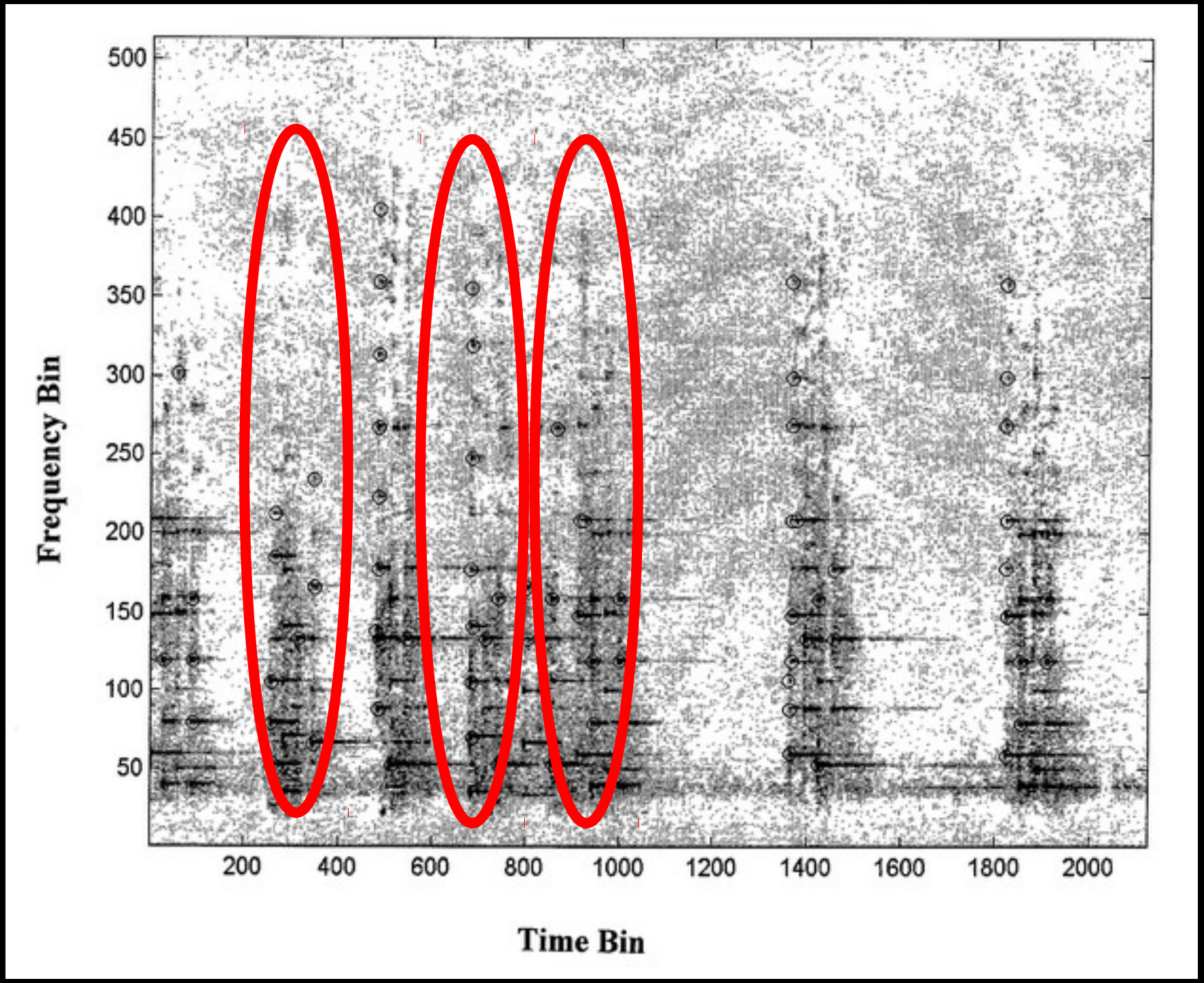
800
1000
1200
1400
1600
1800
2000
Time Bin


Frequency Bin
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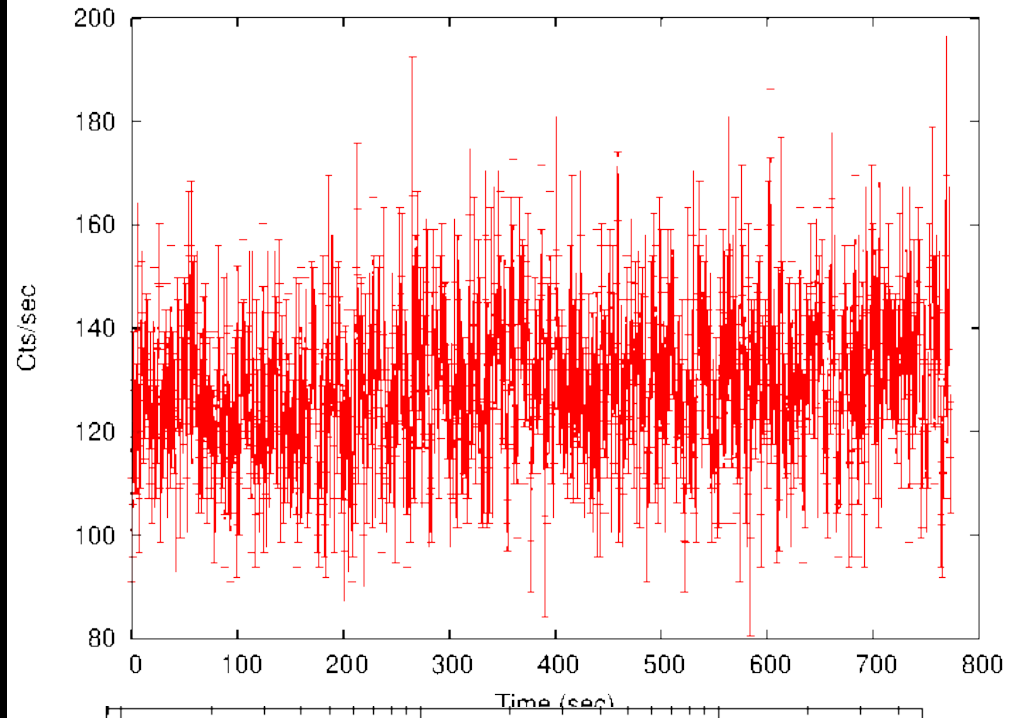
Time Bin


Cts/sec
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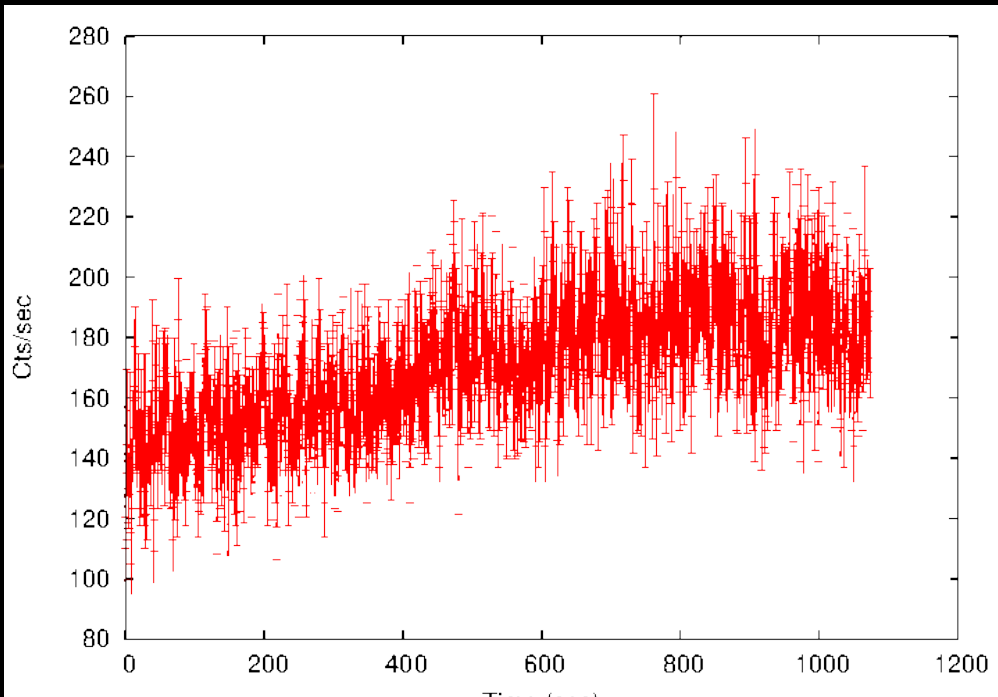
Time (sec)


Cts/sec
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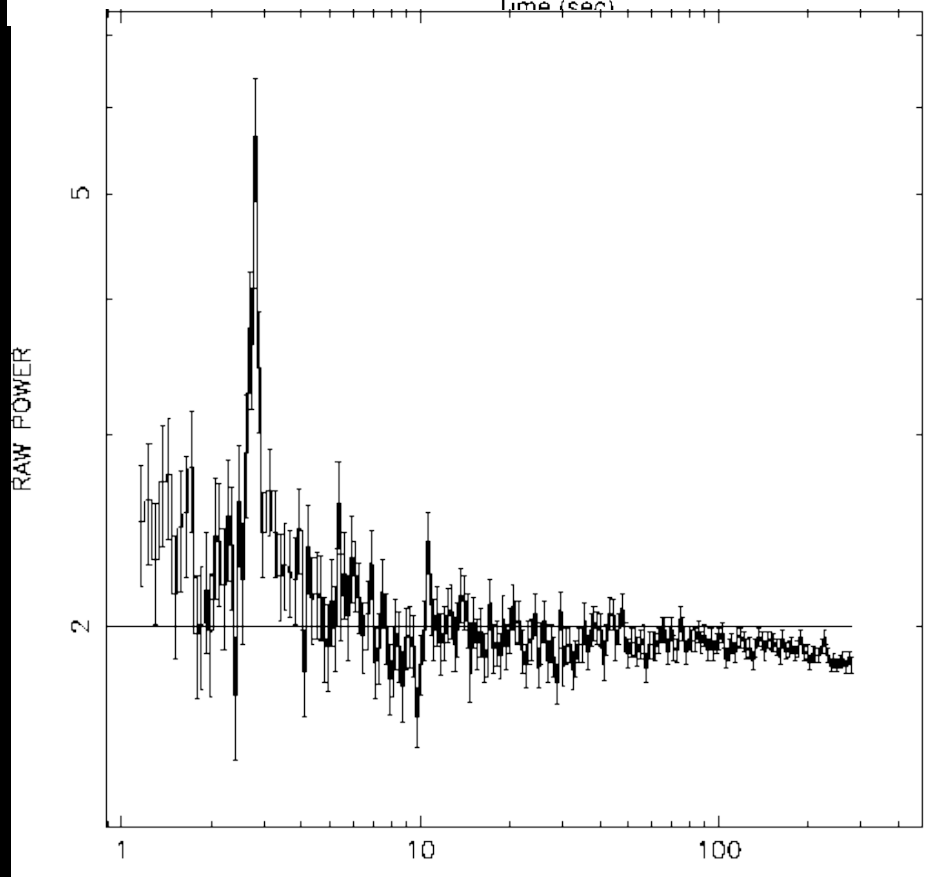
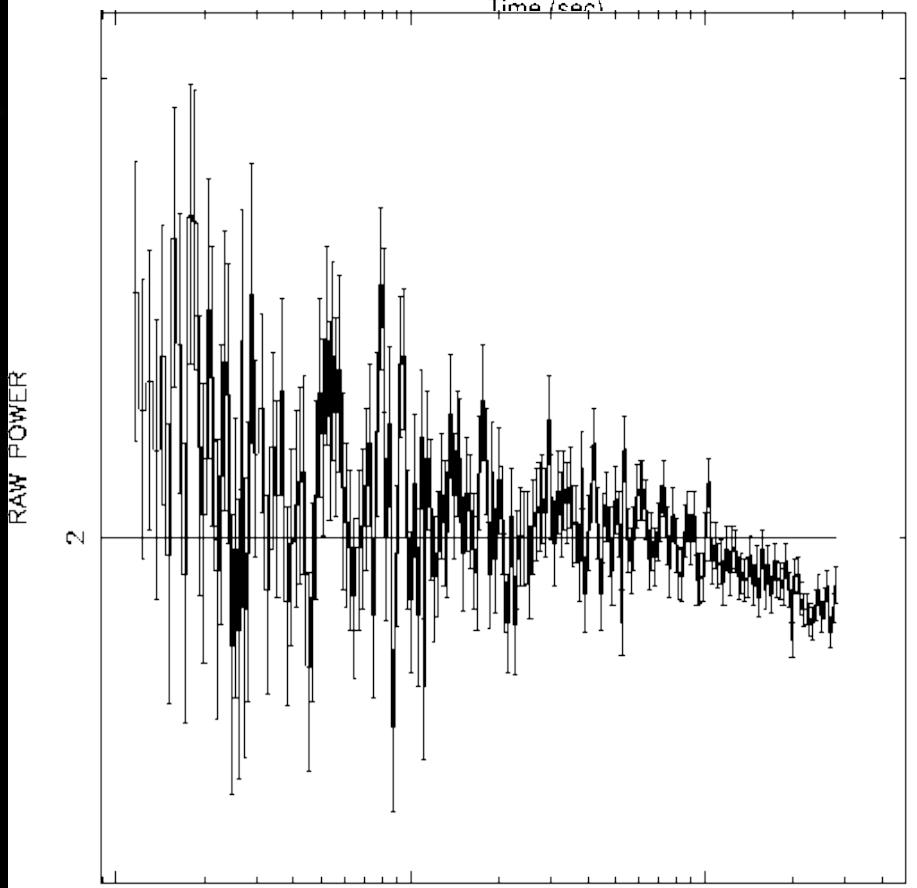
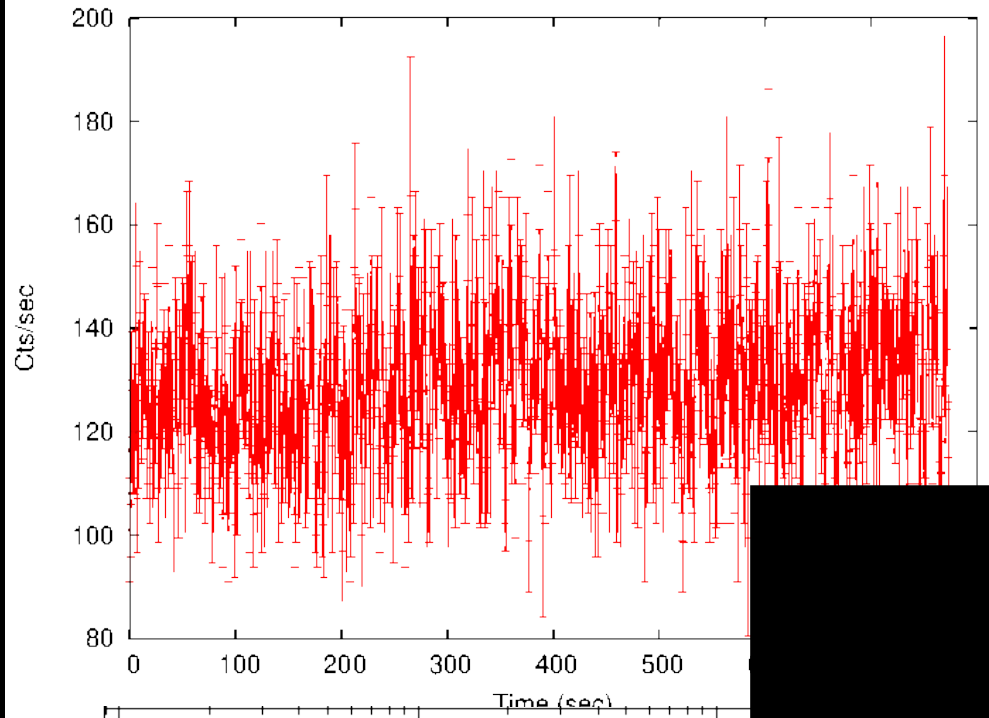
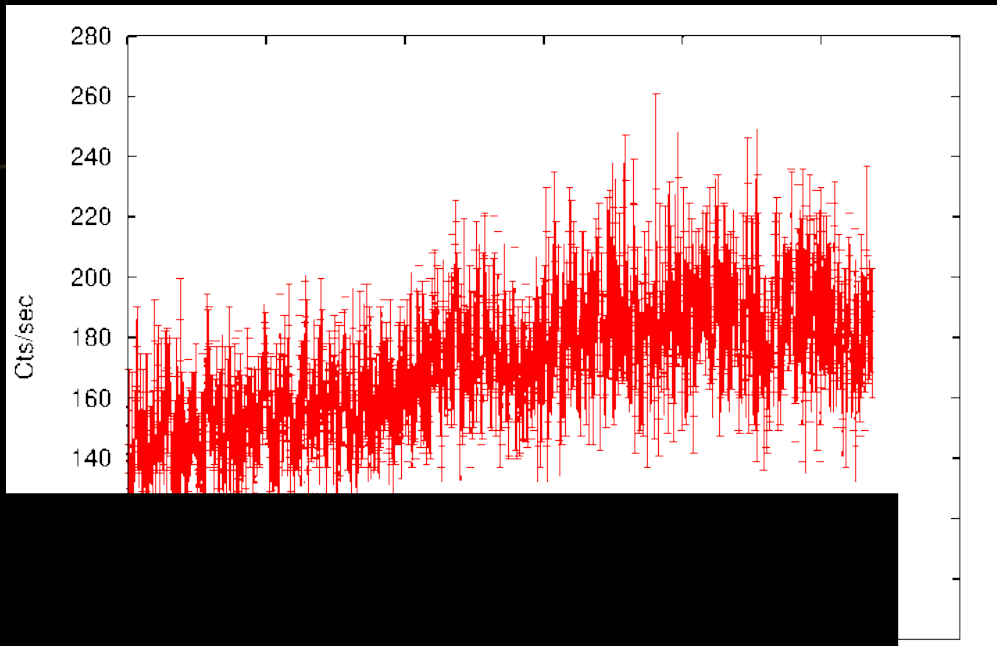
Time (sec)

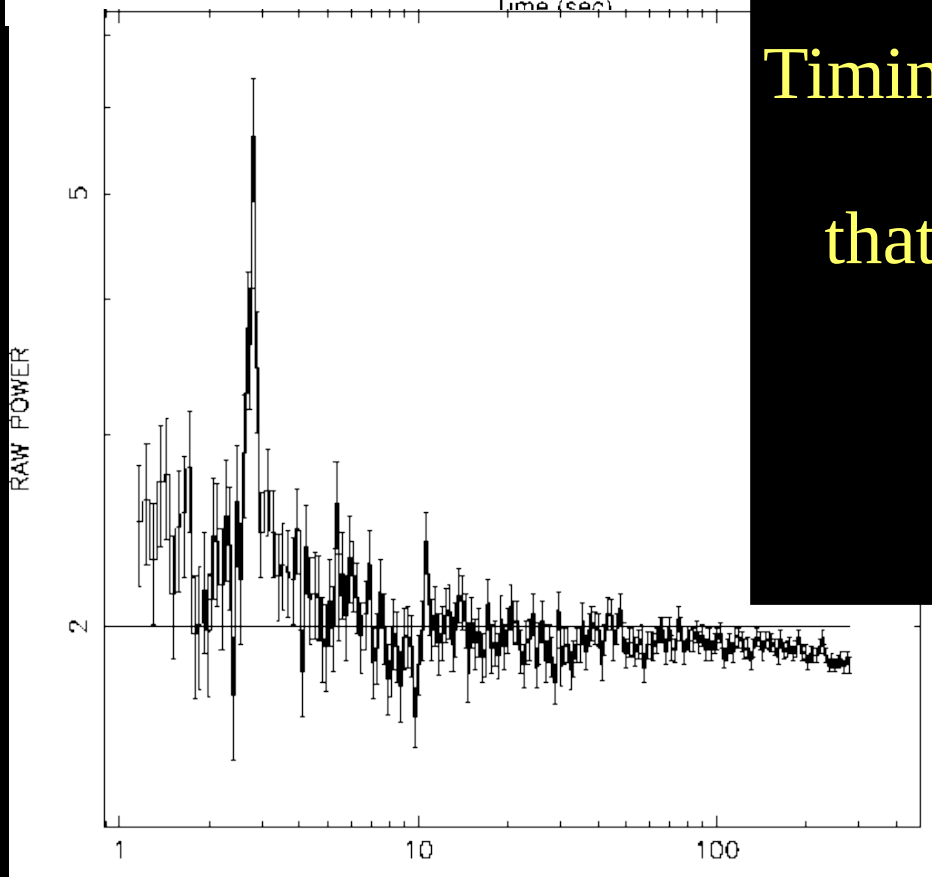

RAW POWER
5
2
1
10
100


RAW POWER
2





Timing analysis may seem like “magic,” since it can reveal features that are not apparent to the eye in the raw data

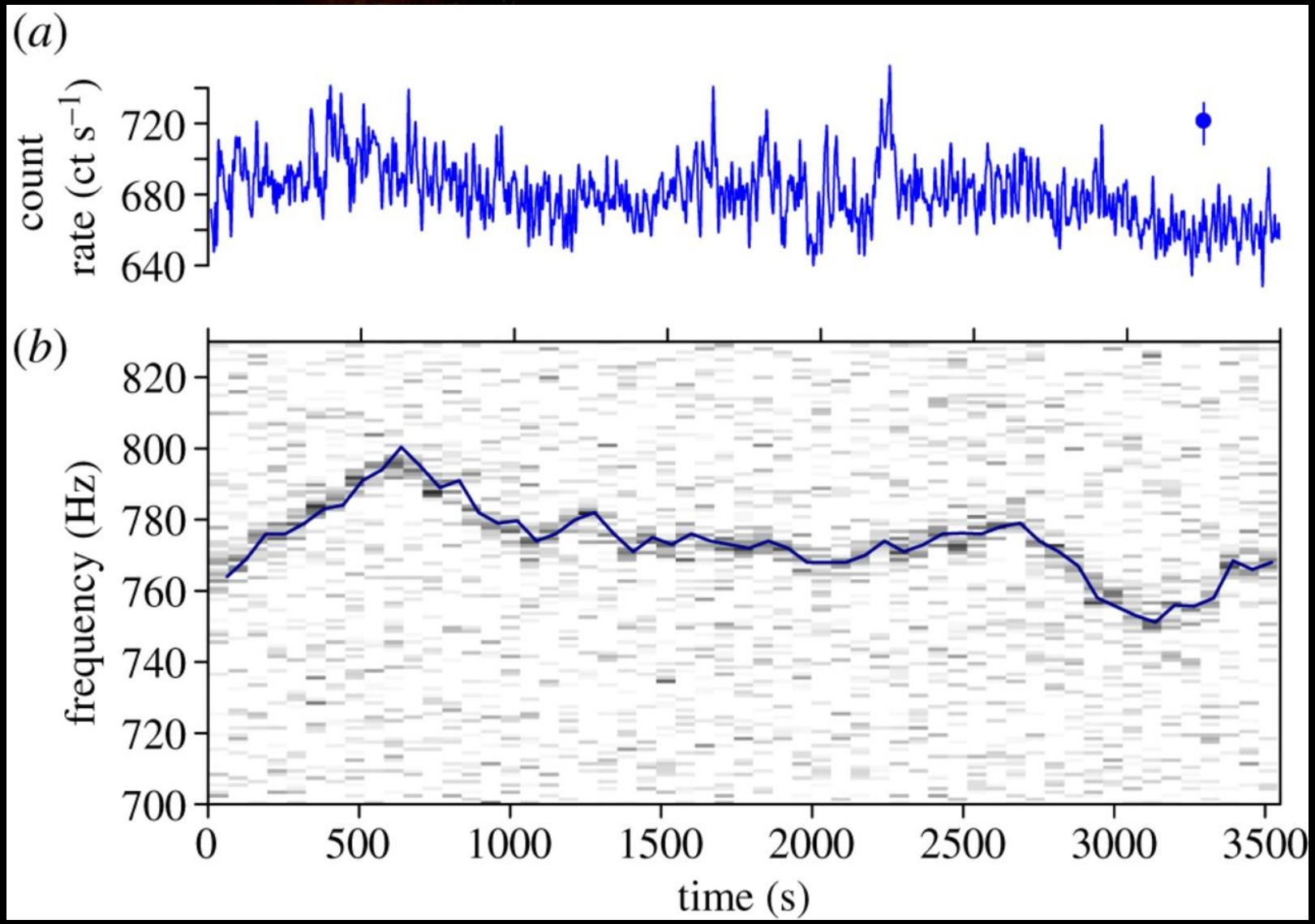


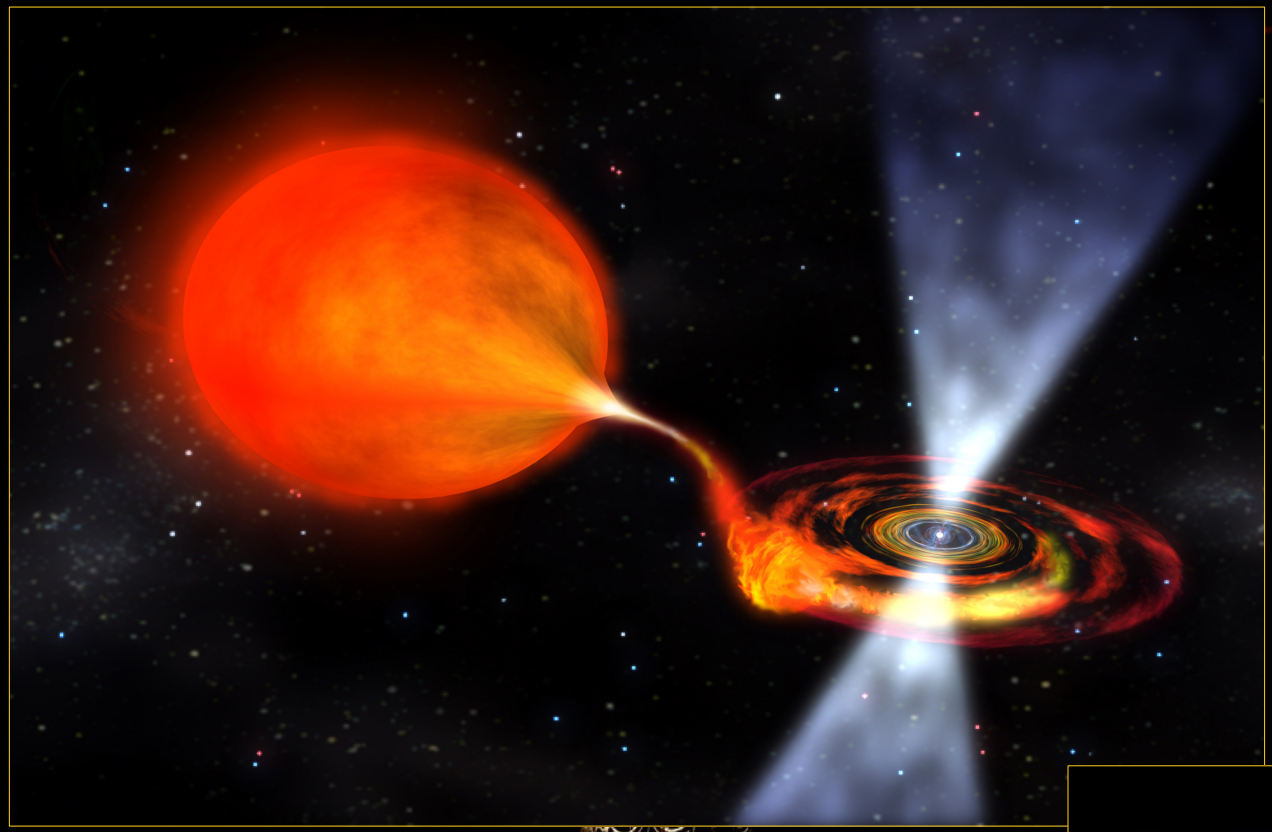
Number of Trials to First Success

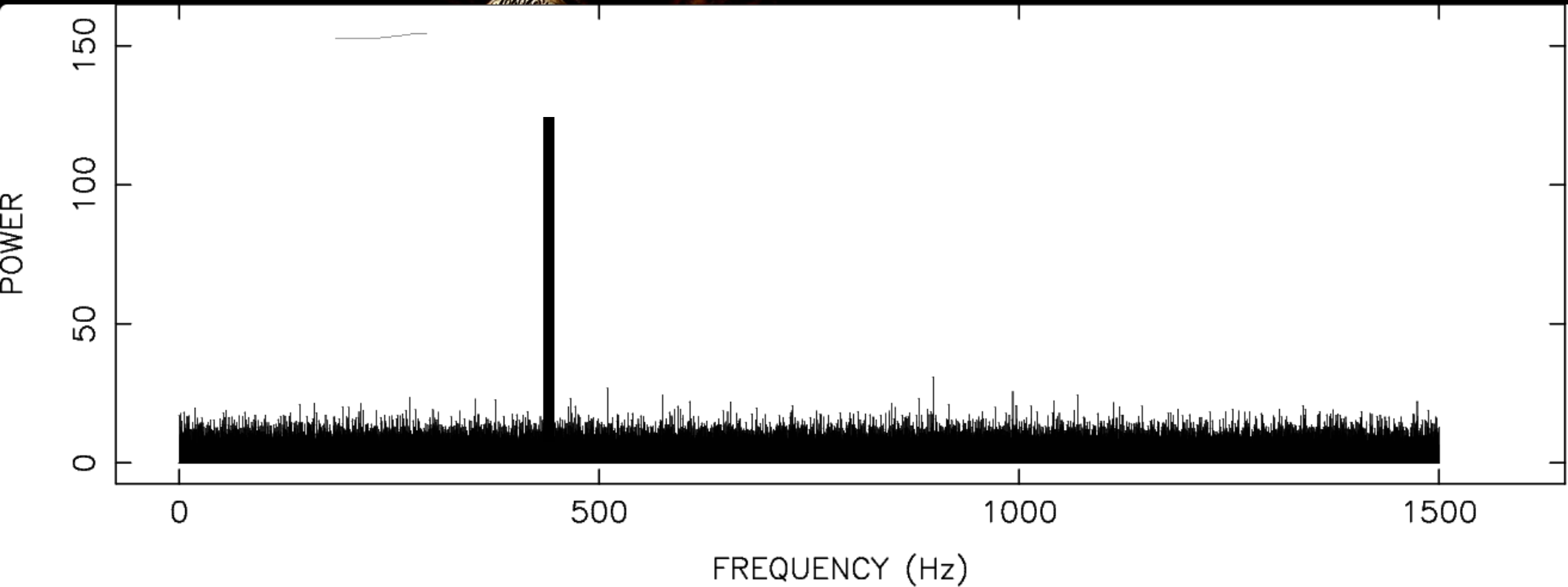
Informally, the probability of an event is the average number of times the event occurs in a sequence of trials. Another way of looking at that is to ask for an average number of trials before the first occurrence of the event. This could be formalized in terms of mathematical expectation.

(http://www.cut-the-knot.org/)

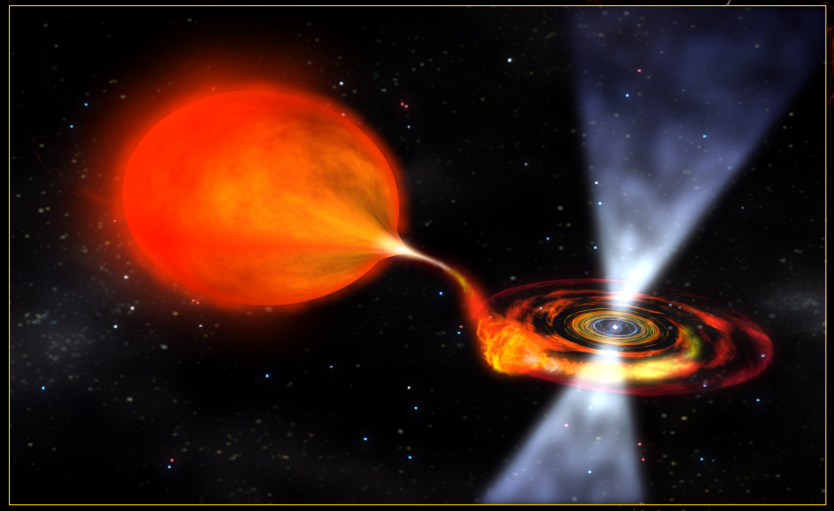
Dynamical Power spectrum

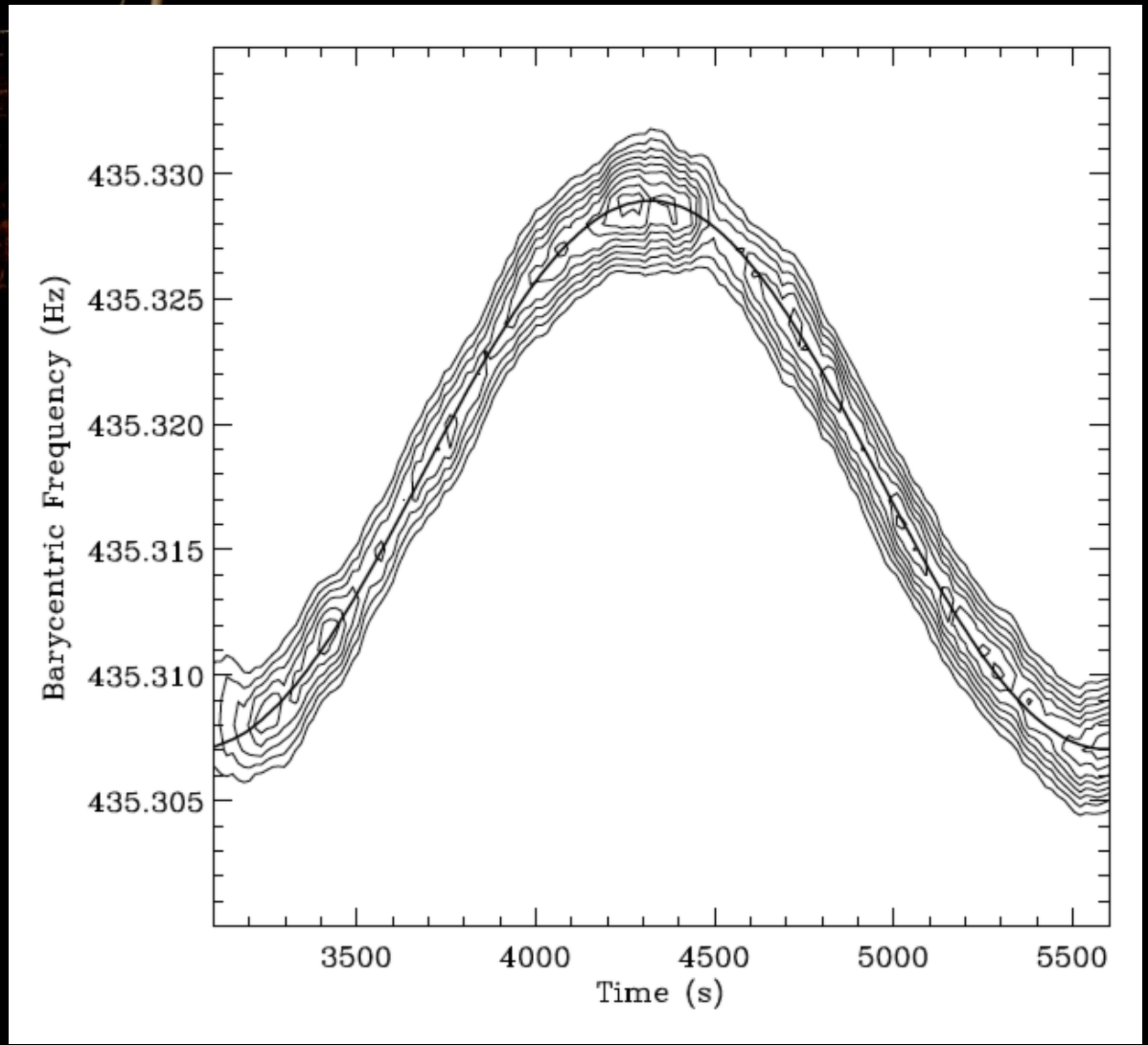




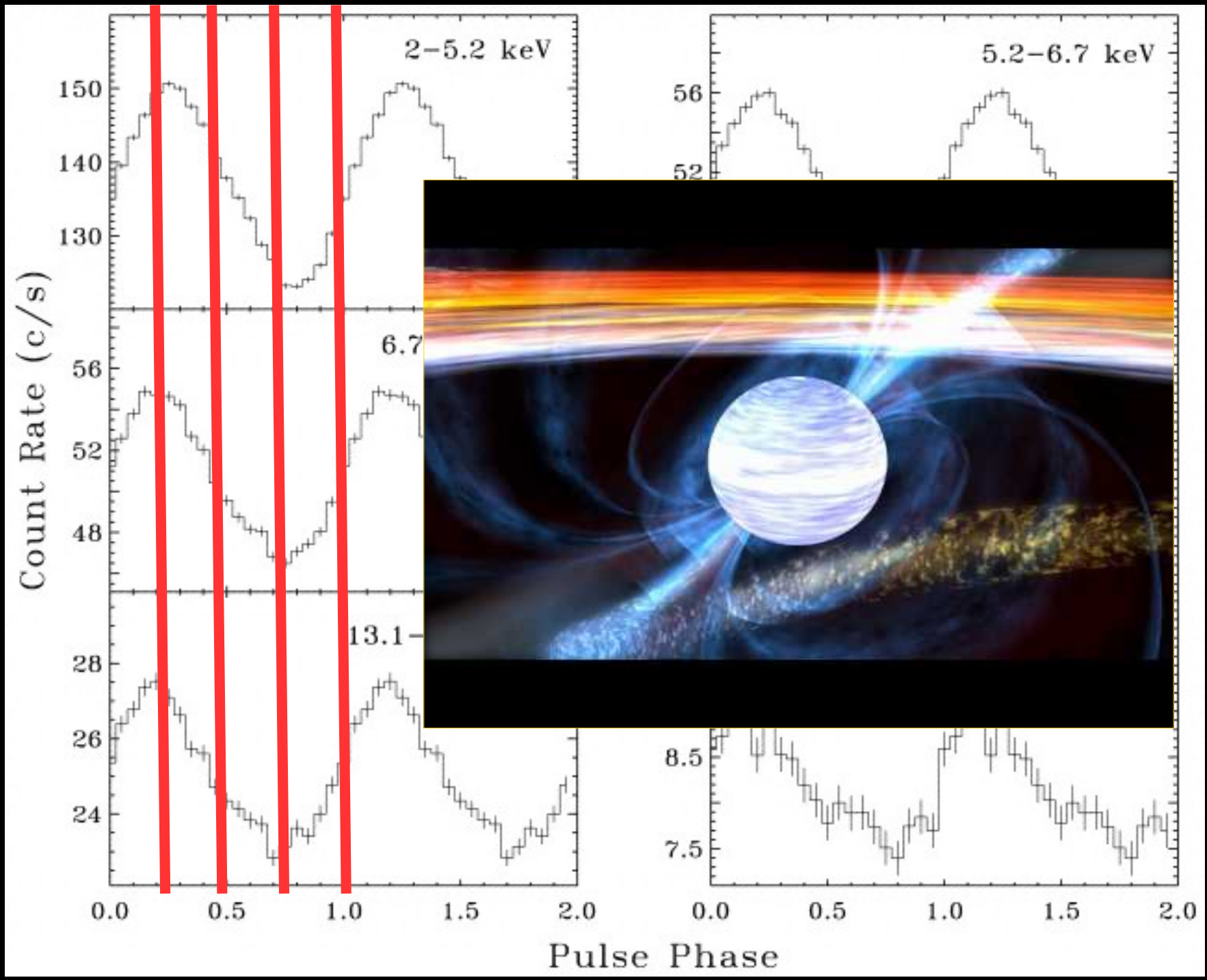

POWER
150
100
50
0
0
500
1000
1500
FREQUENCY (Hz)

Dynamical Power spectrum --> Gives the orbital period!!

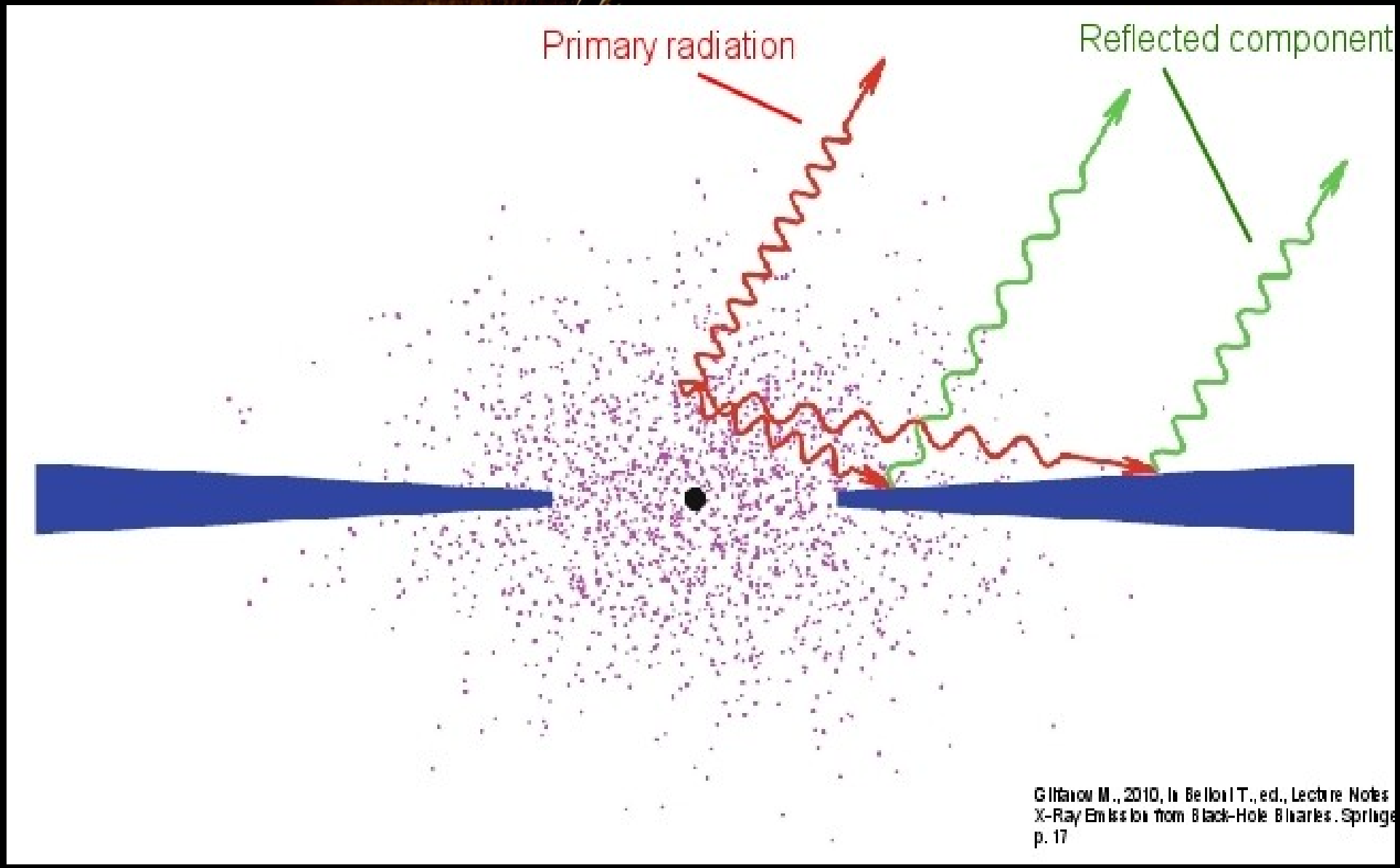




2–5.2
5.2–6.7 keV
6.7–8.9 keV
8.9–13.1 keV
13.1–19.7 keV
19.7–29.9 keV
Count Rate (c/s)
Pulse Phase
150
140
130
48
56
52
48
56
52
48
28
26
24
9.5
8.5
7.5
0.0
0.5
1.0
1.5
2.0


2–5.2 keV
5.2–6.7 keV
6.7
13.1
Count Rate (c/s)
Pulse Phase
150
140
130
56
52
48
28
26
24
8.5
7.5
0.0
0.5
1.0
1.5
2.0

Phase / Time Lags

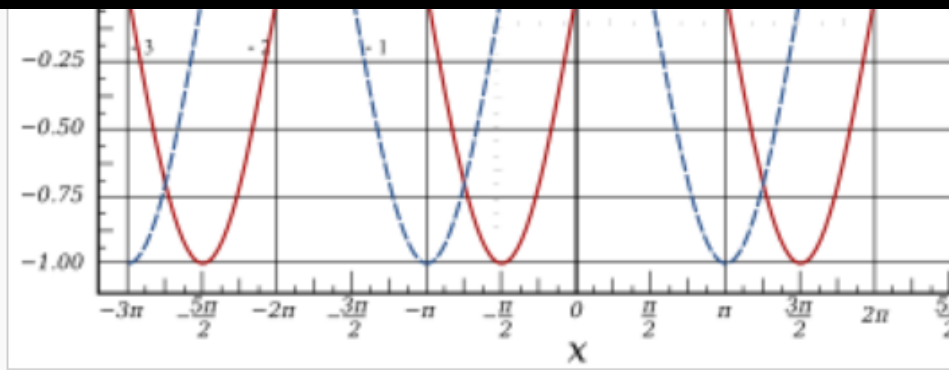


Phase ... Phase ... Phase

$$y(t) = A\sin(2\pi f t + \varphi) = A\sin(\omega t + \varphi)$$

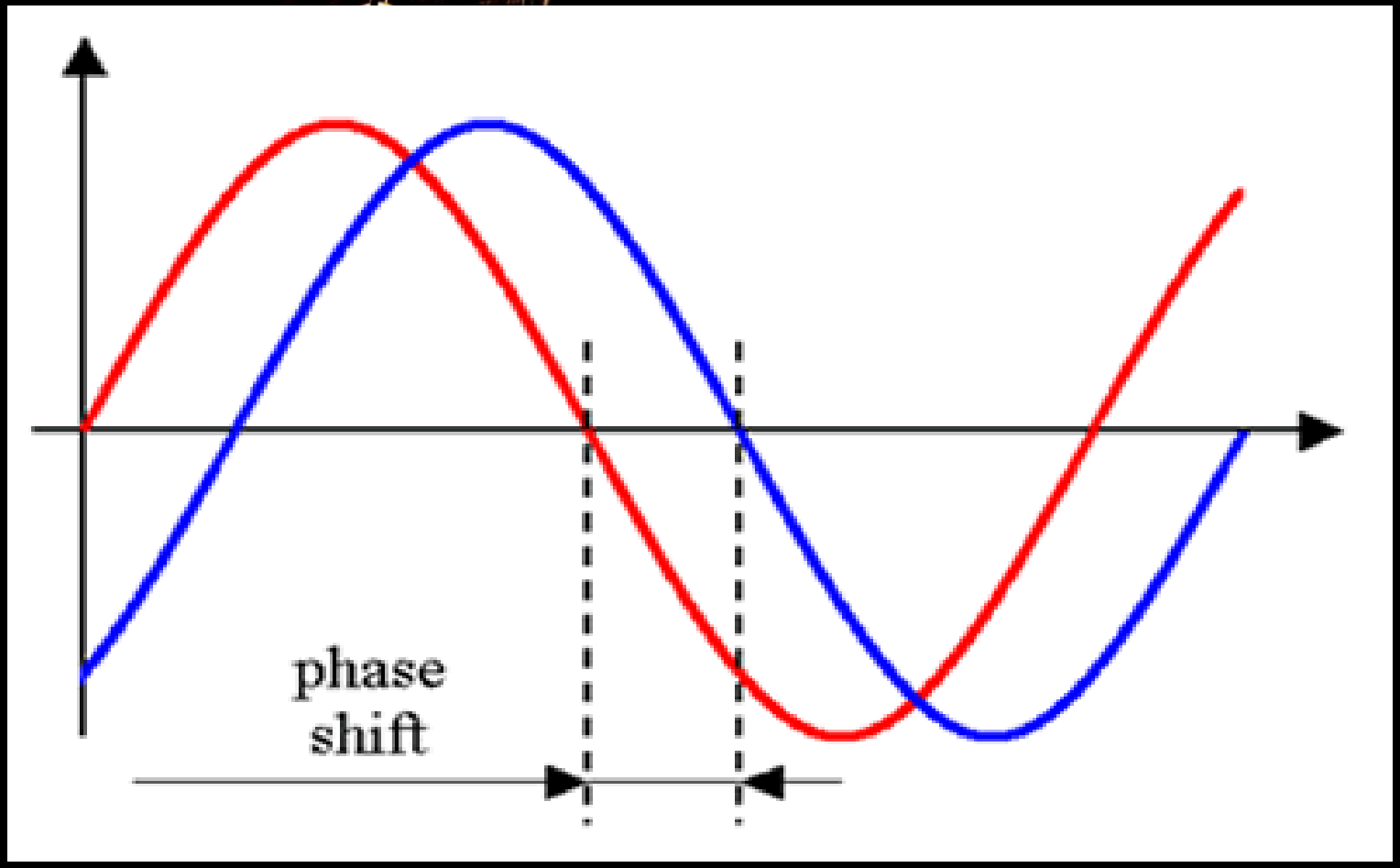
where:

- *A*, the *amplitude*, is the peak deviation of the function from zero.
- *f*, the *ordinary frequency*, is the *number* of oscillations (cycles) that occur each second of time.
- $\omega = 2\pi f$, the *angular frequency*, is the rate of change of the function argument in units of radians per second
- φ, the *phase*, specifies (in radians) where in its cycle the oscillation is at $t = 0$.
  - When φ is non-zero, the entire waveform appears to be shifted in time by the amount φ/ω seconds. A negative value represents a delay, and a positive value represents an advance.

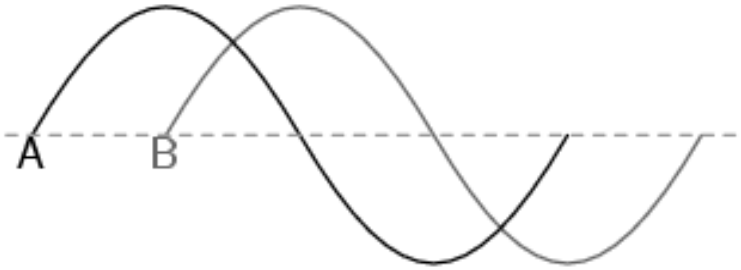


The graphs of the sine and cosine functions are sinusoids of different phases.

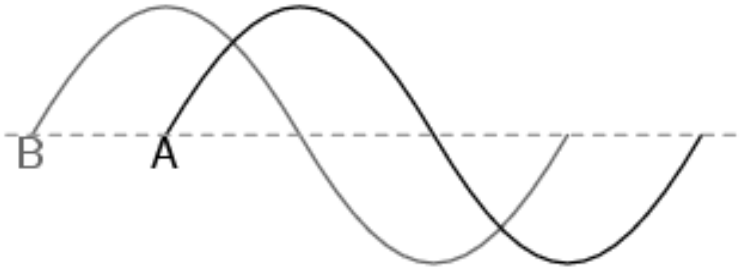
Phase ... Phase ... Phase



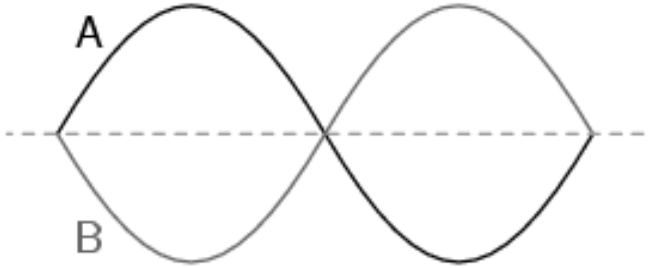
Phase / Time Lags



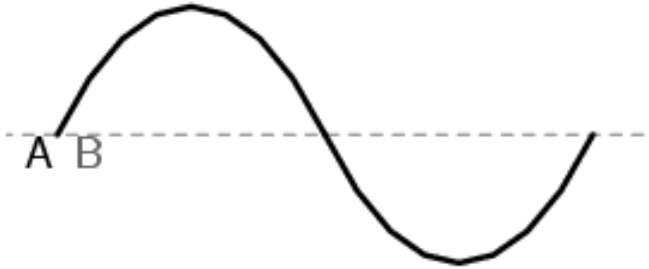
Phase shift = 90 degrees
A is ahead of B
(A "leads" B)



Phase shift = 90 degrees
B is ahead of A
(B "leads" A)

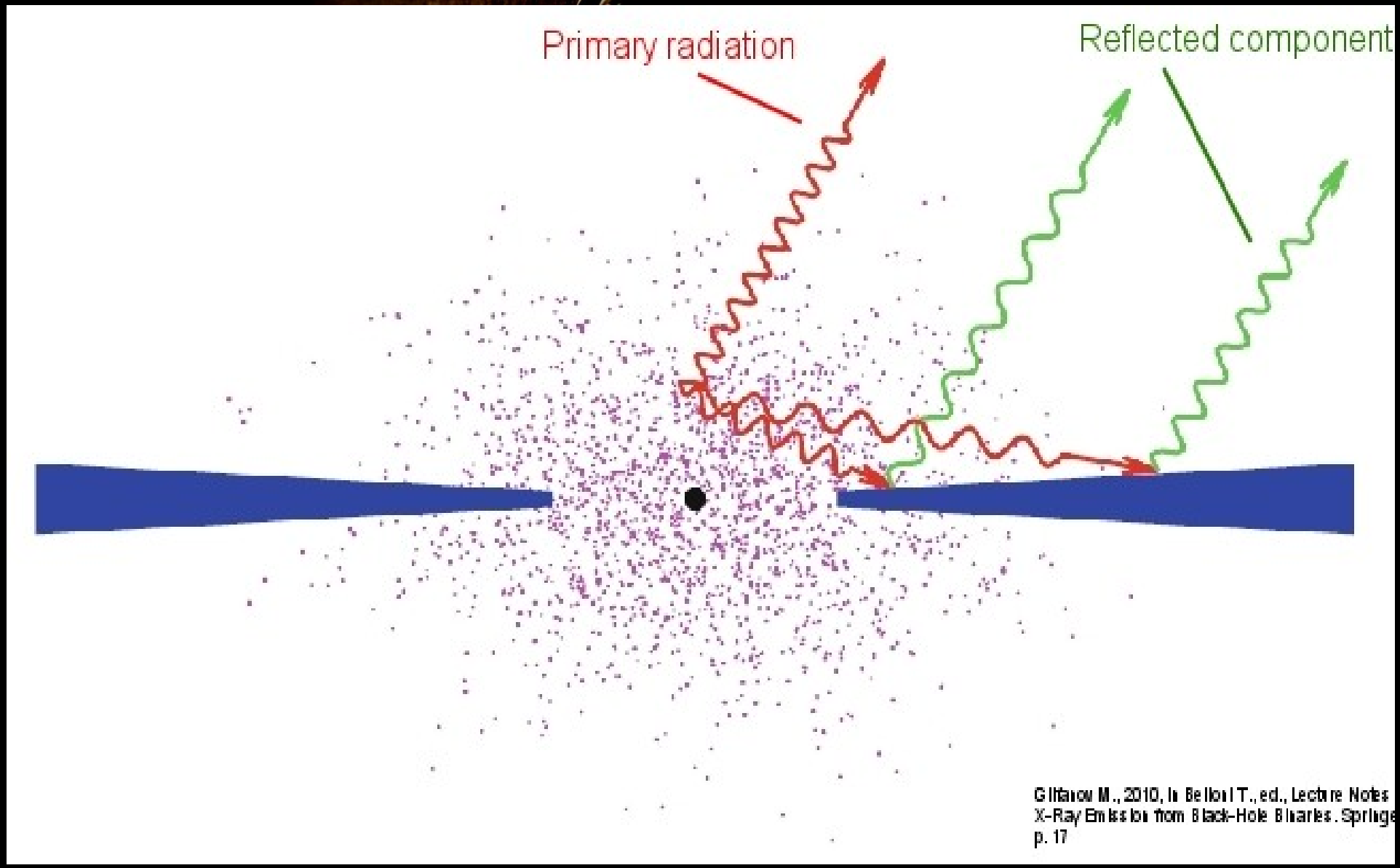


Phase shift = 180 degrees
A and B waveforms are
mirror-images of each other



Phase shift = 0 degrees
A and B waveforms are
in perfect step with each other

Phase / Time Lags



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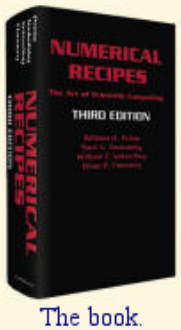

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