常用软件和工具

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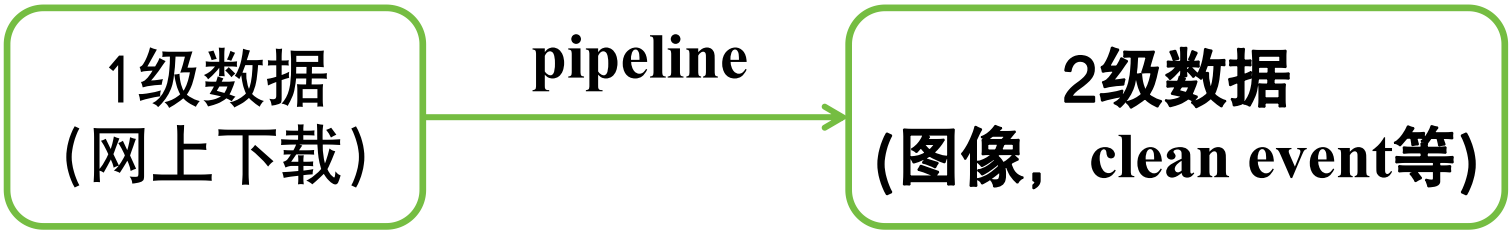


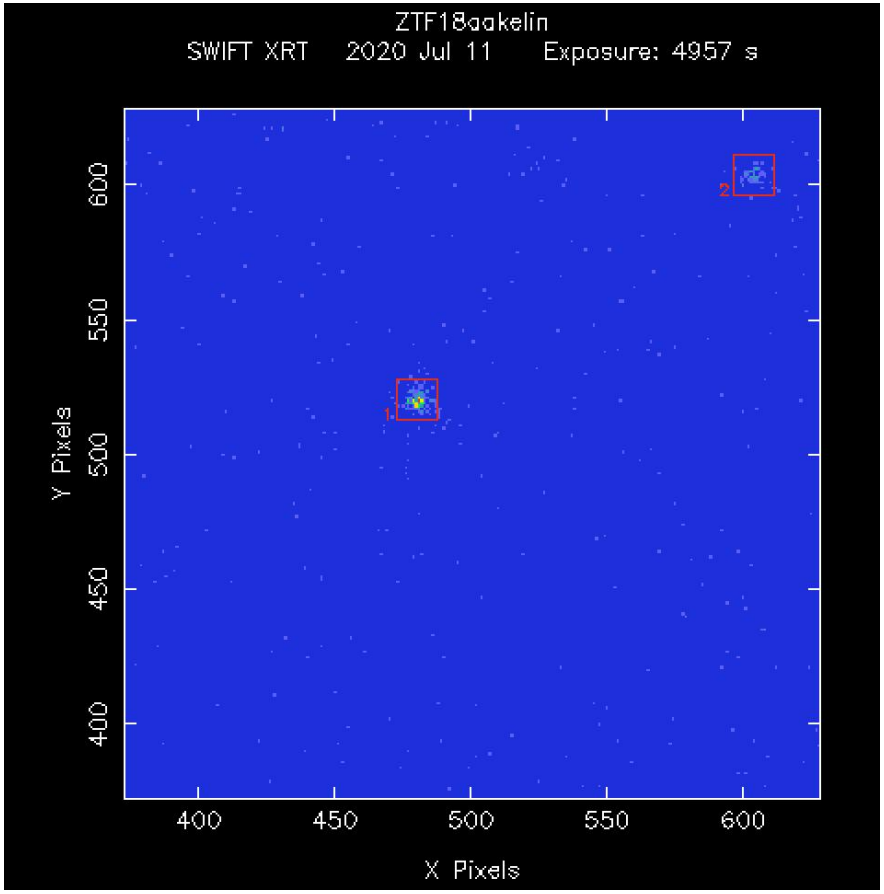
pipeline

XMM-Newton	epproc
Chandra	chandra_repro
NuSTAR	nupipeline
Swift/XRT	xrtpipeline
EP/FXT	fxtchain

ximage

1.用于源探测

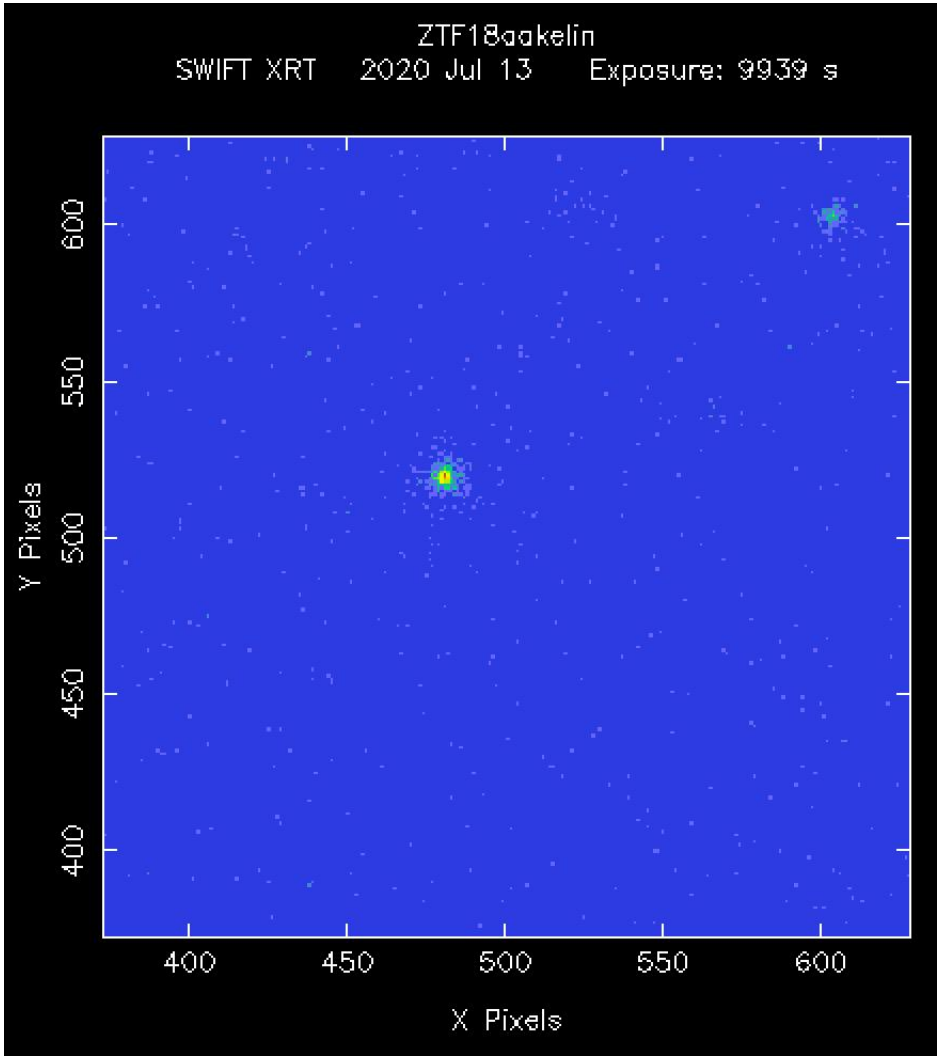
```
(base)  zwj@M1MacBookPro  ~/itest/00013608001/xrt/event  ximage
**************************************************************
*                          Welcome to XIMAGE
**************************************************************

                                                    Type "he


                                          VERSION 4.5.1  15:30:25


 No of detectors read in:   34
[XIMAGE> read sw00013608001xpcw3po_cl.evt
 Telescope SWIFT XRT
 Image size = 256 x 256 pixels
 Image rebin = 1.000
 Image center = 500.5, 500.5
 Using gti for exposure 4956.93209922 s
 Reading an events file
 File contains       1589 events
 Accepted: 529 Rejected: 1060
  Image level, min = 0.0000000 max = 13.000000
 Copied MAP1 to MAP9
[XIMAGE> display
 Plotting image
  Min =    0.00000000      Max =     13.0000000
[XIMAGE> detect/snr=5
#   count/s    err         pixel      Vig  RA(2000)   Dec(2000)   Err  H-Box
                          x     y     corr                        rad  (sec)
 1 4.71E-02+/-3.6E-03   480.5   520.2 1.00 13 53 54.5 +53 59 51.8  -1     18
 2 1.60E-02+/-2.1E-03   604.1   603.4 1.07 13 53 21.4 +54 03 07.8  -1     18
```



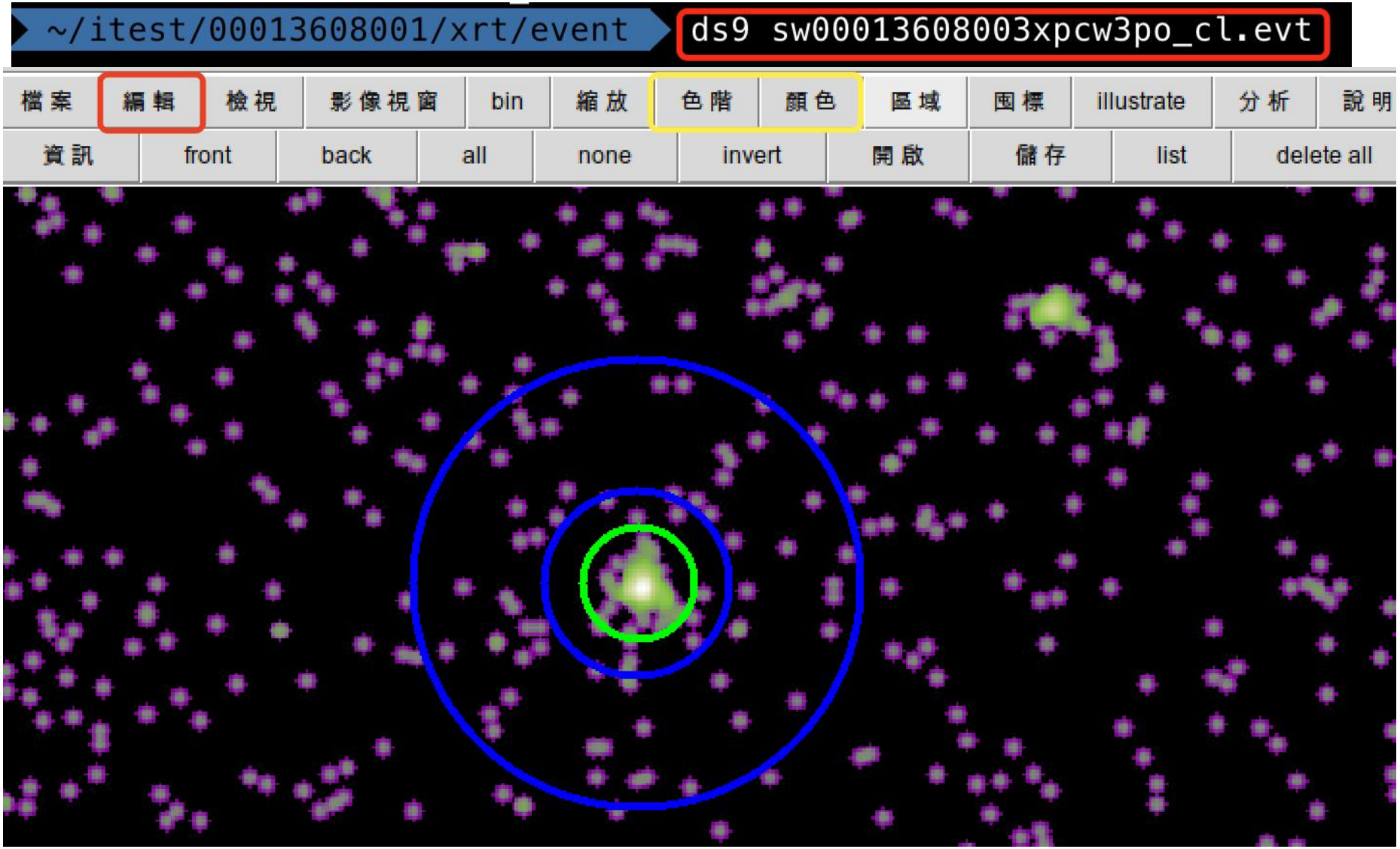
ximage

2.用于叠加图像

```
(base)  zwj@M1MacBookPro  ~/itest/00013608001/xrt/event  ximage
**************************************************************
*                          Welcome to XIMAGE
**************************************************************

                                                    Type "he


                                          VERSION 4.5.1  15:49:49

 No of detectors read in:   34
[XIMAGE> read sw00013608001xpcw3po_cl.evt
 Telescope SWIFT XRT
 Image size = 256 x 256 pixels
 Image rebin = 1.000
 Image center = 500.5, 500.5
 Using gti for exposure 4956.93209922 s
 Reading an events file
 File contains       1589 events
 Accepted: 529 Rejected: 1060
  Image level, min = 0.0000000 max = 13.000000
 Copied MAP1 to MAP9
[XIMAGE> read sw00013608003xpcw3po_cl.evt
 Telescope SWIFT XRT
 Image size = 256 x 256 pixels
 Image rebin = 1.000
 Image center = 500.5, 500.5
 Using gti for exposure 4982.00509977 s
 Reading an events file
 File contains       1745 events
 Accepted: 631 Rejected: 1114
  Image level, min = 0.0000000 max = 17.000000
[XIMAGE> sum
 Processing MAP1 image
 Freed TMPMAP1
[XIMAGE> display
```



DS9



保存源区域文件src.reg，背景区域文件bkg.reg

xselect (常规光谱抽取)

https://heasarc.gsfc.nasa.gov/FTP/software/lheasoft/release/doc/xselect/Xselect_2.5.pdf

光谱的4个文件：src.pha，bkg.pha，src.arf，src.rmf

终端输入xselect后，导入需要抽取光谱的clean event文件：

- **filter region src.reg**
- **extract spectrum**
- **save spectrum src.pha**
- **clear region**
- **filter region bkg.reg**
- **extract spectrum**
- **save spectrum bkg.pha**

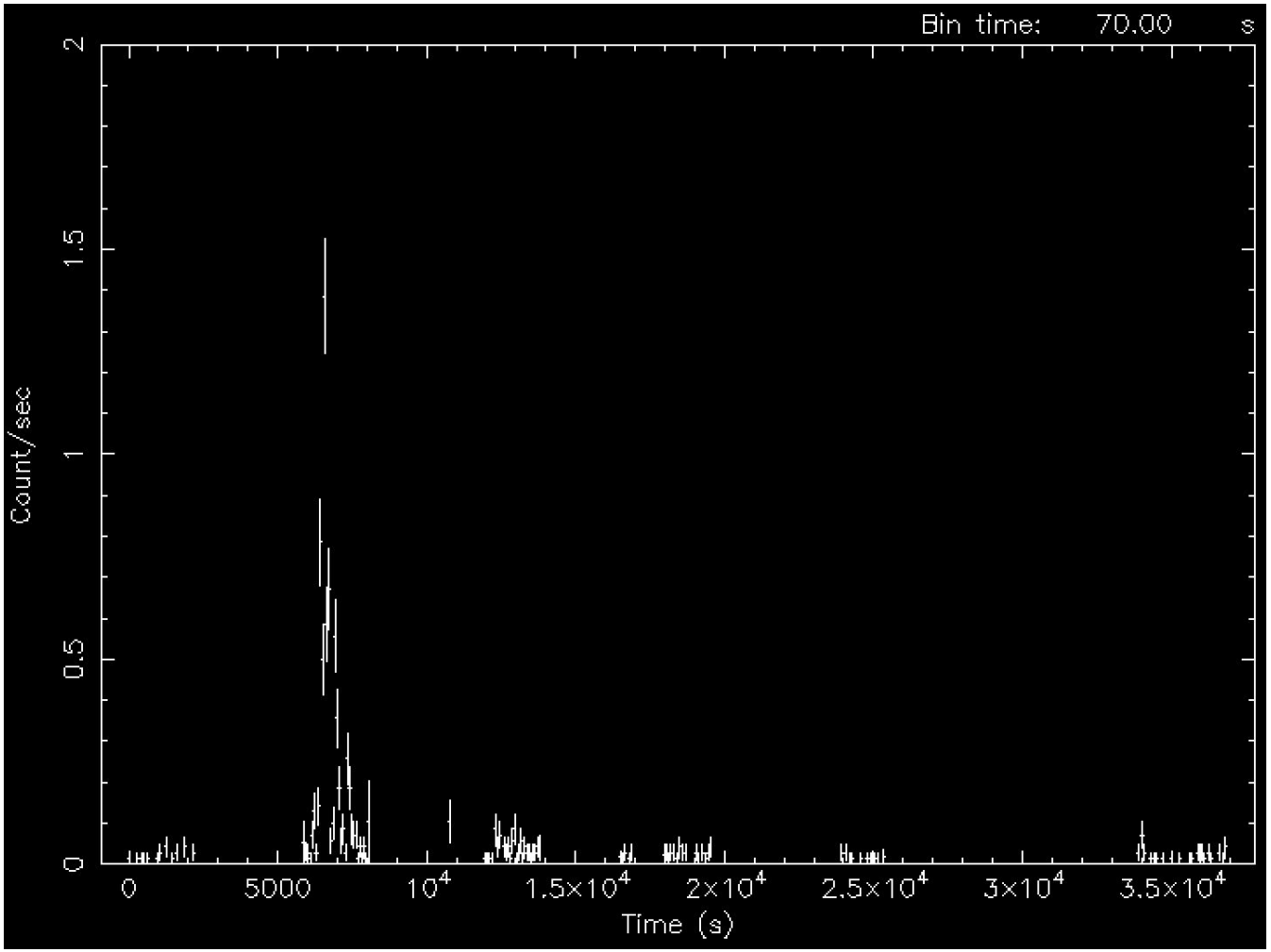
xrtmkarf

终端输入xrtmkarf

- **Name of the input exposure file: ***ex.img**
- **Name of the input PHA FITS file: src.pha**
- **Apply PSF correction: yes**
- **Name of the output ARF FITS file: src.arf**
- **Source X coordinate: -1**
- **Source Y coordinate: -1**

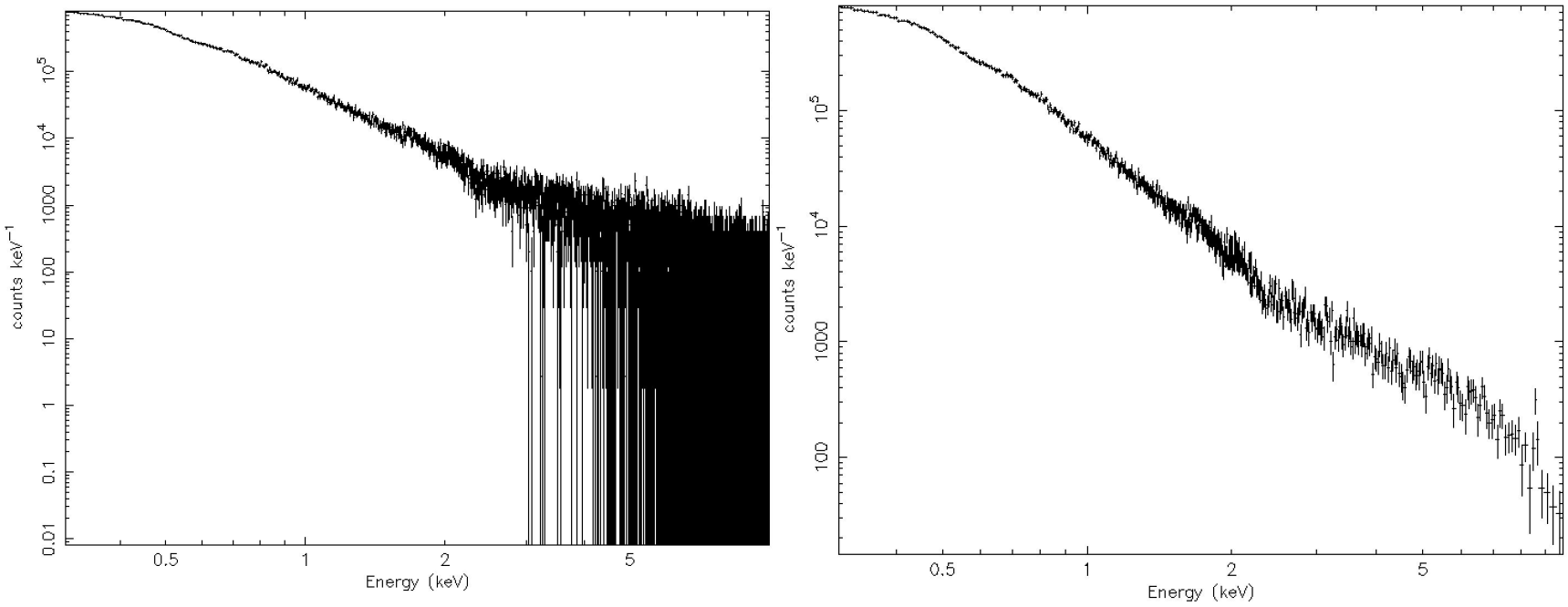
src.rmf从CALDB标准响应矩阵文件中调用

xselect (特殊光谱抽取)



- **filter time file gti.txt**

grppha



- Please enter PHA filename: src.pha
- Please enter output filename: 20_src.pha
- group min 20
- chkey backfile bkg.pha
- chkey ancrfile src.arf
- chkey respfile src.rmf
- exit

xspec

https://heasarc.gsfc.nasa.gov/docs/xanadu/xspec/XspecManual.pdf

Xspec

An X-Ray Spectral Fitting Package

Users' Guide for version 12.15.0

Keith Arnaud, Craig Gordon, Ben Dorman & Kristin Rutkowski

HEASARC
Astrophysics Science Division
NASA/GSFC
Greenbelt, MD 20771

March 2025

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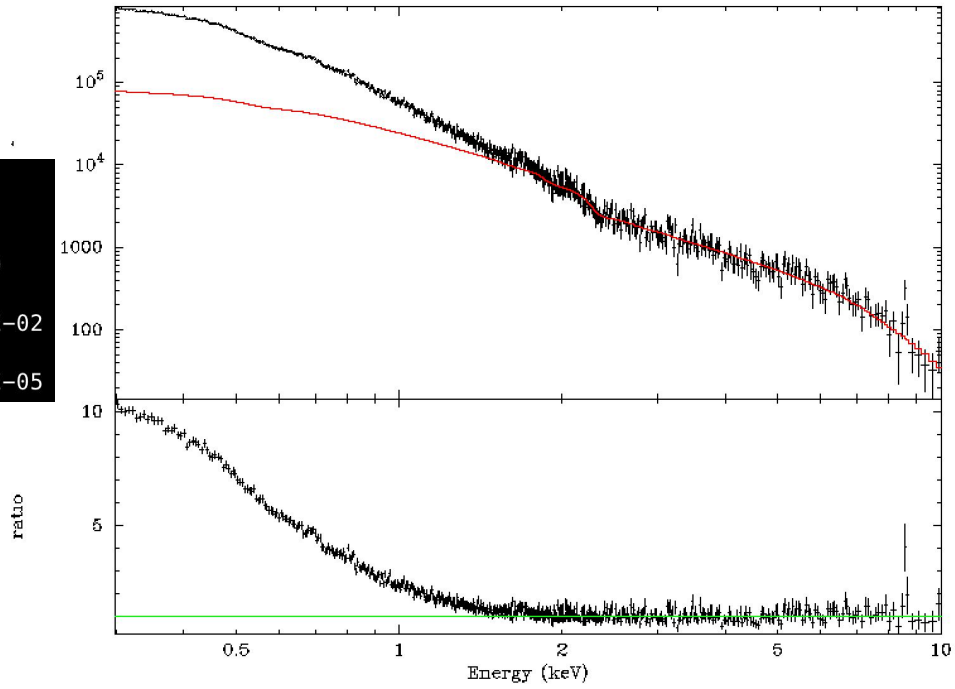
4. Walks through XSPEC

```
%xspec

            XSPEC version: 12.12.1
        Build Date/Time: Mon Feb  7 15:09:57 2022

XSPEC12>data s54405.pha

1 spectrum  in use

Spectral Data File: s54405.pha  Spectrum 1
Net count rate (cts/s) for Spectrum:1  3.783e+00 +/- 1.367e-01
 Assigned to Data Group 1 and Plot Group 1
  Noticed Channels:  1-125
  Telescope: EXOSAT Instrument: ME  Channel Type: PHA
  Exposure Time: 2.358e+04 sec
 Using fit statistic: chi
 Using Response (RMF) File            s54405.rsp for Source 1
```

xspec

示例1： model wabs*zwabs*zpower

Model par	Model comp	Component	Parameter	Unit	Value	
1	1	wabs	nH	10^22	1.50000E-02	frozen
2	2	zwabs	nH	10^22	7.98245E-06	+/- 0.291690
3	2	zwabs	Redshift		4.20000E-02	frozen
4	3	zpowerlw	PhoIndex		2.21537	+/- 9.70485E-02
5	3	zpowerlw	Redshift		4.20000E-02	frozen
6	3	zpowerlw	norm		5.05728E-04	+/- 8.19039E-05



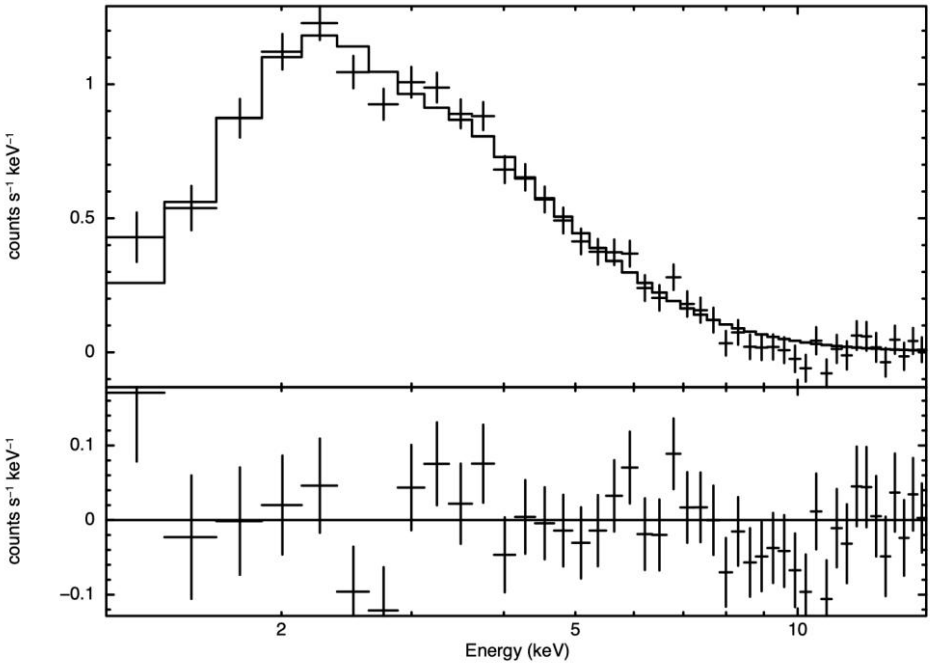

```
Fit statistic  : Chi-Squared                2309.40     using 557 bins.

Test statistic : Chi-Squared                2309.40     using 557 bins.
 Null hypothesis probability of 1.33e-212 with 553 degrees of freedom
```

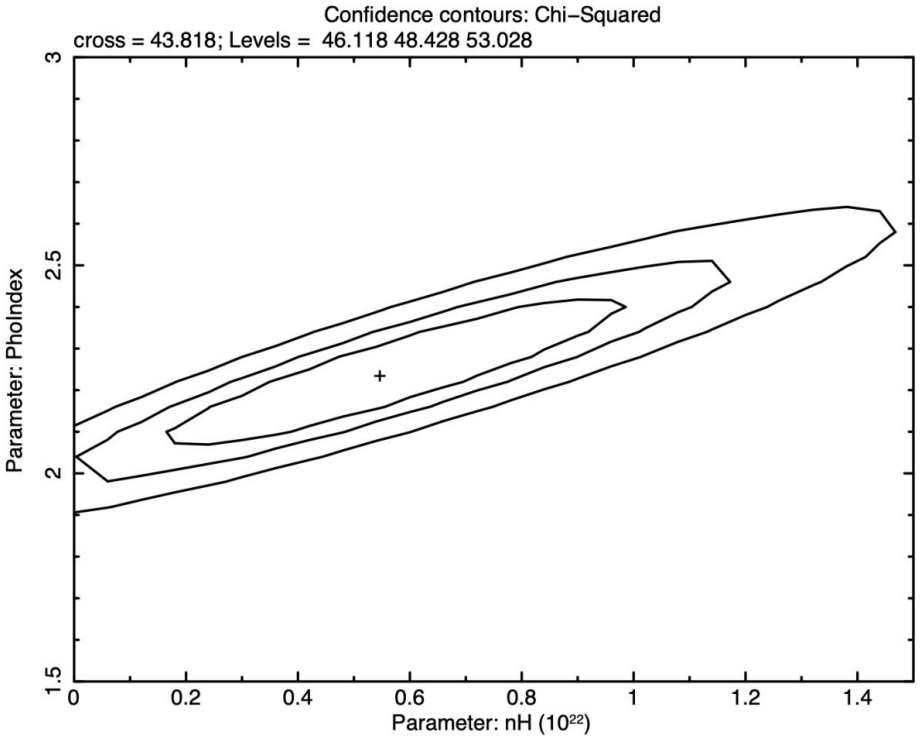
Chi-Squared statistic? Cash statistic?

xspec

示例2：图片选自Xspec手册Figure 4.4和4.5

steppar 1 0.0 1.5 25 2 1.5 3.0 25





问题：1. steppar命令后数字的含义?

2.等高线图每个圈代表什么意思?

3.等高线图不同的形状分布有什么含义?

xselect (光变曲线的抽取)

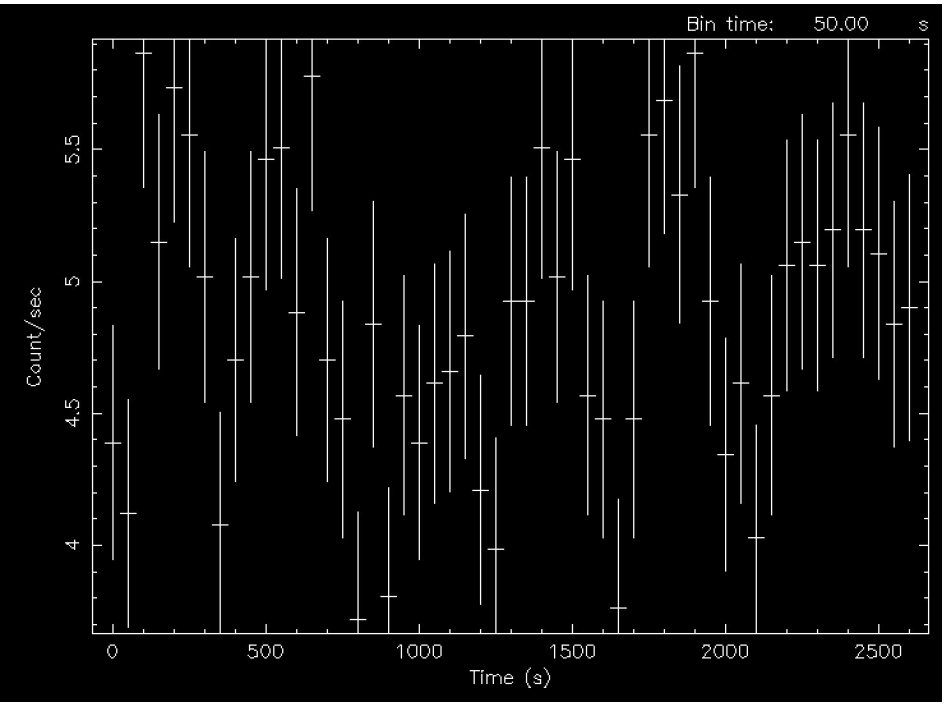
终端输入xselect后，导入需要抽取光变的clean event文件：

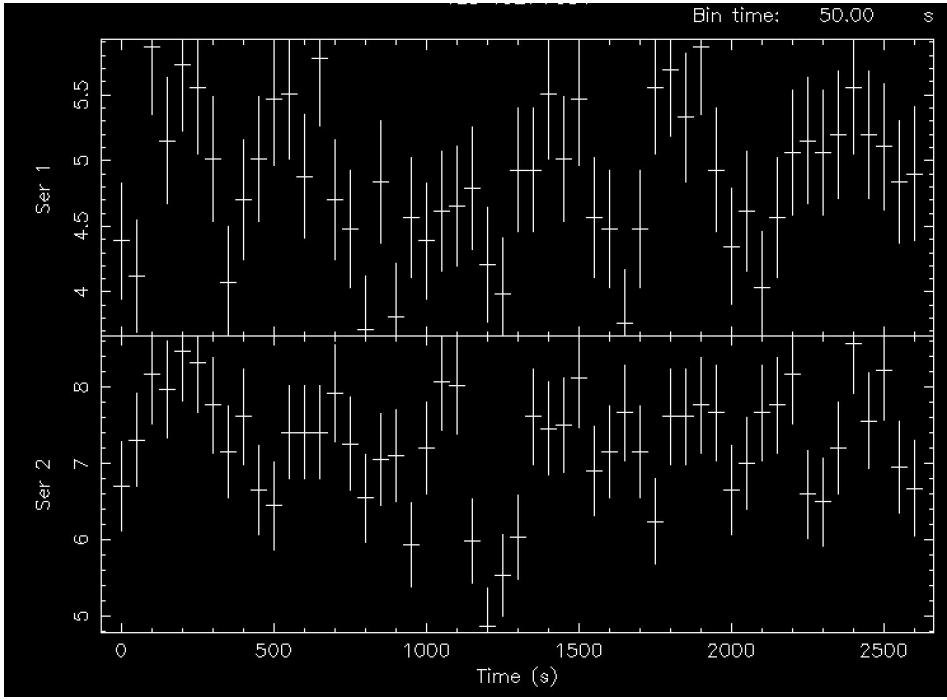
- **filter region src.reg**
- **extract curve**
- **save curve src.lc**
- **clear region**
- **filter region bkg.reg**
- **extract curve**
- **save curve bkg.lc**

lcurve

终端输入lcurve

- Number of time series for this task[1]

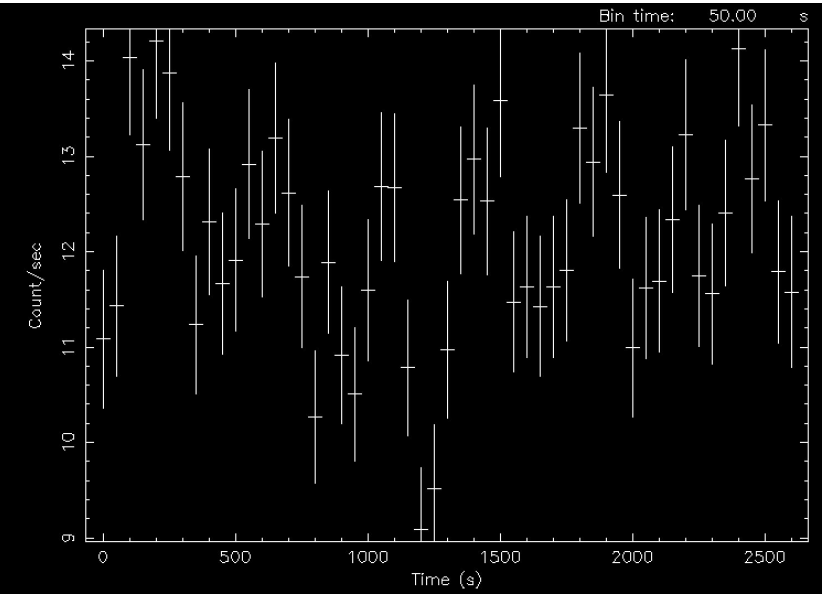




lcmath

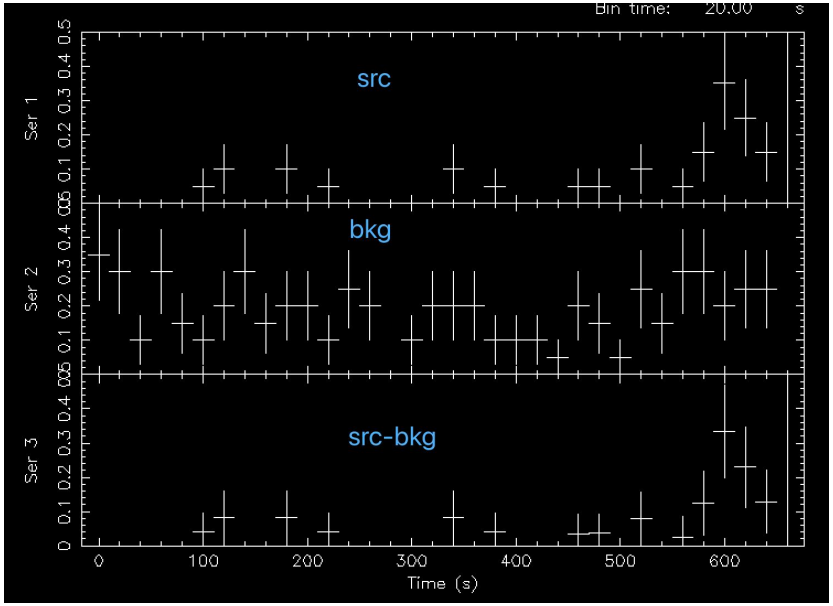
功能1：光变曲线的叠加

- Name of input FITS file: 1.lc
- Name of background FITS file: 2.lc
- Name of output FITS file: add.lc
- Scaling factor for input: 1
- Scaling factor for background: 1
- Add instead of subract? yes



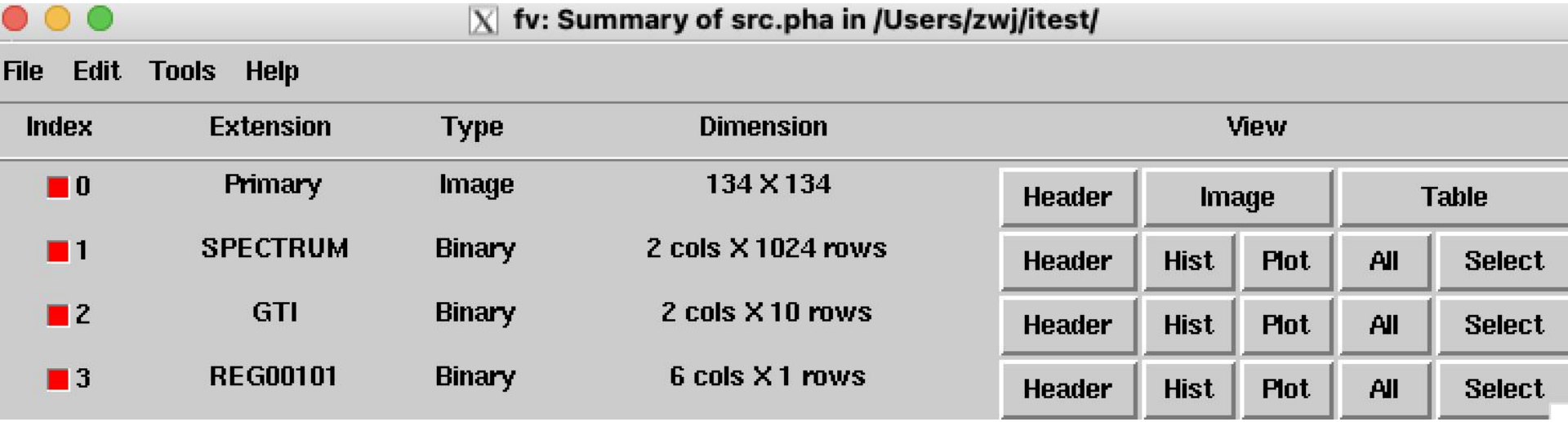
功能2：背景光变的扣除

- Name of input FITS file: src.lc
- Name of background FITS file: bkg.lc
- Name of output FITS file: sub.lc
- Scaling factor for input: 1
- Scaling factor for background: 0.1
- Add instead of subract? no

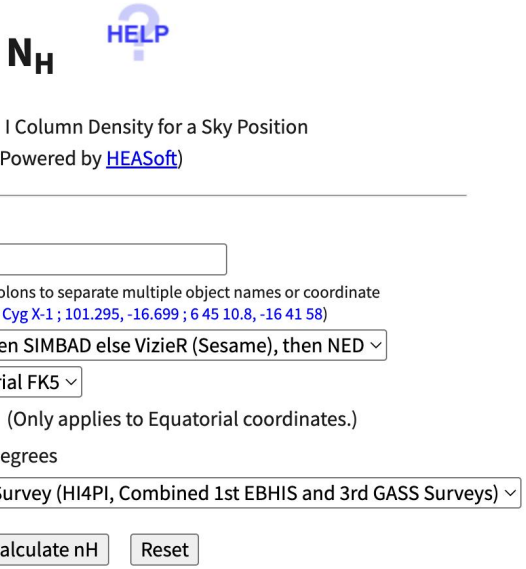


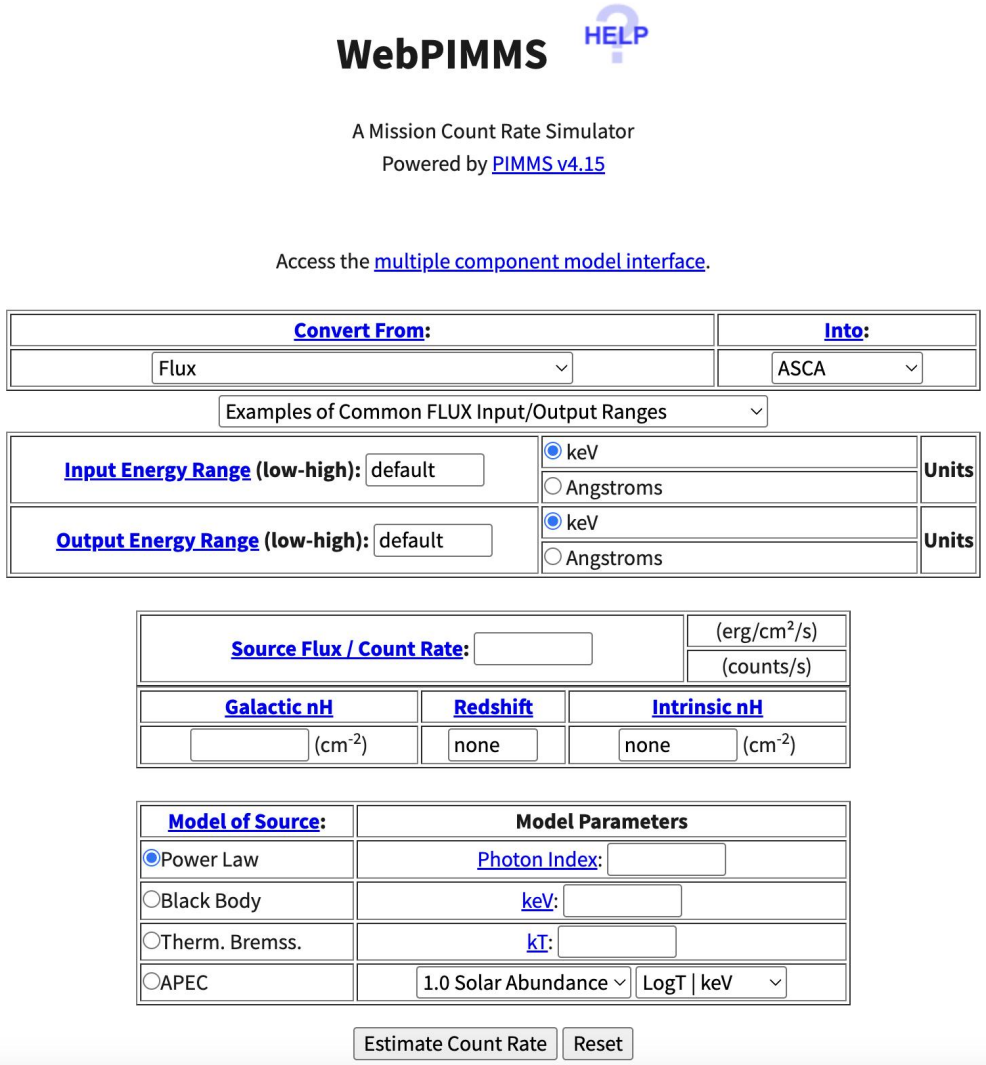
fv

终端输入fv src.pha



nH Calculator and WebPIMMS





https://heasarc.gsfc.nasa.gov/cgi-bin/Tools/w3nh/w3nh.pl

https://heasarc.gsfc.nasa.gov/cgi-bin/Tools/w3pimms/w3pimms.pl

总结

1. 展示的仅为部分软件和工具的最简单应用，仅供参考

2. 软件和工具的深刻理解来自熟能生巧

Day 2：X 射线数据处理培训讲座		
14:00-14:20	X 射线能谱处理和分析	程华清
14:20-14:40	X 射线时变分析	张文达

nature astronomy

Article

https://doi.org/10.1038/s41550-025-02571-1

A fast X-ray transient from a weak relativistic jet associated with a type Ic-BL supernova

Sun et al. 2025

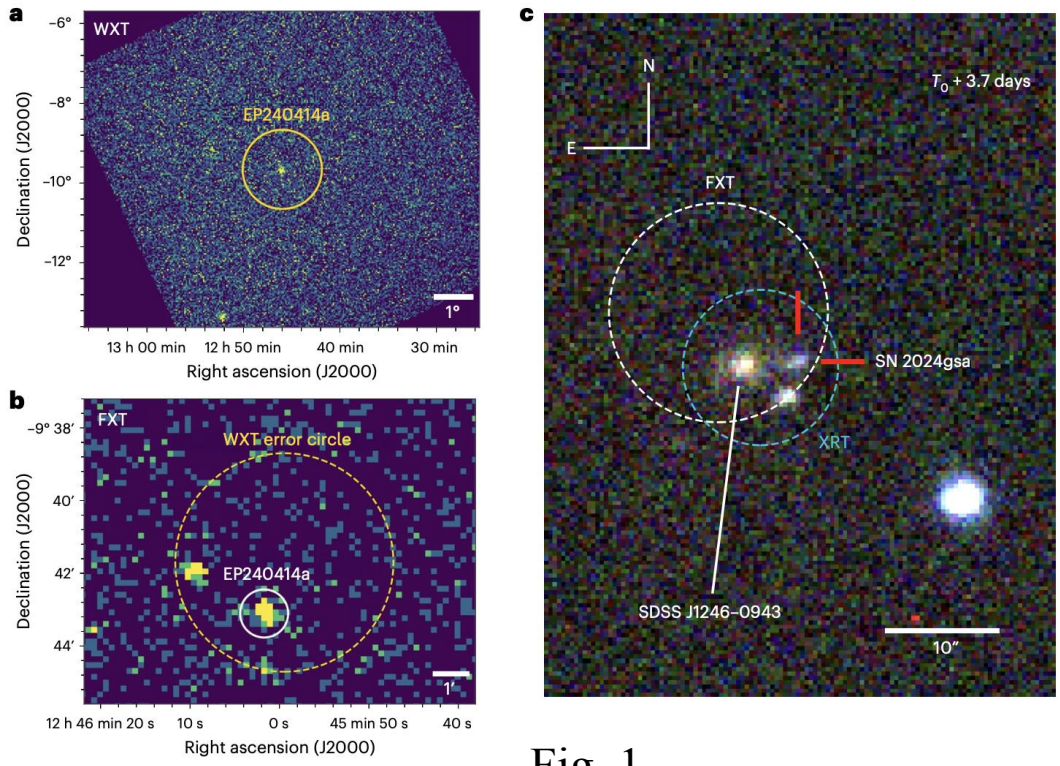


Fig. 1

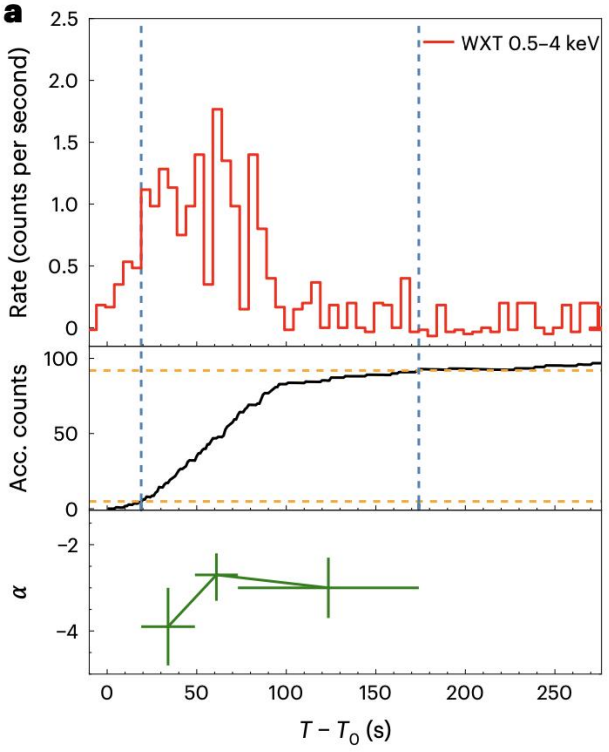


Fig. 2

LETTER

https://doi.org/10.1038/s41586-019-1556-x

Nine-hour X-ray quasi-periodic eruptions from a low-mass black hole galactic nucleus

G. Miniutti[1]*, R. D. Saxton[2], M. Giustini[1], K. D. Alexander[3,4], R. P. Fender[5,6], I. Heywood[5,7,8], I. Monageng[9], M. Coriat[10], A. K. Tzioumis[11], A. M. Read[12], C. Knigge[13], P. Gandhi[13], M. L. Pretorius[9] & B. Agís-González[14]