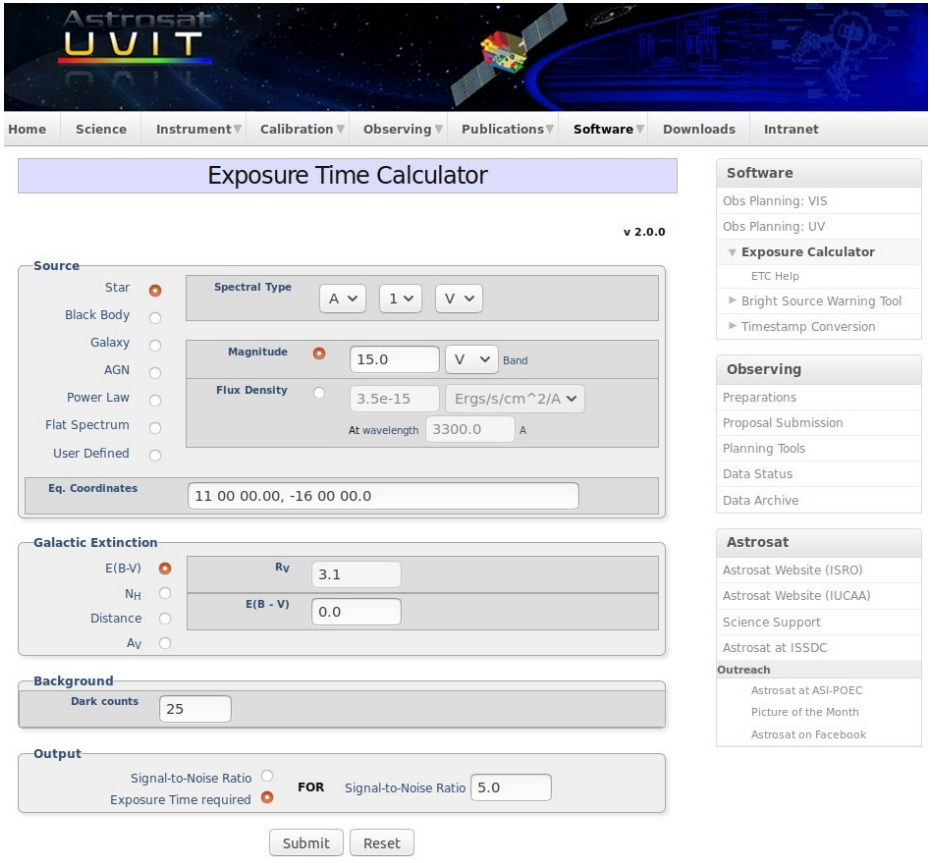
AstroSat Proposal Preparation

Md Shah Alam

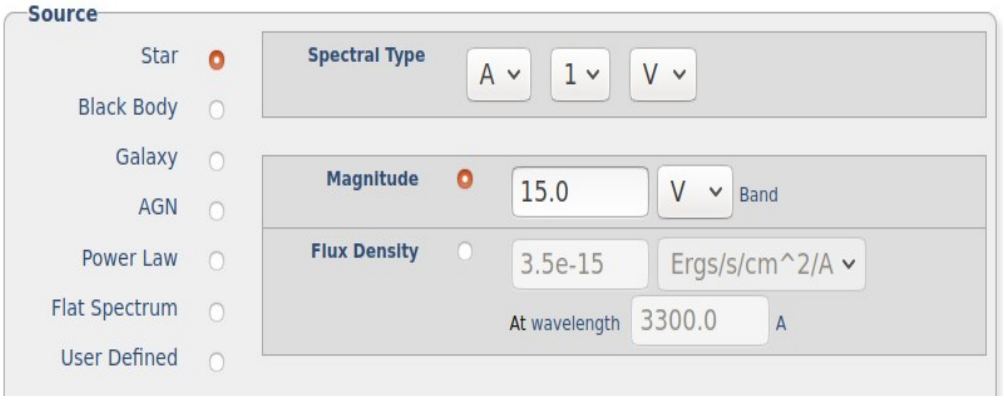
UVIT exposure time calculator



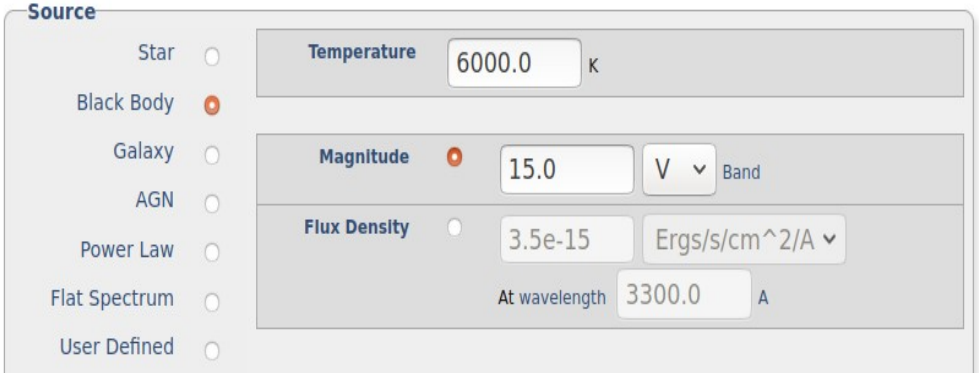
- Source Type: generate spectrum
- Magnitude/Flux Density: scaling
- Source coordinate
- Galactic extinction
- Output

Link: https://uvit.iiap.res.in/Software/etc

Parameter: Source Type



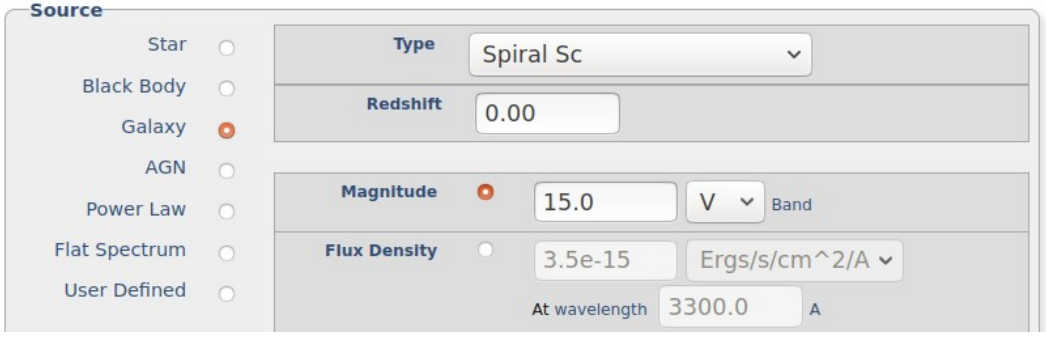
Star



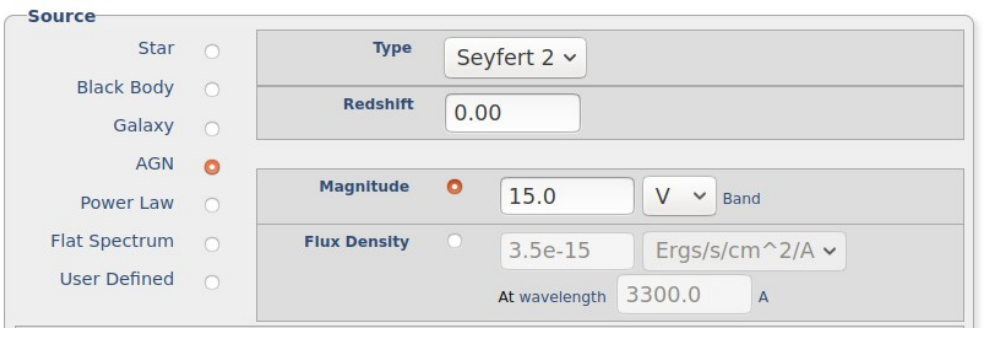
Black Body

- Temperature of a blackbody decides the shape of its spectrum.
- Allowed Range: 0.0K to 10^8K

Parameter: Source Type



Galaxy

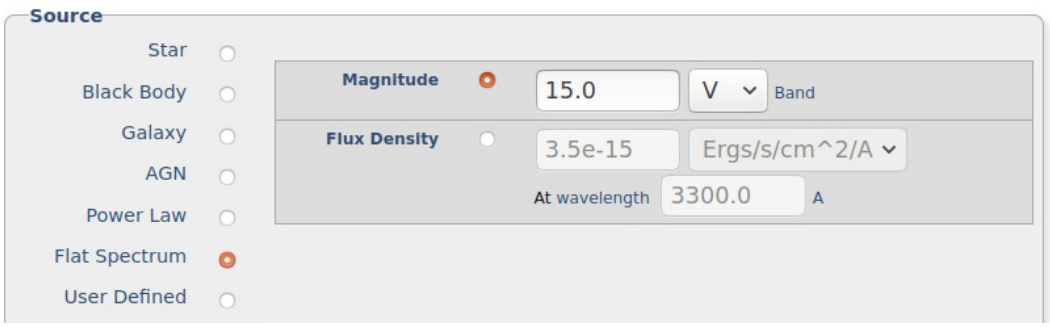


AGN

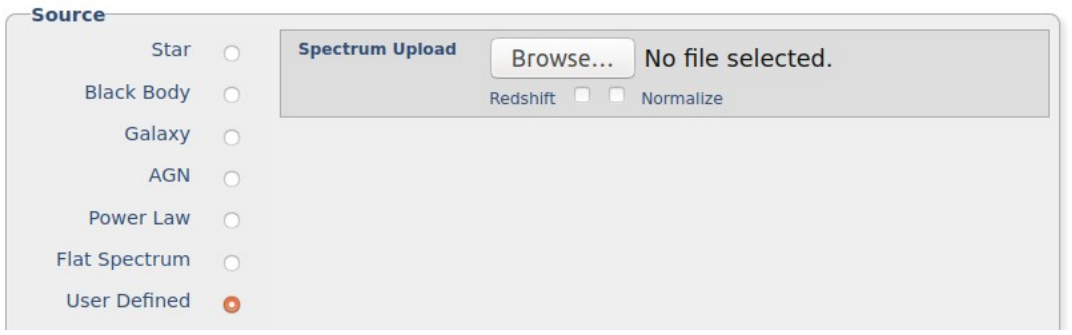
- It uses template spectra for different types of Galaxies and AGNs.
- AGN type linear: spectrum of M81
- AGN type Seyfert 2: spectrum of NGC 5548

Parameter: Source Type

Power Law



Flat Spectrum



User Defined Spectrum

```
# My source's spectrum
#
# Wavelength     Flux density
# (angstroms)    (ergs/s/cm^2/Å)
1370.10144043    3.97418026e-09
1441.79272461    5.91593765e-09
1502.95971680    9.01411200e-09
1569.54650879    1.03960225e-08
1642.30700684    1.38279651e-08
1722.14147949    1.42179048e-08
1810.13403320    1.73137944e-08
```

User Defined Valid Spectrum

Parameter: Source Coordinate

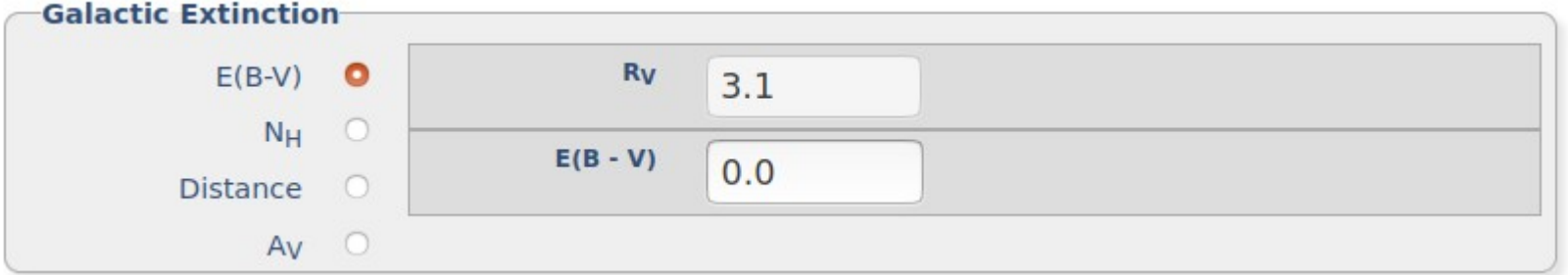
- Format: (RA, decl) = "hh mm ss.ss, +/-dd mm ss.ss"
- Name of the source can also be given
- warning in case source is too close to the galactic plane

Parameter: Galactic Extinction

- Galactic extinction: $R_v = A_v / (E(B-V))$

$$E(B-V) = A_B - A_v$$

- It can be estimated using inputs like E(B-V), NH, Distance and Av



Parameter: Background Counts

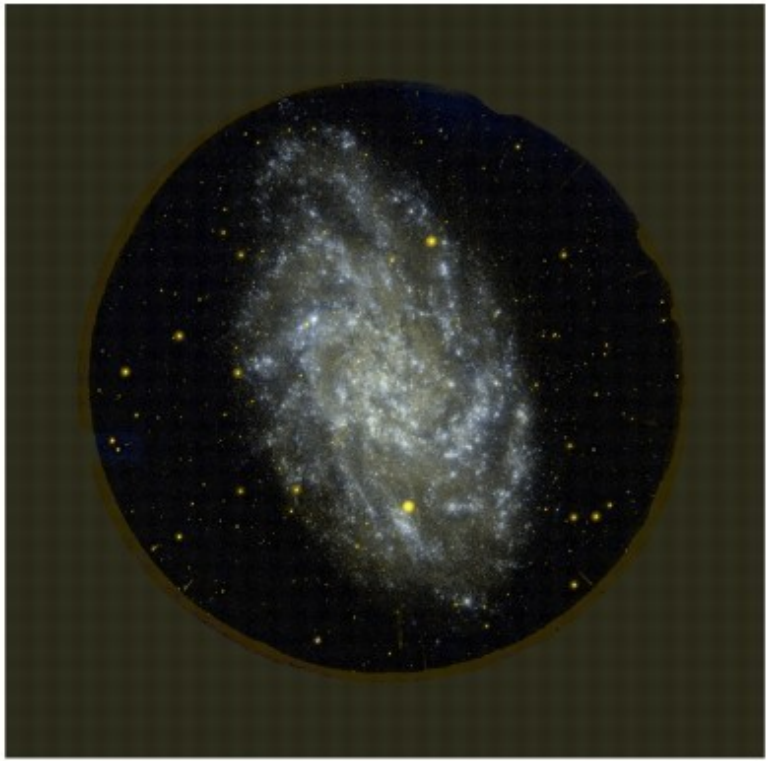
- The normal value ~ 25 counts per second which is detector noise,
- provide larger if user thinks that he needs to consider other external contribution.

Parameter: Output

- Signal to noise ratio or
- Exposure time

Example

- Source : Galaxy, M 33
- Type Sc
- Redshift = 0.000597
- V magnitude = 5.28
- Rv = 3.1
- Av = 0.114



Data and image taken from http://ned.ipac.caltech.edu/cgi-bin/nph-objsearch?objname=M33&img_stamp=YES&list_limit=9&extend=no

Output

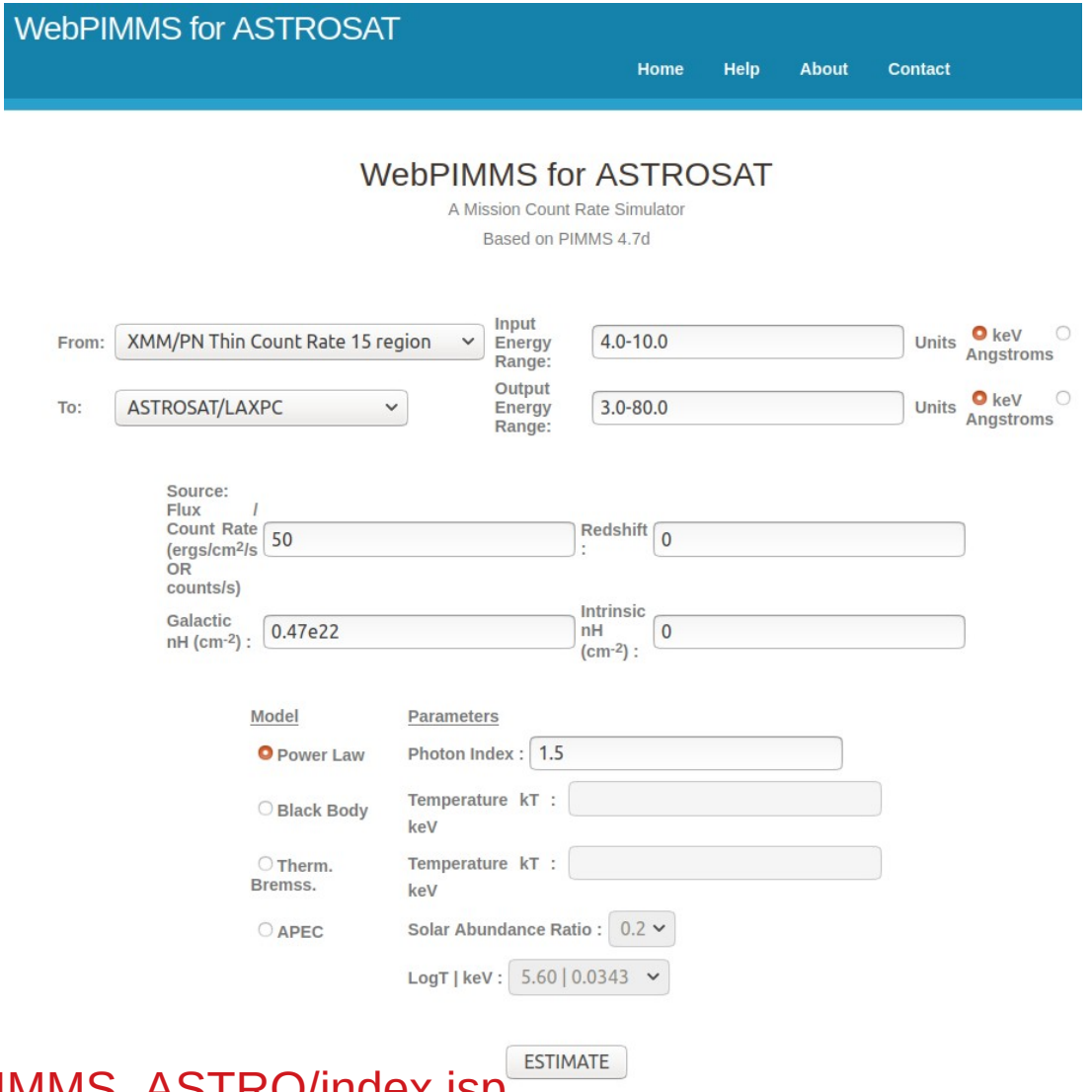
Galactic Latitude:	-30 deg. (Lower limit is 30 deg.)	
Filter	Source count rate (s^{-1})	Exposure Time (s)
FUV CaF2-1	357.1	28.00
FUV BaF2	303.6	33.00
FUV Sapphire	239.8	42.00
FUV Silica	97.86	102.0
FUV CaF2-2	315.3	32.00
NUV Silica	3722.4	2.69
NUV B15	78.70	127.0
NUV B13	1167.6	8.56
NUV B4	1471.1	6.80
NUV N2	334.0	30.00
VIS 3	$2.70 \times 10^{+04}$ Too Bright!	0.37
VIS 2	8161.4	1.23
VIS 1	6972.6	1.43
VIS ND1	623.9	16.00
VIS BK-7	$4.32 \times 10^{+04}$ Too Bright!	0.23

Note: Source Count Rate is over the instrument PSF, 1.8"

Download Output [TXT]

Return to User Inputs

- This tool is useful to get an approximate value of count rate with AstroSat instruments SXT, LAXPC, CZTI and SSM.
- One should have prior knowledge of some parameters with other instruments like XMM-Newton, RXTE, etc.



Link: http://astrosat-ssc.iucaa.in:8080/WebPIMMS_ASTRO/index.jsp

WebPIMMS output

WebPIMMS for ASTROSAT

Home Help About Contact

Web PIMMS for ASTROSAT - Result

INPUTS:

From	: xmm pn thin	
Instrument	: astrosat laxpc	
Input Energy	: 4.0-10.0	keV
Output Energy	: 3.0-80.0	keV
Source : Count Rate	: 50 counts/s	
Galactic nH	: 0.47e22 cm-2	
Redshift	: 0	
Intrinsic nH	: 0 cm-2	
Model	: Power Law	
Photon Index	: 1.5	

OUTPUTS:

* For power law model with photon index = 1.5000; NH = 4.700E+21
and 5.000E+01 cps in XMM PN THIN (4.000- 10.000keV)
%!% Pile-up corrected PATTERN=0-4 rate in 5 arcmin region assumed
(Internal model normalization = 1.895E-01)
* PIMMS predicts 2.581E+02 cps with ASTROSAT LAXPC20 (3.000- 80.000keV)
PIMMS >

Download the above output as a PDF file

Back

Simulation of energy spectrum using astrosat.sl

- To find the optimum exposure time
- Large exposure corresponds to less uncertainty in model parameters.
- Response files and background files are available on the website: http://astrosat-ssc.iucaa.in/?q=proposal_preparation
- Energy spectrum can be simulated using XSPEC using fakeit.
- ISIS code astrosat.sl also uses fakeit task.
- This code is available on ASSC proposal preparation web page.

XSPEC task: Fakeit

fakeit

simulate observations of theoretical models

Produce spectra with simulated data.

Syntax: **fakeit** [nowrite] [<file spec>...]

where <file spec> =:: [<file number>] <file name>[{ranges}]... is similar to the syntax used in the backgrnd, corfile, and response command. The fakeit command is used to create a number of spectrum files, where the current model is multiplied by the response curves and then added to a realization of any background. Statistical fluctuations can be included. The integration time and correction norm are requested for each file. The file names input as command line arguments are used as background. The number of faked spectra produced is the maximum of the number of spectra currently loaded and the number of file specifications in the command line arguments. The special case fakeit none makes one fake spectrum for each spectrum loaded (or one fake spectrum if there are none loaded). See the examples below for a clearer description.

If fakeit is immediately followed by the nowrite specifier, no actual output files will be generated. In this case the fake spectra will exist just for the duration of the Xspec session (or until they are unloaded).

If a faked spectrum is based on a currently loaded spectrum, then by default the background, response, correction file, and numerical information are taken from the currently-defined data, unless a background file is specified on the command line in which case it becomes the background. The fakeit none case prompts for the rmf and arf filenames and sets the default numerical data to 1.0, except the correction norm, which is set to zero. If the output file is type II then the exposure time and correction scale factor will be the same for all spectra in the file.

For each output file, the user will be prompted for an output file name. If a background file is in use then fakeit will also simulate a new background for each spectrum. Background files are given the same names as output spectrum files but with _bkg appended to the end of the stem.

The simulated spectra automatically become the current data files. The ignore status is completely reset.

Link: https://heasarc.gsfc.nasa.gov/xanadu/xspec/manual/node73.html

Installation

- Dependent software: ISIS

startup scripts

ISIS Installation Guide

John C. Houck
<houck@space.mit.edu>
2018 Apr 20

For more information about isis, see: http://space.mit.edu/cxc/isis/

Send bug reports, comments and suggestions to: isis-users@space.mit.edu

Overview

The easiest way to set up a new isis installation is to run an installation script that will automatically download and install isis and a few commonly used modules. This installation method is documented in Part I, Scripted Installation.

For those who prefer greater control and customization, full details of the isis installation process are documented in Part II, Manual Installation.

Once isis is installed, a number of optional components are available to support a variety of specialized tasks. For details, see Part III, Optional Components.

Link: https://space.mit.edu/asc/isis/install.html#XI

Loving ISIS - Confessions of a Former XSPEC User

Download the ISIS Startup Files and Example Data

Here is a gzipped, tar file that contains the following files:

```
./.isisrc
./.isisrc_conf
./.isisrc_data
./.isisrc_fitfun
./.isisrc_flux
./.isisrc_plots
```

These files are meant to be unpacked in your main directory. In the main `.isisrc` file, there is a `path` variable that needs to be edited to point to your main directory, so that the other `.isisrc_*` files will be loaded as well. *Important Note:* These files contain on only my own custom `s-lang` routines. You still need to download and install ISIS separately!

The data shown and analyzed on these pages is found here.

The script used to perform these analyses is found here.

A brief description of the custom ISIS functions found in the above `.isisrc` files is found here.

For links to more web pages with other useful ISIS modules and scripts, take a look at the ISIS Power Tools page.

Link: https://space.mit.edu/home/mnowak/isis_vs_xspec/download.html

Functioning of astrosat.sl

- Give the path of response and background files in the code astrosat.sl
- Define the model one wants to fit.
- Use function like astrosat_laxpc2_simulate_spec(exposure);
- It will simulate the energy spectrum for LAXPC2 and fit the energy spectrum using the above-defined model
- Here exposure can be varied
- We can easily find the optimum value of exposure.
- One can also follow the example given in my talk:
- http://astrosat-ssc.iucaa.in/images/isisi_session_shahalam.pdf

Tasks available

- astrosat_sxt_simulate_spec
- astrosat_laxpc1_simulate_spec
- astrosat_laxpc2_simulate_spec
- astrosat_laxpc3_simulate_spec
- astrosat_czti_simulate_spec
- astrosat_xray_simulate_spec
- astrosat_get_count_rate
- astrosat_multi_rebin_spec
- astrosat_sim

- astrosat_uvit_fuv_baf2_sim astrosat_uvit_fuv_caf21_sim
- astrosat_uvit_fuv_caf22_sim astrosat_uvit_fuv_saph_sim
- astrosat_uvit_fuv_sil_sim astrosat_uvit_fuv_sim
- astrosat_uvit_nuv_b13_sim astrosat_uvit_nuv_b15_sim
- astrosat_uvit_nuv_b4_sim astrosat_uvit_nuv_n2_sim
- astrosat_uvit_nuv_sil_sim astrosat_uvit_nuv_sim
- astrosat_uvit_sim astrosat_uvit_vis_bk7_sim
- astrosat_uvit_vis_nd1_sim astrosat_uvit_vis_sim
- astrosat_uvit_vis_vis1_sim astrosat_uvit_vis_vis2_sim
- astrosat_uvit_vis_vis3_sim

Some commands

- Invoke isis
- Load astrosat.sl:

  .load astrosat.sl
- Define the model:

fit_fun("wabs*(diskbb+gaussian+powerlaw)");

```
[shahalam@ASSC-S01 isis_code_test_17feb21]$ isis

Welcome to ISIS Version 1.6.2-47
Copyright (C) 1998-2020 Massachusetts Institute of Technology

         Isis web page: http://space.mit.edu/cxc/isis/
   Mailing list archive: http://space.mit.edu/cxc/isis/archive/
 Send questions to the mailing list: <isis-users@space.mit.edu>.
     For a summary of recent changes, type:  "help changes"
```

```
isis> .load astrosat.sl
Keyword not set: EXPOSURE
Warning: RMF matrix maps to detector channels outside EBOUNDS grid
Keyword not set: EXPOSURE
Keyword not set: EXPOSURE
Warning: RMF matrix maps to detector channels outside EBOUNDS grid
Keyword not set: EXPOSURE
Keyword not set: EXPOSURE
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Keyword not set: EXPOSURE
Keyword not set: EXPOSURE
isis>
```
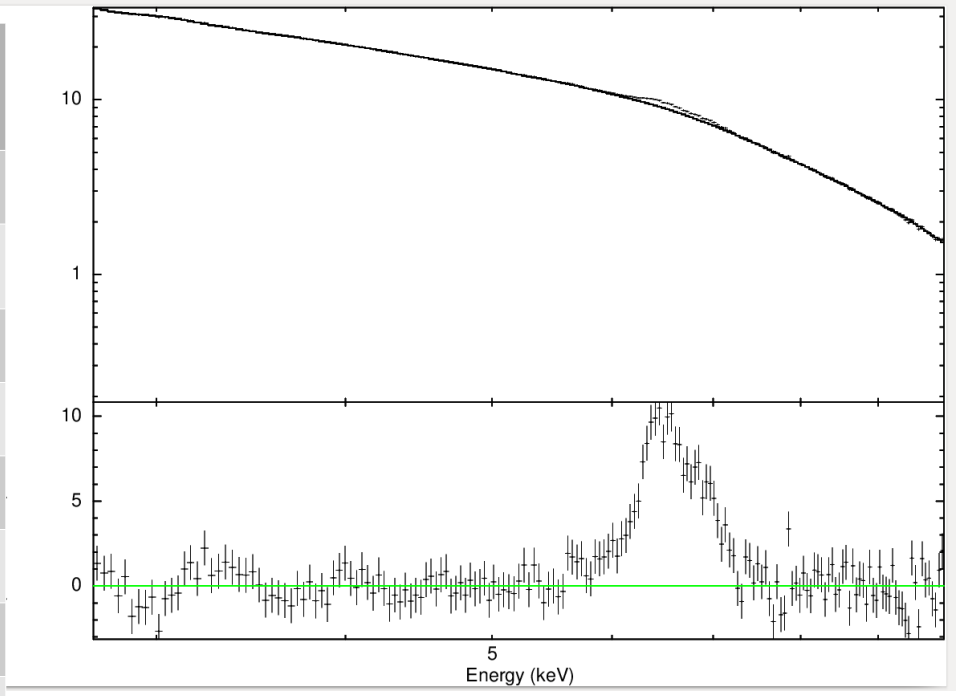

Prior knowledge of source: Black hole binary system GX 339-4

Model	Parameters	unit	value
WABS	nH	10^{22}	0.5(fixed)
DISKBB	T_{in}	keV	$0.45^{+0.10}_{-0.09}$
	norm		$205^{+852.35}_{-148.92}$
Gaussian	LineE	keV	$6.56^{+0.023}_{-0.023}$
	sigma	keV	$0.33^{+0.028}_{-0.026}$
	norm	10^{-4}	$7.73^{+0.062}_{-0.58}$
powerlaw	PhoIndex		$1.50^{+0.007}_{-0.006}$
	norm		$0.20^{+0.003}_{-0.003}$



Values obtained with XMM-Newton observation, between energy band 2.5-10 keV.

- Edit parameters and save

  set_par(1,0.5);

  edit_par(); (open all parameters in vi editor)

  save_par(“file_name”);
- Simulate data for instruments like SXT, LAXPC and CZTI:

  For LAXPC2

  astrosat_laxpc2_simulate_spec(**exposure**);

- This task simulates the data and fit with the model already defined
- Give simulated count rate

```
isis> astrosat_laxpc2_simulate_spec (1000);
 Parameters[Variable] = 8[8]
            Data bins = 256
          Chi-square = 236.2156
   Reduced chi-square = 0.9524821
Reporting Net count rate

 Parameters[Variable] = 8[8]
            Data bins = 30
          Chi-square = 27.79407
   Reduced chi-square = 1.263367
Faked LAXPC2 data binned by a factor of 5.

1
0
LAXPC2 rate =  282.52 +/- 0.83 counts/s
```

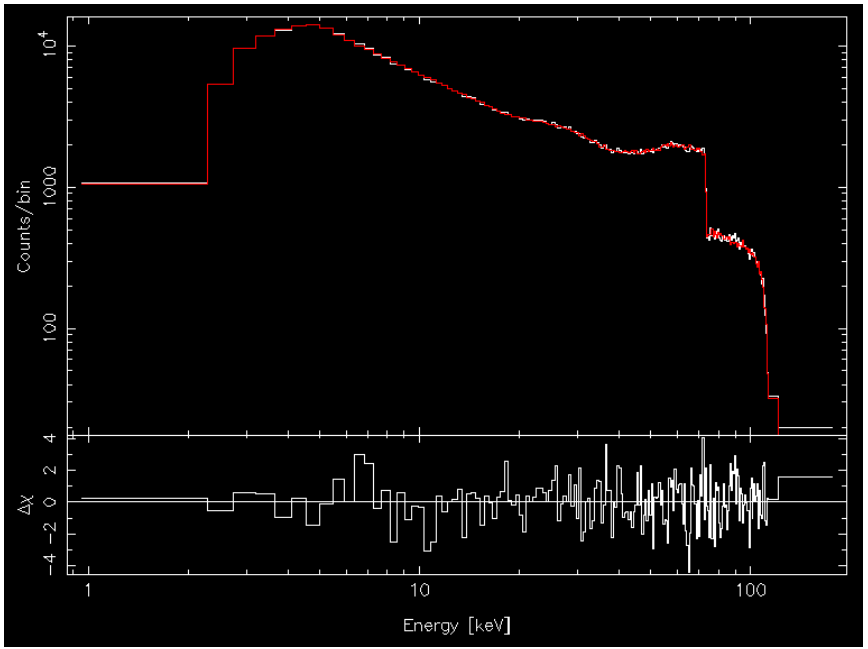
- Renormalization and fitting:

  renorm_counts();

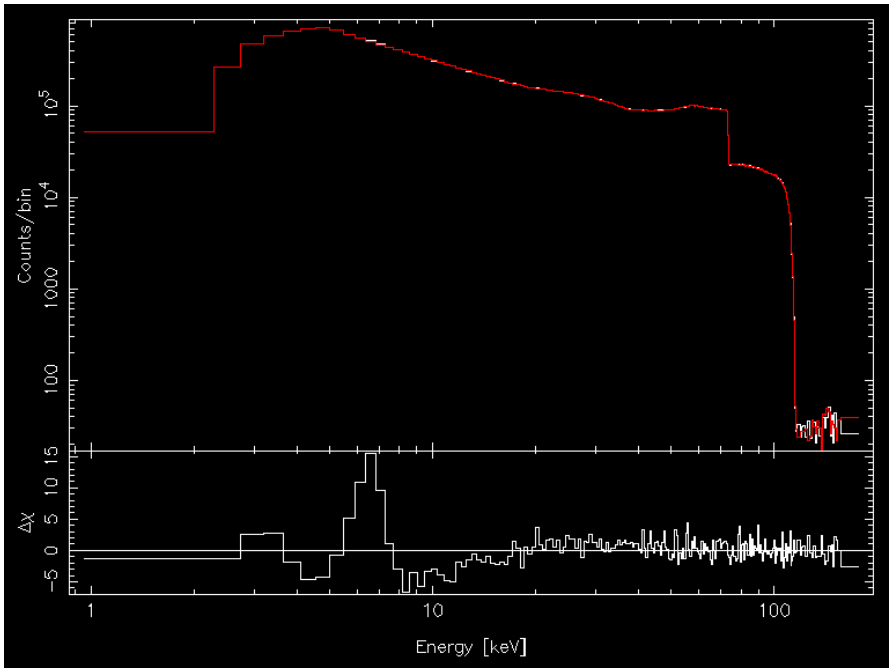
  fit_counts();
- Uncertainty calculation:

  (pmin, pmax) = conf_loop ([1,2,3,4,5,6,7,8] ; save,prefix="file_name");

Vary exposure time



Exposure 1000 sec
Param value min max
nH (10^22) 7.74 1.38 4.40

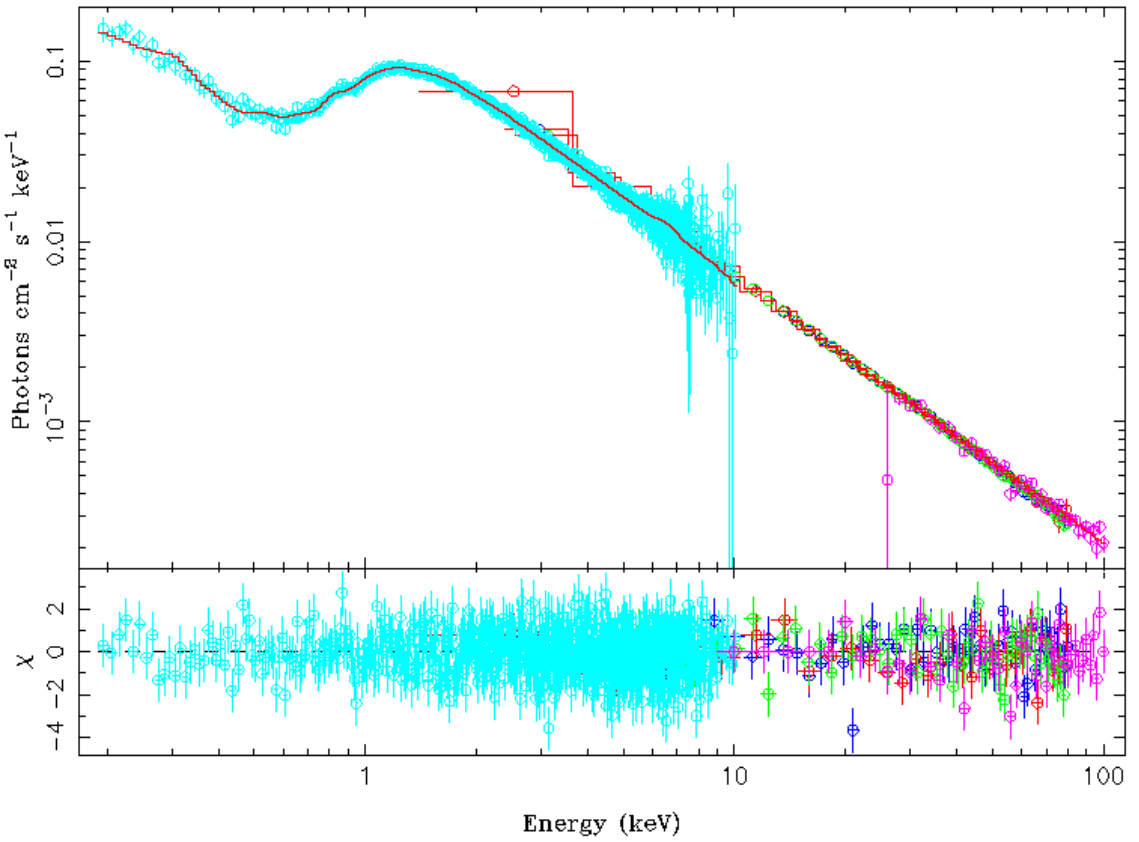


Exposure 50000 sec
Param value min max
nH(10^22) 0.62 0.45 0.84

Low exposure: Large uncertainty

Function: astrosat_xray_simulate_spec (exposure)
Single task to simulate energy spectra of SXT, LAXPC and CZTI

- CZTI rate = 11.17 +/- 0.13 counts/s
- SXT rate = 7.94 +/- 0.01 counts/s
- LAXPC3 rate = 293.60 +/- 0.12 counts/s
- LAXPC2 rate = 282.92 +/- 0.12 counts/s
- LAXPC1 rate = 308.34 +/- 0.13 counts/s



UVIT count rate

- astrosat_uvit_fuv_caf21_sim (2000.0);
- astrosat_get_count_rate (1);

  Output:
- Count rate 1.59
- Count rate error 0.028

Thank You