Black hole X-ray binary Swift_J1658p2-4242: https://arxiv.org/pdf/1910.07804.pdf

1. Unzip the level1 data:

cd /home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242

>**unzip** LEVL1AS1LXP20180220T02_004T01_9000001910_12977.zip
>**unzip** LEVL1AS1LXP20180220T02_004T01_9000001910_12978.zip
>**unzip** LEVL1AS1LXP20180220T02_004T01_9000001910_12980.zip
>**unzip** LEVL1AS1LXP20180220T02_004T01_9000001910_12981.zip
>**unzip** LEVL1AS1LXP20180220T02_004T01_9000001910_12982.zip

OUTPUT :

The orbit files inside the folder : /home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242/20180220_T02_004T01_9000001910_level1/laxpc$ **ls**

12977 12978 12980 12981 12982

2. Create Analysis folder:

>~/home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242$ **mkdir Analysis**

3. In the Analysis folder set the path of laxpc level1 data (Set the variable $LAXPCDATAPATH to where your data is ending with the laxpc directory)

/home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242$**cd Analysis**
/home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$**export LAXPCDATAPATH="/home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242/20180220_T02_004T01_9000001910_level1/laxpc"**

4. Initialize heasoft:

/home/jayashree/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$**heainit**

Creating level2 events file and gti

5. Make data files list of level1 data

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_filelist**

OUTPUT: eventfiles filterfiles orb_filelist

6. Create level2 fits event file from level1 event files

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_event eventfiles**

OUTPUT: level2.event.fits

7. Create good time interval (gti) file by removing removes earth occulation and SAA

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_stdgti filterfiles**

OUTPUT: usergti.fits

Create lightcurve in 3-50 keV energy range from corrected level2 fits event file

6. Create eneinput file in 3-50 keV energy band.

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$**gedit eneinput**

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$**more eneinput**

3.0 50.0

7. To make lightcurve in 3-50 keV using all layers from LAXPC 10 and LAXPC 20 data

USAGE: laxpc_make_lightcurve [-p (which pcu? all or e.g. 12)] [-t timebin] [-u (user gti asci file)] [-o output filename] [-e energy define file] [-l Layer no] level2.event.fits

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_lightcurve -u usergti.fits -t 50.0 -p 12 -e eneinput -o lightcurve_p12 level2.event.fits**

OUTPUT:lightcurve_p12_3.0_50.0keV.lc

Plotting Lightcurve using task “lcurve”

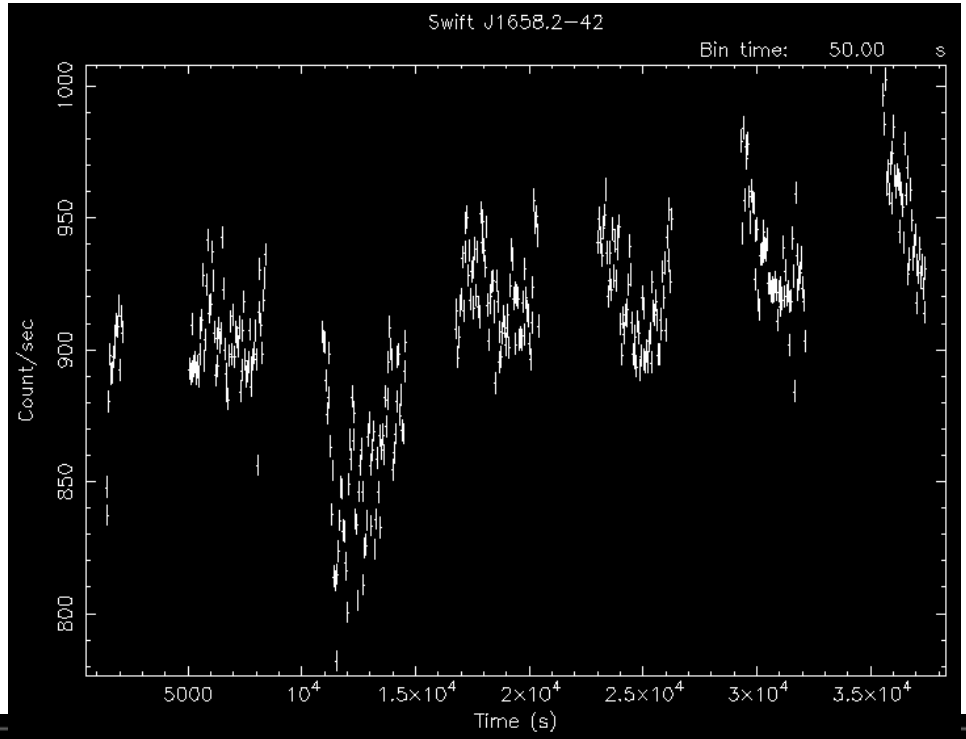
8. Plotting lightcurve using lcurve

USAGE: lcurve nser file(s)+options window dtnb nbint outfile plot plotdev

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **lcurve 1 lightcurve_p12_3.0_50.0keV.lc**

window=default dtnb=50.0 nbint=722 outfile=default plot=yes plotdev=/xw

OUTPUT:lightcurve_p12_3.0_50.0keV.flc



Generating Spectrum and Background Spectrum

9. SPECTRUM USAGE: laxpc_make_spectra [-u (user gti asci file)] [-r resp_files] [-l Layer no] [-g Energy grouping factor] level2.event.fits

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_spectra -u usergti.fits level2.event.fits**

OUTPUT: spectrum_10.pha spectrum_20.pha spectrum_30.pha

spectrum_grp_10.pha spectrum_grp_20.pha spectrum_grp_30.pha

lx10v1.0.rmf lx20cshm01v1.0.rmf lx30cshp28v1.0.rmf

10. BACKGROUND USAGE: laxpc_make_backspectra -u (user gti file) -g igain -l ilayer -s syserr

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_backspectra -u usergti.fits filterfiles**

OUTPUT: backlxp10.pha backlxp20.pha backlxp30.pha

Generating Background Lightcurve in 3-50 keV energy band

11. Creating background lightcurve:

USAGE: laxpc_make_backlightcurve -p (which pcu? all or e.g. 12) -t timebin -u user_gti_file -e energy define file -l Layer no -s syserr filterfiles

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_make_backlightcurve -u**

usergti.fits -t 50.0 -p 12 -e eneinput filterfiles

OUTPUT: Back_lightcurve_3.0_50.0keV.lc

TASK: You can plot the background light curve using task "lcurve" as explained earlier.

Create background subtracted lightcurve task "lcmath":

~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **lcmath**

Name of input FITS file[] **lightcurve_p12_3.0_50.0keV.lc**

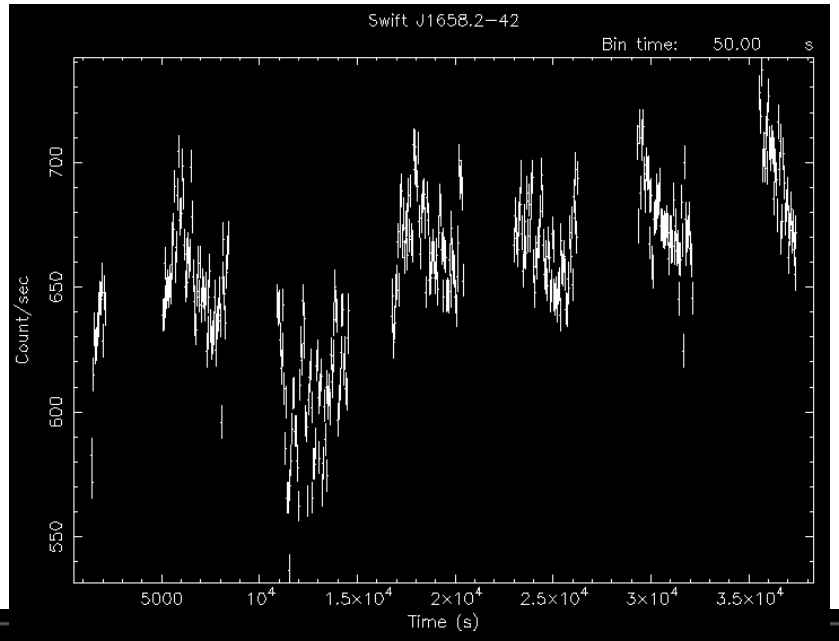
Name of background FITS file[] **Back_lightcurve_3.0_50.0keV.lc**

Name of output FITS file[] **net_lightcurve_p12_3.0_50.0keV.lc**

Scaling factor for input[]**1.0**

Scaling factor for background[]**1.0**

Add instead of subract?[] **No**



Create Power Density Spectrum in 3-15 and 15-30 keV:

9. Power Density Spectrum:

USAGE: laxpc_freq_lag [-u user gti file] [-p (which pcu? all or e.g. 12)] [-h max freq] [-l min freq] [-f frequser] [-r ref_PCU] [-e energy define file] [-o output filename] [-L layer] eventfile

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_find_freqlag -u**

usergti.fits -p 12 -l 0.01 -h 10.0 -f 2 -e eneinput1 level2.event.fits

Here eneinput1 file contains 3-15 and 15-30 keV energy information.

OUTPUT: 1Pow_level2.event 2Pow_level2.event Lag_level2.event Tpow_level2.event

PLOT: gnuplot> plot '1Pow_level2.event' u 3:8 w l

10. Fitting of QPO & Rebining power density spectra which loads the data in xspec

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_rebin_power powfiles**

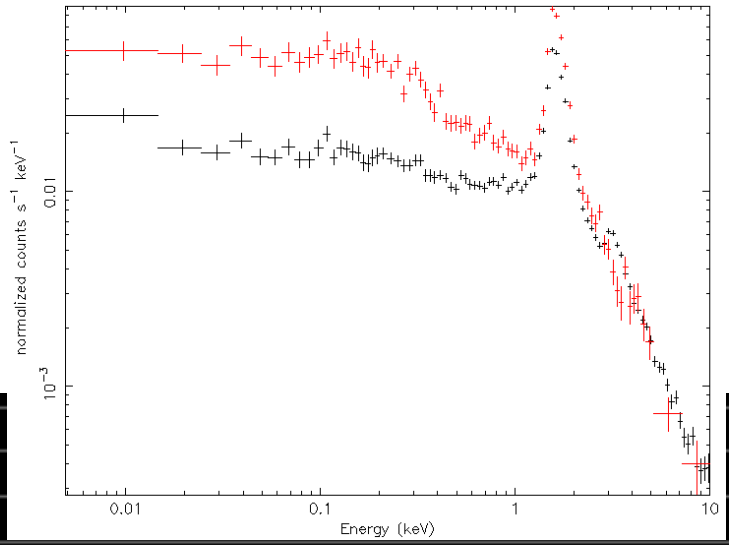
OUTPUT: 1Pow_level2.event 2Pow_level2.event

Plot: XSPEC>**data reb_Pow_level2.event.pha1**

XSPEC>**data 2:2 reb_Pow_level2.event.pha2**

XSPEC12>**setp ene**

XSPEC>**cpd/xw**
XSPEC> **pl ld**



Dynamical Power Density Spectrum:

9. Dynamical Power Density Spectrum:

USAGE: laxpc_dynpower [-u user gti file] [-p (which pcu? all or e.g. 12)] [-h max freq] [-l min freq] [-t time segment] [-e energy define file] [-o output filename] eventfile

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$**laxpc_dynpower -u usergti.fits -p 12 -h 3.0 -l 0.1 -t 10 -e eneinput1 level2.event.fits**

OUTPUT: Dyn_3.0_15.0keV_level2.event Dyn_15.0_30.0keV_level2.event

10. Plotting dynamical PDS in gnuplot:

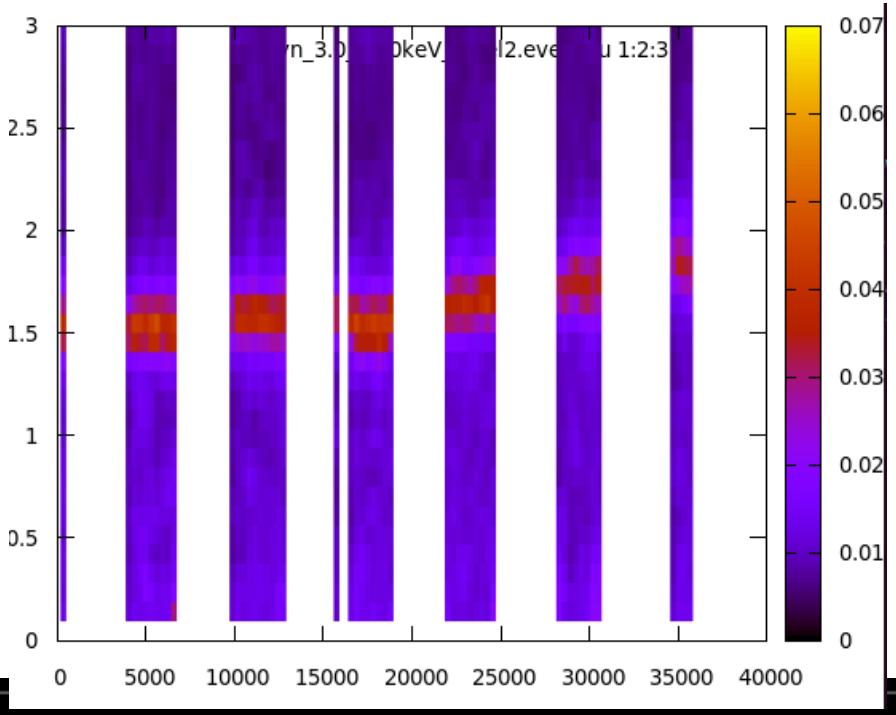
~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis

$**gnuplot**

gnuplot> **set pm3d map**

gnuplot> **sp "Dyn_3.0_15.0keV_level2.event" u 1:2:3**

Column 1 is time, column 2 is frequency and column 3 is power



FRACTIONAL RMS & TIME LAG (QPO at 1.561 Hz)-I

11(a). Divide the data in two segment based on Dyamical pds.

jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **cp usergti.fits seg_1_usergti.fits**

Open seg_1_usergti.fits in fv and delete rows 5, 6 and 7

(b) Create a energy input file (eneinput_lag):

3.0 5.0
5.0 7.0
7.0 9.0
9.0 11.0
11.0 13.0
13.0 15.0
15.0 18.0
18.0 22.0
22.0 27.0
27.0 33.0
33.0 50.0

(c) jayashree@jayashree:~/Desktop/LT_workshop/Swift_J1658p2-4242/Analysis$ **laxpc_find_freqlag -u seg_1_usergti.fits -p 12 -l 0.068 -h 10.0 -f 1.561 -e eneinput_lag -o 1.561Hz_Pow_level2.event level2.event.fits**

FRACTIONAL RMS & TIME LAG (QPO at 1.561 Hz)-II

OUTPUT: TPow_1.561Hz_Pow_level2.event 1Pow_1.561Hz_Pow_level2.event 3Pow_1.561Hz_Pow_level2.event 2Pow_1.561Hz_Pow_level2.event 6Pow_1.561Hz_Pow_level2.event 5Pow_1.561Hz_Pow_level2.event 4Pow_1.561Hz_Pow_level2.event 9Pow_1.561Hz_Pow_level2.event 8Pow_1.561Hz_Pow_level2.event 7Pow_1.561Hz_Pow_level2.event 11Pow_1.561Hz_Pow_level2.event 10Pow_1.561Hz_Pow_level2.event powfiles Lag_1.561Hz_Pow_level2.event

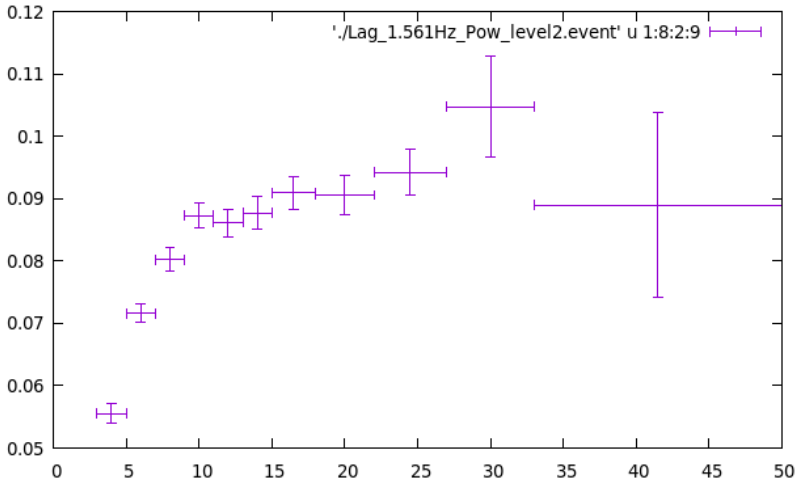
(d)~Swift_J1658p2-4242/Analysis$ **gnuplot**

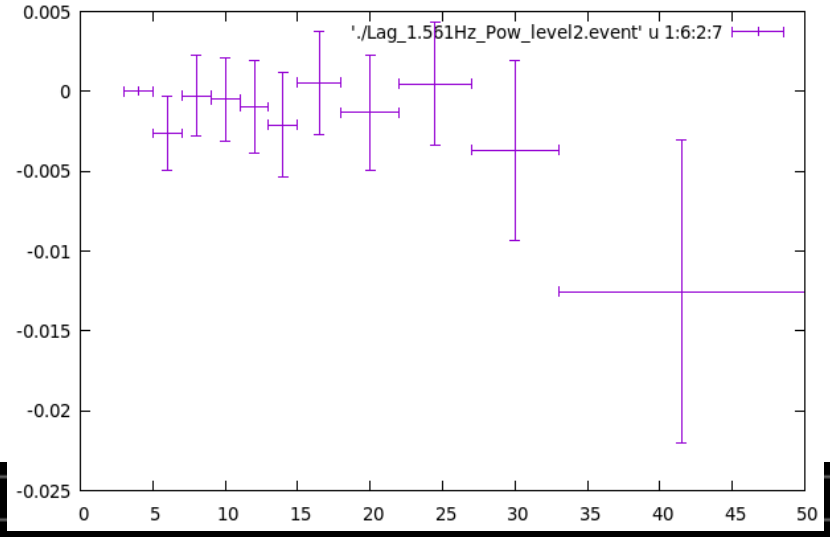
Plotting RMS variation

gnuplot> **plot './Lag_1.561Hz_Pow_level2.event' u 1:8:2:9 w xyer**

(Mid Point Energy (keV) , Intrinsic fractional r.ms., Energy Range (keV),

error on Intrinsic fractional r.ms.)





Plotting Time Lag

gnuplot> **plot './Lag_1.561Hz_Pow_level2.event' u 1:6:2:7 w xyer**

(Mid Point Energy (keV) , Time lag (secs), Energy Range (keV), error on time lag.)

TASK :

Create time lag and RMS variation for the second QPO at 1.740 Hz using the command:
laxpc_find_freqlag -u seg_2_usergti.fits -p 12 -l 0.098-h 10.0 -f 1.740 -e eneinput_lag -o 1.740Hz_Pow_level2.event level2.event.fits

Here,

cp usergti.fits seg_2_usergti.fits

Open seg_2_usergti.fits in fv and delete rows 1, 2, 3 and 4