BASSMAN

Manual

Whole BASSMAN software uses 4 programs:

- tess_lightcurve
- npz_plot
- star_prep_bassman
- bassman

Code tess_lightcurve is used to download light curves from the TESS database, npz_plot is used to check .npz files after preparation using star_prep_bassman. Program bassman itself is used to model starspots.

1. tess_lightcurve

tess_lightcurve is a simple program to download lightcurves from the TESS database.

Usage: tess_lightcurve <-tic=str> [-sec=int] [-mark=float] [--save] [--long] [--short] [--fast] [--nodisp] [--mask] [--sap]

The only needed parameter for this program is the tic number of the star passed as a -tic=tic_number. The rest of the parameters are:

-sec=int ← with this key you give the sector number, if not given than code downloads all possible sectors
-mark=float ← allows to mark selected time point (time as TBJD) on the light curve
--save ← saving the light curve
--long ← data with cadence 30 minutes
--fast ← data with cadence 20 sec
--short ← data with cadence 2 minutes
–nodisp ← program do not display any figures (by the default it shows the light curve)
--mask ← program shows mask for the star for every possible sector
--sap ← program downloads the sap flux

2. star_prep_bassman

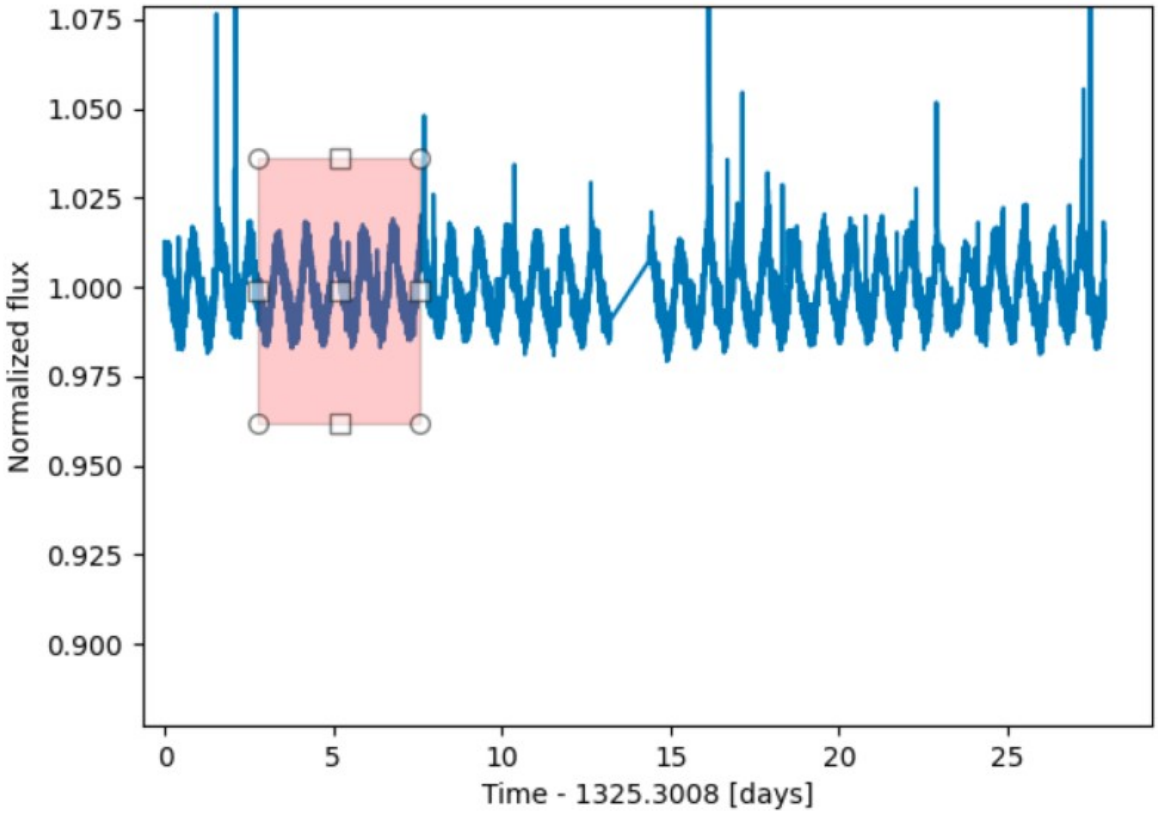
Star_prep_bassman is a program that prepares the light curve downloaded by the tess_lightcurve for bassman. This code allows to manualy remove flares, remove flares using the median filter and remove outliers. Also the code allows to select the part of the light curve that the user wants to analyze. The only thing that this code needs is the tic number of the star. The code will produce by the default file star_params.npz where all informations about the star (including light curve) needs to be passed to bassman. Program bassman will by the default look for this file so its name does not have to be passed.

Program star_prep_bassman.py for MacOS and Linux written by K. Bicz, ver. of Nov 23, 2021.
Preparing parameters of the star for modelling stellar spots.

Usage: star_prep_bassman.py <-tic=str> [-out=file] [-lc=file] [-edit=file] [-model=file]
[-ylm=int] [-dinc=float] [-p0=float] [-rmflares[=float]]
[-niter=int] [-npoints=int] [-sigma=float] [--fulltime]
[-rmparts] [--noerr] [--disp] [--force]

option -tic : tic number of star.
-out : destination file for parameters of star (default out = star_params.npz).
-lc : light curve of star (default lc = lc.data).
-edit : edit previously selected part of light curve (default edit = star_params.npz).
-model : plot given model on selected part of light curve (default model = model.dat).
-sigma : sigma for zscore outliers (default sigma = 1.9).
-ylm : spherical harmonic degree (default ylm = 20).
-dinc : default inclination if vsini not availeable (default dinc = 50).
-p0 : plot as dashed lines moments of time corresponing to given moment of phase = 0.
-rmflares : uses median filter to remove outliers (sigma = 0.05).
-npoints : works only with rmflares, n of points for median filer.
-niter : works only with rmflares, number of repetitive usages of the median filter.
--fulltime : Take whole light curve, not selected time interval.
--rmparts : select and remove any number of parts of the light curve.
--noerr : Forces not to remove outliers.
--disp : Display selected interval after z score outliers remove.
--force : Forces to use default inclinaction (dinc value).

The selection of the light curve is presented on the below figure. Similarly is with the flare removing.



3. npz_plot

npz_plot is a simple program to plot seleted data from star_params.npz file. The usage of the code is npz_plot file1 file2 file3 … (you can pass how much you want star_params.npz files) Also the program can plot files downloaded by tess_lightcurve program to compare with the intervals selected by the star_prep.

4. bassman

Program bassman.py for MacOS and Linux written by K. Bicz, ver. of Oct. 27, 2022.
Recreating possible locations, sizes and amplitudes of spots on given star.

Usage: bassman.py [-star=str] [-nspots=int] [-prec=float] [-dprec=float] [-pers=float]
[-omb=float] [-obm=float] [-adap=int] [-nstep=int] [-mprod=float]
[-finc[=float]] [-gv=float] [-ylm=int] [-ampl=float] [-almin=float]
[-almax=float] [-save[=file]] [-amin=float] [-amax=float]
[-smin=float] [-smax=float] [-lamin=float] [-lamax=float] [-lomin=float] [-lomax=float]
[-gsp=int] [-model=str] [-aran=float] [-sran=float] [-laran=float] [-loran=float]
[-falpha=float] [-tbjd=float] [-ncores=int] [-nchains=int] [-chi=float] [-logp=float]
[-temp=float] [-terr=float] [--pran] [--filter] [--init] [--diff] [--force] [--nodisp]
[--sample] [--noadap] [--fulltime] [--nosphere] [--nochi] [--check] [--ps] [--fscale]
[--pcom] [--liveplot] [--modelonly] [--singlecache]

option -star : file with parameters of star (default star = star_params.npz).
-nspots : number of spots for starting model (default nspots = 1).
-prec : precision for modelling light curve (default prec = 0.000107).
-dprec : minimal differential precision (default dprec = 0.00005).
-pers : maxminal |1-person| value (default pers = 0.1).
-omb : maximal |1-b| value (default omb = 0.015).
-obm : interval to fit max model flux (default obm=0.005)
-adap : number of successful models to start adaptating (default adap=5).
-nstep : number of calculated models to add another spot (default = 30).
-mprod : maximal product of correlation to start adapting (default mprod=8).
-finc : force exact inclination value (default finc = 70).
-gv : value to find if there is a gap in the time series (default gv = 0.2).
-ylm : spherical harmonics l number (default ylm = 25).
-ampl : maximal amplitude of star (it is by default maximum of model).
-almin : minimal alpha for differential rotation modeling (default almin = 0).
-almax : maximal alpha for differential rotation modeling (default almax = 1).
-save : save modelled stellar spots as image (default image = sspots.eps).
-amin : minimal amplitude of the spot (default amin = -0.1).
-amax : maximal amplitude of the spot (default amax = 0.0).
-smin : minimal surface of stellar spots (default smin = 0.0).
-smax : maximal surface of stellar spots (default smax = 0.05).
-lamin : minimal latitude of stellar spots (default lamin = -70).
-lamax : maximal latitude of stellar spots (default lamax = 70).
-lomin : minimal longitude of stellar spots (default lomin = -180).
-lomax : maximal longitude of stellar spots (default lomax = 180).

-gsp : speed of gif (default gsp = 1).
-model : file with starting parameters for spots (default = spots.txt).
-aran : amplitude range to fit spots using model (default aran = 0.015).
-sran : surface range to fit spots using model (default sran = 0.02).
-laran : latitude range to fit spots using model (default laran = 8.0).
-loran : longitude range to fit spots using model (default loran = 8.0).
-falpha : value of differential rotation shear given by user (default falpha = 0.0).
-tbjd : make images for selected TBJD (default it is the first time point from data).
-ncores : use selected number of cores to sample data (default ncores = 4).
-nchains : use selected number of chains to sample data (default nchains = 4).
-chi : after reaching selected chi value program accepts calculated model.
-logp : after reaching selected logp value program accepts calculated model.
-temp : temperature of analysed star (default value is read from TESS_params file).
-terr : error of the temperature of analysed star (use only with --pran).
--pran : print analicitcal solutions from Notsu et al. 2019, ApJ, 876:58.
--filter : filter output images.
--init : plot initial model.
--diff : turns on differential rotation.
--nodisp : Turns off displaying recreated stellar spots.
--force: force to create model for selected nspots.
--sample: uses sampling to determine many best models.
--noadap: turns off adapting precision to data.
--fulltime : reconstruct light curve for whole sector(s).
--nosphere : program does not create rotating star sphere gif.
--nochi : do not write chi^2 values in legend.
--check : do check amplitudes of spots.
--ps : print value of scale.
--fscale : fit scale of flux to data (default scale = 1/nspots).
--pcom : plot light curve of every spot to compare with light curve of star.
--liveplot : plot recreate light curve after every spot estimation.
--modelonly : save results to file model_results.npz and fisnish program.
--singlecache : do not create additional folder for theano cache.