AGILE tutorial

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AGILE TUTORIAL

Load the environment for the AGILE analysis:

```
module load agile-AB

Find tools in /home/groupX/AGILE
```

1. Build the maps

map.rb FM3.119_ASDCe_I0023 OP06800 54894.50 54921.50 351.28925 40.138743 timetype=MJD binsize=0.5 <additional parameters>

- **OP06800** = Name of the maps (you can choose what you want!).
  E.g. OP06800.
  Results:
  OP06800.cts.gz ← Counts map
  OP06800.exp.gz ← Exposure map
  OP06800.gas.gz ← Diffuse emission map
  OP06800.maplist4 ← This file contains the list of all the generated maps

- **54894.50 54921.50** = MJD start and MJD end

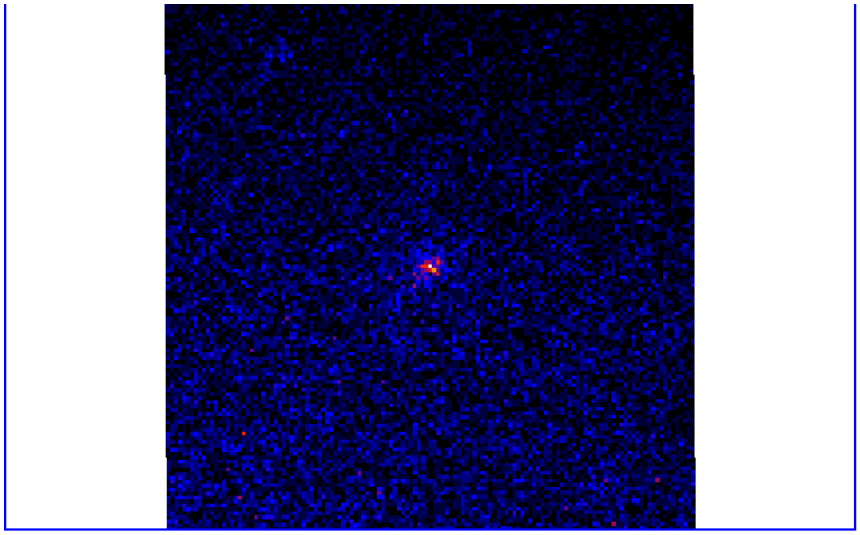
- **351.28925 40.138743** = l, b (in Galactic coordinates) of the map center

- **Additional parameters:**
- mapsize=50
- emin=100
- emax=50000
- **energybin=3 -> a set of maps with different energy bins (e.g [100,200], [200, 400], [400, 1000], [1000-3000] MeV**
- energybin=0 -> use emin, emax as energy range

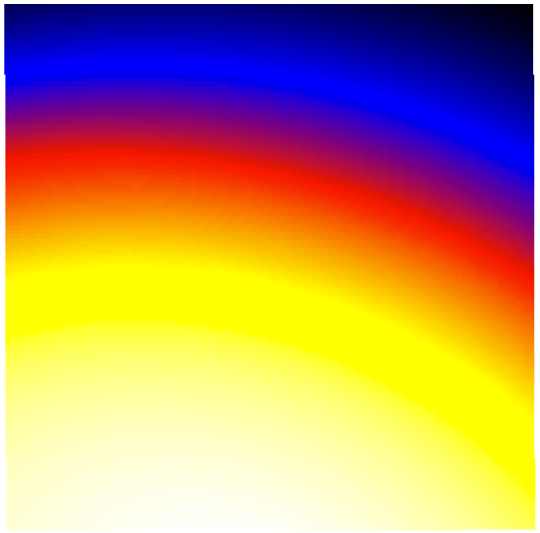
2. view the maps

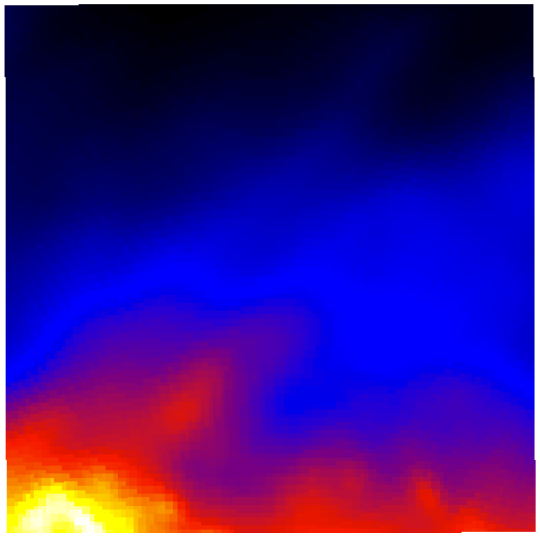
Use **ds9** to load the maps

Counts map: OP06800.cts.gz



Exposure map: OP06800.exp.gz





Galactic diffuse emission map: OP06800.gas.gz

*.maplist4

Open and see what's in .maplist4 file

Example:

OP06800.cts.gz OP06800.exp.gz OP06800.gas.gz 30 -1 -1

This file is used

- To list all the maps used for the analysis
- To make hypothesis about the
  - Galactic diffuse emission = g_{gal}
  - Isotropic emission = g_{iso}

How to assign a value to gal and iso:

- -1 = keep the parameter free
- <val> (e.g. 0.7) = assign the value and keep the parameter fixed

For AGILE analysis outside the Galactic plane we keep g_{gal} = 0.7.
To fix the gal parameter see multi5.rb command (next slides)

3. Prepare the source list

Create the file *.multi (e.g.listSources.multi)
Modify listSources.multi file adding the source that you are looking for

```
2.0e-07 351.2 40.138743 2.1 3 2 PKS1510-089
```

1. Flux (in ph. cm^{-2} s^{-1} sr^{-1})
2. l (Galactic coordinates)
3. b (Galactic coordinates)
4. Photon index
5. Fixflag
6. 2 (fixed)
7. Source name

listSources.multi

```
total 904
-rw-r--r--   1 bulgarelli  staff      48 26 Nov 00:32 listSources.multi
```

How to use the fixflag keyword

- Fixflag = 0: everything is fixed. This is for known sources which must be included in order to search for other nearby sources.

fixflag	Flux	Position	Photon index (power law)
0	Fixed	Fixed	Fixed
1	Variable	Fixed	Fixed
3	**Variable**	**Variable**	**Fixed**
5	Variable	Fixed	Variable
7	**Variable**	**Variable**	**Variable**

4. Evaluation of parameters of the model (MLE, Maximum Likelihood Estimator)

```
multi5.rb OP06800.maplist4 listSources.multi
OP06800.res prefix=FM3.119_ASDCe_I0023 galcoeff=0.7
```

- OP06800.maplist4 = .maplist4 from the map creation
- listSources.multi = .multi file with all the sources to be analyzed
- OP06800.res = name of the output of the analysis
- galcoeff=0.7 = fixing the galactic diffuse emission to 0.7

OP06800.res

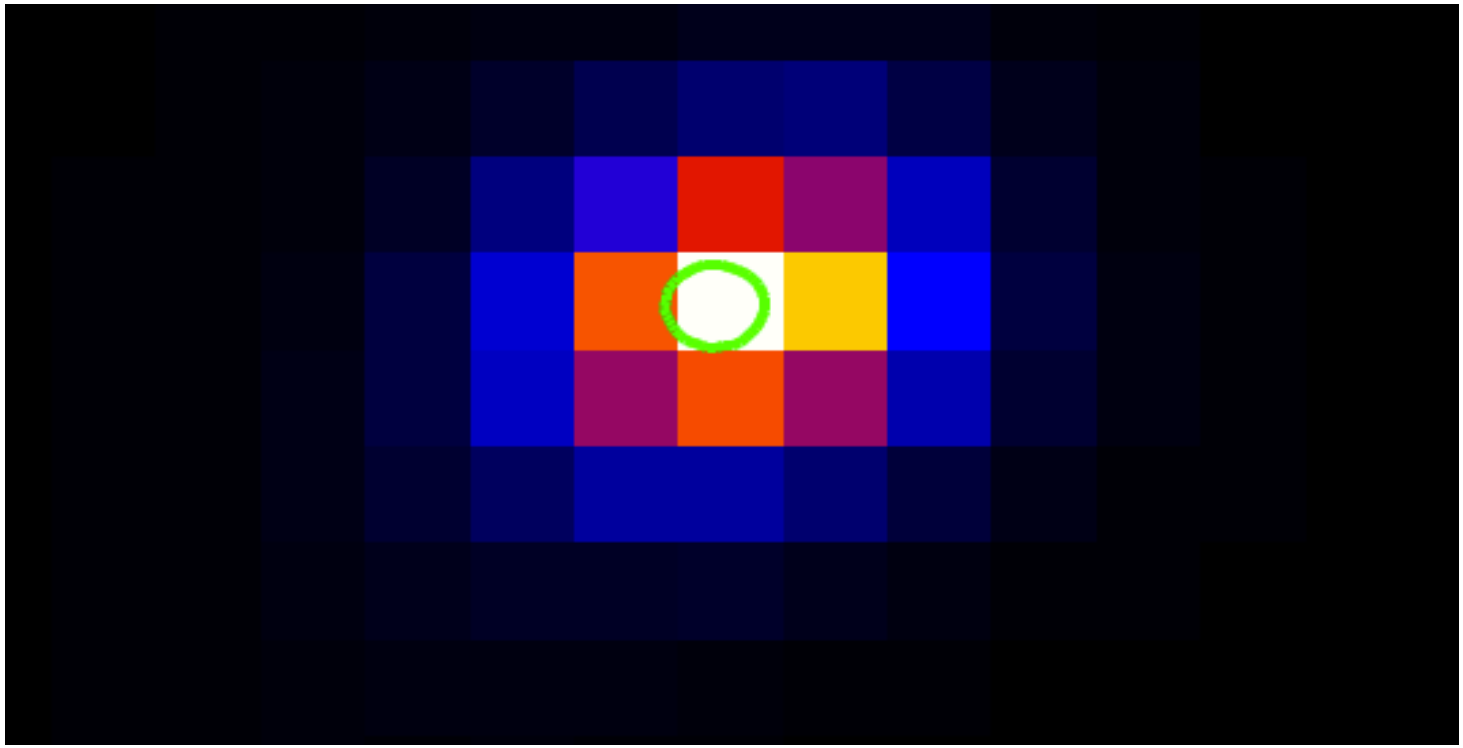
```
! DiffName, Coeff, Err, +Err, -Err
Galactic 0.7 0 0 0
Isotropic 12.3384 0.251798 0.253005 -0.250588
! SrcName, sqrt(TS), L, B, Counts, Err, Flux, Err, Index, Err
PKS1510-089 21.0946 351.293 40.075 609.346 41.9956 2.09337e-06
1.44273e-07 2.1 0
2009-03-04T12:01:06
2009-03-31T12:01:06
```

OP06800.res_PKS1510-089.src

```
! Label, Fix, index, UL conf. level, srcloc conf. level, start l, start b, start flux, [ lmin , lmax ],
[ bmin, bmax ]
! sqrt(TS)
! L_peak, B_peak, Dist from initial position
! L, B, Dist from initial position, r, a, b, phi
! Counts, Err, +Err, -Err, UL
! Flux, Err, +Err, -Err, UL, Exp
! Index, Err
! cts, fcn0, fcn1, edm0, edm1, iter0, iter1
! Gal coeffs and errs
! Gal zero coeffs and errs
! Iso coeffs and errs
! Iso zero coeffs and errs
! Start date, end date
! Emin..emax, fovmin..fovmax, albedo, binsize, expstep, phasecode
PKS1510-089 3 2.1 2 5.99147 351.2 40.1387 2e-07 [ -1 , -1 ]  [ -1 , -1 ]
21.0265
351.293 40.0709 0.098022
351.298 40.0683 0.102907 0.130882 0.12864 0.116451 47.872
606.969 41.9371 42.5338 -41.3396 693.252
2.0852e-06 1.44072e-07 1.46122e-07 -1.4202e-07 2.38162e-06 2.91084e+08
2.1 0
4209 948.236 727.179 9.26366e-12 4.15762e-08 311 353
1.64313e-11 0.131777
7.49401e-13 0.0810538
13.5687 0.356715
15.6467 0.00250459
2009-03-04T12:01:06 2009-03-31T12:01:06
100..50000 0..60 80 0.5 0 2
```

If sqrt(TS) < 2 use the Upper Limit (UL)

OP06800.res_PKS1510-089.reg



> ds9 OP06800.cts.gz -region OP06800.res_PKS1510-089.src.reg

Light curve of PKS 1510-089

Load the environment:
> module load python2.7-sci

To view the image:
> eog <image_name>

Light curve of PKS 1510-089

Create a file collecting the result to be plotted in the light curve.
The file must have 5 columns with the following information:

Flux (photons cm^{-2} s^{-1})	Flux error (photons cm^{-2} s^{-1})	Error type (0/1)	T start (MJD)	Time bin (MJD)

Error type:

- 0: flux value is NOT an upper limit (flux error ≠ 0)
- 1: flux value is an upper limit (flux error = 0)

Example:

```
3.394e-07       0               1       54305.50        6.00
8.61005e-07     5.27225e-07     0       54344.50        1.00
4.98313e-07     0               1       54345.50        1.00
```

Light curve of PKS 1510-089

Python script to build the light-curve: **visLightCurve.py (in /AGILE/LightCurve)**

Usage instruction:

```
> python visLightCurve.py out_name N_lc "Title" filename1 "label1"
<filename2 "label2”>
```

Parameters:

- out_name: name of the image to be hardcopied
- N_lc: number of loaded light curves (<= 5)
- "Title": plot title
- filename: path+name of the file
- "label": light curve label
- <filename2 "label2”> = optional (> 1 light curves to plot together)

Example (one lightcurve):

```
> python visLightCurve.py prova.png 1 "Prova” lc_3.dat "curva 1”
```