Photometry Tutorial Muphoten

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Short Outline of this Tutorial

Part I : a (short) talk

- what Muphoten does
- How to install it
- How to run it

Part II : Hands on session

- Exercice 1 : Extract magnitude of a LT image
- Exercice 2 : Extract magnitude of GRB220514A CAHA image

Quick Overview

- **Muphoten** is a simple **photometry pipeline**
- It is a pipeline, so it **does not require** more **coding from user** side
- **Command line** based

What it can do:

- Subtract template image
- Perform photometry of **detected transient** (i.e. no "detection mode")
- Estimate the limiting magnitude of images

Installation

Advice : Using Anaconda

Requirements : Sextractor, Swarp, Scamp, PSFex

Requirements (2) :

- Cfitsio - see : https://heasarc.gsfc.nasa.gov/fitsio/
- HOTPANTS - see : https://github.com/acbecker/hotpants

Installing Muphoten :

- https://gitlab.in2p3.fr/icare/MUPHOTEN/-/tree/master/muphoten/
- cd MUPHOTEN
- pip install .

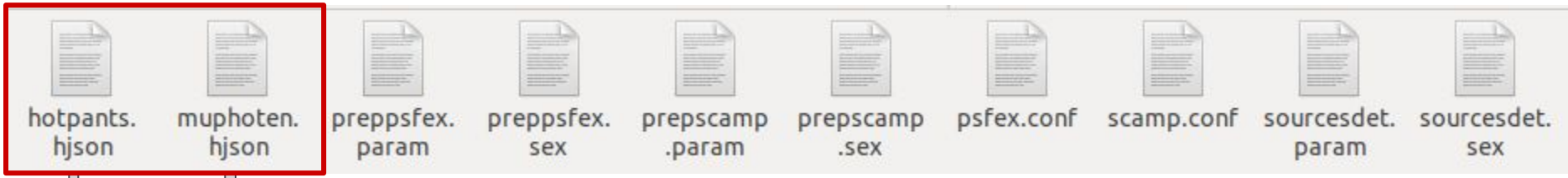
Muphoten Scripts

- **mu_bkg_subtraction** : Estimation of image background
- **mu_psf** : Launch PSFex on images
- **mu_sanitise** : Create a copy of image with header containing only relevant information for muphoten + add Filter & telescope information
- **mu_mag_lim** : Estimation of the limiting magnitude
- **mu_subtraction** : Subtract a template image for removing host galaxy
- **mu_photometry** : Perform photometry

Important scripts

Configuration Files

Performing photometry with many telescopes => Use of configuration files



Controls the parameters for Muphoten

Controls HOTPANTS parameters for template subtraction

- Outside of HOTPANTS & Muphoten, other conf files can be used to default
- If your telescope is not in the proposed choices -> create a folder and import the conf files from an already existing one in it

mu_mag_lim

- Launched from terminal on a repertory containing the images
- Estimate the limiting magnitude using the **ratio** of **detected** object to objects detected in **Pan-STARRS** matching FoV per mag bin
- Limiting magnitude reached when **ratio drops below** a given threshold (default **50%**)

```
--images IMAGES          Path to images.
--outname OUTNAME        Name of the output file.
--telescope   Telescope that acquired the images.
--precision PRECISION
                  Bin size for the estimation
--lower-mag LOWER_MAG
                  Lower bound for the limit magnitude.
--upper-mag UPPER_MAG
                  Upper bound for the limit magnitude.
--threshold THRESHOLD
                  The threshold, where the limit magnitude is considered reached
```

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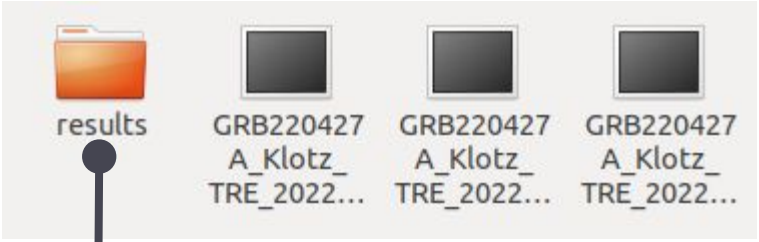
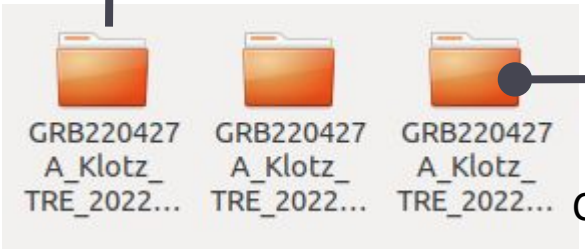
mu_mag_lim (2)

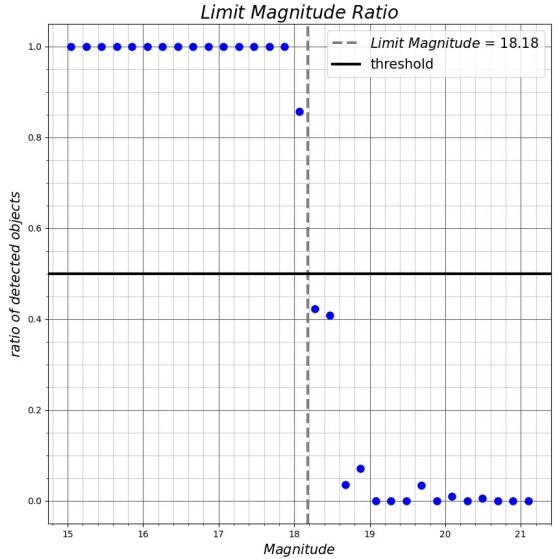
After launching the script a "results" repertory is created:



Containing a repertory for each analysed image & the file with all the results inside



Containing a repertory "mag_lim"



mu_subtraction

- Script for subtracting *template* images to remove host contribution
- *Template* : Either a reference image user provided or a Pan-STARRS downloaded image

Important parameters *from experience* :

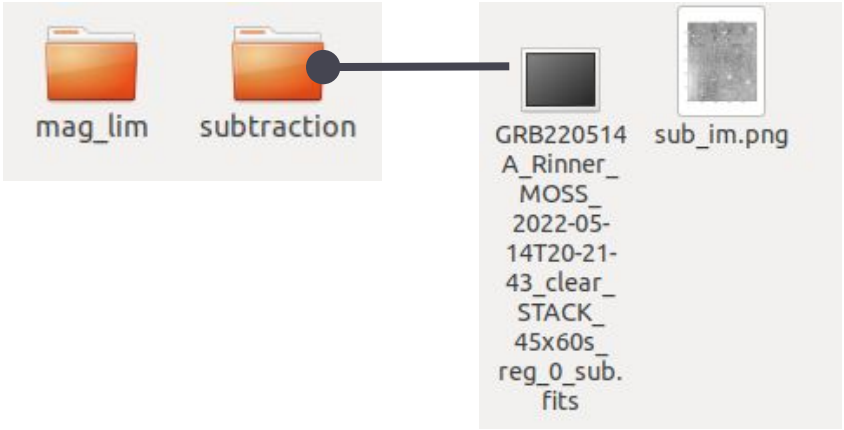
- kernelorder
- bgorder
- rkernel
- radius

```
# radius: half width substamp to extract around each centroid, default: 15
rss: 30

# fitthresh: RMS threshold for good centroid in kernel fit, default: 20.0
ft: 20.0

# statsig: threshold for sigma clipping statistics, default: 3
ssig: 3

# kerfracmask: fraction of abs(kernel) sum for ok pixel, default: 0.990
kfm: 0.99

# badkernelsig: high sigma rejection for bad stamps in kernel fit, default: 2.0
ks: 2.0

# fill: value for invalid (bad) pixels, default: 1.0e-30
fi: 1.0e-30

# spread: Ditto output mask, negative = no diffim masking, default: 1.0
mous: 1

# verbosity: level of verbosity, 0-2, default: 1
v: 0


}
```

Part of the config file for HOTPANTS

mu_subtraction (2)

Similar repertory structure as previously but this time it is called "subtraction"



"subtraction" repertory contains the subtracted image and a png plot of the subtracted image

WARNING : If Pan-STARRS is used for template subtraction, Muphoten will download PS images :

- Can take few minutes
- **Will take memory** - a lot if you are working with a large FoV instrument
- the downloaded images will be rescaled - will take more memory

-> When the analysis is done, you should erase those images

mu_photometry

- Main script for photometry in Muphoten
- Background subtraction
- 3 types of photometry : Kron - Fixed - Isophotal
- Crossmatch with : Pan-STARRS - SDSS - Gaia - USNO-B1

Prerequisite :

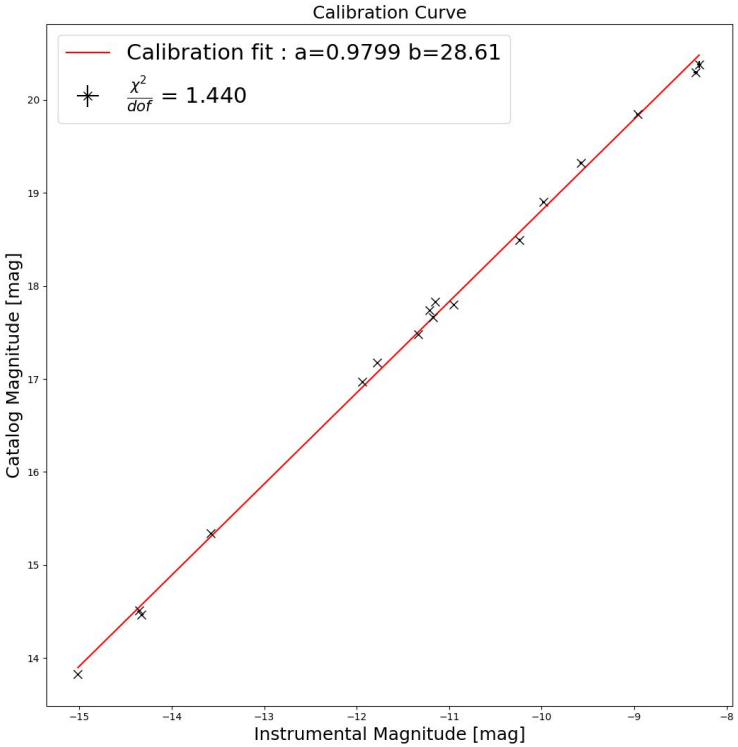
- If host subtraction required : use *mu_subtraction* beforehand
- Create a *coord.dat* file with the transient coord and a ref star coord (used for sanity check)

```
# type Ra Dec
transient 147.66556 13.1562
star 147.6902 13.1495
```

- Two new repertories created :

mu_photometry (2)

- psf : output of PSFex
- calibration : output of Muphoten
  - apertures.png : plot of the image and the apertures of the sources used for calibration
  - calibration.dat : information about the sources used for the calibration
  - calibration.png : plot for the calibration
  - segmentation.png : source detected in the image



Questions ?

It would also be great to have feedback/inputs from you to improve the code :)