



SPHOTOM - Package for an Automatic Multicolour Photometry



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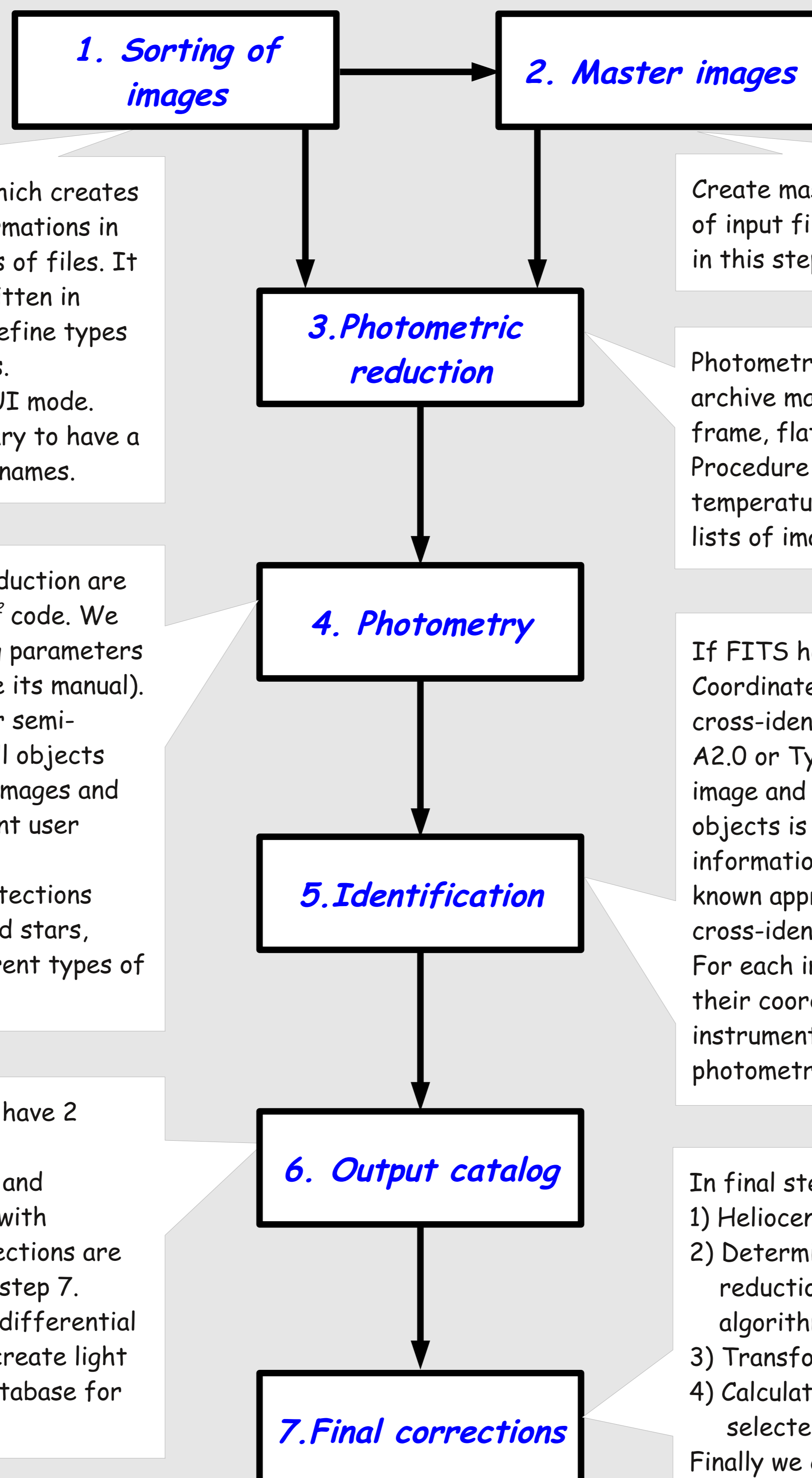
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We present basic informations about package SPHOTOM for an automatic multicolour photometry. It could operate in two independent modes, (I) **GUI mode**, in which user can select images and control functions of package through interface and (ii) **command line mode**, in which all processes are controlled using a main parameter file. This mode is suitable for a creation of photometric pipe-line, which we plan to use in near future with our new instruments.

SPHOTOM is developed as an universal package for Linux based systems with easy implementation for different observers.

Photometric part of package is based on *Sextrator* code, what allow us to detect all objects on the images and perform their photometry with different apertures. We can also perform astrometric solution of all images for a correct cross-identification of the stars on the images. The result is a catalogue of all objects with their instrumental photometric measurements which are consequently used for a differential magnitudes calculations with one or more comparison stars, transformations to international system and colour indices determinations.

On this poster we give a brief description of all steps of reduction and analysis using SPHOTOM.



1. Sorting of images

The first step in command line mode, which creates different lists of images based on informations in FITS header of images as well as names of files. It uses robust sorting scheme and it is written in Python using PyFits¹ module. User can define types of lists, which will be used in next steps. Sorting could be executed also from GUI mode. For a correct functionality it is necessary to have a consistent FITS headers and/or image names.

2. Master images

Create master images using an average or a median of input files. No other corrections are performed in this step.

3. Photometric reduction

Photometric reduction of images using created or archive master images. We can use, bias, dark frame, flat-field and dark for a flat corrections. Procedure automatically control image dimensions, temperatures and used colours. The results are the lists of images based on their colours.

4. Photometry

All images in lists after photometric reduction are used for a photometry using *Sextrator*² code. We can control all photometry options using parameters files of *Sextrator* (for more details see its manual). This package is very effective on non or semi-crowded fields and allow us to detect all objects above defined background level on the images and perform their photometry with different user defined apertures.

It can also remove bad or corrupted detections (stars on the edges of images, saturated stars, cosmic ray hits). User can define different types of informations in output file.

If FITS header of images have a WCS (World Coordinate Systems³) information, we perform cross-identification with external catalogs (USNO-A2.0 or Tycho) using up to 20 brightest stars on image and then astrometric solution of all detected objects is calculated. If we have no WCS information we calculate astrometric solution with known approximate coordinates of image center and cross-identification with external catalogs. For each image file with detected objects with their coordinates (celestial and image) and their instrumental magnitudes in apertures from photometry is created

6. Output catalog

After identification of the objects we have 2 possibilities:
(I) in GUI user can select up to 9 stars and generate their multicolour light curves with differential magnitudes. No other corrections are performed. User can use procedures in step 7.
(II) in command line mode we generate differential magnitudes between all pairs of stars, create light curves and store them in temporary database for an easier manipulation.

In final step we perform several corrections:
1) Heliocentric correction of time
2) Determination of extinction coefficients and reduction of systematic effects using SARS algorithm⁴
3) Transformation to international system
4) Calculation of average comparison star from user selected objects
Finally we create result differential light curves.

7. Final corrections

References:

- 1) http://www.stsci.edu/resources/software_hardware/pyfits
- 2) Bertin, E., Arnouts, S., 1996 *Astron. Astrophys. Suppl.*, 117, 394
- 3) http://fits.gsfc.nasa.gov/fits_wcs.html
- 4) Ofir et al., 2010, *MNRAS Letters*, 404, L99

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