Kourovka Astronomical Observatory of Ural Federal University

ASTROKIT MANUAL

A. Burdanov[1], V. Krushinsky[2]

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INTRODUCTION

This document is a short guide to using Astrokit software. The main objective of the program is post processing of time-series CCD photometric data obtained be means of IRAF package. Description of Astrokit algorithms and some results obtained with it are presented in the third issue of the 69th volume of "Astrophysical Bulletin" which is available here http://www.maik.ru/cgi-perl/search.pl?lang=eng&name=aspbull&year=2014&lyear=2014. If you have any questions or comments please write us an email.

INSTALLATION

To compile Astrokit on Linux one needs to download source code available at http://astro.ins.urfu.ru/sites/default/files/astrokit.gz. In addition, you must have g++ (GNU C + +) compiler. An example of installing Astrokit version 1.5 in the terminal of Debian GNU / Linux is shown below:

bu@bu-S540:~$ mkdir Astrokit
bu@bu-S540:~$ cd Astrokit
bu@bu-S540:~$ wget http://astro.ins.urfu.ru/sites/default/files/astrokit.gz
bu@bu-S540:~$ gunzip astrokit.gz
*bu@bu-S540:~$ g++ -o astrokit astrokit*cpp*
bu@bu-S540:~$ chmod a+x astrokit
bu@bu-S540:~$ sudo cp astrokit /usr/local/bin

[1]burdanov. art@gmail. com
[2]krussh@gmail. com

USING ASTROKIT

To launch Astrokit just execute command *astrokit:*

bu@bu-S540:~/Data/test astrokit

To work properly Astrokit needs two input files in the working directory: a file with results of photometric data reduction and coordinate file.

Photometry file (outfile) is formed using *pdump* command of IRAF/apphot task. These columns must be present in outfile: ID, FLUX, AREA, SUM, NSKY, MSKY, ITIME:

apphot> pdump @list "ID,FLUX,AREA,SUM,NSKY,MSKY,ITIME" > outfile

There must be three tabulated columns in coordinate file:

– RA (right ascension in degrees);
– DEC (declination in degreees);
– ID (running number of each star);

In addition, there can be an extra column with color indices. Order of the columns is not important. This file can be easily created using Aladin.

Examples of input data can be downloaded from Kourovka observatory web site http://astro.ins.urfu.ru/sites/default/files/data.zip

A short example. When you launch Astrokit in your working directory:

1. *Enter CCD gain in e/ADU: 1.5*

2. *Enter CCD readout noise in e/px: 10.5*

3. *Enter name of input photometry file: outfile*

4. *Enter name of coordinate file*: *coo*

4.1 *Enter number of column with RA: 1*

4.2 *Enter number of column with DEC: 2*

4.3 *Enter number of column with ID: 3*

4.4 Type "y" if there is a column with color indices and then enter column ID. In our example, there is no such column.

NB:

Check the absence of an empty line the end of coordinate file, otherwise an error will occur: "ERROR: number of stars in the coordinate file and in the photometry file is not equal. Please check format of files!".

5. *Enter ratio of bad stars in the frame to mark the frame as bad*

Bad stars are stars with the standard deviation of their magnitudes bigger that one mag or mean theoretical error less than 0.002 mag.

Frame marked as bad if there are more bad stars that entered ratio. Astrokit will not reduce such frames.

Example:

Enter ratio of bad stars in the frame to mark the frame as bad (bad stars / all stars = 0.1, 0.5, etc): 0.35

All frames are good!

Enter ratio of bad stars in the frame to mark the frame as bad (bad stars / all stars = 0.1, 0.5, etc): 0.01

2 bad stars from 56 on frame #67; Frame is marked as bad

2 bad stars from 56 on frame #68; Frame is marked as bad

2 bad stars from 56 on frame #69; Frame is marked as bad

6. *Use median filtering? (y/n)*

There is a possibility to use simple median filter. Enter "y" for it.

7. Astrokit corrects the brightness variations caused by variations of atmospheric transparency: to this end, the program selects for each star an individual ensemble of reference stars having similar magnitudes and positions in the frame.

7.1 *Enter initial distance in arcminutes for stars to align (recommended 5 arcmin): 5*

7.2 *Enter max magnitude difference for stars to align (recommended 2 mag): 2*

8. *Enter sigma criteria (magnitude stdv/theoretical error; recommended 2): 2*

After composing the initial ensemble, the standard deviation from the mean magnitude is computed for all stars and the star with the greatest standard deviation is flagged. If the standard deviation from the mean magnitude is more than twice greater than the mean theoretical photometric error averaged over all frames (we call this the cutoff ratio of the sigma criterion), which can also be varied, the star is removed from the ensemble, and the procedure of brightness correction is repeated from beginning.

If after all stars with large standard deviations are removed the ensemble contains less than 10 stars, the size of the ensemble domain is increased by 1 arcmin and all the above steps are repeated. The correction of instrumental magnitudes is thus an iterative process, which is repeated until the ensemble contains more than nine stars or the search radius increases to 30 arcmin.

9. *Enter ROMS criteria for variable stars (recommended 1-3): 1*

The RoMS criterion allows estimating the variations of the object brightness. If it exceeds one, the star is considered to be a suspected variable.

10. Information about the number of variable stars found (variable stars), constant stars (constant stars) and stars classified as bad (bad stars) are shown at the end.

Total number of stars = 2837

bad stars = 80 (2.8%)

variable stars = 151 (5.3%)

constant stars = 2606 (91.9%)

11. In working directory (its name are the coordinates of the center of studied field) Astrokit creates directory with following files:

clear_mag_all – file with corrected magnitudes of every star on every frame. In file header there are stars ID. There can be no more than 256 stars in each file.

raw_mag_all – file with raw magnitudes of every star on every frame.

clear_mag_var – file with corrected magnitudes of every *variable* star on every frame.

err_all – file contains:

– ID of each star (ID);

– mean corrected magnitude of each star (mean_mag);

– number of stars in ensemble used to correct stars magnitude (ens_star);

– radius of ensemble in arcminutes where reference stars were found (dist);

– standard deviation of corrected magnitude of each star (stdv);

– theoretical error of measurement of stars magnitude (mean_err);

– RoMS value (RoMS);

– coordinates of star (RA(deg), DEC(deg), RA(h:m:s), DEC(d:m:s)).

raw_err_all – this file contains raw data:

– ID of each star (ID);

– mean raw magnitude of each star (mean_mag);

– standard deviation of raw magnitude of each star (stdv);

– theoretical error of measurement of stars magnitude (mean_err)

– coordinate of each star (RA(deg), DEC(deg), RA(h:m:s), DEC(d:m:s)).