

Feedback from users of software tools

T-PHOT and EGG

INAF – OAR for the Astrodeep project



ASTRODEEP

"Unveiling the power of the deepest images of the Universe"

THEME [SPA.2012.2.1-01]

[Exploitation of space science and exploration data]

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ABSTRACT

In this document we provide a brief summary of the procedures that we followed to validate our software within the collaboration and information on their release. We also include direct feedback (collection of emails) from internal users about the functionality and reliability of the developed tools. This feedback has been used by the software creators to analyze and debug the code before making it available to the wider astronomical community

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*Prepared by: E. Merlin, C.
Schreiber*

Approved by: AEC

Date: 16/12/2015

1. T-PHOT: Feedback from users

E. Merlin started developing the code T-PHOT during the summer of 2013, combining existing software (namely TFIT and CONVPHOT) in a new architecture, and beginning to add new features and options (e.g. the so called *cells-on-objects* fitting method, and the option to use analytical models as input high resolution priors). The new code turned out to be a factor of ~ 100 in computational speed when compared to existing similar codes. A first beta-version of the software was ready in the autumn of 2013 and was tested by E. Merlin and OAR members (M. Castellano, A. Grazian, S. Pilo, A. Fontana) as well as by a few external collaborators (K. Huang, M. Song).

The first ASTRODEEP internal release of the code dates back to April 2014; N. Bourne, C. Schreiber, M. Castellano, V. Bruce, F. Buitrago, T. Wang, X. Shu, K. Okumura, K. Huang, M. Song, A. Mortlock, D. McLoed, R. McLure and others have helped finding and correcting bugs, and the first stable version of the code (1.5.7) has been publicly released in October 2014. T-PHOT has been presented at the XXIV ADASS conference, and the code has been available for downloading from the ASTRODEEP website ever since, with the latest public version (1.5.11) released in March 2015. A paper describing the code by E. Merlin et al. has been published on *Astronomy & Astrophysics* (ref. 2015A&A,582A,15M).

Currently ~ 90 users have downloaded T-PHOT from the ASTRODEEP website, and new requests are constantly submitted. The code is being used routinely by many researchers worldwide, and the first papers reporting results obtained using it are beginning to be submitted to scientific journals.

A new version of T-PHOT is under development and testing; it includes many new features and options, many of which have been included after requests by users and collaborators (e.g. on-the-fly background subtraction, flux prioriting to freeze faint sources in FIR processing, circular aperture photometry, individual kernel fitting, residual image statistics, etc.), and it will be probably included in the Euclid processing pipeline.

In [appendix A](#) there is a selection of email interactions with users, illustrating the process.

2. Simulation tools – summary of internal testing

The current simulation process consists of two tools: the *EGG*¹ (Empirical Galaxy Generator) is used to create mock galaxy catalogs, while *SkyMaker* is used to produce the corresponding images. We summarize below the various tests and corrections that were undergone within the Astrodeep collaboration on both these tools.

The mock galaxy catalogs were first produced with *Stuff*. However, using these catalogs to produce far-infrared images showed a number of flaws in this approach, including imperfect number counts in the optical domain and incorrect stellar mass function at high redshifts. For this reason, C. Schreiber introduced the *EGG* software to replace *Stuff* (see email 1 for details). The quality of the catalogs produced by this new tool has been assessed by E. Merlin and M. Castellano on multiple occasions. In particular, they first noticed that the number counts in the simulated catalogs overpredicted the observed counts in CANDELS GOODS-South (email 2). This was mostly caused by an inconsistent definition of the angular size of the galaxies' disk (email 3), and later interaction (during the Paris meeting in May 2015) revealed a smaller mismatch in the definition of the galaxy stellar mass function, which is the starting ingredient of *EGG*.

In the mean time, *EGG* was released internally to the collaboration on the 23rd of March 2015. Several members of the collaboration checked that it could be properly installed on a variety of operating systems (N. Bourne, T. Wang, E. Merlin), including both Linux and MacOS. A number of portability issues were fixed as a consequence of these tests (e.g., email 4).

Lastly, *EGG* and *SkyMaker* were tested on wide fields in preparation for the Euclid simulations. C. Schreiber and E. Merlin found a bug in the code of *SkyMaker* that prevented the creation of large images (the bug has been reported to E. Bertin and is now fixed). Also, M. Castellano and E. Merlin reported a new mismatch in the simulated number counts at bright magnitude (email 5), which was fixed by correcting the mass-to-light ratios of low redshift galaxies (email 6).

In [appendix B](#) there is a selection of email interactions with users, illustrating the process.

¹ This program was initially called “gencat”, then “Ifni”. “EGG” is the final name that was adopted in the Astrodeep Edinburgh meeting in November 2015.

Appendix A

Da: "Mimi Song" <mmsong@astro.as.utexas.edu>
 Oggetto: Fwd: [Fwd: TPHOT v1.0]
 Data: Ven, 7 Febbraio 2014 6:23 am
 A: emiliano.merlin@oa-roma.inaf.it
 Cc: stevenf@astro.as.utexas.edu

Dear Emiliano,

Hi, I'm Steve's student, Mimi Song. First, THANK YOU so much for putting your efforts in developing tphot.
 I'm very impressed by how cleverly you designed to upgrade tfit.

- installation on OS X

1) alloc.h
 I got tphot v0.1 from Steve a few days ago, and had time to install it on Mac OS X.
 But I got an error while running install.sh/install.py, which is caused by a missing "error" function in "alloc.h". This is the exactly same error that I got when I tried to install Andrea's dilation code on OS X a while ago, and a simple workaround to solve this is to delete a few lines in alloc.h. But before taking that risk of deleting a memory allocation related function (though I already did for test run), I wonder if there's any other way to fix it. /So I wonder if tphot has ever been tested on OS X, and if you have the solution for the error that I'm having. If not, could you find the "error" function that's called and send it to me so that I can take a look at?/

2) maybe-too-trivial-but-worth-stating-in-the-document-thing

Besides what is mentioned in the document, I had to change the first line of Makefiles for OS X.

- pixel scale of lores image

Anyway, I managed to install it and test-run it with HST/WFC3 and IRAC image, which has a pixel scale of 0.06"/pix and 0.6"/pix, respectively. But I found some weird behavior in convolution stage, and tracing back, I found that current version assumes lores image has the same pixel scale as that of hires image (so scale_factor should be 1).
 I noted that in convolve.py, you commented out lines dealing with "scale_factor" which probably was something in the early developing stage, so /I wonder if you're planning to implement this later/. Even if not, that's fine, but I thought it would probably better to state it explicitly in the parameter files and document that lores image should be resampled in advance, as this is a new feature compared to the old tfit (it's possible that you mentioned this already but I missed it, though). Besides that, it runs just beautifully. It took a couple of hours to run tphot on ~30000 sources, which originally took over a several days.

Thank you again for this great code, and please feel free to let me know if you need any help on test.

Thanks,
 Mimi

```
> *From:* "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
> <mailto:emiliano.merlin@oa-roma.inaf.it>
> *Date:* January 31, 2014 at 12:29:46 PM CST
> *To:* stevenf@astro.as.utexas.edu <mailto:stevenf@astro.as.utexas.edu>
> *Cc:* adriano.fontana@oa-roma.inaf.it
> <mailto:adriano.fontana@oa-roma.inaf.it>
> *Subject:* *[Fwd: TPHOT v1.0]*
>
>
> Hi Steve,
> here is the TPHOT (TFIT 2.0) code at its present stage of development.
> Dwdl the tarball, put it in the dir you prefer, untar, enter the tphot
> subdir and in the README file you'll find the instructions to compile,
> install and run the code. It should be quite straightforward, however of
> course please tell me if you have any trouble.
>
> The parameter files you will find are already set to TFIT-like settings,
> so in principle to run TPHOT in standard mode you'll only have to change
> the name of the input files (detection and measure images, segmentation
> map, detection catalog, measure rms image, convolution kernel). Again, ask
> me for any clarification.
>
> Let me know how it goes and please report any bug or trouble, it will be
> of great help to me.
> Best,
> e.
```

Da: "Kuang-Han Huang" <kh Huang@ucdavis.edu>
 Oggetto: Re: TPHOT v1.3
 Data: Gio, 13 Marzo 2014 6:30 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

Hi Emiliano,

Thanks for all the testing! I'm glad that you are making progress. Let me know if there is any other test I can do to help.

Cheers,

Kuang

Kuang-Han Huang, Ph.D.
 Postdoctoral Scholar
 Department of Physics, UC Davis
 kh Huang@ucdavis.edu
 astrokuang@gmail.com

On Mar 13, 2014, at 4:25 AM, "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it> wrote:

> Hi Kuang,
 >
 > I corrected a couple of bugs I found in TPHOT and in attach you see the
 > result for the 2nd TPHOT pass I'm obtaining now. It is clearly much better
 > and similar to the TFIT one, although a few differences remain (I'd say
 > TFIT residuals are still slightly better in some regions). So I'm going to
 > work on it again and keep you posted, however I'd say we're on the right
 > trail. Btw: I don't remember whether I told you, but for now please set
 > the dancefft parameter on False since the FFT correlation give worse
 > results.
 > Ciao
 > E.
 >
 >
 >
 >> Hi Emiliano,
 >>
 >> Here I attach the results from 2nd pass of TFIT v.s. TPHOT, both run on
 >> IRAC chl images of the Bullet Cluster. The TFIT settings are close to the
 >> default ones, especially it was run in 100x100 cells (unlike TPHOT, which
 >> I ran the entire image in one cell). Both runs use exactly the same input
 >> (high-res and low-res) images and PSF kernels.
 >>
 >> It looks like TPHOT residual is slightly worse than the TFIT residual.
 >> There are a lot of challenges to run TFIT in such a crowded field, and the
 >> non-uniform background (likely from intra-cluster light) make background
 >> subtraction extremely hard. To prepare the input image in this run, I
 >> subtracted the median local background around one of our z~7 LEG
 >> candidates, so that background is not representative of the entire field.
 >> That is probably why we see a sea of faint, negative sources in the
 >> residual image. But if we just focus on the residuals of the bright
 >> sources, it seems to me that the TPHOT residuals show larger astrometric
 >> shifts than TFIT residuals. I'm not sure how much of it is
 >> fitting-all-in-one-cell (TPHOT) v.s. fitting-within-smaller-cells (TFIT),
 >> but I think you probably have done lots of tests yourself using much
 >> better behaved images.
 >>
 >> Using cluster images as diagnostics for TPHOT is probably not ideal, but
 >> it provides another type of real-world example of how TFIT will behave
 >> other than the CANDELS images, which have much more uniform background. In
 >> the short term, what I'm planning to do is running TFIT just around the
 >> high-z galaxy candidates in IRAC. But in case I need to run artificial
 >> source simulations, the blazing speed of TPHOT will be of tremendous value
 >> for us.
 >>
 >> Let me know if I can provide more information to help your work on TPHOT!
 >>
 >> Kuang
 >>
 >>

Da: "Kuang-Han Huang" <kh Huang@ucdavis.edu>
 Oggetto: Re: TPHOT problem with multikern
 Data: Mer, 26 Marzo 2014 5:57 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

Hi Emiliano,

OK, this time it works! I also compared the TPHOT results (residual image from pass 2) with my previous successful runs and they look identical. So it looks like this problem is resolved for now.

Thanks a lot for your help! Is there anything in particular about TPHOT that you're working on right now (other than solving the bugs I found)?

Kuang

On Mar 26, 2014, at 3:12 AM, Emiliano Merlin <emiliano.merlin@oa-roma.inaf.it> wrote:

```
> Uhm, it seems the problem was due to a wrong determination of the template
> final dimensions. Weird it didn't crash on my machine, but I'm quite used
> to software magics. :)
> Try out the new convolve.c in attach and let's see what happens...
> Thanks a lot for your help Kuang!
> Ciao
> e.
>
```

Da:	"Mimi Song" < mmsong@astro.as.utexas.edu >
Oggetto:	Re: [Fwd: TPHOT 1.3]
Data:	Mer, 2 Aprile 2014 1:22 am
A:	"Emiliano Merlin" < emiliano.merlin@oa-roma.inaf.it >

Hi Emiliano,

Sorry for this very late reply, I was away for a while. I saw Adriano's email, and I'm glad that tphot is finally on the stage distributable to the team members.

I tested the new version of tphot that you sent me about a week ago (hope it's still the latest version), and it seems to work fine! (with different pixel scales)

I'm attaching plots that compare 1) tphot vs tfit and 2) tphot vs Guo+13 catalog on HUDF IRAC ch1 data. As you can see, tphot and tfit now have negligible difference at least for bright sources, unlike the last version of tphot. I believe the offset in flux error seen in my tphot run vs Guo+13 is because Guo+13 applied some additional factor in flux error. I tested "single fit" and "cells-on-objects" and two seem to be consistent.

I'm running tphot on GS, GN Ks, ch1, ch2 bands, and I'll email you if I find something noticeable.

Thanks,
Mimi

Da:	"Corentin Schreiber" < corentin.schreiber@cea.fr >
Oggetto:	Re: TPHOT
Data:	Ven, 4 Aprile 2014 10:48 am
A:	"Emiliano Merlin" < emiliano.merlin@oa-roma.inaf.it >

Hi Emiliano,

I just installed and tested TPHOT on Linux Mint 14.

My first comment would be: do you know CMake? It would make the installation step a bit easier, and would allow TPHOT to run on a variety of platforms without too much trouble. I.e. : on your side, you just write (almost) platform independent scripts, and the users don't have to manually edit Makefiles. The build process is quite simple:

```
mkdir build & cd build
cmake ../ # will warn if any dependency is missing & build Makefiles automatically
make # build the program
sudo make install # install the program in chosen location (default: /usr/bin for example)
```

Anyway. I'm not a regular python user, so I was missing a lot of things. First I needed the "python-pip" package from the Ubuntu repositories to run the "sudo pip install .." command:

```
sudo apt-get install python-pip
```

Building TPHOT was successful on first try (good job!).

Trying to run the test sample, I figured I was missing "pylab" from another python package named "scipy" (it's huge!):

```
sudo pip install scipy
```

That was not enough, I also had to install matplotlib. For some reason it failed at first, I needed to update "distribute" :

```
sudo easy_install -U distribute
Then :
sudo pip install matplotlib
```

And that's it. The test program now runs correctly: the output was identical to the one in the "output_check" directory. The log file is attached.

A few side notes:

- 1) On Ubuntu, cfitsio and fftw3 are also in the repositories:
`sudo apt-get install libcfitsio3-dev libfftw3-dev`
 Because they are installed in system locations, there is no need to manually specify the include and link directories.
- 2) "sudo" is not necessary (and not recommended) to run `install.sh` (nor `install.py` I would guess).
- 3) Calling "tphot" with no argument triggers a python error. Common behavior in this case is to print the name & version of the program along with a short help text. I think it would be nice, as it would give a more polished feeling to the whole thing ;)

Thanks for your work,
 Corentin.

Da: "Stefanon, Mauro" <stefanonm@missouri.edu>
 Oggetto: Re: TPHOT tests
 Data: Lun, 14 Aprile 2014 6:23 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
 Cc: "Yan, Haojing" <yanha@missouri.edu>

Hi Emiliano,

I have uploaded to dropbox the outputs from the tests with tphot on EGS/IRAC. You should be able to download the data from:

https://www.dropbox.com/sh/u5xnmzgwjjfe4t7/_pAciP9eD6

Let me know if you need anything else.

In the root directory you will also find a plot of the magnitude differences between tfit and tphot for each channel. They look a bit weird, especially at the very faint end. I would have expected that, once the flux decreases, the spread in the difference of mag increases, but, as you will see, after a certain point the spread between the 2 magnitudes decreases again, becoming 0 for the faintest sources.

The installation was ok. I just found a typo in the Macrodefs.darwin. The last line is:

```
INCDIR = -I ../include -I /path/to/cfitsio/include # insert here path to
cfitsio/include dir
```

but I guess it should read as (and worked this way)

```
INCDIR = -I ../include -I /path/to/cfitsio/include # insert here path to
cfitsio/include dir
```

i.e. there is an extra space between "-" and "I" when setting the second include path.

Finally, a suggestion. As it also happens with tfit, in the wcs module one can disable the assert check on the non-diagonal WCS matrix elements (CD_1_2..). This will allow for running the tfit/tphot on images with the RA and Dec not necessarily aligned to the image x and y, *provided* that the high-res and low-res images have the same alignment (i.e. same position angle). If I recall correctly, this works because the relative pixel scale is read as a parameter from the configuration file, and it is not computed from the wcs CD1_1 or CD2_2.

Cheers,
 m.

Da: "Steven Finkelstein" <stevenf@astro.as.utexas.edu>
 Oggetto: Re: TPHOT availability
 Data: Mer, 23 Aprile 2014 7:19 pm
 A: "Fontana Adriano" <adriano.fontana@oa-roma.inaf.it>
 Cc: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>,"Casey Papovich" <papovich@tamu.edu>

Thanks Emiliano. Yes, we would definitely be willing to be part of a controlled test, with only a few people involved here at UT and/or Texas A&M (with Casey). I'll look forward to hearing back from you.

- Steve

On Apr 23, 2014, at 12:01 PM, Fontana Adriano <adriano.fontana@oa-roma.inaf.it> wrote:

```
> Ciao Steve (& Casey),
>
> yes Emiliano was quite glad of the feedbacks from Mimi.
>
> The final goal is of course making it fully public, once fully tested.
> For your SDSS project, I will talk with Emiliano tomorrow, but my first reaction
is that we're happy, I am really curious to see how it behaves - it may be
interesting for our plan of porting it to Euclid.
> I would only request that it is still "controlled", i.e. it is used by a set of
people who remain in touch with Emiliano to report feedback and bugs etc, and that
it's not distributed further around before we make it public.
```

```

> Just to avoid that something not yet fully tested spreads around..
>
>
> More on this tomorrow, as I have a chance to talk with Emiliano.
> A.
>
>
> On 23/apr/2014, at 18:40, Steven Finkelstein <stevenf@astro.as.utexas.edu> wrote:
>
>> Hi Adriano,
>>
>> I had a question regarding the ultimate public availability of TPHOT. We've been
>> very impressed with the speed of TPHOT compared to TFIT, and it looks like Mimi
>> has helped Emiliano iron out some of the bugs.
>>
>> We're interested in using this eventually for a non-CANDELS project - we're doing
>> a 28 deg^2 imaging survey in SDSS Stripe 82, which will ultimately have
>> spectroscopy from HETDEX. Right now we have both DECam optical and IRAC infrared
>> imaging over the full field. Our plan was to use TFIT to measure IRAC fluxes for
>> the DECam sources, but our individual DECam pointings are ~3GB in size, so this
>> would be extremely time consuming.
>>
>> If you're willing to have TPHOT testers outside of CANDELS, we'd be interested in
>> applying TPHOT to this project. We understand if not, but in that case, we were
>> wondering when/if you were planning to make this software public.
>>
>> Thanks,
>> Steve
>

```

```

Da: "SHU Xinwen" <Xinwen.Shu@cea.fr>
Oggetto: RE: FW: TPHOT
Data: Lun, 9 Giugno 2014 5:48 pm
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

```

Fantastic, this is a big jump, awaited..:)

-X.W.

```

From: Emiliano Merlin [emiliano.merlin@oa-roma.inaf.it]
Sent: Monday, June 09, 2014 6:28 PM
To: SHU Xinwen
Subject: RE: FW: TPHOT

```

Sure, your visit comes at the right time :)
 In the meantime, I replaced the python script with a faster C code, and
 included the possibility to process mixed (resolved+unresolved) catalogs.
 We'll see how it works on Wednesday
 See you
 E.

```

> Hi, Emiliano,
> Sorry for my late reply. Yes, we (I and Tao) will visit you on
> Wednesday and Thursday.
> I checked that now our results are in good agreement, though not
> exactly the same and several outliers
> with difference by a factor of two (see attached). I have no idea at
> present why such difference still appears, as both our templates
> are now identical enough. Maybe we can discuss it more when we are in
> Rome.
>
> Looking forward to seeing you in Rome.
>
> Xinwen

```

```

Da: "Alice Mortlock" <alicem@roe.ac.uk>
Oggetto: Re: TPHOT question
Data: Lun, 23 Giugno 2014 5:49 pm
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

```

Hello,

I've figured it out! It turns out some of the values in the weight maps
 are negative which they shouldn't be.

Sorry for wasting your time on something so silly!

Thanks so much for your help :)
 Alice

```

On 23/06/14 17:07, Emiliano Merlin wrote:
> Dear Alice,
> the error is due to something being wrong in the RMS image, which I can't

```



```
> open with ds9 and which has the following header:
> Header listing for HDU #1:
> SIMPLE = T / Written by IDL: Mon Jun 23 15:15:19 2014
> BITPIX = 8 / Number of bits per data pixel
> NAXIS = 1 / Number of data axes
> NAXIS1 = 75 /
> EXTEND = T / FITS data may contain extensions
> DATE = '2014-06-23' / Creation UTC (CCCC-MM-DD) date of FITS
> header
> COMMENT FITS (Flexible Image Transport System) format is defined in
> 'Astronomy
> COMMENT and Astrophysics', volume 376, page 359; bibcode 2001A&A...376..359H
> END
>
> In particular, having NAXIS1 different from NAXIS1 of the measure image,
> and having NO NAXIS2 (!), plus missing all the other required keywords,
> TPHOT is VERY unhappy. ;)
>
> Ciao
> E.
>
```

```
Da: "Koryo Okumura" <koryo.okumura@cea.fr>
Oggetto: Fwd: Run fastphot with fits
Data: Lun, 1 Settembre 2014 7:33 pm
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
```

Hallo Emiliano,

So I am now back and I want to do the test I said below before this weekend. Can you give me a set of fits files you used so I can try with Fastphot here? The S/N=100 is the one which gave offsets. Do you still have the corresponding fits files and the positions?

Thanks,
Koryo

Begin forwarded message:

```
> From: OKUMURA Koryo <koryo.okumura@cea.fr>
> Subject: RE: Run fastphot with fits
> Date: August 6, 2014 11:27:56 AM GMT+02:00
> To: Emiliano Merlin <emiliano.merlin@oa-roma.inaf.it>
>
> Hi Emiliano,
>
> Hmm, this is intriguing... Maybe I can use your simulated images to run it with fastphot and see if there appears an offset this time with fastphot..! But, all this will be in September!
> I will get in touch with you then.
>
> Thanks,
> Koryo
```

```
Da: "OKUMURA Koryo" <koryo.okumura@cea.fr>
Oggetto: Tphot result
Data: Ven, 5 Settembre 2014 11:16 pm
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
```

Hi Emiliano,

As expected the result from Tphot has no offset. So it is consistent!

Cheers,
Koryo

Allegati:

emilianoNewTphot.ps	
Dimensione:	235 k
Tipo:	application/postscript
Info:	emilianoNewTphot.ps

Da: "Kuang-Han Huang" <kh Huang@ucdavis.edu>
 Oggetto: Re: New version available: T-PHOT 1.5.10
 Data: Mar, 13 Gennaio 2015 7:24 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

Hi Emiliano,

Thanks so much for the fast response!

I think we've figured out what's going on here. There are actually two user errors on our side:

1. The input hi-res catalog had two columns (X_WORLD, Y_WORLD) that TPHOT doesn't recognize, so TPHOT was reading the wrong values for FLUX_ISO. I think that's what caused the "holes" in the center of cutouts, especially for bright objects.
2. We were using the wrong RMS map that contained too much shot noise from bright sources (among other things). We've figured out the issue and used a more reasonable RMS map and the residual is now much better---at least there isn't a sea of negative fluxes anymore!

I'm attaching a screen shot of the new residual image after fixing the above two issues. I think our PSF kernel is too broad, so there are systematic hot cores in the residual image, but at least this is something I understand and I can work on.

Thanks so much for your help (and I finally upgraded to TPHOT v1.5.10!)

Cheers,

Kuang

--

Kuang-Han Huang
 Postdoctoral Research Fellow
 Department of Physics, University of California Davis
kh Huang@ucdavis.edu

On January 13, 2015 at 12:48:22 AM, Emiliano Merlin
emiliano.merlin@oa-roma.inaf.it wrote:

... and the segmentation map also :)

```
> Hi Emiliano,
>
> I hope everything is going well for you!
>
> Recently I ran into an issue with TPHOT that I've never seen before and
> perhaps you know what is going on. I ran TPHOT on IRAC images around a
> lensed quasar with Subaru SuprimeCam r-band image as the high-resolution
> prior. There are a few bright stars within the field but I don't really
> care about them. Then I realized that TPHOT produces cutouts for the
> bright stars with "holes" in the center that look like the attached image.
> In the TPHOT output catalog there are a lot of negative fluxes for fainter
> sources surrounding the bright ones. I'm worried that the cutout issue
> with bright sources will affect the fits for the nearby fainter sources
> (which I DO care), and the negative holes in the center of bright sources
> looks like a numerical artifact to me. Have you ever seen this before?
>
> I have also attached the input, model (collage), and residual IRAC images
> as the input and output from TPHOT. Object 117, circled in the input IRAC
> image (at the upper-right corner), has a negative hole in the cutout image
> (from Subaru r-band). I also attach an image of the Subaru r-band image
> that I used as the high-resolution prior. As you can see from the collage
> image, several other bright sources also have negative holes in their
> centers.
>
> Thanks a lot,
>
> Kuang
>
>
> --
> Kuang-Han Huang
> Postdoctoral Research Fellow
> Department of Physics, University of California Davis
> kh Huang@ucdavis.edu
>
> On January 12, 2015 at 5:30:01 AM, Emiliano Merlin
> emiliano.merlin@oa-roma.inaf.it wrote:
>
>
> Dear T-PHOT user,
> a new version of the code is available. Please download it at this link:
> http://www.astrodeep.eu/t-phot-1-5-10-tarball/
> Password: 12Jan2015AD33p
>
> T-PHOT 1.5.10 features:
> Corrected a bug in priors blending detection algorithm and a problem in
> the naming convention of point-source catalogs
>
>
```

>

Da: "Roberto Avila" <avila@stsci.edu>
 Oggetto: Re: TPHOT installation
 Data: Ven, 20 Marzo 2015 7:33 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

OK, the test ran correctly.
 I will use the package with the modified file you provided. Thanks a lot for your help.

Roberto

On Mar 20, 2015, at 12:28 PM, Emiliano Merlin

<emiliano.merlin@oa-roma.inaf.it<<mailto:emiliano.merlin@oa-roma.inaf.it>>> wrote:

I tried funcns_walk_out.cc and the test finishes, but the results are different. The cutouts directory seems to be missing.

Please do like this:
 - remove the cutouts directory from the test directory, and also remove any LRI_SingleFit* directory you have in the test directory;
 - run the test (be sure the "order" keyword in the file test.param begins with "cutout,", and that the "fitting" keyword is "single");
 - you should have a new cutouts directory in the test directory and a LRI_SingleFit directory with all results. Is it like that?

When I use funcdc_walk_out.cc the lores_tphot.cat_pass1 file has 0.000 in columns 10 & 11.
 I'm attaching the tpipe_tphot_1.log file from that run.

Yes, I made it write like that. You can use t-phot for your purposes like that, columns 10 and 11 are just check entries and won't change your photometry results. This while we try to understand what's going on with the true code of course. :)

e.

I'm using Mac OSX, 10.9.5

Roberto

Da: "Nathan Bourne" <bourne@roe.ac.uk>
 Oggetto: Re: tphot issue
 Data: Mer, 25 Marzo 2015 12:51 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

Thanks, I can try those options at least. I feel a bit more encouraged if these times sound reasonable to you.

By the way, do you expect the "clip" option to add anything much to the computation time?

Also, is there any benefit in me upgrading to the latest version for running TPHOT in this mode?

cheers,
 Nathan

On 25 Mar 2015, at 11:09, Emiliano Merlin <emiliano.merlin@oa-roma.inaf.it> wrote:

>
 > Hi Nathan,
 > well, fitting in single cell mode a very crowded image can take quite a
 > lot of time. For example, I'm doing some fits using Guo H band catalog as
 > prior list (35000 sources) on IRAC images of 2000x2500 pixels, and it
 > takes 4 days, so 16 hours is completely reasonable for your problem. The
 > issue is that single cell fitting gives the most accurate results but
 > convergence is quite hard to reach for crowded regions. You could try to
 > use the cells-on-objects method, but since most of the sources are blended

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> each cell is going to be very large so probably computational times won't
> decrease (you can give it a try however...).
> The only solution to this problem would be to find out a way to
> parallelize the chi square minimization, which is on the "far future todo
> list". ;)
>
> (Suggestion: try putting the RMS outside your region of interest to 1000.
> I have put a threshold in tphot so that if a source has RMS higher than
> 100 it will be excluded from the fitting process).
> E.
>
>
>> Hi Emiliano
>>
>> I'm having some difficulties running TPHOT on a large 850um map and I
>> wondered if I'm doing something wrong, or if there's anything I should try
>> to do differently.
>>
>> The problem is that it is taking a very long time to obtain a fit. It gets
>> to the message "Beginning fit in SingleCell mode / Please hold on..", and
>> then it can take up to 16 hours to obtain a fit. I imagine that it is
>> simply having difficulties converging. I have tried the three linear
>> solvers but the default LU seemed to be the best. The results once it
>> finally finishes don't seem to be obviously bad, although there are some
>> high values in the covariance matrix which makes me think that perhaps
>> it's just that my catalogue is too crowded/clustered. Do these computation
>> times sound reasonable to you or do you think there is a problem?
>>
>> Here are the details of my data:
>> 3667x3520 map @ 2arcsec per pix ~ 4 sq deg
>> Mask area = circular region in centre of map ~2.8M pixels = 0.86 sq deg (I
>> set the map to zero and the rms to 99 outside of this, so there is a lot
>> of wasted space - could this cause problems?)
>> Beam size = 14arcsec FWHM => ~50000 beams within the mask, and I'm trying
>> to fit this data with around 10000-15000 point-source positions, so it is
>> quite crowded, although not much worse than the runs I have done on the
>> much smaller 450um maps.
>>
>> I've also attached a parameter file in case there's something wrong in my
>> setup. I'm currently running version 1.5.10.
>>
>> Any thoughts you might have on this setup would be welcome.
>>
>> thanks,
>> Nathan
>>
>>

```

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Da: "Fernando Buitrago" <fb@roe.ac.uk>
Oggetto: comments on TPHOT paper draft
Data: Mer, 8 Aprile 2015 4:33 pm
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
Cc: astrodeep-all@oa-roma.inaf.it

```

Ciao Emiliano,

needless to say that TPHOT is a wonderful program and you have worked a lot. This is my list of suggestions for your paper:

MAJOR COMMENTS

=====

-I would add the word "deconfusion" both to the abstract and the conclusions. Besides, it might be good to show more examples at different PSF sizes, i.e., not (almost) only focussing in the case deconfusing IRAC using HST. One of the TPHOT assets is its versatility, you can use the same code for deconfusing many kinds of data and this feature is great.

-Even though you created the Section 3.3 and the Figures 15 and 16, it is (in my opinion) unclear by looking at this paper how much TPHOT improves TFIT and CONVPHOT results. You pointed out that the biggest advantages are computational time and lower fluxes due to better neighbour light treatment. However, I miss things as showing (for instance) galaxy SEDs in which TPHOT output really makes a difference as regards with which galaxy template you should use (and any possible generalisation of those cases). Ideally, we should test everything using mock surveys, but I guess this is a further step using Corentin's program and the GALFIT GOODS-S results.

MINOR COMMENTS

=====

ABSTRACT

-There is a lack of quantification, especially at the end of it. Imagine you are the person reading it: could you give a number about how fast is TPHOT? (say for example, giving this and this conditions, TPHOT is up to 10x faster than TFIT). Could you tell what are the paradigmatic cases in which TPHOT retrieves different solutions in comparison with TFIT or CONVPHOT?

INTRODUCTION

-When you speak about about TPHOT is the next generation code after TFIT and CONVPHOT, I miss a description/enumeration of which features are being taken of each code.

-In the footnote, I would say "multi-wavelength" instead of "multi-frequency": we are not radio astronomers.

SECTION 2

-Add a footnote with the webpage where the user can download TPHOT. Other software

oriented questions: What is the TPHOT licence? Would you release the code for modifying TPHOT at will? Would you provide any support to the users?
 -I believe our model for publishing TPHOT should be GALFIT webpage, although this is very big owing to the fact it has developed through many years. However, a dedicated TPHOT webpage "a la GALFIT" with less sections might be useful (containing, very importantly, tips for its usage).

SECTION 2.1.1

-What about if the image is in counts, energy units or other units rather than counts/s?

SECTION 2.2

-Flags' details should be on the appendix in my opinion.

Figure 3, 4 and 5

-The images look poor. For starters, you should utilise the logarithmic scale on all the science and model images throughout the paper, in order to enhance low surface brightness features. However, for residuals, you should better use a linear scale, playing with the contrast to show clearly the pixels where we struggle to get an optimal solution. Of course, the choice of scales should be highlighted in the caption, to tell the reader that the residuals have been worsened on purpose (because if they were displayed on logarithmic scale, they would appear inexistent).
 -Additionally, although these images do not contain any science information per se, I would like to display more information about them, at least a bar to give an idea about the image size.
 -Figure 5 seems to be one of my old renditions of COSMOS, because the dark squares are very small for the very bright objects. Could you use any other image in which the stamps were enlarged for the higher signal-to-noise objects? If you don't have any, I could provide you with it.

SECTION 3.1.2

-When you speak about the limiting magnitude and you say that it was set equal to the zero point, do you mean that the noise is set to 1 count or that the objects you are taking into account for your analysis have a minimum flux several times this 1 count value?
 -You write that, in Figure 8, the solid black line (which btw I cannot see) is consistent with zero down to $S/N=0.63$. Could write explicitly where is the noise in Figure 8? (for example, add a dashed black vertical line in the figure). In addition, when you say that all sources have a measured flux 2σ from their "true" flux, do you mean that they are contained within the -2 to 2 values of the y-axis? If so, could you call it sigma or just Δ_f ?
 -In the next paragraph, you quote a magnitude. Wouldn't it be better to use magnitudes in the x-axis instead of \log_f ? We are observational astronomers, when speaking about galaxies we are used to see magnitudes in the plots. You can convert from fluxes to magnitudes assuming your zero-point.
 -"The bottom line of this analysis..." -> I like this paragraph but it lacks a quantification: could you speak about a certain combination of both covariance index and flags?
 -"Even in this much more complex..." -> you speak in this phrase about "some flagged sources". It is vague. Could you write explicitly how many objects out how many total objects?
 -I like the paragraphs "The second histogram compares..." and "In summary, it is clear that...".
 -You need to argue why Figure 9 and 10 are representative of the problems the user is going to find when running TPHOT. So far, it is unclear why you use the two examples and only these two examples.
 -Figure 9 looks a little messy. Perhaps aligning everything or creating plots of the same size would help (I use the xfig program). In addition, top left image would benefit enormously from using the logarithmic scale (I can see only two objects the way it looks now) and the bottom left plot axes are very hard to read.
 -Both in Figure 10 and Figure 12 it's odd that the y-axis (Δ_{flux}) is only positive. You stated before that TPHOT retrieves values that are usually smaller than the ones derived from TFIT and CONVPHOT (and thus I would naively expect the y-axis to be negative). But here the tendency is reversed (unlike in Figure 13) and the plotted points are asymmetric, i.e., the scatter of the points only goes in the positive direction. Why is this happening?

SECTION 3.2

-I don't understand the "global effect" and Figure 14.

FIGURE 16

-I cannot see anything.

APPENDIX

-Could you please detail every parameter in the input files "id x y xmin ymin xmax ymax background SE_x flux"?
 -I don't understand how galfit2tphot works.

Do not hesitate to reply in case you have any questions. Thank you for making me a co-author of your paper. Best,

Fer

ps. Figure 1 is wonderful for selling your work in talks. It reminds me to the figure in the first page of "Le Petit Prince", you know that one in which the author speaks about when he was a child. He drew a similar shape and, instead of a hat, in reality it was a snake that has shallowed an elephant. You can tell the audience that, using TPHOT, either you find the right fluxes in the LRI or a snake that has shallowed an elephant :D

/*****/
 Fernando Buitrago

Da: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
 Oggetto: Re: T_PHOT issues unresolved priors
 Data: Mer, 27 Maggio 2015 1:31 pm
 A: "Peter Hurley" <P.D.Hurley@sussex.ac.uk>

Dear Peter,
 thanks for downloading and trying out T-PHOT.
 From what you say I understand the PSF and the maps have different pixel scales, and I guess this may be the cause of the error because for T-PHOT the PSF should have the same pixel scale as the LRI. The error message you report me would at first seem unrelated to the issue, but a similar problem never arised before so I would first of all try to bin down the PSF to the image pixscale.
 Cheers
 E.

> Dear Emiliano,
 > I am trying to use tphot to carry out source extraction on Herschel
 > SPIRE maps, with a 24 micron catalogue as a prior (hence unresolved
 > point like priors option).
 >
 > Unfortunately, I am running into a bit of trouble.
 >
 > I provide as input the low resolution image, the low resolution error
 > map, and a PSF of the SPIRE beam (but on a 1 arcsecond pixel grid
 > compared to 6 arcsecond pixel grid used for the maps).
 >
 > I have the code installed properly, with the test running correctly,
 > however when I run with my inputs, the code fails on tphot_psf with error:
 > FITSIO status = 320: illegal number of dimensions
 >
 > Having delved into the code, I find its failing when reading in the PSF
 > fits file. From my naive understanding of the code it would appear its
 > due to the 'Width' and 'Height' not being set before reading in the psf
 > file in psf.c (line 103).
 >
 > Any suggestions or assistance would be greatly appreciated,
 > Many thanks,
 > Peter Hurley
 >
 >
 > On 12/05/2015 13:09, Emiliano Merlin wrote:
 >> Thanks for your request!
 >>
 >> You can download T-PHOT from this direct link:
 >> <http://www.astrodeep.eu/t-phot-1-5-11-tarball/>
 >>
 >> Password: 20Mar2015AD33p
 >>
 >> For any issue on downloading, installing or using T-PHOT, or for
 >> comments
 >> and suggestions, feel free to contact emiliano.merlin@oa-roma.inaf.it
 >>
 >>
 >>
 > --
 > Dr Peter D Hurley
 > Research Fellow & HELP Project Scientist
 > Pevensey III, 4C14
 > Astronomy Centre, Dept of Physics & Astronomy
 > University of Sussex, Falmer, Brighton BN1 9QH
 >

Da: "Ken-ichi Tadaki" <tadaki@mpe.mpg.de>
 Oggetto: Re: tphot
 Data: Lun, 8 Giugno 2015 11:14 am
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

Dear Emiliano,

As you say, the issue was solved after rough background subtraction.
 Many thanks for your quick response.
 I will surely cite your paper when publishing our results.

Best regards,
 Ken

> Dear Ken-Ichi,
 >
 > I believe the problem comes from the fact that the IRAC image is not
 > correctly background subtracted. If you check void regions, you will see a
 > constant value of ~-0.004 counts/s/pixel. I tried a run on an image
 > crudely obtained adding a constant 0.004 to your LRI and the residuals
 > look much better (see attached plot: new residual on left, your residual
 > on right, same scale). As of the 1.5.11 version, t-phot does not perform
 > background subtraction on its own (it will in a new upcoming release).
 >
 > Also, please consider making a double pass run (I would set dzonesize=50

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> and maxshift=4 in the paramfile of pass1 for your test case) to minimize
> kernel misregistration effects.
>
> Let me know if this cures your issues.
> Best,
> E.
>
>> Dear Emiliano,
>>
>> Thank you so much for your quick response.
>>
>> These pixel scales are actually same ('`interpolation= nearest'' is used
>> when position matching).
>>
>> - K-band image
>> CD1_1 = -7.4555559300000E-5
>> CD2_2 = 7.45555593000001E-5
>> - IRAC image
>> CD1_1 = -7.4558909772933E-5
>> CD2_2 = 7.45599926123024E-5
>>
>> Do you find any other problems?
>>
>> Best regards,
>> Ken
>>
>>>
>>> Dear Dr. Tadaki,
>>> LRI and HRI have different pixel scales (looks like IRAC pixscale = 2* K
>>> pixscale) so you should either bin down the IRAC image to the K pixels
>>> scale (e.g. using Swarp) or set the keyword "relscale" to 2 in the
>>> paramfile. In this case, note the kernel should be in HRI pixscale.
>>> Let me know if this fixes your issue,
>>> Best
>>> E.
>>>
>>>> Dear Dr. Emiliano Merlin,
>>>>
>>>> I used the tphot software you developed.
>>>> IRAC ch1 photometries were measured using K-band HR images in UDS.
>>>> But the output seems not to be correct for faint sources.
>>>>
>>>> Could you look at the input files I used and tell me what is wrong?
>>>>
>>>> Best regards,
>>>> Ken
>>>>
>>>>

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Da: "Nathan Bourne" <bourne@roe.ac.uk>
Oggetto: 450/500um results for TPHOT paper
Data: Mer, 10 Giugno 2015 10:14 am
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
Cc: astrodeep-all@oa-roma.inaf.it

```

Hi Emiliano

Regarding the referee's comment on testing TPHOT in the submm, I'm attaching four figures for you, I don't know if you'll want to use them all, but let me describe them and we can discuss what to use. I have tried to produce plots in a similar style to what is already in the paper for a consistent appearance.

Results at 450 and 500um using 24um priors:

residuals_450_500_fit24priors.eps
 Top row: SCUBA-2 450um image (left) of the COSMOS-CANDELS field and Herschel 500um image (right) of the same region with the same scaling. Lower row: residuals of the two images after running T-PHOT with 24um priors. In order to remove the background in each fit, T-PHOT was run to create a residual map, then the modal pixel value of the residual was subtracted from the raw map and T-PHOT was re-run on the result. After two iterations the background was fully removed.

fluxdiff_450_500_fit24priors.eps
 Comparison of fluxes measured in the T-PHOT fits to the 450-mum and 500-mum maps at 24um prior positions. Error bars combine the errors on both flux measurements. The solid (and dashed) lines indicate the mean (+/- standard deviation) in bins. Agreement within the errors implies successful deconfusion of the 500um image (PSF 36 arcsec FWHM) to reproduce the fluxes measured in the higher-resolution 450um image (PSF 7.5 arcsec FWHM). We find no bias in the flux measurements, although 26 per cent of sources have 500um fluxes that deviate from the 450um measurement by more than 3-sigma. This indicates that the error bars do not fully account for the uncertainties, and there is residual confusion noise in the map due to sources not present in the prior list.

Next: the same thing but with additional priors from 850um:

residuals_450_500_fit24850priors.eps
 Top row: SCUBA-2 450um image (left) of the COSMOS-CANDELS field and Herschel 500um image (right) of the same region with the same scaling. Lower row: residuals of the two images after running T-PHOT with priors combining sources detected at 24um and 850um (representing low- and high-z galaxies respectively). Note that the model has now removed all significant sources from the 450um map and the majority from the 500um map.

fluxdiff_450_500_fit24850priors.eps
 Comparison of fluxes measured in the T-PHOT fits to the 450-mum and 500-mum maps at 24mum+850mum prior positions. Error bars combine the errors on both flux measurements. The solid (and dashed) lines indicate the mean (+/- standard deviation) in bins. Note that the scatter is larger than in the model with only 24mum priors, but this scatter is now better accounted for by the error bars, because the confusion noise is better accounted for with the more complete prior list. The number of 500mum fluxes that deviate from the 450mum measurement by more than 3-sigma is reduced to 13 per cent.

Please let me know what you think, whether you want anything changed, etc.

Nathan

Da: "Nathan Bourne" <bourne@roe.ac.uk>
 Oggetto: Re: Error in TPHOT
 Data: Ven, 26 Giugno 2015 4:17 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

Yes, this seems to work :D
 What did you fix?

On 26 Jun 2015, at 16:05, Emiliano Merlin <emiliano.merlin@oa-roma.inaf.it> wrote:

```
> Uhm, maybe I have a clue. Try with these new files (both in
> lib/src/fitter_src/)
>
>
>
>> Here it is.
>>
>> Actually there are some outputs (lores_tphot.covar_pass1_1,
>> lores_tphot.cat_pass1_1, lores_tphot.cell_pass1_1, templates). So it must
>> be getting close to the end before it fails.
>>
>> cheers
>> N
>>
>>
```

On 26 Jun 2015, at 14:55, Emiliano Merlin

```
>> <emiliano.merlin@oa-roma.inaf.it> wrote:
>>
>>> Ok. BUT, if you put all 1.6.1 files EXCEPT funcs_walk.cc, you get the
>>> error. So it's some other routine of the *cc files, which is weird since
>>> I
>>> expect an earlier crash if it's like that. I have put some marks in the
>>> routine, go back to the 1.6.1 version and use this one, and send me the
>>> log. Thanks :)
>>> E.
>>>
>>> (I suppose it does not produce any lores_tphot.cat_pass1* , right?)
>>>
>>>
>>>
>>>> Yes, all from 1.6.1 except for convolve.py and fit.py which are the
>>>> newer
>>>> versions you sent me.
```

Da: "Vishal Joshi" <onlyvishal@gmail.com>
 Oggetto: Re: Seek help for TPHOT
 Data: Mer, 26 Agosto 2015 5:40 pm
 A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>

It's working... Fantastic... I will play with the parameters to get best out of it.
 Thanks a lot again for continuous guidance.

Regards,
 Vishal.

Dr. Vishal Joshi
 Post Doctoral Fellow,
 Inter-University Centre for Astronomy & Astrophysics (IUCAA)
 Pune

On Wed, Aug 26, 2015 at 9:40 PM, Emiliano Merlin <emiliano.merlin@oa-roma.inaf.it> wrote:

```
>
> Yes, make a second paramfile with
> order positions, fit, diags, archive
> and
> multikernels true
>
> Also, change consistently the output names (where a "pass1" is present
> change it to "pass2").
>
> Note that depending on the degree of inaccuracy you find in your first
> pass output you might want to modify the maxshift keyword in the first
> pass paramfile, i.e. allowing for larger PSF registration shifts if
> necessary.
>
> Cheers
> E.
>
> > I have checked the output. It seems that the second pass is required as
> > PSF
> > positions are not very accurate. Do I need to write another param file in
> > the same directory for second pass? Can you suggest me the changes in
> > parameters for second pass?
> >
> > Regards,
> > Vishal.
> >
> > Dr. Vishal Joshi
> > Post Doctoral Fellow,
> > Inter-University Centre for Astronomy & Astrophysics (IUCAA)
> > Pune
> >
> >
> > On Wed, Aug 26, 2015 at 9:24 PM, Vishal Joshi <onlyvishal@gmail.com>
> > wrote:
> >
> >> Great... TPHOT finishes without error...
> >> I will check the output.
> >>
> >> Please confirm that header WCS keyword values like CRPIXn, CRVALn,
> >> CDn_n,
> >> CTYPE will have no effect in my case.
> >>
> >> Regards,
> >> Vishal.
> >>
> >> Dr. Vishal Joshi
> >> Post Doctoral Fellow,
> >> Inter-University Centre for Astronomy & Astrophysics (IUCAA)
> >> Pune
> >>
> >>
> >> On Wed, Aug 26, 2015 at 9:19 PM, Emiliano Merlin <
> >> emiliano.merlin@oa-roma.inaf.it> wrote:
> >>
> >>>
> >>> Absolutely right, this bug too is fixed in forthcoming version. Please,
> >>> just add two keywords XOFF 0 and YOFF 0 to the header of your image.
> >>> By the way, you should already have a first pass fit, if you want to
> >>> check
> >>> the basic outcomes - it has crashed in the dance stage, after the fit.
> >>> Let me know how it goes,
> >>> Cheers
> >>> E.
> >>>
> >>>
```

Da: "Nathan Bourne" <bourne@roe.ac.uk>
 Oggetto: TPHOT background fitting
 Data: Ven, 4 Settembre 2015 2:42 pm
 A: astrodeep-all@oa-roma.inaf.it

Dear all

I will not be able to attend the telecon next week due to holidays, so instead I will describe here what I've been doing over the summer.

Emiliano had adapted TPHOT to fit a constant sky background as a free parameter. This is important for confusion-limited submm maps because the background cannot simply be measured in regions free of sources, and in general the image is scaled to have zero mean so there is therefore an arbitrary negative background behind all the positive sources. The value is just not a property of the map but also of the prior catalogue, because it depends on how much of the image is resolved into sources in the TPHOT model, and how much is left behind as part of the residual background.

I ran some tests to check that the background subtraction achieved by TPHOT is accurate. For my SCUBA2 work I am interested in the average fluxes of very faint sources so it's crucial to get the background subtraction right to very high precision, hence I have taken some care to convince myself of that. First of all I compared against the method I had previously been using, which was to run TPHOT (without any background fitting) iteratively, each time subtracting from the image a background estimated from the residual of the previous iteration. This method

seemed to converge very well when the prior list was not too dense. The results from BG fitting and from the iteration method agree reasonably well for the same images and catalogues, within a tolerance of about 0.1mJy or better. The actual value of the background subtracted can be anything from about -0.2mJy at 450 or 850um to around -6mJy at 350 or 500um, but it depends on how dense the priors are in relation to the beam of the image.

As an acid test I then ran source-injection simulations. In each realisation I would add one point source to the real map (so as not to affect the overall map statistics), then run TPHOT with the position of the fake source added to the prior along with all the real priors. Input fluxes were drawn from a distribution that was uniform in log flux between 0.01 and 10mJy.

The statistics of output-input flux show some skewness, which is to be expected because most injected sources land on faint regions of the map but a few will land on top of bright sources. Generally I find that median offsets of output-input flux are slightly negative, but by no more than -0.3mJy (450um). The overall mean output-input is often close to zero, but can be biased by sources with large errors in the covariance matrix. The inverse-variance-weighted mean of output-input is very close to zero (within a tolerance of 0.05mJy), and I think this is the most reliable indicator, at least for the purposes of the paper I'm working on. There is no significant trend in the offsets as a function of input flux, but obviously on an individual basis, output fluxes are subject to random noise at a level comparable with the instrumental RMS of the PSF-convolved image.

For an example, in the attached plots I show some of the statistics of the output-input fluxes (all in mJy) in a 450um map, where I have run 1000 realisations of injecting sources with fluxes between 0.01-10mJy. Overall the results seem very encouraging and I am fairly convinced of the accuracy of the background fitting. As I said, unfortunately I won't be around to discuss this next week since I'm going on holiday, but can discuss at a future telecon.

cheers,
Nathan

Da: "Victoria Bruce" <vab@roe.ac.uk>
Oggetto: Tphot fits with multiple component models
Data: Ven, 11 Settembre 2015 3:05 pm
A: "Emiliano Merlin" <emiliano.merlin@oa-roma.inaf.it>
Cc: "fbuitrago@oal.ul.pt" <fbuitrago@oal.ul.pt>,"Derek McLeod" <mcleod@roe.ac.uk>

Hi Emiliano,
After the terrible communication during the telecon today I thought I'd update you on what we're doing in Edinburgh in terms of multiple component models for input into TPHOT.

At the moment we're working internally on running single Sersic, and multiple component models through TPHOT to see how much of a difference the actual input models make to the fitted fluxes in IRAC. Essentially we just want to test whether investing any more effort into the double component modelling is worthwhile. So right now we're running through bulge only, disk only, 2 component and just point source models to see if for example, by the time we get to IRAC everything is so point source dominated anyway the fluxes would be best represented by just this simplest of fits, or whether the increased freedom in double component models really does make a difference fitting to the morphological changes in these systems across the H band to IRAC ranges.

Derek is currently helping out with this as one of our resident Edinburgh TPHOT runners, but he's never used TPHOT with the model inputs before so he might be in touch soon with some questions about how best to run with that setup and some specifics about the catalogue input format etc.

Fer - I'm having another look at some of our models for the same objects and I'm digging out a few test cases where things are drastically different between our models to see if we can track down why that's happening and what best represents the data in those cases, so I'll be in touch next week about that, but don't worry if you're busy I realise things must be super chaotic right now :)

All in all we hope to present the results of these tests at the meeting here in November.

Cheers,
Victoria

Appendix B

Email 1

From: Corentin Schreiber
To: ASTRODEEP collaboration
Date: 19/01/2015

Dear all,

As we discussed during a previous telecon, there was some issue with the clustered positions I generated for the mock catalog. These were too clustered compared to the observed catalogs. I have now understood why, and fixed the issue. The problem was that I overestimated the uncertainties on the photometric redshifts, which lead me to dilute too much the clustering when comparing my simulated positions to the real ones.

However, when you fix a problem, it's always to discover another one... ;) The new issue is that, without this strong clustering, I cannot reproduce anymore the Herschel SPIRE pixel distributions starting from the Astrodeep optical mock catalog. I have investigated in more details the mock catalog, and apparently the reason is that the mass functions are not properly reproduced at $z > 2$. In particular, the mock catalog is lacking massive star forming galaxies, which produce the bulk of the SPIRE emission at these redshifts.

So I have looked at the Stuff program, trying to see if there was an easy way to fix this, but as you know the documentation is scarce. Therefore, I decided last week to extend the program I wrote to generate FIR catalogs, in order to generate a full mock catalog from scratch ranging from the optical to the FIR. I call it, without much poetry, "gencat". This new mock catalog, generated using gencat, includes positions, redshifts, stellar masses, SFRs, morphological parameters, and of course fluxes in any band from the UV to the FIR. The fluxes are decomposed between disk and bulge components, so as to mimic the output of Stuff: this way, one should be able to use the resulting catalog directly in Skymaker to produce accurate optical images.

Then I used this program to produce a new mock catalog. Now, the FIR fluxes are in agreement with the observed ones in all the Herschel bands, which should not come as a surprise. I was also able to correctly reproduce the magnitude distribution in all NIR bands (from z to IRAC channel 4). The situation in the UV-optical is not perfect yet, but now that I understand the tool, that should be fixable if need be ;)

I have written a report that you will find attached to this email, where I explain in detail the methodology. The end of the PDF also provides the figures where I show the agreement between the mock catalog and the observed fluxes in GOODS-South. Unfortunately I don't think I ever had a full version of the current mock catalog produced by Stuff, with all the optical fluxes. I would have liked to compare the two.

Anyway, that was just an experiment to see if it was feasible to replace Stuff in a relatively easy way, in order to better control the catalog-building process, and still have a good quality mock catalog. I am now convinced that this is true, but I do not want to push more on this without having your opinion on the subject.

Do you think it is worth exploring this option any further, or do you consider that you have already spent a lot of time with Stuff on your side, and that it would be a waste of time trying to change this again? I guess I can also come up with a way to compensate for the missing massive galaxies in the current mock catalog, so as to properly reproduce the SPIRE counts even with the wrong mass functions.

Also, since this program was developed within and for Astrodeep, David suggested that we could present it in an Astrodeep paper, maybe in the one where we describe the simulations. But we are not sure what was the plan here, initially: is somebody in Rome working on a simulation paper? Or was it supposed to be part of the T-PHOT paper? Note that gencat could be distributed within Astrodeep in complement to T-PHOT.

Cheers, and see you soon,
Corentin.

Email 2

From: Marco Castellano & Emiliano Merlin
To: Corentin Schreiber
Date: 28/04/2015

Hi Corentin,

we have been working on the production of the images using your Gencat catalogs, but we are having troubles in reproducing the expected number counts from the SExtracted catalog as compared to the Candels ones. The first attached plot shows the counts on the H160 image, compared to those from CANDELS (total magnitudes; black: Candels, red: simulation normalized to the same area).

We checked if this could be due to A) the generation of the image from the catalog with SkyMaker (e.g., wrong noise level) or B) the SExtraction procedure, but it seems both steps are ok. We checked the S/N (second attachment; total magnitudes; red: simulation, black: Candels) and it seems roughly consistent with Candels, and the T-phot measured flux for fake point sources in void regions, obtaining a distribution peaked around 29 as expected (third attachment; total mag at 1sigma). Also, we checked on the simulated image that there is no obvious failure in detecting evident sources.

So, we are speculating that the effect might be due to a wrong size distribution, i.e. an excess of too extended sources. Indeed, we found some examples of even bright sources (H=25-26) which have low surface brightness because of their large radii, so they are not detected by SExtractor (see attached examples: for each object there are the simulated image with its segmentation and with the "input noise-free" image).

What do you think about this?

Ciao
 Emiliano&Marco

Email 3

From: Corentin Schreiber
To: Marco Castellano & Emiliano Merlin
Date: 29/04/2015

Great, thanks! Now I think I have figured it out.
 SkyMaker expects a "scale length" R_h for the disk ($n=1$) component, while I output "half light radius" R_e .
 According to the Galfit documentation: $R_e = 1.678 \times R_h$

So I we should modify the skymaker catalogs to divide the disk radii by this factor 1.678, so that SkyMaker interpret this correctly. I will update the code and send you back updated catalogs. In the mean time, can you check that indeed it would make sense for the two galaxies we compared?

The bulge components are ok though, SkyMaker does use the effective radius here, so there is no correction to be made.

Corentin.

Email 4

From: Nathan Bourne
To: Corentin Schreiber
Date: 08/04/2015

Hi Corentin

I downloaded the tar files again and it seems to work now on both machines with very little fuss. On the linux box, because I don't have root access, I just had to specify the install prefix and PHYPP root dir in the options to cmake. On the Mac I installed it to /opt/local (which is where most programs seem to get installed on OSX) and I just had to be logged in as root (using "sudo bash", since su doesn't work on OSX, and sudo'ing each command led to problems writing files).

All seems to be working now.

cheers
Nathan

Email 5

From: Marco Castellano & Emiliano Merlin
To: Corentin Schreiber
Date: 19/11/2015

Ciao Corentin,

we were looking at wide field simulations with Ifni and compared the output of a 50 sq.deg. simulated catalogue to SDSS number counts in different bands (see attachments). We are finding that there is a sharp cut at the very bright end, and a mismatch at "intermediate" magnitudes. What do you think? Is the cutoff possibly related to the $10^{12}M_{\text{sun}}$ cut in the MF you use or maybe a volume cut of some kind? Cheers,

M&E

Email 6

From: Corentin Schreiber
To: Marco Castellano & Emiliano Merlin
Date: 26/11/2015

Fix is now figured out, and has been committed to the online repository.

I'll talk about in more detail in the coming days, but my conclusion is that my recipe to generate UVJ colors did not work well at $z < 0.5$ and produced bluer colors than what is observed (I confirmed that by studying the GAMA catalogs). Therefore I was overestimating the L/M ratios at low redshifts (by a factor of ~ 2 in J band), hence producing too much flux.

Cheers,
Corentin.