

Topic : Psf Creation Using PHOSIM

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Date : Jun 24, 2016

Last update : Sep 13, 2016

1. Create background file for Phosim

Program : a1_create_background.py

Inputs :

Outputs : backgrounds/background1.bkg

The physics_command for the phosim software is chosen with following modifications:

pixelsize 1.5

saturation 0

blooming 0

chargesharing 0

The location of this background file is:

backgrounds/background1.bkg.

Here, we are disabling the saturation effect. If we turn on saturation (value 1) we will get psf that looks like a comet with a tail.

2. Create seds for instance catalogs of Phosim

Program : a2_create_seds.py

Inputs : sed_flat.txt

Outputs : seds/broadband.sed and narrowband*.sed

Sed files are the wavelength(nm) versus flux(ergs/cm²/s/nm) datafiles. The given sed sed_flat.txt ranges from 300 nm to 1210 nm and flux decreases in a curve from 6.6×10^{-6} to 1.6×10^{-6} .

This program creates 21 sed_files from the given input_sed_file. It also normalizes the flux at wavelength 500 nm (after rescaling down by the factor of 100). The broadband wavelength range is 531-696 nm, which was chosen from LSST r-band filter such that transmission is NOT $\leq 5\%$. The range 531-696 is broken into 21 pieces and corresponding narrowbands are created. For example: *narrowband0.sed* has NON_ZERO flux for wavelength range 531 nm to 538.9 nm, including at 500 nm, and all the flux for rest of the wavelengths are zero.

We can plot and observe the nature of the sed files.

3. Create instance catalogs for Phosim

Program : a3_create_instance_catalogs_seed.py Inputs : seed
Outputs : instance_catalogs/broadband.icat and instance_catalogs/broadband*.icat

This program creates 21 narrowband instance catalogs and one broadband catalog inside the folder instance_catalogs.

These instance catalogs are required by Phosim software.

4. Run the phosim software to create unnormalized zipped PSFs

Program : a4_run_phosim_all_catalogs.py Inputs : instance_catalogs/.icat & sed/sed & backgrounds/background1.bkg
Outputs : phosim_output_zipped/broadband_out/17_zipped_psf_fitsfiles AND narrow bands.

This script run the phosim software command:

```
cd ~/phosim;  
./phosim instance_catalogs/required_instance_catalog.icat  
-c Research/psf_creation/backgrounds/background1.bkg  
-o Research/psf_creation/outputs
```

N.B. phosim is installed at ~/phosim

```
.icat is instance_catalog file : e.g. narrowband0.icat  
-c is physics_command file      : e.g. background1.bkg  
-o is output_folder             : e.g. outputs
```

To run phosim command we need an instance_catalog, background is optional.
All the paths are relative to phosim installation directory.

For the each input instance catalog, the phosim software gives
16 zipped output amplifier psf fitsfiles and
1 zipped electron image psf fitsfile.
We need this electron image and may not need amplifier images.

Estimated time to run 21 catalogs: 2 hours
(for sed_flat.txt)

5. Unzip zipped psf files created by Phosim

Program : a5_unzip_all_psf.py Inputs : phosim_output_zipped/*
Outputs : phosim_output_unzipped/psf*.fits

This program will unzip all the psf files into the output directory.

6. Normalize unnormalized psfs created by Phosim

Program : a6_normalize_phosim_psf.py Inputs : phosim_output_unzipped/psf.fits
Outputs : *phosim_normalized_psf/psf.fits*

This program will make sum of all the pixels in the all psf files equal to that of psf10.fits.

6a. Check the sum of all pixels of normalized and unnnormalized psfs

Program : a6a_psf_sum_all_pixels.py Inputs : phosim_output_unzipped/psf.fits
& *phosim_normalized_psf/psf.fits*

This program will print sum of all pixels of normalized and unnormalized psfs.

7. Create weighted psf

Program : a7_weighted_normalized_psf.py Inputs : phosim_normalized_psf/psf*.fits
Outputs : weighted_psf.fits

This program will create a weighted average of input 21 normalized psf files within the weight range 1.0 to 1.2. The weight range 1 to 1.2 are the average flux ratio of 100 f606 and f814 galaxies. (refer: ~/phosim/simdatabase/average_flux_ratio.py)

8a. Check the difference between sum_of_narrobands_psf and broadband_psf

Program : b1_sum_narrowbands.py Inputs : phosim_output_zipped/*_out/electron_image
Outputs : phosim_output_zipped/narrowbands_sum.fits

This program will create a narrowbands_sum.fits

8b. Check the difference between sum_of_narrobands_psf and broadband_psf

Program : b2_create_difference_fits.py Inputs : narrowbands_sum.fits and broadband.fits from phosim output dir Outputs : phosim_output_zipped/difference.fits

The difference.fits should have small count and no any particular structure.

9. Plot sed files

Program : c1_plot_sed.py
Inputs : sed_flat.txt or, seds/broadband.sed, etc.
Outputs : input + '.png'

- The plot of sed files (wavelength vs flux) for sed_flat.txt looks like monotonically decreasing curve from value $(6.6-1.6) \times 10^{-6}$ ergs cm⁻² s⁻¹ nm⁻¹.

