PHOTOMETRIC CONVOLUTION

The PACS and SPIRE instruments aboard Herschel are able to perform photometric observations in a total of 6 bands, with characteristic wavelengths of 70, 100 and 160 micron and 250, 350 and 500 micron for PACS and SPIRE respectively. Due to the difference in PSF FWHM between these bands, comparing images obtained at different wavebands can be complicated and can result in non-representative color ratios. To correct for this, images should be convolved to a common PSF, being the one of the image obtained at the lowest angular resolution (i.e. the largest PSF FWHM, highest wavelength).

The Photometric Convolution task is able to automatically do this in HIPE, offering multiple options as to the convolution kernel to be used, being either a precalculated rotationally symmetric kernel (Aniano et al. 2011, PASP, 123, 1218, arXiv:1106.5065v2 [astro-ph.IM]), a Gaussian kernel generated from the beam characteristics or a user submitted custom kernel. The convolution kernels are normalized as to assure flux conservation. To further facilitate image comparison, the convolved image is finally regridded to the WCS of the second image.

HIPE task plugin

Installation of the plug-in

To install the plug-in, select "Plug-ins" from the Tools menu in HIPE, click "Install new plug-in" and paste the URL provided on the plug-in page. If successful, upon restarting HIPE a new task named PhotometricConvolution will be listed in the "Tasks" workbench window under the categories "General" and "Image". *Note that this task is only compatible with HIPE tracks starting from the 10.1500 build and onwards.*

Task parameters

- input:
  - map1 [SimpleImage]: The original image, which is to be convolved with the kernel.
  - map2 [SimpleImage]: The image to which PSF map1 is to be convolved to.
  - kernelSelect [String] (optional): The type of kernel to be used. Possible string values are: 'Premade kernel (online)', 'Create Gaussian kernel' and 'User input kernel'. When using a premade or Gaussian kernel, all necessary information for the loading or respectively generation of the kernel will be automatically obtained from the map1 and map2 metadata, or prompted for when unavailable.
  - customKernel [SimpleImage] (optional): A user defined custom kernel. This will only be used if kernelSelect is set to 'User input kernel'. When selecting a custom kernel, the task will present the user with the option of rotating the selected kernel in accordance with the scan angle used in the observation.

- output:
  - convMap1Regrid [SimpleImage]: The convolved map1 image, regridded and rescaled to match the WCS of map2.

All of the image parameters are SimpleImages, being the standard HIPE image read-in filetype.

Execution of the task

The photometric convolution task, as any HIPE task, can be either executed from the console or using the HIPE built in GUI. For execution from the console enter a command in the manner of:

```
convMap1Regrid = convolvePhotometric(map1, map2 [,kernelSelect, customKernel]).
```

Here map1 and map2, being the original image to be convolved with the kernel and the image to which PSF map1 is to be convolved to respectively, are mandatory parameters (SimpleImages) and kernelSelect and customKernel are both optional. Allowed string values for kernelSelect are 'Premade kernel (online)' (default), 'Create Gaussian kernel' and 'User input kernel'. The optional SimpleImage customKernel will only be used when the kernelSelect parameter is set to 'User input kernel'.

An even easier execution method is using the HIPE GUI. This is done by selecting (double clicking) the task in the workbench window, and adding the parameters by dragging the loaded SimpleImages from the "Variables" window towards the grey dots. The type of kernel to be used can be selected from the drop-down menu. After this the task can be started by pressing the "Accept" button and the progress can be monitored in the "Execution Status" part of the GUI window.

Script version

For users preferring a normal script version as opposed to a HIPE task, there is a Jython script of the Photometric Convolution available as well. The main difference with the task version is that it is a lot more interactive by means of a custom GUI in getting info from the user. Input images don't need to be SimpleImages anymore, but can be directly loaded from locally stored .FITS files. Maps created with Scanamorphos, which have a different layout than normal HIPE processed maps, can be loaded and read in correctly as well. Finally, observations can be loaded directly from the Herschel Science Archive, by interactively providing an obsid number and selecting which level and waveband to use of the observation (available ones are printed in the console). The convolved and regridded map is saved locally as a .FITS file automatically as well.

SPECTROSCOPIC CONVOLUTION

PACS spectral observations are often made in the wavelength range around a certain characteristic line. By integrating the spectral cube around this line, one can obtain line flux maps. Except for being spatially undersampled (due to the IFS nature of the PACS instrument), these line flux maps are in a way similar to regular photometric images. To obtain so-called line ratio maps, comparing line fluxes around different spectral lines, the maps can be convolved to a common PSF, just as in the photometric case.

The Spectroscopic Convolution task operates much in the same way as the Photometric Convolution, below we list the major differences.

Kernel selection

The options for the convolution kernel are the same as for the photometric case, being 'Closest premade kernel (online)', 'Create Gaussian kernel' and 'User input kernel'.

Due to the finite number of premade kernels available, the task will automatically select the closest available kernel for the observations spectral bands and line wavelengths. For the Gaussian kernel, the beam information is obtained from the HIPE calibration tree and interpolated to match the line flux maps wavelengths before generating a Gaussian convolution kernel.

Metadata

Considering there are no clearly defined universal keywords for line flux maps metadata yet, chances are the user will be prompted to input spectral observation band (B2A, B2B, B3A or R1 for PACS) and line wavelength manually.

Background substraction

Before performing the convolution, the background of the line flux map1 is calculated as the median pixel value and substracted from the map. After successfully convolving with the kernel, the background is added again to the convolved map. This is done because of the small size of the line flux maps, where edge effects due to FFT convolution can become a much larger factor than is the case for normal photometric maps.

Script version

Just as for the photometric task, there is a normal Jython script version of the Spectroscopic Convolution available as well. However, as line flux maps are processed from spectral cube products, there is no option to automatically load maps from the HSA or import Scanamorphos maps.