Prototype of spectrum extraction for point sources

Sara Regibo

Abstract

The spectrum extraction algorithm starts from a PACS cube containing a spectroscopic observation of a point source of which we want to extract the spectrum (in an optimal way). This document describes the prototype of the algorithm and improvements foreseen for the future.

The prototype can be found under herschel.pacs.toolboxes.spg.SpectrumExtractionTask.

1. The prototype

In the prototype it is assumed that the point source is nicely centered in the middle of the central spaxel (i.e. module 12), so no corrections have to be applied to the data (see section 3).

The first step is the construction of a wavelength grid, which is done by the WavelengthGridTask from the herschel.pacs.spg.spec package. The user can choose to apply oversampling (1x or 3x) and/or upsampling. The result is a list of wavelengths that will be used in the final spectrum, together with the minimum and maximum wavelength of the corresponding wavelength bin. Note that the width of the wavelength bins is wavelength dependent, as the resolving power depends on the wavelength. Also jumps in RA (from 360 to 0) have to be corrected for.

Once these steps are taken, the actual extraction of the spectrum can take a start. The program loops over all wavelengths and determines for each of them which spaxels from the input PACS cube contribute to the spectrum.

Now consider one specific wavelength. A spaxel contributes to the spectrum at this wavelength if its wavelength is contained in the wavelength bin corresponding to the considered wavelength. For this wavelength, we have a list of intensities and corresponding weights, and we will use this to determine the signal at this wavelength.

The determination of the weight of a specific pixel is done using a PSF-image (given as input for the algorithm), centered at the middle of module 12 and rotated in the same way as the detectors on the sky. The sky coordinates of the spaxels are determined and the corresponding area on the PSF-image is integrated and the result of the integration is used as weight for the spaxel.

As we construct a list of intensities and weights for each wavelength, multiple methods can be used to determine the signal in the spectrum at each wavelength. The prototype offers average, median and sigma-clipped median.

2. Usage

The following parameters should be given as input for our algorithm :

- PacsCube cube → the PACS cube containing the point source
- Boolean oversample (by default : true) → whether to oversample (3x) or not
- Double upsample (by default : 3.0) → the upsample factor
- PacsCal calTree (optional) → the PACS calibration tree
- SpecProperties specProperties → the spectrometer properties
- SimpleImage psf → an image describing the PSF

The output of the task is

- Spectrum1d average → the average spectrum
- Spectrum1d median → the median spectrum
- Spectrum1d sigmaClipped → the sigma-clipped median spectrum

The algorithm can be run in HIPE like any other task in the HCSS.

3. Improvements for the future

In the future we would like to use a wavelength dependent PSF, instead of a single PSF-image for the whole wavelength grid. Another important step is to correct for the fact that the point source is almost never centered in the middle of the central spaxel. As the point source is offset in the dispersion direction, we expect the spectral line to get skewed, a change in line flux, central wavelength and width of the profile. This is under investigation and follow-up observations are needed.