Realistic synthetic observations from radiative transfer models

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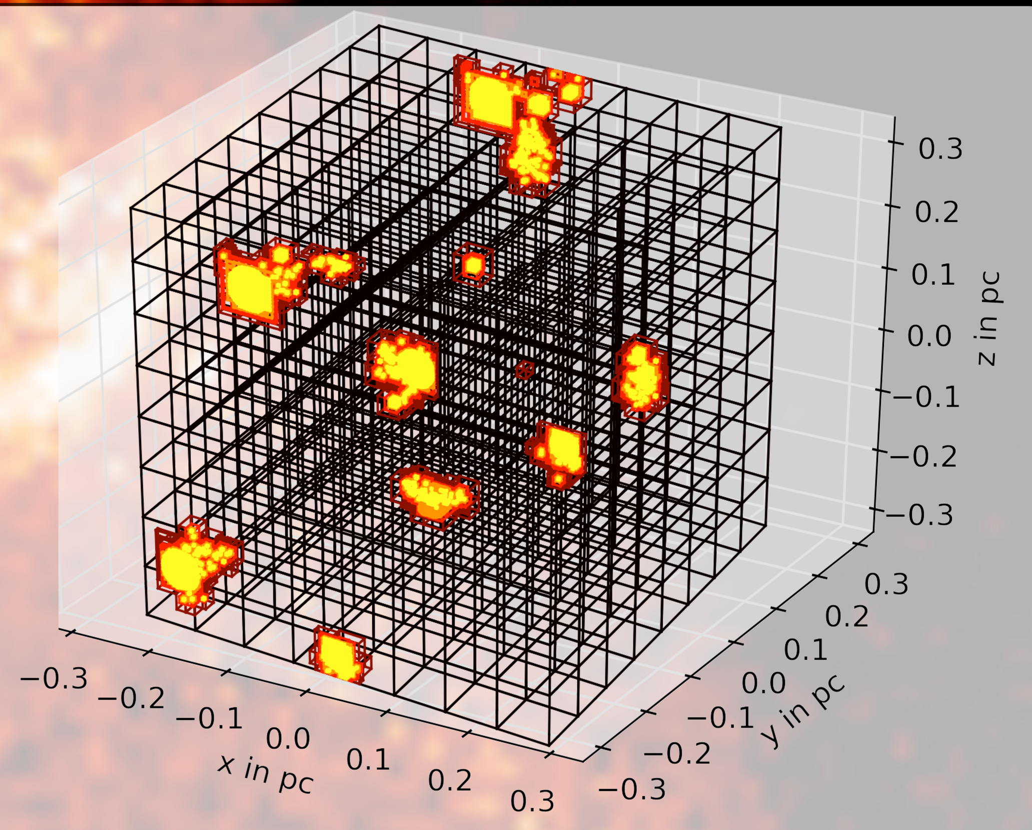
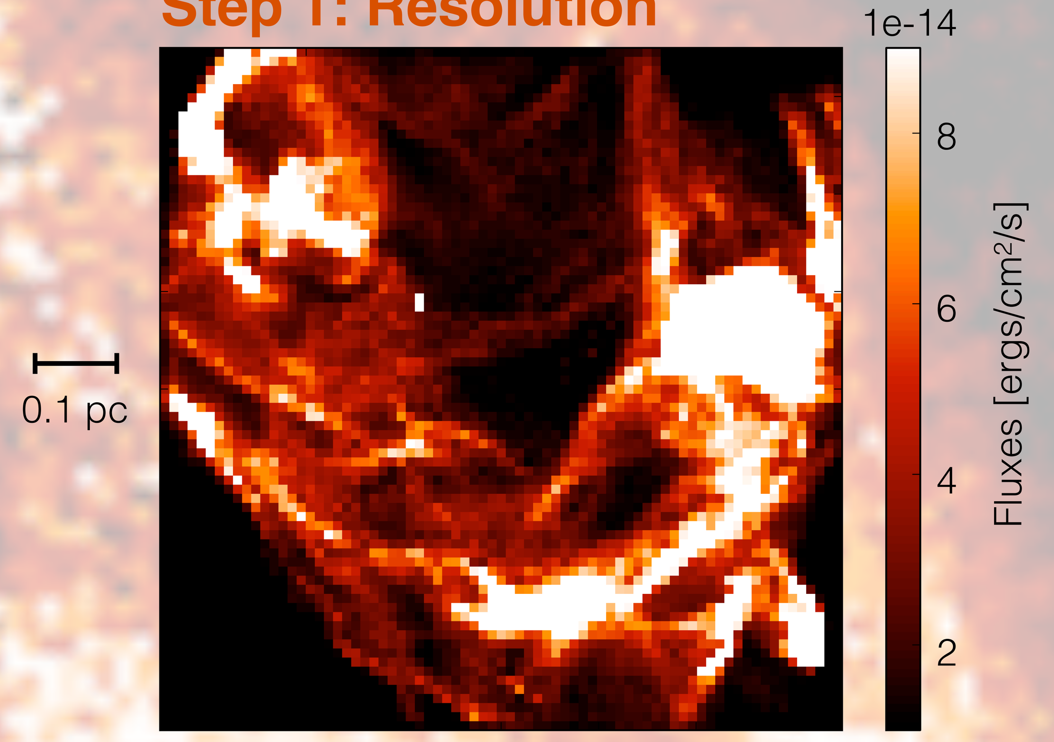
Abstract

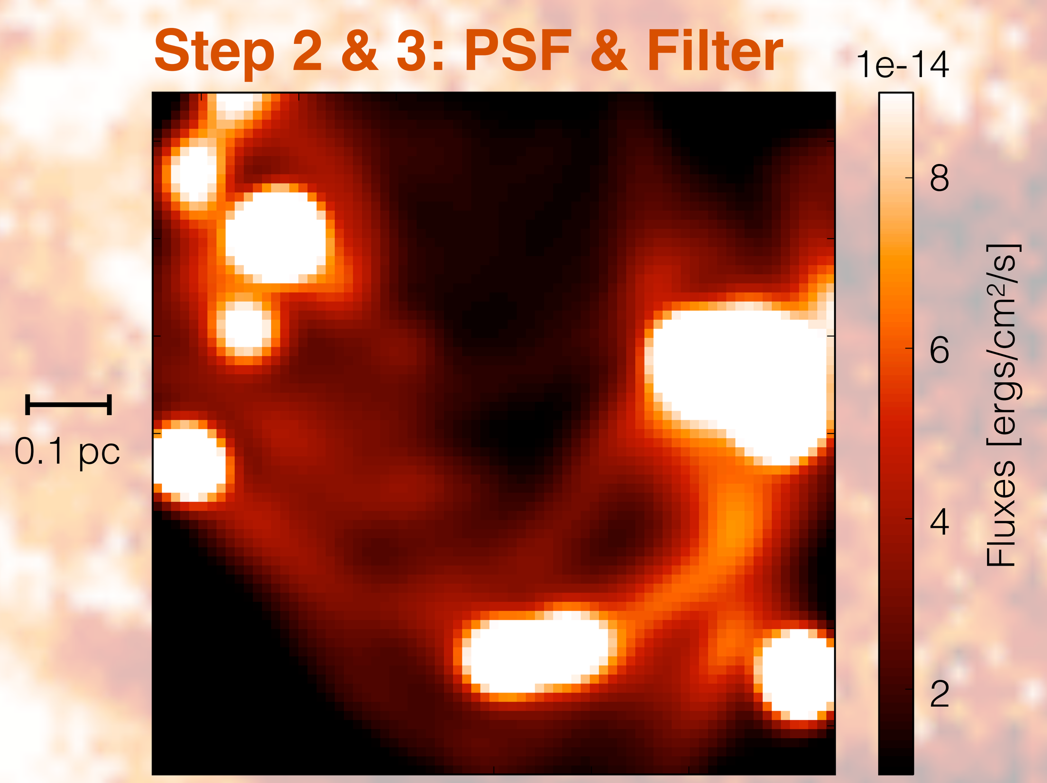
When modeling young stars and star-forming regions throughout the Galaxy, it is important to correctly treat the limitations of the data such as finite resolution and sensitivity. In order to study these effects, and to make radiative transfer models directly comparable to real observations, we have developed a Python package that allows post-processing the output of the 3-d Monte Carlo Radiative Transfer code HYPERION (Robitaille 2011 A&A 536, A79, see poster 2S001). With this package, realistic synthetic observations can be generated, modeling the effects of convolution with arbitrary PSFs, transmission curves, finite pixel resolution, noise and reddening. Pipelines can be written to compute synthetic observations that simulate observatories such as the Spitzer Space Telescope or the Herschel Space Observatory. In this poster we describe the package and present examples of such synthetic observations.



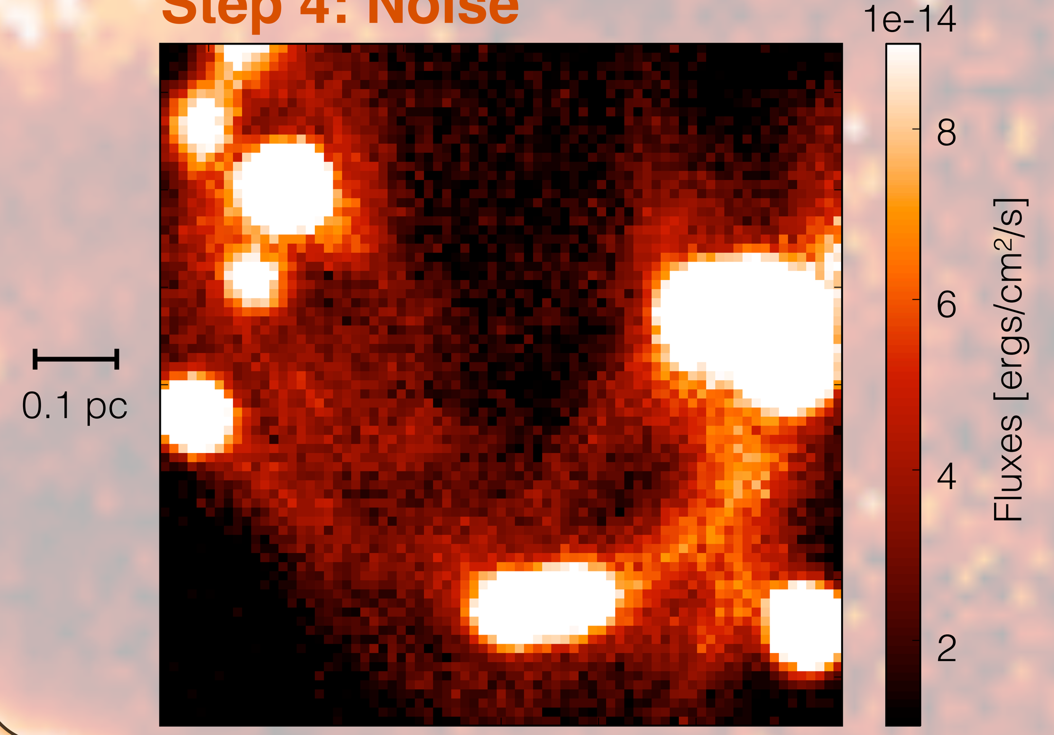
Step 1: Resolution



Step 2 & 3: PSF & Filter



Step 4: Noise



Description

HYPERION is a 3-d dust continuum Monte Carlo Radiative Transfer tool that can take any arbitrary 3-d distribution of dust and compute temperatures, SEDs and images. The tool presented here extends HYPERION by reading in the HYPERION output SEDs and images, and using these to produce simulated observations.

In the left panel, we show the steps for a typical pipeline, which we describe below. This example uses a hydro-simulation (Offner 2009 APJ 703, 131) with effective resolution of 4096^3 as input to HYPERION. The grid has higher resolution around the sources which is displayed on the top left. The initial images are computed by HYPERION for a certain wavelength range and fixed pixel resolution. We assume a distance of 300 pc.

Step 1: Adjust Resolution

The initial step is to adjust the pixel resolution for a given detector (e.g. SPIRE 500µm).

Step 2: Convolve with PSF

Due to the optical diffraction of the light at the opening of the telescope we need to convolve with a Point Spread Function (PSF). To first order the Airy disc can be approximated with a Gaussian profile, but the tool presented here enables users to use any function or PSF files from commonly used telescopes to convolve the image (e.g. Herschel, Spitzer, WISE, 2MASS, also available in the package database).

Step 3: Filters & Fluxes

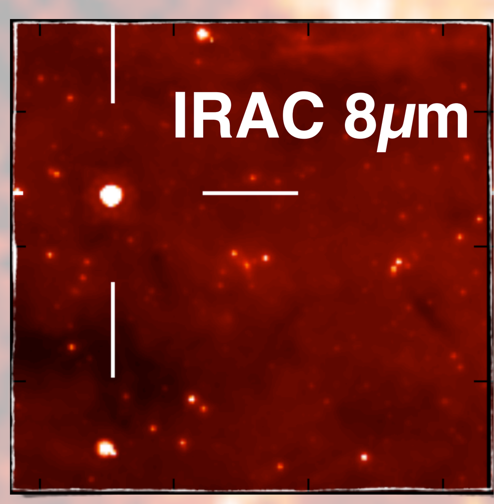
The tool enables the user to convolve the multi-wavelength radiative transfer output with an arbitrary transmission curve or filters from from commonly used detectors, (e.g. in Herschel, Spitzer, WISE, 2MASS, also available in the package database).

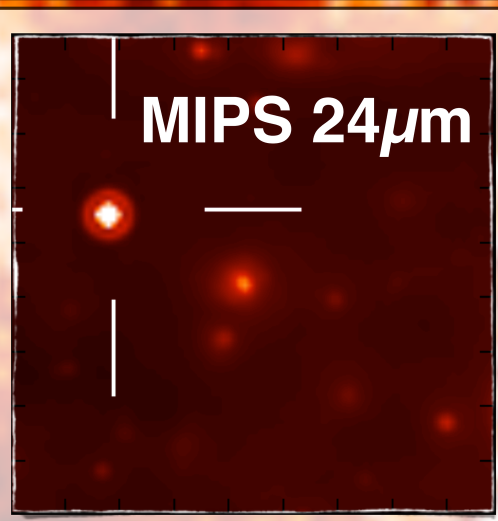
Step 4: Noise

To account for noise in the observation (e.g. background, readout noise, etc.) Gaussian noise can be added.

Compare directly to Observations

Here we added the simulated image of an embedded YSO (after applying the pipeline) to an actual observation in IRAC 8µm and MIPS 24µm at 10 kpc distance. The simulated sources are highlighted with a cross.





Additional Options

- converting units
- visualization of input grids (AMR)
- extinction laws
- image plots (at different cuts)
- photometric fluxes at every step
- convolving SEDs with filters
- visualization of filter functions
- visualization of SEDs

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Conclusion

We have presented a tool that can compute realistic synthetic observations from radiative transfer models, accounting for resolution, reddening, PSF and filter convolution and addition of noise. Taking into account these effect is especially important when modeling distant star-forming regions, where multiple objects may be blended into a single source. The tool will be made publicly available in the future.
For more information about HYPERION, and to sign up to be notified once the package presented here is available, visit http://www.hyperion-rt.org