Expanding a framework for modeling protostellar objects: overview and first results

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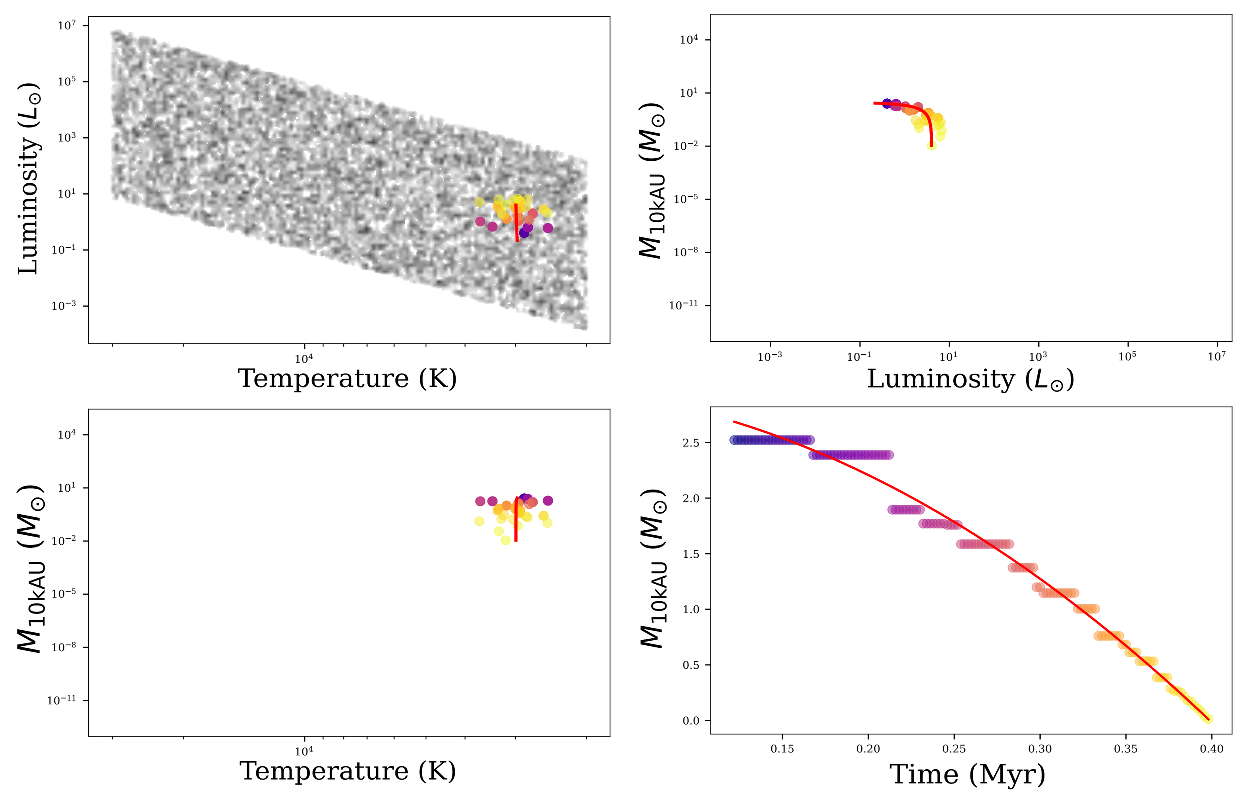
We **model spectra of evolving YSOs** using the **formation-agnostic** Robitaille (2017) grid of YSO models. We show that **isothermal-sphere** and **turbulent-core** accretion histories produce **different predicted model tracks** in the 100-micron/3-millimeter flux observational space. We also provide **new calculations** of several properties for each model in the grid, expanding the ability to use these templates to interpret observations.

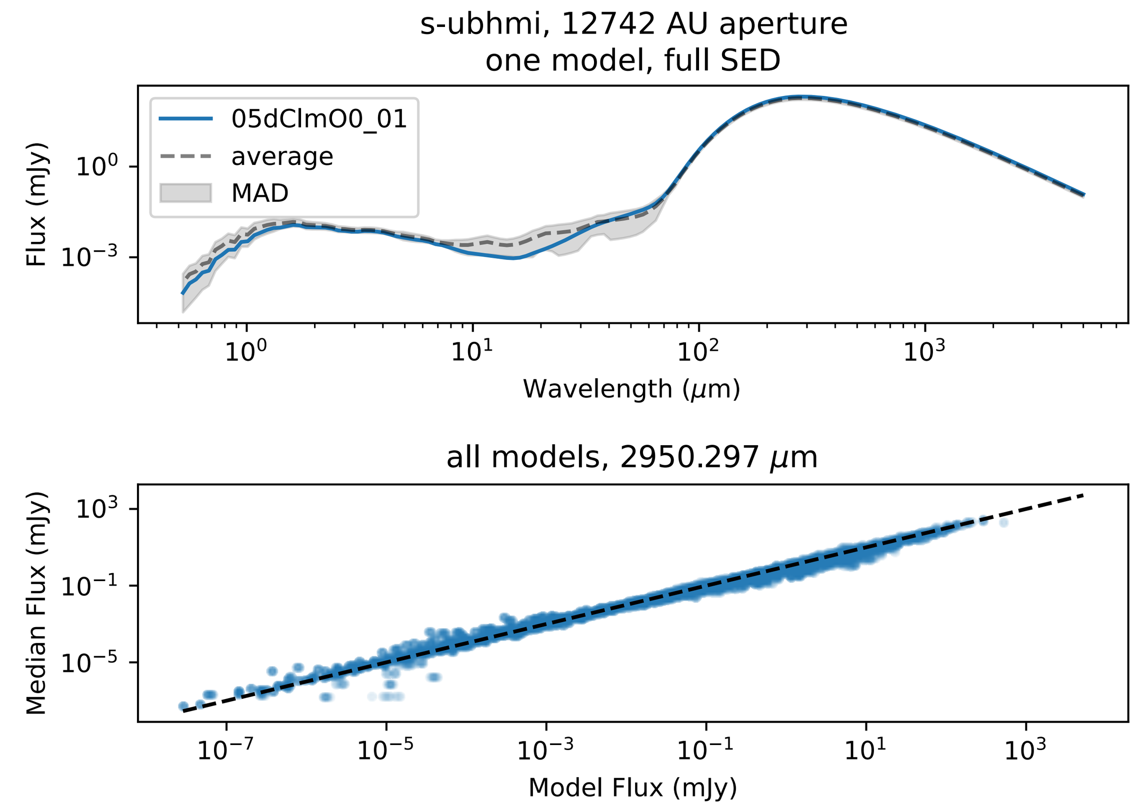
Motivation

Observations of the properties of young stellar objects (YSOs) offer insights into the pre-main-sequence evolution of stars. Measurements of YSO properties are generally made by comparing observed radiation to grids of template SEDs (e.g. Robitaille+ 2006, Furlan+ 2016, Haworth+ 2018, Zhang/Tan 2018.) However, these grids are often generated assuming particular accretion histories and narrow sets of parameter values consistent with the underlying theory. As a result, these grids face common limitations when used to constrain YSO properties. The wider ability to measure protostellar properties would be helped by an approach to YSO modeling that is self-consistent, applicable outside the bounds of existing model grids, and not beholden to any particular theory by design.

Methods

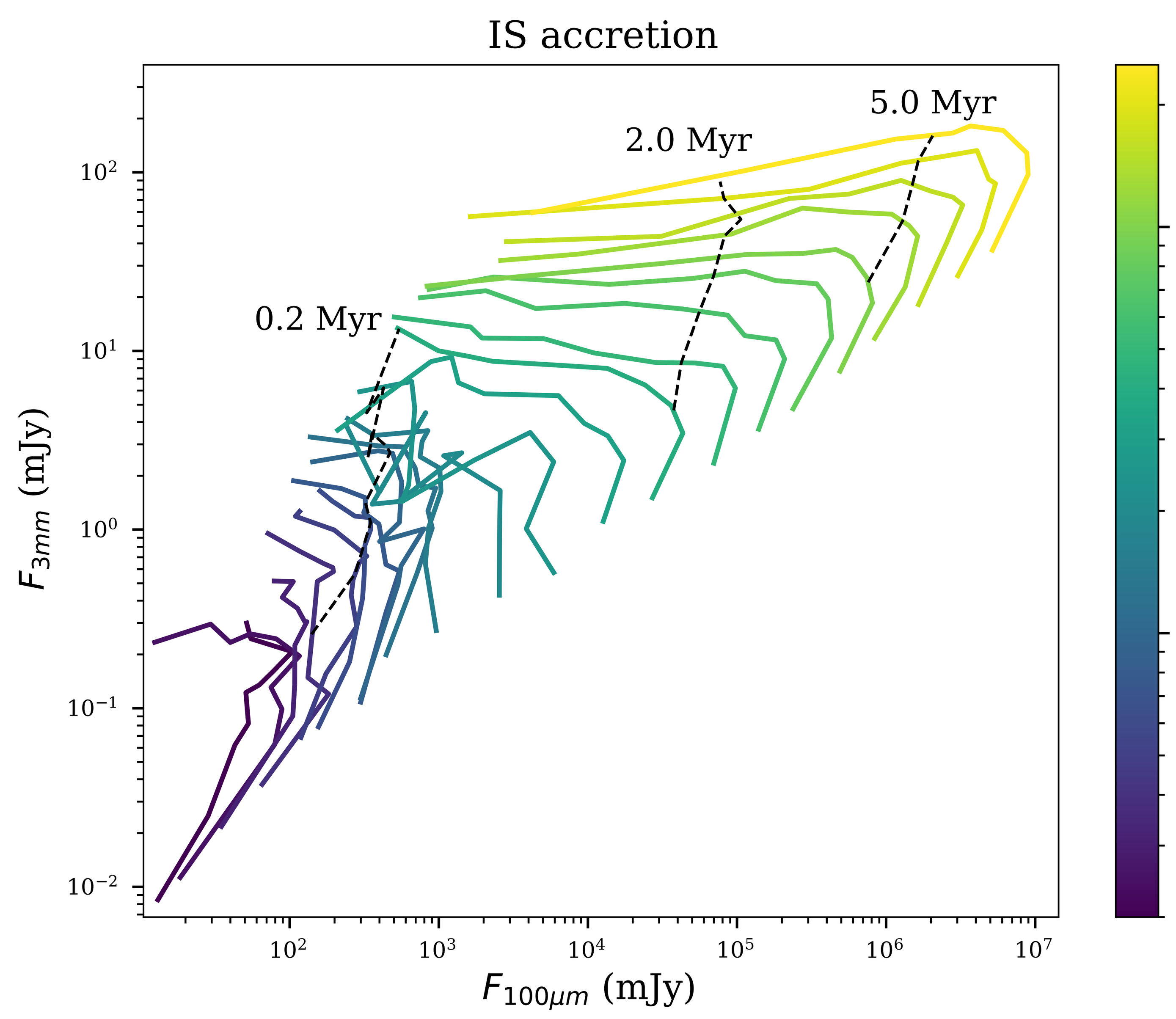


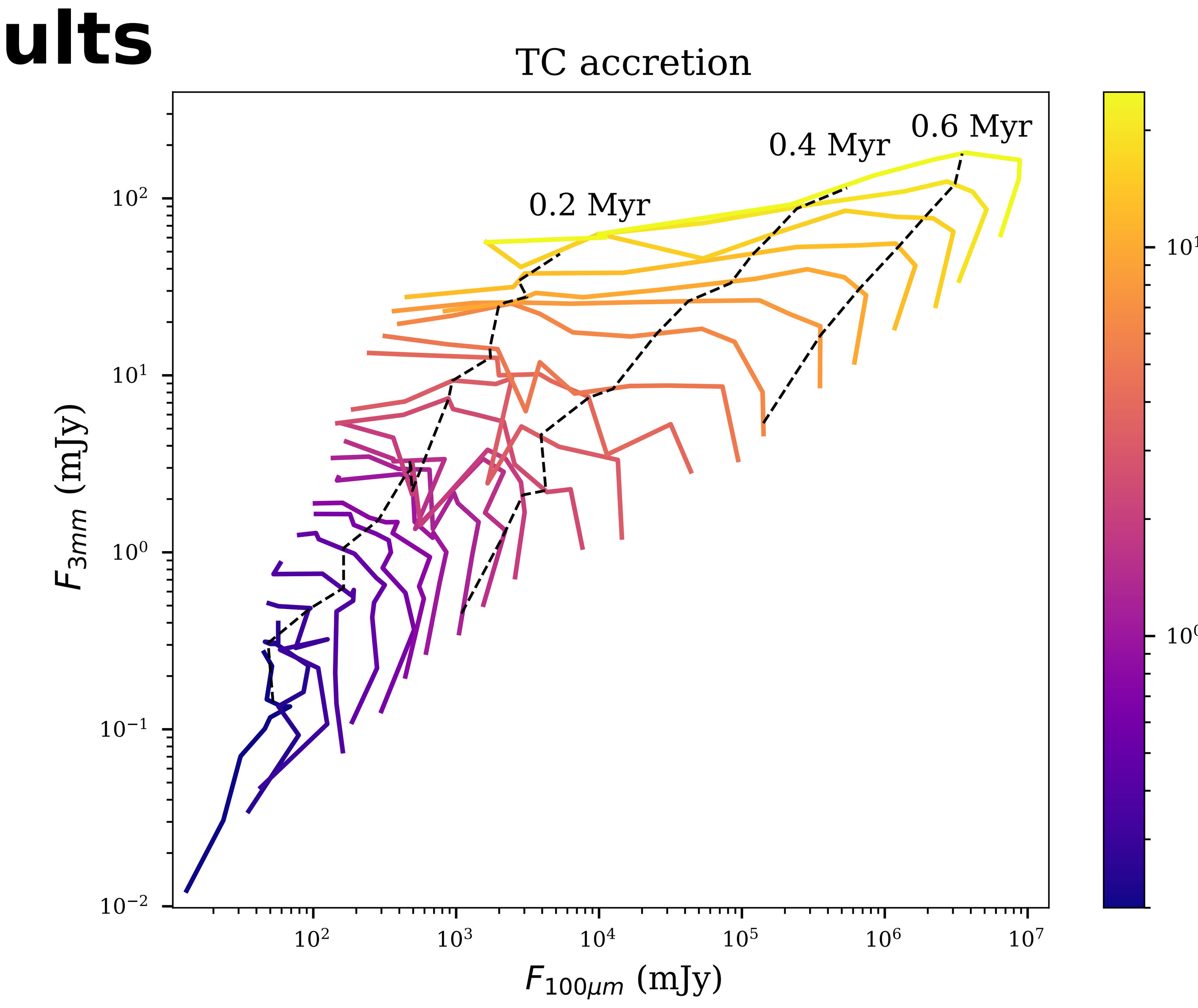
Projections of the parameter space of stellar temperature/ stellar luminosity/core mass within a radius of 10,000 AU for all models with the **`s-ubhmi`** geometry. The projected evolutionary track of a solar-mass star following a turbulent-core accretion history is traced in red. The nearest models to the track are colored by time.



Top: An SED from the **`s-ubhmi`** geometry plotted against the average and MAD of its ten nearest neighbors in our parameter space. ***Bottom:*** The 3-mm flux of every **`s-ubhmi`** model plotted agains the average of its ten nearest neighbors. We are able to reproduce the long-wavelength flux of the overwhelming majority of models.

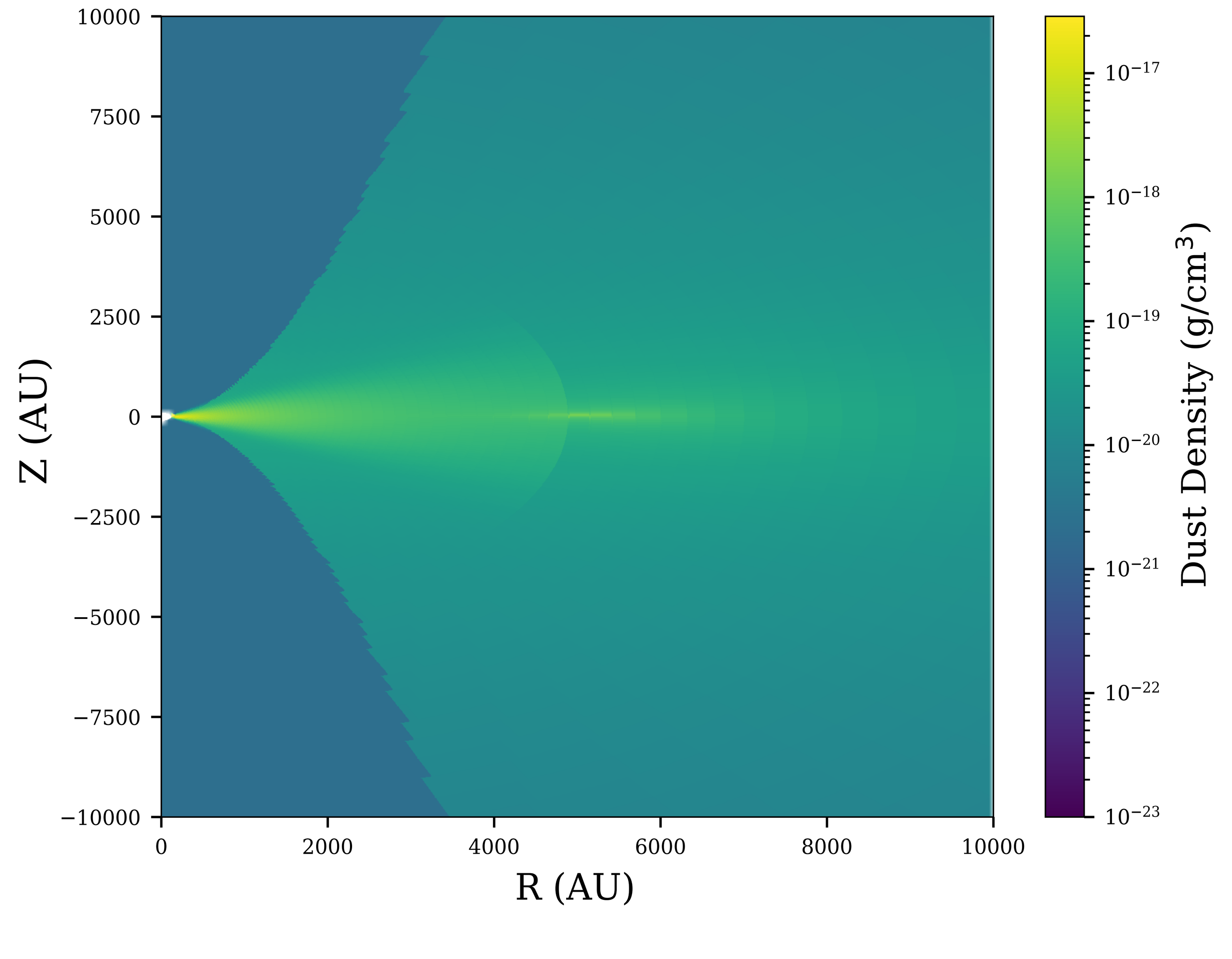
Results





The 3-mm vs. 100-µm flux of YSOs assuming isothermal-sphere (IS, left) and turbulent-core (TC, right) accretion histories. Each line is the average of the SEDs of the ten nearest neighbors from the entire grid, over all inclinations, to the underlying protostellar evolutionary track as a function of time. We smooth the results by averaging these averaged fluxes within ten time bins. Line color is determined by zero-age stellar mass. Each line spans the ignition of a central source in a YSO to depletion of the core. We place isochrones on each plot to indicate the timescale. Most stars undergoing IS accretion will take longer to accrete than in a TC scenario and inhabit a different area of flux space, usually having lower 100-µm flux, at the same times.

Additions



The SEDs in R17 were calculated using the radiative transfer code Hyperion (Robitaille 2011). The output files from these runs include the density and temperature profiles of each model, which enable us to calculate several properties not included in the 2017 release. These include:

- the mass contained in the envelope, both around the source and within a sightline to the source
- the average dust temperature, as mass
- the stability of disks
- the amount of sightline extinction
- convolutions with JWST filters (linked in QR code)

A visualization of a model from the **`spubhmi`** geometry, including bipolar cavities, a passive disk, and the overdensity resulting from mass inflow at the outer edge of an accretion disk (or alternatively, the centrifugal radius) as put forth in Ulrich (1976).

Link to this poster/JWST convolutions:

...or contact me!
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References

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