

Improving accuracy for extracting dense clouds from molecular maps using Abel's transform.

Using Abel's Reconstruction to Extract Dense Regions from Observed Molecular Clouds

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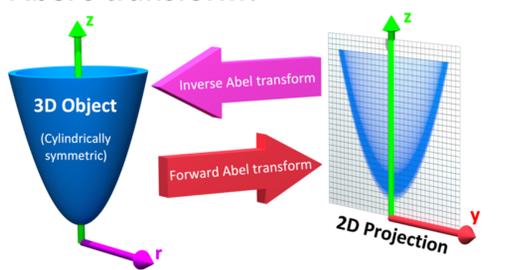
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Why extract a smaller cloud from the molecular clouds?

- We only see the projection of 3-D molecular regions. Therefore, we need an extraction method when trying to study a specific dense cloud within these larger regions.
- These methods are useful when we do a virial analysis. In Singh et al. 2019, we have described a way to directly estimate gravitational and kinetic energy with minimal assumptions, where getting the closest representation of the cloud is crucial.
- **Commonly used methods to extract a cloud:**
 - A single cut off based on the column density value at the edge of the cloud.
 - Interpolating using the edges of the cloud and then subtracting.
- These methods do not deal with the effects of limb-brightening as shown by the grey line in Figure 3. Our method does.

What is Abel's transform?



Hickstein et al. 2019

Figure 1: This is a visual representation of Abel's transform.

References:

- Abel, N. 1826, JRAM, 1, 153
- Fryxell, B. 2000, ApJS, 131, 273
- Hickstein, D.D, Gibson, S. T., et al. 2019 ArXiv preprint: arXiv:1902.09007
- Singh, A., Matzner, C.D., et al. 2019, ApJ, 878, 22

Method:

- Using Inverse Abel's transform (Abel 1826), we are able to reconstruct the density distribution from the projected column density.
- We define the edge of the cloud and use that to obtain the density distribution of the dense cloud.
- We apply Forward Abel's transform on the new density distribution to obtain column density of the cloud.

Applying Abel's Reconstruction to simulated data:

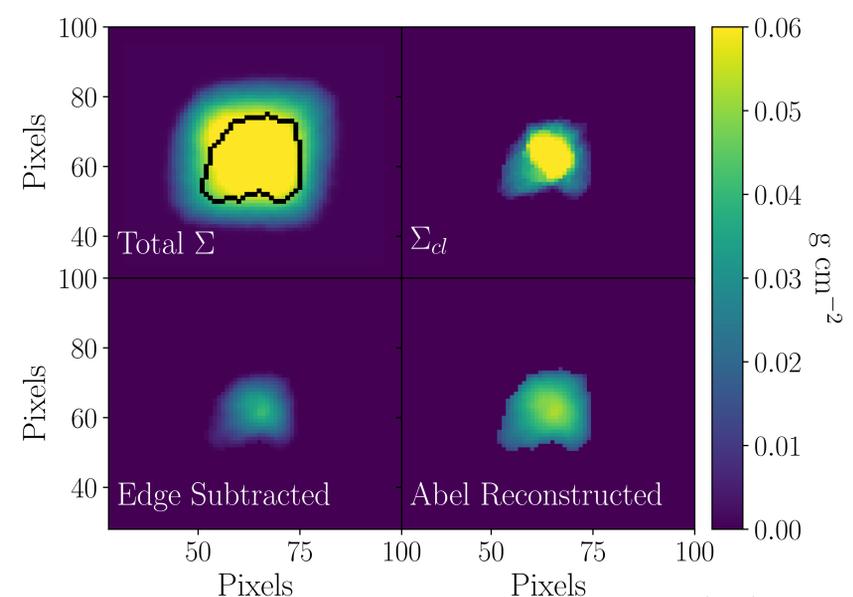
- We perform non-magnetized, effectively isothermal simulations within the Flash code (Fryxell 2000) at fixed 64^3 pixel resolution and projected x, y and z axis.
- In top left panel of Figure 2, we show column density of a single snapshot projected onto one axis.

Result:

Figure 2 and Figure 3 present the results from using Abel's Reconstruction. This method gives a more accurate representation of the cloud than the edge interpolation method. The purple dashed line in Figure 3 shows that this method does take limb-brightening into account.

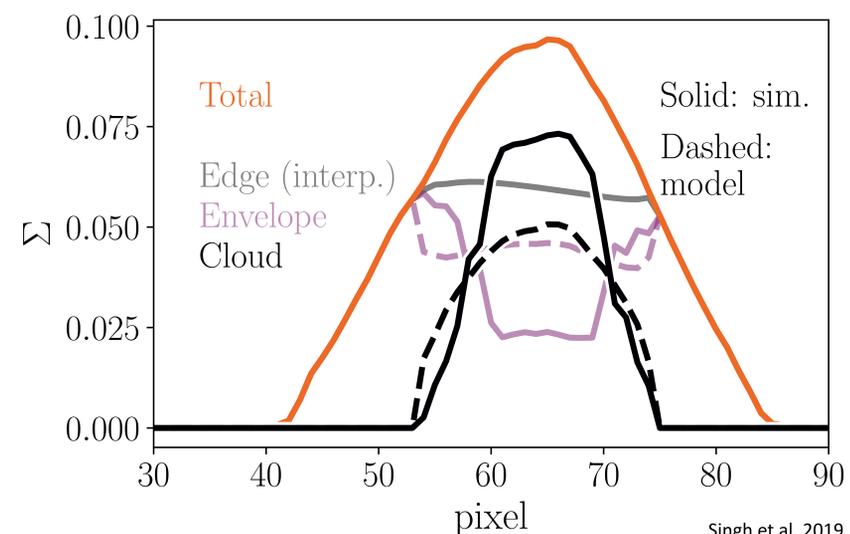
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Singh et al. 2019

Figure 2: Top left: Column density maps of total cloud. Top right: The true column density map of dense cloud (top right) using simulations. Bottom left: Reconstruction of dense cloud using edge interpolation method. Bottom right: Reconstruction using Abel's transformation.



Singh et al. 2019

Figure 3: Profile of a slice through the middle of a column density map. The black line is true and reconstructed dense cloud; the grey line is the envelope using the edge interpolation method; the envelope is shown in purple and the total cloud in red. Solid lines are computed directly from the simulation, while the dashed lines refer to reconstructions based on Abel's transformation.

