Loops in My Lup?

Looking for asymmetries/substructures in an inclined protoplanetary disk

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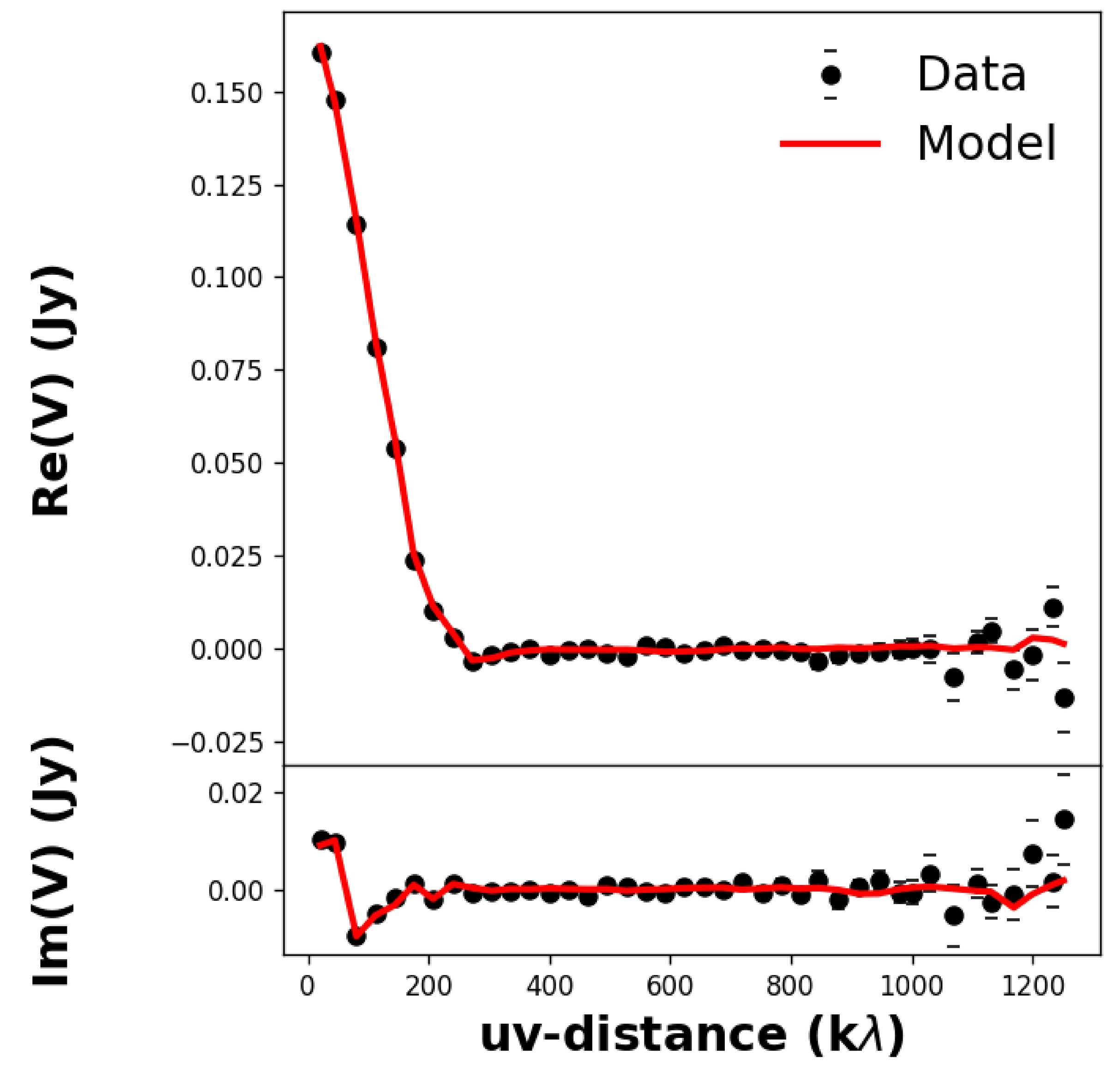
1. Abstract

The investigation of protoplanetary disks plays a crucial role in understanding the formation and evolution of planetary systems. The atmospheric properties and composition of mature exoplanets are ultimately determined by the composition and properties of their protoplanetary disks at the location of the planetary embryos, thus the chemical history of the parent molecular clouds translates into the abundances to be found in exoplanets.
In this study, we analyze the protoplanetary disk My Lup. Our objective is to investigate the disk's structure and contrast it with theoretical models, utilizing data obtained from the Atacama Large Millimeter/submillimeter Array (ALMA).
To achieve our goal, we use a multi-frequency analysis (ALMA Bands 6 and 7) to get a complete picture of the disk's features, both in the dust continuum and gas spectral lines. We hope to constrain the disk's properties, such as dust mass, disk size, and structure, and compare the observed data to protoplanetary disk models and observations of the disk at shorter wavelengths. We expect the analysis will reveal any asymmetries or substructures in the disk that could indicate the presence of planetary embryos or other dynamical interactions within the system if they are present in the data.

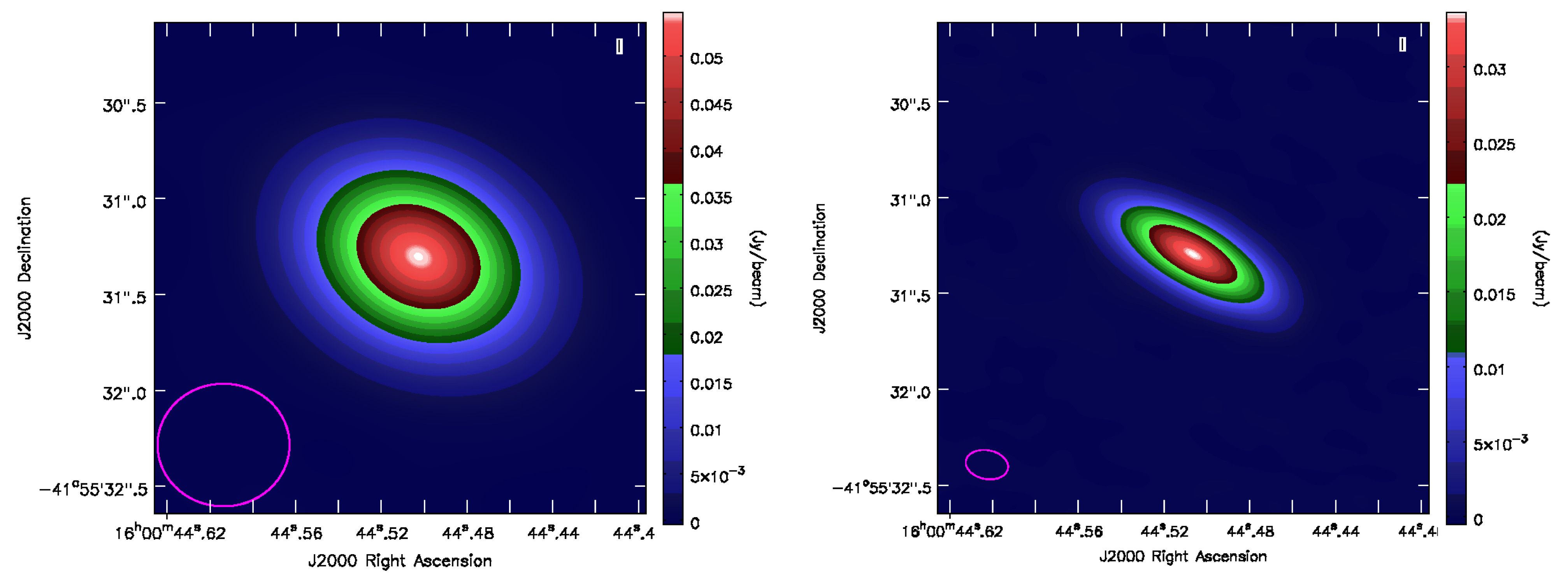
2. The Data



Here is shown the visibility's and the model created with the tclean task, deprojected and azimuthally averaged radial intensity profile, considering the position angle (PA) and the inclination (i).

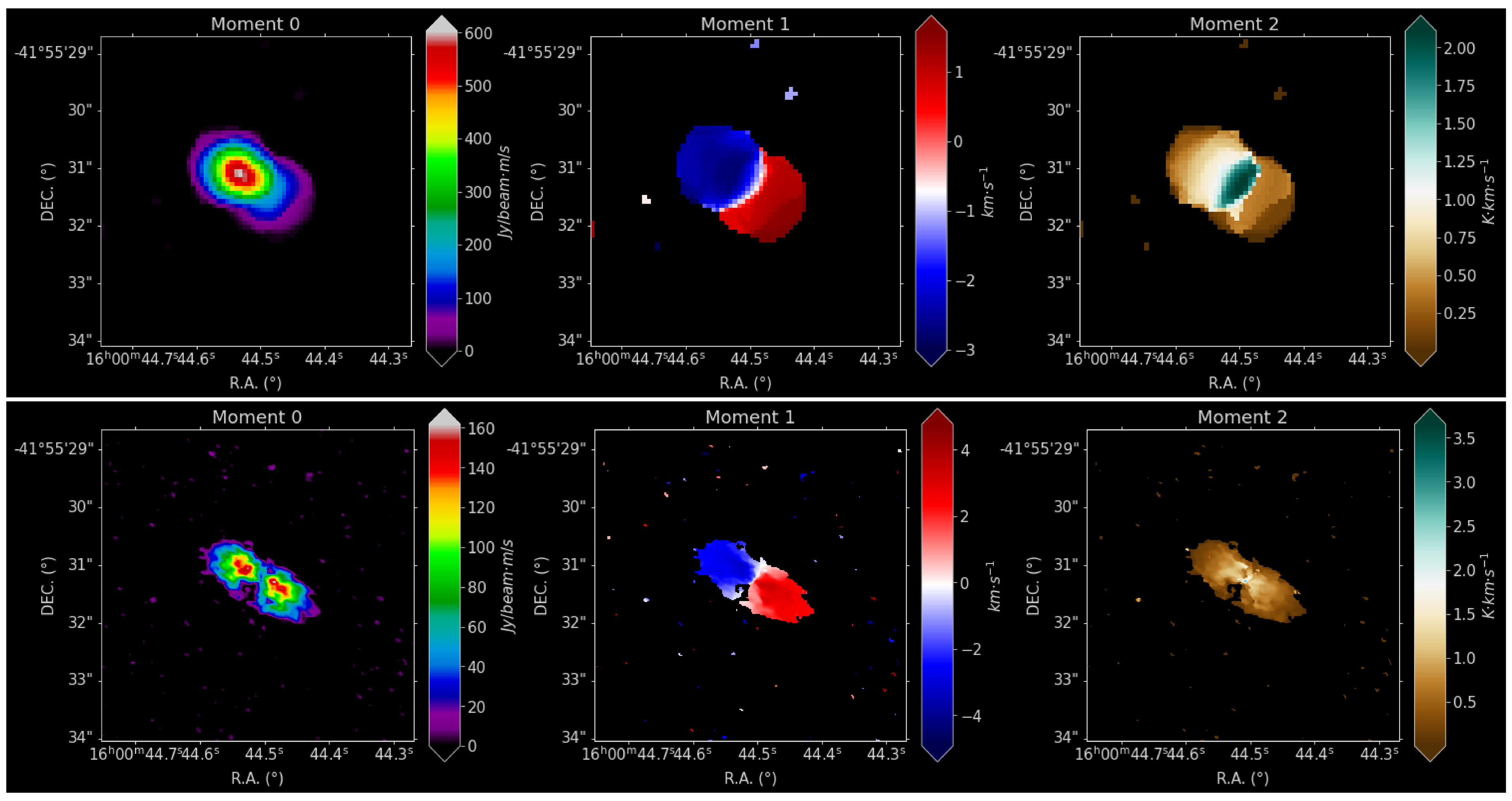
We account with data in 2 Bands (6 & 7) with 4 spectral windows each one we have use the common software CASA to analyze the visibility's and make the deconvolution. In Fig() we are showing the reprojected visibility's and model considering the relative angles of the disk, this is performed assuming collapsing the visibility's and seeing just the radial profile, then by fitting a Gaussian we can reproject the visibility's (this information will be useful at the time of modeling the Disk) [1, 2].

3. Continuum



We are showing the continuum along the whole band and the resulted image interpolated for viewing purpose (bicubic), also is plotted the beam size and the typical number of pixels are around 25 pixels/beam .**Left:** *Band 6* **Right:** *Band 7.*

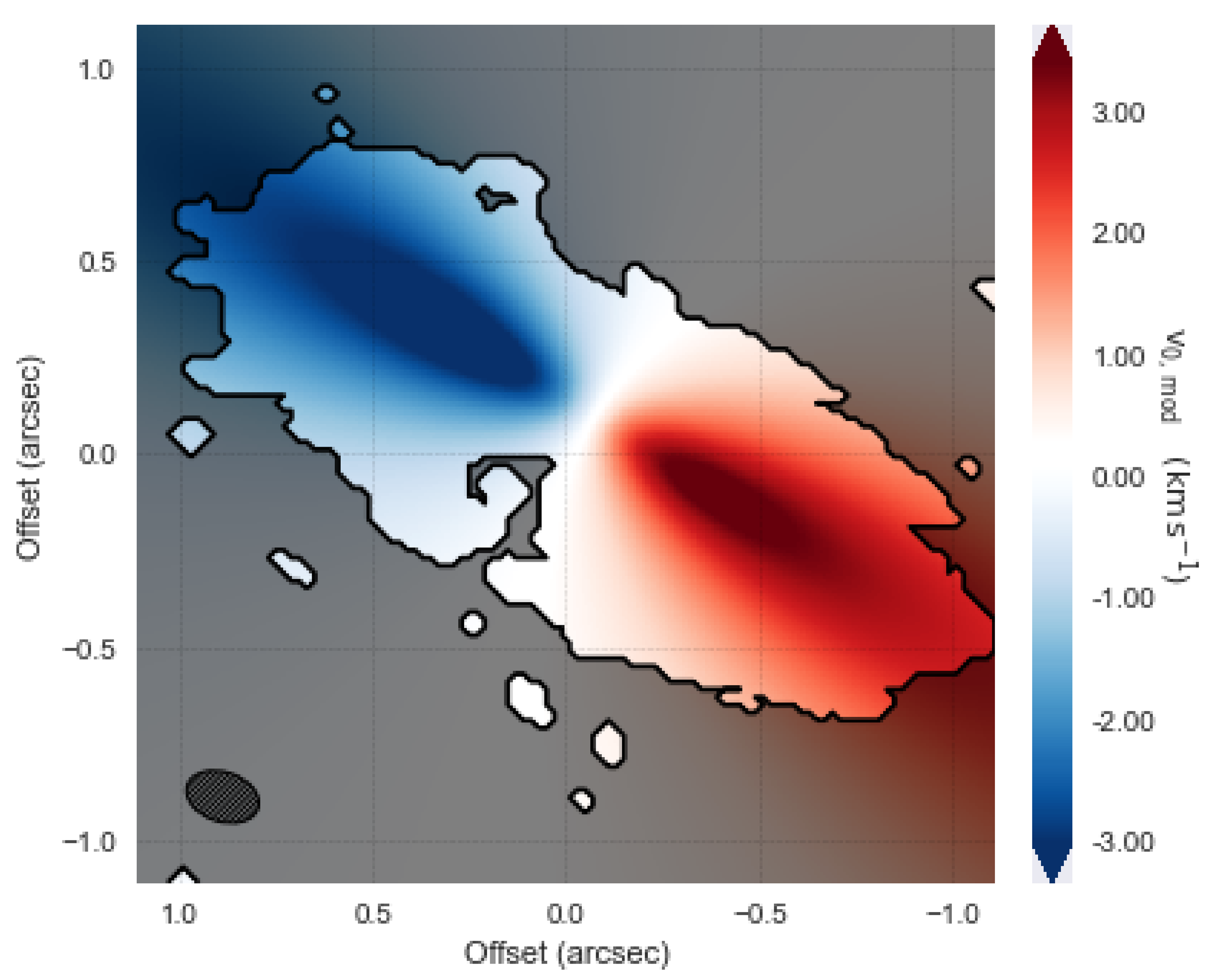
4. Emission Lines



Moments 0,1,2 of lines targeted in spectral window 6 and 7 respectively and these were done with the software [3].

We have employed several spectral windows, here we are showing two of them in bands 6 and 7. Specifically, our focus in band 7, spectral window 3, enables us to explore the dynamics of the disk with heightened sensitivity, as we target the $CO^{(v=0)}_{(J=3-2)}$ transition at approximately 345.8 GHz. In contrast, within band 6, we are looking towards at the $^{13}CO^{(v=0)}_{(J=2-1)}$ line, resonating at approximately 230.5 GHz, with weaker intensity. This information is invaluable, as it empowers us to model the behavior of the disk and extract key physical parameters, including the proto-star's mass and the radio extent of the disk. Analysis of the plots suggest that the disk is profoundly embedded within its molecular cloud environment. Notably, a significant portion of flux proximal to the rest frequency eludes retrieval during the deconvolution process.

5. Modeling the Disk



Showing a simple keplerian model of the moment 1 of the disk band 7 spw 3 ([4]), This step still needs to consider the flaring of the disk, and is a work in progress.

6. References

[1] M. Tazzari, "mtazzari/uvplot," Oct. 2017.

[2] J. Jennings, R. A. Booth, M. Tazzari, G. P. Rosotti, and C. J. Clarke, "frankenstein: protoplanetary disc brightness profile reconstruction at sub-beam resolution with a rapid Gaussian process," *Monthly Notices of the Royal Astronomical Society*, vol. 495, pp. 3209–3232, July 2020.

[3] R. Teague and D. Foreman-Mackey, "A Robust Method to Measure Centroids of Spectral Lines," *Research Notes of the American Astronomical Society*, vol. 2, p. 173, Sept. 2018.

[4] R. Teague, "eddy," *The Journal of Open Source Software*, vol. 4, p. 1220, feb 2019.