HD 100546 Modeling

2016

Tasks

- Check how aspect is defined in amom.py
- Add isovelocity contours to channel maps and mirror plot and add beam (make white?)
- Make table of best fits for different parameter sets
- Add flaring index and warp

Someday / Maybe

- Stellar mass error bars?
- Reclean with different start velocity– increase by half a channel (0.075 km/s)?
- Spectral profile of outer disk? Use polygon to make a ring, compare to Pineda

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5 July 2016

Started taking notes on modeling work

Over the past two weeks, I have been using the script amom.py (jointly written by Catherine Walsh and Atilla Juhasz) to model the first moment map of HD 100546. This is done with the help of a front end, exectute_amom.py, that reads in the disk's first moment map, creates an ideal model given certain parameters, and then convolves the model with the ALMA image's beam. Current model parameter information can be found in Table 1.

Parameter	Start Value	Preferred Value
Stellar Mass	2.4	N/A
Distance (parsecs)	96.9	N/A
Aspect Ratio	0.0	0.02
Cone	Lower	Lower
Position Angle	146	144
Inclination	45	36

Table 1: HD 100546 Parameters

execute_amom.py creates a model for each possible permutation of a set of parameters. For each model, a plot is saved containing four images:

1. ALMA data first moment map
2. Convolved model first moment map
3. Residuals $(data - model)$
4. Normalized Residuals $\frac{(data-model)}{data}$

For each combination of aspect ratio and cone, a plot is saved containing the fit statistics of each model in a square matrix of position values and inclinations. Position angle currently ranges between 130 and 160, and inclination ranges between 30 and 60. Two goodness of fit quantifications are used: a χ^2 with $\sigma = 1$ (i.e. $\sum(data - model)^2$), and the peak residual. The sum of squares tends to be better for assessing overall goodness of fit, while the peak reveals where and how badly the model fails to fit the data. The the models with the smallest sums of squares and smallest peaks are summarized in Tables 2 and 3, respectively.

Stellar masses I have found:
2.4 (van den Ancker et al.) fits model better, but is older and the original source seems to be gone
2.5 (Manoi et al.)
4 (Levenhagen and Leister)

References

Aspect Ratio	Cone	Position Angle	Inclination	Sum of Squares
0	N/A	144	36	75.28
0.01	Lower	144	36	74.84
0.01	Upper	144	36	75.91
0.02	Lower	144	36	74.61
0.02	Upper	144	36	76.75
0.03	Lower	144	36	**74.58**
0.03	Upper	144	36	77.80
0.04	Lower	144	36	74.76
0.04	Upper	144	36	79.05
0.1	Lower	144	36	80.10
0.1	Upper	144	36	90.94
0.2	Lower	144	36	106.05
0.2	Upper	142	36	128.39
0.3	Lower	144	34	149.06
0.3	Upper	142	34	185.48
0.4	Lower	144	32	215.49
0.4	Upper	142	34	267.70
0.5	Lower	144	32	300.60
0.5	Upper	142	32	370.85

Table 2: Best-Fitting Models (Sum of Squares)

Aspect Ratio	Cone	Position Angle	Inclination	Peak Offset	Peak Residual
0	N/A	130	30	$(0.24, 0.12)$	1.31
0.01	Lower	130	30	$(0.24, 0.12)$	1.32
0.01	Upper	130	30	$(0.24, 0.12)$	1.31
0.02	Lower	130	30	$(0.24, 0.12)$	1.32
0.02	Upper	130	30	$(0.24, 0.12)$	1.31
0.03	Lower	130	30	$(0.24, 0.12)$	1.32
0.03	Upper	130	30	$(0.24, 0.12)$	1.31
0.04	Lower	130	30	$(0.24, 0.12)$	1.32
0.04	Upper	130	30	$(0.24, 0.12)$	1.31
0.1	Lower	130	30	$(0.24, 0.12)$	1.33
0.1	Upper	130	30	$(0.24, 0.12)$	1.29
0.2	Lower	130	30	$(0.24, 0)$	1.36
0.2	Upper	130	30	$(0.24, 0.12)$	1.27
0.3	Lower	130	30	$(0.24, 0)$	1.40
0.3	Upper	130	30	$(0.24, 0.12)$	1.25
0.4	Lower	130	30	$(0.24, 0)$	1.45
0.4	Upper	130	30	$(0, -0.24)$	**1.23**
0.5	Lower	130	30	$(0.24, 0)$	1.49
0.5	Upper	132	30	$(0.24, 0.12)$	1.26

Table 3: Best-Fitting Models (Peak Residuals)