A General Modeling of Protoplanetary Disks in Chameleon II and Taurus

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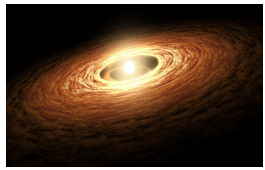
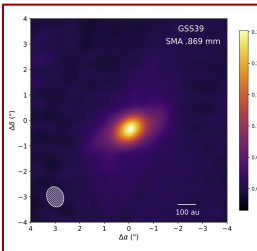
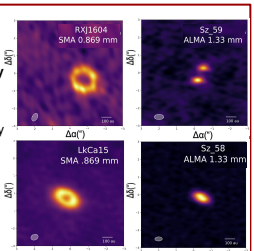




Standardizing the Study of Planetary Nurseries

- **Protoplanetary disks** are disk of **gas** and **dust** that surround **newly formed stars**.
- We used **radio-wavelength interferometric** observations from the Atacama Large Millimeter Array (**ALMA**) and the Submillimeter Array (**SMA**) to image and analyze disks from two star forming regions: **Chameleon II and Taurus**.
- Our goal was to **uniformly model** the disks in order to complete a **database** of disk structure that can be used to study **planet formation** across **star-forming regions**.



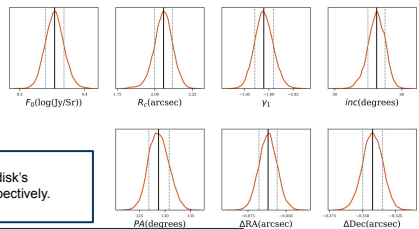
Using MCMC to Fit Structural Parameters

- Chameleon II and Taurus disks imaged using **CASA** and **Miriad**
- **18** single disks, **3** binary systems in Chameleon II
- **49** disks in Taurus, **4** with inner radii
- Fitting parameters: ***flux, critical radius, inclination, position angle,*** γ_1 and γ_2 , and offset position (***right ascension and declination***)
- Initial estimates are derived from **Gaussian Fits** of the Visibilities

- Slope of Power law (γ_1) and exponential tail (γ_2) model disk's **brightness** with respect to its inner and outer regions,respectively.

- **Emcee**, an Affine Invariant Markov chain Monte Carlo (**MCMC**) algorithm, explores parameter space to find probable values and uncertainty for the parameters and power law indices.
- **Galario** software used to create synthetic ALMA observations.
- γ_2 fixed because of **degeneracy** with flux; γ_1 fixed for low signal, unresolved disks

GSS39 Posterior Distributions



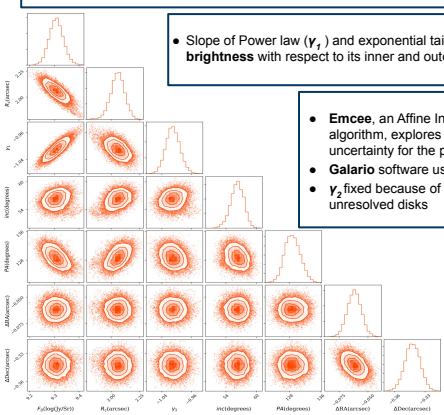


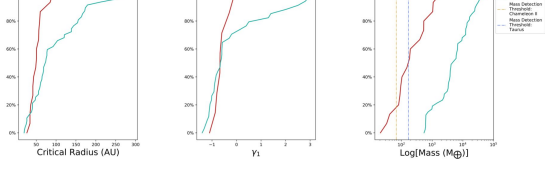
Table 1. MCMC Result Examples

Disk	Flux (mJy)	Radius (arcsec)	Gamma1	Inc (deg)	PA (deg)	RA (arcsec)	Dec (arcsec)
GSS39	1180 ± 40	2.06 ± 0.06	-1.01 ± 0.02	56.2 $\pm^{1.3}_{1.2}$	129 ± 2	-0.062 ± 0.06	-0.342 $\pm^{0.008}_{0.007}$
Sz 58	103± 2	0.507± $^{0.08}_{0.07}$	-0.07± 0.05	57.9± 0.5	62.7± 0.6	-0.427 ± 0.002	-0.165 ± 0.002
CITau	580 ± 20	1.27± 0.05	-0.92± 0.02	47± 2	11± 2	0.347 ± 0.005	-0.335± 0.005

Features of Chameleon II and Taurus

- Mass is expected to decrease while critical radius increases as a protoplanetary disk ages.
- Comparison between the two regions shows us that **Taurus** contains disks of **higher** Flux, Radius, and mass overall compared to Cha II.
- Ages of the two regions are comparable. **P.A.B. Galli et al. (2021)** found the median ages of stars in Cha II to be 1-2 Myr while **Krolikowski et al (2021)** found the median of Taurus stars to be 2.01 Myr.
- Results show the **variability** of mass and radius in star-forming regions of the similar age.

Cumulative Distributions



- **Mass Detection thresholds differ** significantly between the observations of Cha II and Taurus (6.8 and 170 M⊕). This may have **contributed** to the **high** mass **median** of disks in **Taurus**.

Table 2. Median Values of Region Features

Region	Mass (M⊕)	Radius (AU)	Gamma1
Cha II	200 $\pm^{700}_{100}$	50 ±10	-0.7 $\pm^{0.3}_{0.2}$
Taurus	5000$\pm^{10000}_{4000}$	70$\pm^{90}_{30}$	-0.7$\pm^{2}_{0.5}$

Acknowledgements

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References

1.Astrobites. (2019, April 9). *A new window into Prebiotic nitrogen chemistry in protoplanetary disks*. AAS Nova https://aasnova.org/2019/04/09/a-new-window-into-prebiotic-nitrogen-chemistry-in-protoplanetary-disks/.