Institute for Theoretical Particle Physics and Cosmology

RWTH AACHEN UNIVERSITY

Precise determination of protoplanetary disc lifetimes and accretion timescales in a single star-forming region

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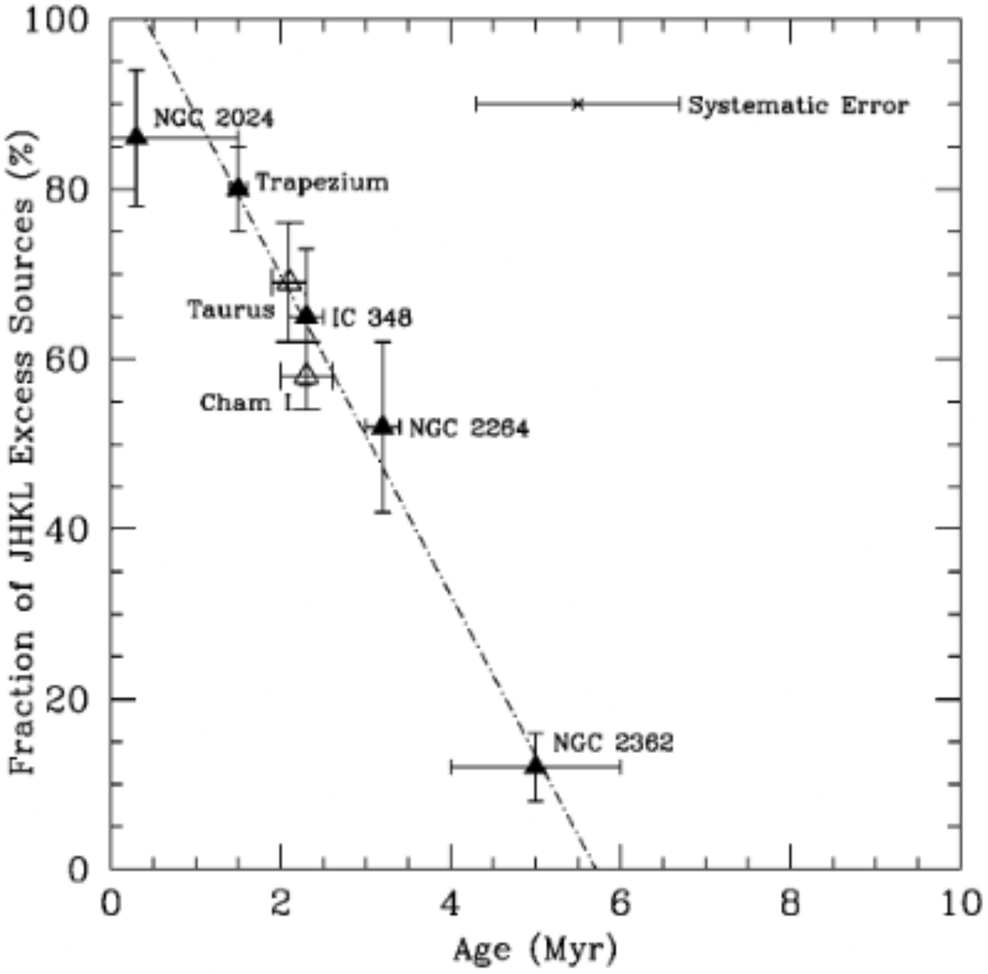
Discs on the Exe - July 30th 2026

Aladin: DSS2 Colours of Scorpius Centaurus

Caveats of using stellar clusters…

- Exponential decay model yield
    - from 2 - 3 Myr (Fedele et al. 2010; Ribas et al. 2014, 2015)
    - to 8 Myr (Michel et al. 2021)
- Using multiple stellar clusters
    - ✓ increases number of data points
    - x mixes environments
    - x mixes initial conditions of star formation

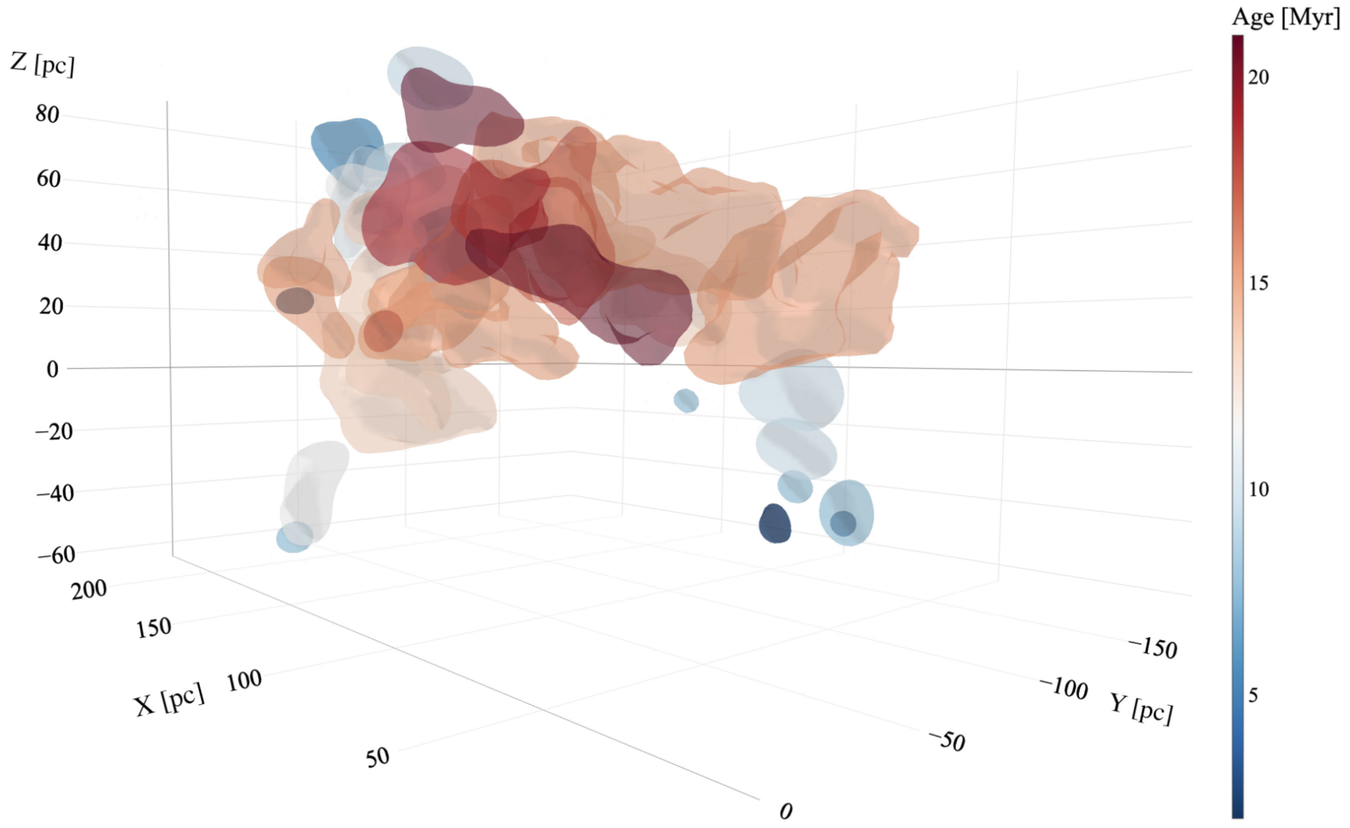
Haisch et al. 2001



… and how to overcome them

- Significance Mode Analysis (SigMa, Ratzenböck et al. 2023a)
- Applied to the Scorpius Centaurus OB association
- Validate through narrow sequences in colour-magnitude space
  - Fit isochrones
  - Coherently determine cluster ages (Ratzenböck et al. 2023b)

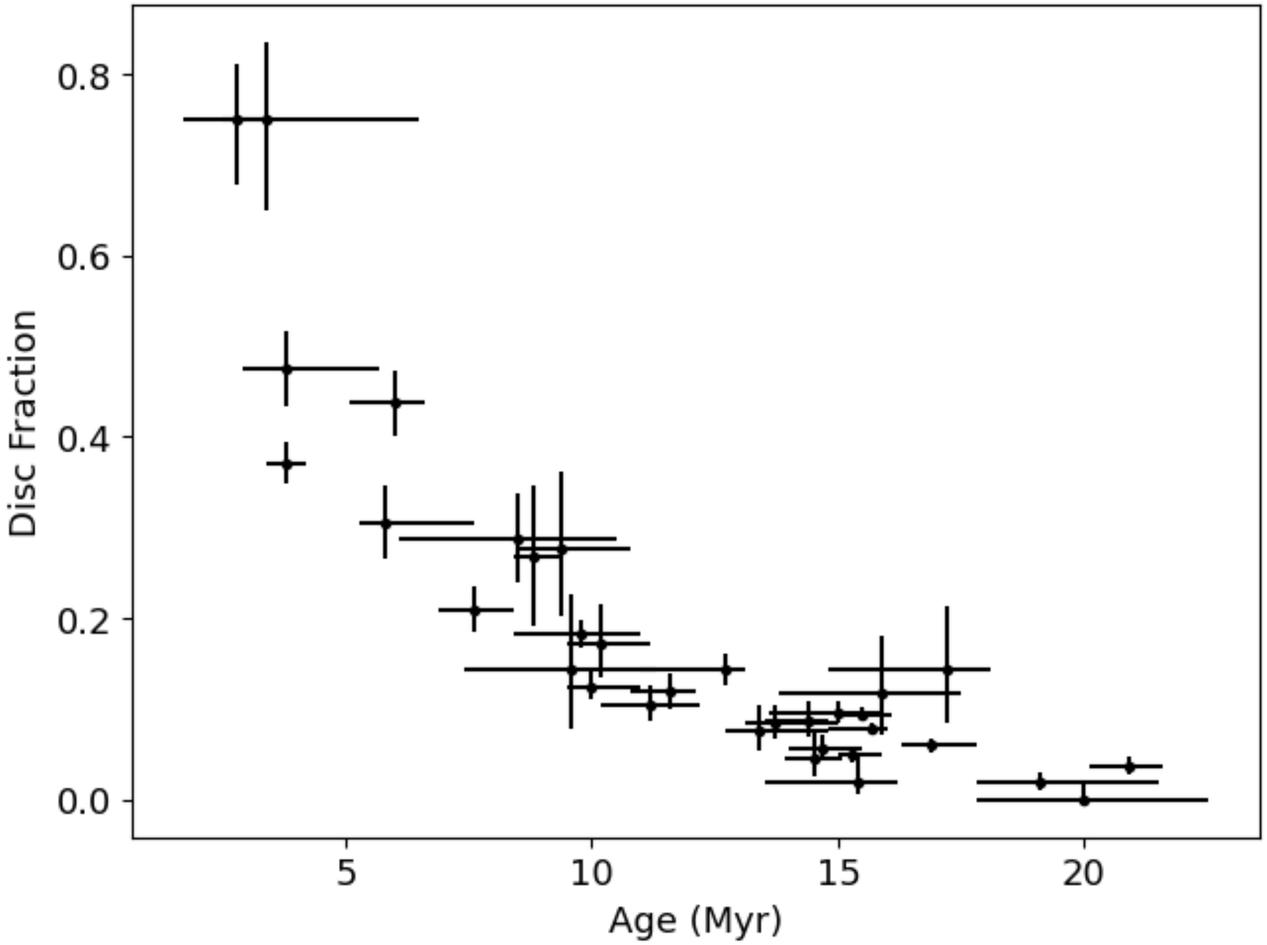
Ratzenböck et al. 2023b



The relation of disc fraction versus age

- Use photometric measurements of WISE (mid-) and 2MASS (near-infrared)
- Identify discs in Colour-colour diagrams
- Functional relation in the model

$$f(t) = f_0 \cdot e^{-\frac{t - t_0}{\tau}}$$



Statistical Model

- Detecting a disc or not is a Bernoulli process

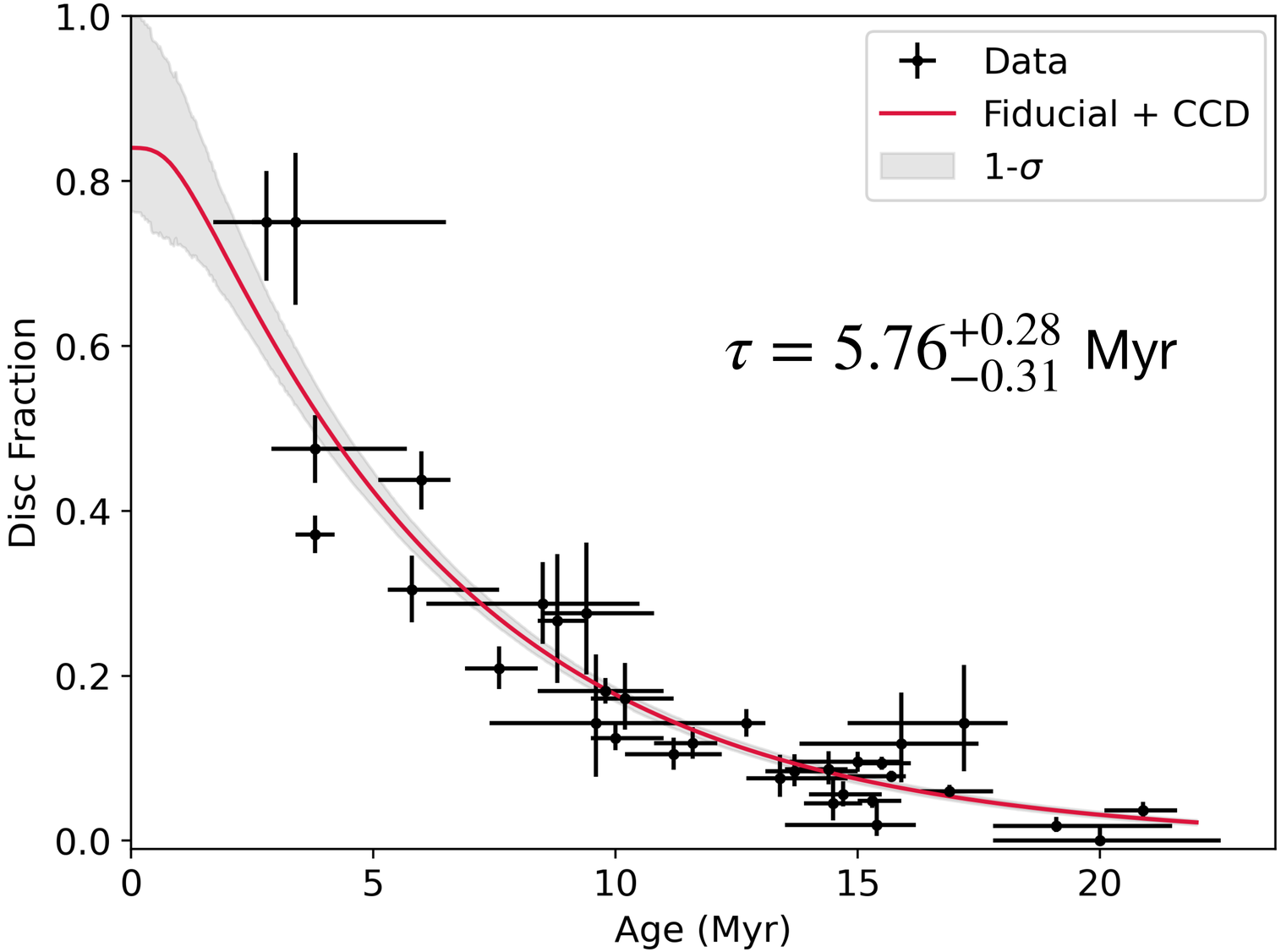
$$k \sim Binomial(N, f)$$

- We know number of discs k and stars N per cluster

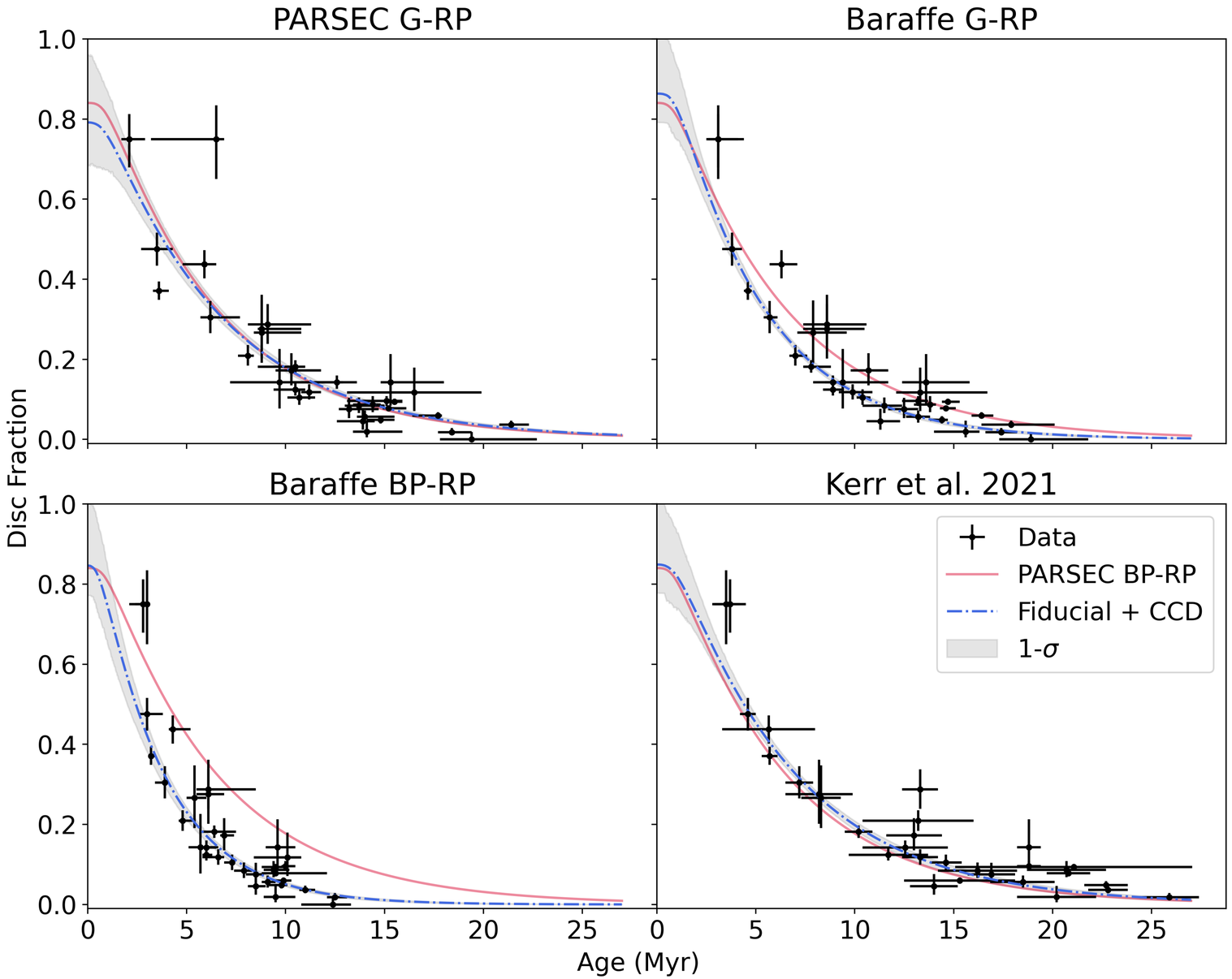
- Invert statement using Bayes' formula

$$p(f \mid k, N) \propto p(k \mid f, N) \cdot p(f \mid N)$$

Functional relations in terms of disc fraction



Functional relations in terms of age estimate



Disc lifetime versus accretion timescales

- Fedele et al. 2010 obtain
  - Disc lifetime = 3 Myr
  - Accretion timescale = 2.3 Myr
- Delfini et al. 2025 find accretion timescale = 2.7 ± 0.4 Myr
- Our disc lifetime = $5.76^{+0.28}_{-0.31}$ Myr

Work in Progress

Using Bayesian modelling and novel clustering and age dating techniques, we can better constrain the timescales of protoplanetary discs

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Polnitzky et al. 2026

https://ui.adsabs.harvard.edu/abs/2026A%26A...707A.216P/abstract

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