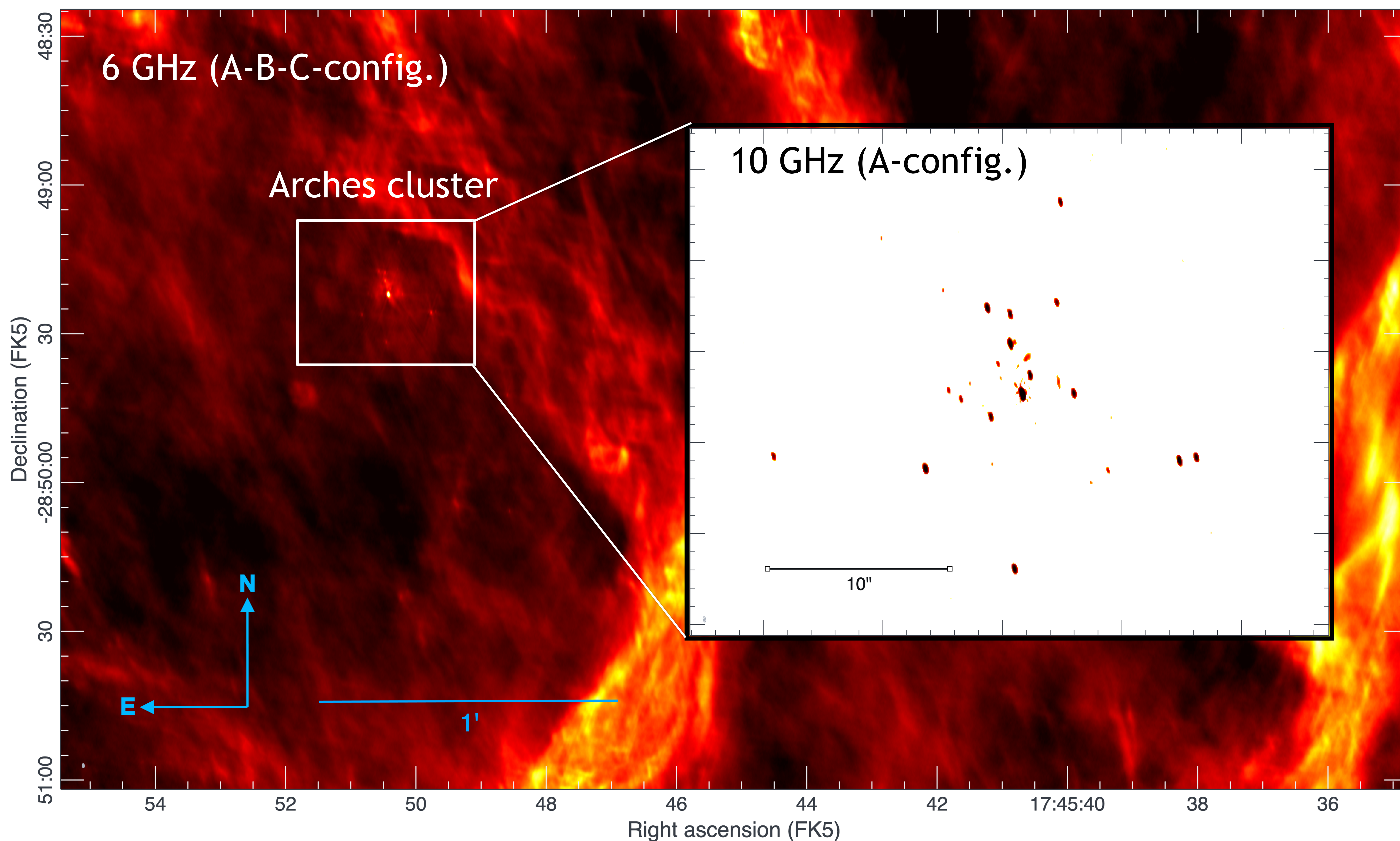


ABSTRACT

We show that radio-continuum observations (VLA X-band, 10 GHz) can serve to estimate key parameters of young massive clusters (YMCs). We use the SPISEA package together with the MIST, Ekström, and PARSEC stellar evolutionary models to simulate clusters at two metallicities ($Z = 0.014$ and $Z = 0.020$), within a Bayesian framework.

- All models and metallicities return preferred **ages in the $2 \lesssim t_{\text{age}}/\text{Myr} \lesssim 3$ range**, uncorrelated to cluster mass and IMF slope.
- Using radio data alone, we obtain an **IMF slope of $\alpha_{\text{IMF}} = -1.85^{+0.28}_{-0.20}$** , where uncertainties are dominated by the degeneracy between cluster mass and IMF slope.
- Using the IMF slope from Hosek et al. (2019) as prior, **we establish a lower limit for the Arches cluster mass at $\gtrsim 2 \times 10^4 M_{\odot}$, and a most probable mass of $\sim 2.7 \times 10^4 M_{\odot}$.**



SAMPLE

ID	type	$\alpha_{4-12\text{ GHz}}$
F6	WN8-9h + ?	-0.11 ± 0.01
F7	WN8-9h	0.71 ± 0.02
F3	WN8-9h	0.51 ± 0.03
Dong19	WN8-9h	0.96 ± 0.04
F4	WN7-8h	0.86 ± 0.08
F5	WN8-9h	0.62 ± 0.04
F8	WN8-9h	0.61 ± 0.05
Dong96	WN8	0.96 ± 0.08
F1	WN8-9h	0.43 ± 0.10
F2	WN8-9h + O5-6Ia ⁺	0.58 ± 0.12
F9	WN8-9h	0.81 ± 0.14
F12	WN7-8h	0.05 ± 0.30
B1	WN8-9h	0.82 ± 0.36
F14	WN8-9h	-0.75 ± 0.37
F16	WN8-9h	—
F19	O4-5Ia	-0.38 ± 0.05
F18	O4-5Ia ⁺	-0.18 ± 0.09
F26	O4-5Ia	-0.47 ± 0.08
F55	O5.5-6III	-0.99 ± 0.60
F10	O7-8Ia ⁺	—
F17	O5-6Ia ⁺	—
F15	O6-7Ia ⁺ + ?	—
F28	O4-5Ia	—

Radio-stellar sample of the Arches cluster along with spectral type and spectral index Cano-González et al. (2024)

METHODS

Stellar type / radio emission dichotomy

Thermal ($\alpha \gtrsim 0.6$) $\rightarrow$ WN
Non-thermal ($\alpha \lesssim 0.0$) $\rightarrow$ OB

SPISEA modelling (age, mass, IMF slope)

$$\theta = (t_{\text{age}}, M_{\text{cl}}, \alpha_{\text{IMF}})$$

Two-term likelihood (flux and counts)

$$\mathcal{L}(\theta) = \mathcal{L}_S^K \times \mathcal{L}_{\text{WN/OB/WC}}$$

Optional prior on IMF slope From Hosek et al. (2019)

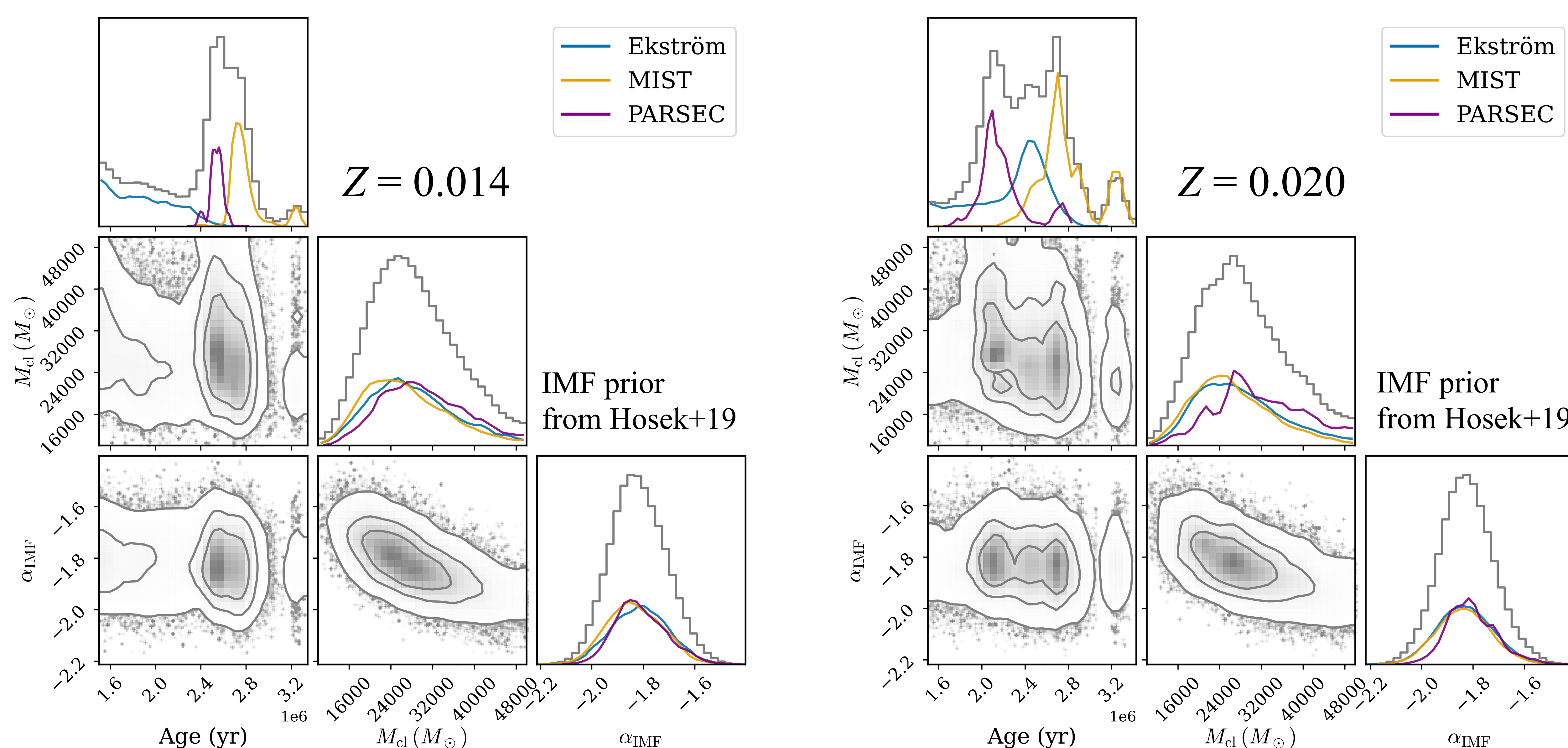
$$p(\alpha_{\text{IMF}}^{\text{H19}}) = \mathcal{N}(\alpha_{\text{IMF}} | -1.8, 0.11),$$

FUTURE WORK

With SKA-Mid

- Better point source characterisation (southern hemisphere)
- Better sensitivity, probing the faint end of the radio luminosity function YMCs
- Better spectral index determination
- Quick, flexible observations to better understand radio-stellar variability
- Other YMCs like Westerlund 1 accessible to cm radio observations

RESULTS



Model-averaged estimates

$$\theta(Z = 0.014) = \begin{cases} t_{\text{age}}(\text{Myr}) = 2.54^{+0.22}_{-0.65} \\ M_{\text{cl}}(10^4 M_{\odot}) = 2.75^{+0.95}_{-0.72} \rightarrow \text{IMF prior from Hosek+19} \\ \alpha_{\text{IMF}} = -1.86^{+0.28}_{-0.18} \end{cases} \quad \theta(Z = 0.020) = \begin{cases} t_{\text{age}}(\text{Myr}) = 2.43^{+0.32}_{-0.38} \\ M_{\text{cl}}(10^4 M_{\odot}) = 2.76^{+1.00}_{-0.72} \rightarrow \text{IMF prior from Hosek+19} \\ \alpha_{\text{IMF}} = -1.85^{+0.28}_{-0.20} \end{cases}$$

CONCLUSIONS

- Radio-continuum observations can be used to estimate parameters of young, massive clusters
- Arches cluster age uncorrelated with cluster mass and IMF slope
- Flux densities alone carry information on cluster age
- Both considered metallicities return ages of ~ 2.5 Myr for the Arches cluster
- We establish the Arches mass within the $20\,000 \lesssim M_{\text{cl}}/M_{\odot} \lesssim 37\,000$ range using IMF prior from Hosek et al. (2019)
- Radio observations favour a top-heavy IMF in Arches

Based on Cano-González et al.
(in prep.)
Keep an eye on arXiv!