Contribution ID: **222** Type: **Oral**

# Constraining Cosmological Parameters from Dark Matter Halo Abundance using Simulation-Based Inference

*Tuesday, 25 October 2022 17:00 (20 minutes)*

Constraining cosmological parameters, such as the amount of dark matter and dark energy, to high precision requires very large quantities of data. Modern survey experiments like DES, LSST, and JWST, are acquiring these data sets. However, the volumes and complexities of these data –variety, systematics, etc. –show that traditional analysis methods are insufficient to exhaust the information contained in these survey data. Specifically, explicit likelihood-based inference as performed with MCMC likelihood fitting is prone to biases because the likelihoods are written as analytic expressions. This calls for a method that can simultaneously process large volumes of data and handle biases in an efficient manner. Simulation-based inference (SBI or likelihood-free inference) is rapidly gaining popularity for addressing diverse cosmological problems because of its ability to incorporate complex physical processes (statistical fluctuations of cluster properties) and observational effects (non-linear measurement errors) while generating the observables by forward simulations. In this work, we train a normalizing-flow-based machine learning algorithm embedded in the SBI framework on two datasets - generated by analytical forward models (via CosmoSIS) and N-body simulations (Quijote simulations suite). We use number counts and mean masses of dark matter halos to estimate posteriors of multiple cosmological parameters (e.g., Ωm, Ωb, h, ns, σ8). Our results show that the SBI method constrains the cosmological parameters within $2\sigma$, which is comparable to the state-of-the-art MCMC-based inference methods, and results in a smaller bias for some parameters (h and ns) than MCMC. Furthermore, SBI trained on the Quijote simulations data permits a much shorter computational time when dealing with large datasets, compared to MCMC method.

## Significance

## References

## Experiment context, if any

**Primary authors:** REZA, Moonzarin (Texas A&M University); ZHANG, Yuanyuan

**Co-authors:** ĆIPRIJANOVIĆ, Aleksandra; NORD, Brian

**Presenter:** REZA, Moonzarin (Texas A&M University)

**Session Classification:** Track 2: Data Analysis - Algorithms and Tools

**Track Classification:** Track 2: Data Analysis - Algorithms and Tools