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Fast and flexible inference framework for continuum reverberation mapping using simulation-based inference

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Continuum reverberation mapping (CRM) measures the time delay in the variability seen in different photometric bands to constrain accretion disk structure and supermassive black hole (SMBH) properties. However, CRM has only been applied to a handful of objects to date due to the stringent observing requirements and large computation time associated with model fitting. I will present a fast and flexible inference framework for CRM using simulation-based inference (SBI) with deep learning to estimate SMBH properties from simulated light curves. We first use a forward-modeling simulator to simulate light curves given the input priors (black hole mass, accretion rate, and inclination angle), then train deep neural networks to learn the mapping between the physical parameters and the simulated data. Once trained, we can estimate an amortized posterior for the physical parameters corresponding to a new simulated light curve with negligible additional computation time. SBI can be applied to different accretion disk models, which is particularly useful for comparing data to models with likelihood functions that are difficult to formulate or compute. I will present how the inference speed and accuracy compare against traditional methods, such as CCF, Javelin, and CREAM. This framework will be useful in estimating physical parameters for the thousands of AGN monitored with LSST, paving the way for new insights into the physics of AGN and the evolution of supermassive black holes.

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