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Harnessing the power of mm-wave intensity mapping to study early galaxy formation

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Line intensity mapping (LIM) is an emerging technique in observational cosmology to spatially and spectrally map the aggregate line emission from large-scale structures, which promises to offer invaluable insights into physical processes that govern galaxy formation and evolution in the cosmological context. The mm-wave sky has been and will be surveyed by a number of LIM experiments such as CONCERTO, TIME, SPT-SLIM, FYST/CCAT-prime, and TIFUUN to study early galaxy formation and cosmic reionization. Novel simulation and analysis tools are thus needed to harness the full power of these LIM observations. I will discuss the development and applications of LIMFAST, a semi-numerical tool that builds on the 21cmFAST code for simulating a multitude of high-redshift LIM signals, including popular target lines like [CII] and [OIII] for mm-wave LIM experiments. I will first introduce how state-of-the-art models of galaxy formation in the early Universe are implemented in LIMFAST to realistically simulate the LIM signals. I will then present recent developments of a simulated-based inference framework that employs neural density estimation to learn key physical aspects of early galaxy formation, such as the star formation law and stellar feedback, from LIMFAST simulations of [CII] and [OIII] signals.

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