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The Universe at $z > 10$ and the first population of stars and galaxies

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The discovery of UV-bright galaxies at redshifts $z > 10$ by JWST, now complemented by ALMA detections of dust and gas emission, has opened an observational window onto the first few hundred million years of cosmic history. These galaxies appear more numerous, more massive, and more evolved than predicted by standard Λ CDM-based models of early structure formation. Their existence poses a tension with theoretical expectations based on the limited time available for halo growth, star formation, and metal enrichment.

In this talk, I will review the current observational landscape: the rapidly increasing sample of high- z galaxy candidates, constraints from their UV luminosity functions, and spectroscopic confirmations. I will emphasize the implications for models of early galaxy formation, including star formation efficiency, feedback. ALMA observations add further weight to the puzzle by revealing significant dust and metal content at unexpectedly early time but no confirmed detections of the very first generation of stars.

This tension—between what we see and what standard theory allows—invites a broader reflection on the interface between observational cosmology and fundamental physics. Are these galaxies outliers, or are we witnessing early hints that physics at the largest scales is probing constraints rooted in the microphysics of the early Universe? This question lies at the heart of the physics of the two infinities.

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