Galaxies at High Redshift and Their Evolution Over Cosmic Time
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The Galaxy UV Luminosity Function Before the Epoch of Reionization

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Abstract. We present a model for the evolution of the galaxy ultraviolet (UV) luminosity function (LF) where star formation is linked to the assembly of dark matter halos under the assumption of a mass dependent, but redshift independent, efficiency. With a calibration at a single redshift, and no further degrees of freedom, our model captures the evolution of the UV LF over all available observations ($0 \lesssim z \lesssim 10$). We make predictions for reionization and future high-redshift surveys with *JWST* and *WFIRST*.

Keywords. cosmology: theory, galaxies: high-redshift, stars: formation

1. Model Description

Our model (Mason *et al.*, 2015) considers the growth of DM halos to be the most important driving force in the growth of galaxies, and aims at predicting the evolution of the UV LF with minimal assumptions. We assume that the SFR is proportional to: (1) the halo mass, through a mass-dependent but redshift-independent efficiency; and (2) to the inverse of the halo assembly time (Lacey & Cole, 1993). This implies that stellar populations that are younger at higher redshift. These assumptions allow us to calibrate our model at a single redshift to derive the effiency, and construct predictions for the LF at all other redshifts from the DM halo mass function and the halo assembly time.

2. Results

Luminosity Functions and SFR density. Our model LFs are very successful in matching observations ($0 \lesssim z \lesssim 10$). Our model reproduces the observed cosmic SFR density well, indicating a sharp decline at $z > 8$, consistent with observed data at $z \sim 10$, explained in our model by a shift of star formation toward less massive, fainter galaxies.

Forecasts for JWST and WFIRST. We construct forecasts for surveys with *JWST* and *WFIRST* and predict that galaxies out to $z \sim 14$ will be observed. Galaxies at $z > 15$ will likely be accessible only through the assistance of strong lensing magnification.

Implications for Reionization. We find that reionization is complete by $z = 7.84^{+0.65}_{-0.98}$, under the assumption that the LF extends down to a minimum galaxy luminosity of $M_{\rm AB} = -12$, with $\tau = 0.056^{+0.007}_{-0.010}$. This is consistent with the Planck Collaboration *et al.* (2015) results and with ultrafaint galaxies being the dominant sources of reionization.

References

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