Uncovering Early Galaxy Evolution in the ALMA and JWST Era
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New constraints on reionization from a redshift-independent efficiency model

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Abstract. We present an empirical model built on a high-resolution N-body dark matter simulation. We assume a redshift-independent star-formation efficiency for each halo to convert the accretion rate into a star-formation rate. Our model is calibrated using the $z = 4$ UV luminosity function (UVLF) and successfully predicts the observed UVLF at $z = 5 - 10$. We present predictions at $z = 5 - 10$ for UV luminosity and stellar mass functions, JWST number counts, the stellar-to-halo mass relation and star-formation histories. We combine this model with bleeding-edge reionization constraints (from $z > 7$ quasars, $z \sim 7$ Lyα line-profiles, the updated Planck τ) to find new perspectives on the Epoch of Reionization (EoR). We find $M_{\rm UV} < -13.5$ galaxies need an average $f_{\rm esc} = 0.22 \pm 0.05$ to drive reionization and a highly compressed timeline: the IGM neutral fraction is $[0.9, 0.5, 0.1]$ at $z = [8.4 \pm 0.2, 7.0 \pm 0.2, 6.3 \pm 0.2]$. Inspired by the newly assembled sample of Lyman Continuum leakers that unanimously displays higher-than-average star-formation surface density (sigma), we fit a model tying $f_{\rm esc}$ to sigma. Since sigma grows by > 2.5dex over $z = 0 - 8$, our model explains the humble values of $f_{\rm esc}$ at low-z. We find, strikingly, that <5% of galaxies with $M_{\rm UV} < -18$ account for $> 80\%$ of the reionization budget. We predict leakers like COLA1 ($z = 6.6$, $M_{\rm UV} = -21.5$) become common towards the EoR and that the protagonists of reionization are not hiding across the faint-end of the luminosity function but are already known to us.