The Galaxy UV Luminosity Function Before the Epoch of Reionization

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Motivation

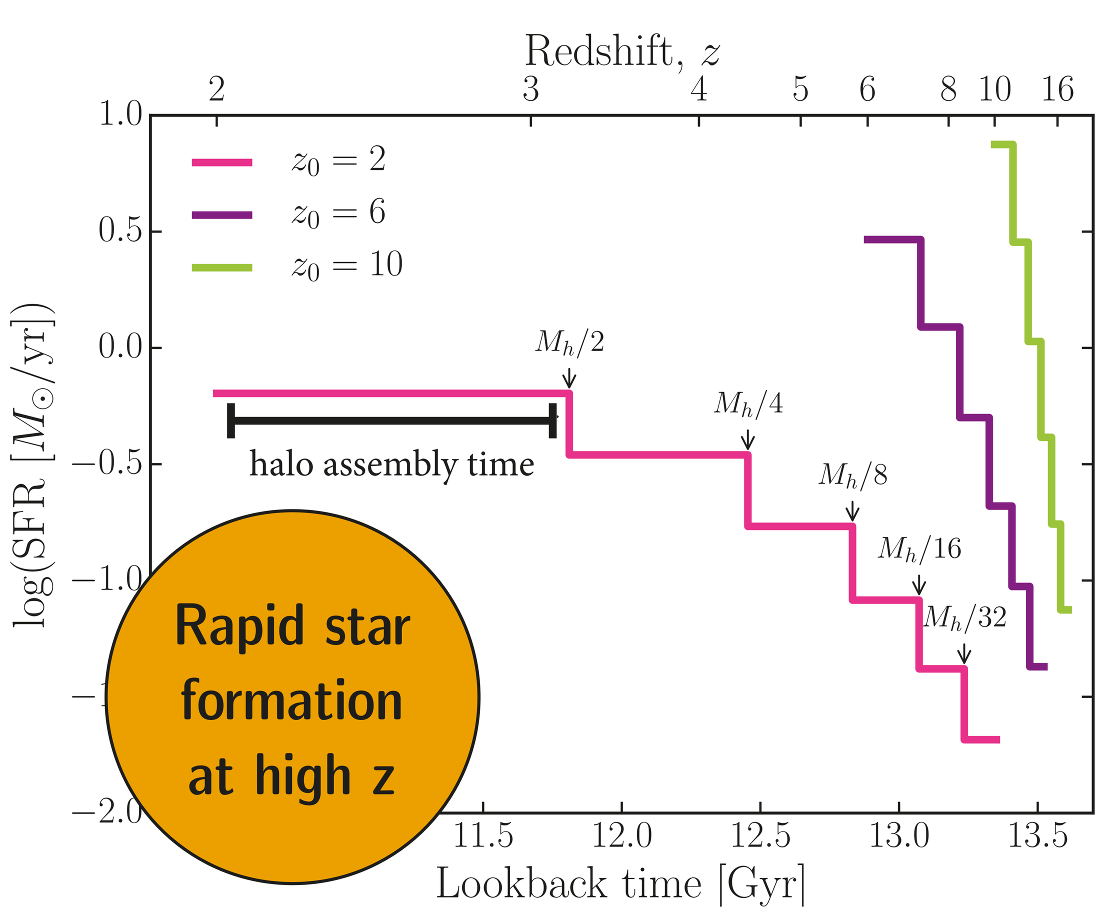
- The rest-frame UV galaxy luminosity function (LF) and its evolution are crucial tracers of galaxy properties over cosmic time.
- The observational frontier is currently z~10, with the number density of galaxies decreasing with increasing redshift, while the LF remains consistent with a Schechter (1976) form.
- The observed population at z>7 does not produce sufficient photons to ionize the universe, but both theoretical modeling and indirect probes suggest that a very faint population of unseen dwarf galaxies at z>6 is the main contributor to the ionizing photon budget (e.g., Alavarez et al. 2012).
- Motivated by the upcoming improvement in discovery capabilities of high redshift galaxies with JWST and WFIRST, we predict the UV LFs at z>10, when the first galaxies were being assembled, and hydrogen in the universe was predominantly neutral.

Model Description

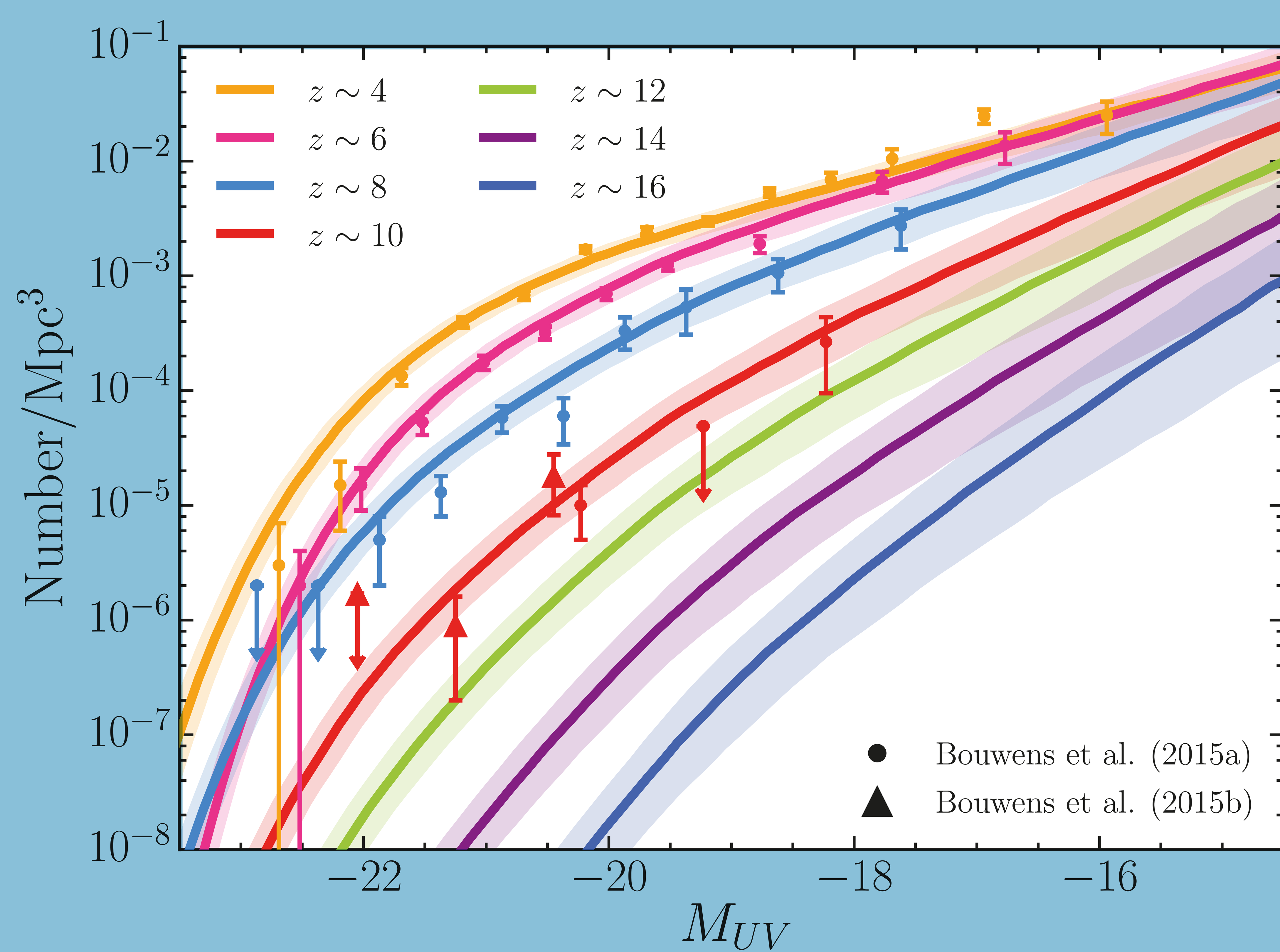
- We introduce a simple model for the evolution of the UV LF from 0 < z < 16, assuming that the average SFH of galaxies is set by their halo mass and redshift, so that halos of the same mass have the same stellar mass independent of redshift.
- Our model builds upon previous similar implementations (Trenti et al. 2010, 2015; Tacchella et al. 2013), but we extend our framework to construct a self-consistent model capable of following the evolution of star formation even when the halo assembly times become very short (at z>10).
- We assume the SFR is proportional to
    (1) Halo mass, through a mass-dependent but redshift-independent efficiency
    (2) The inverse of the halo assembly timescale, which decreases at higher redshift.
- We calibrate our model at one redshift, and then construct predictions for the LF at all other redshifts from the DM HMF and the halo assembly time which are fuly defined by cosmology.

Star Formation Histories

SFH for halos of fixed mass $M_h = 10^{11}\ M_\odot$ observed at z_0



Predicted Luminosity Functions



Results & Conclusions

- Model LFs are very successful in matching observations at all redshifts (0 < z < 10). Faint-end slope steepens with z
- Recent star formation is the largest contribution to UV luminosity, but including earlier star formation better reproduces stellar mass density and average stellar ages
- Results consistent with Planck 2015 and with ultrafaint galaxies being the dominant sources of reionization
- z~14 is within reach of JWST & WFIRST. z>15 will require significant strong lensing magnification, e.g. cluster fields

References

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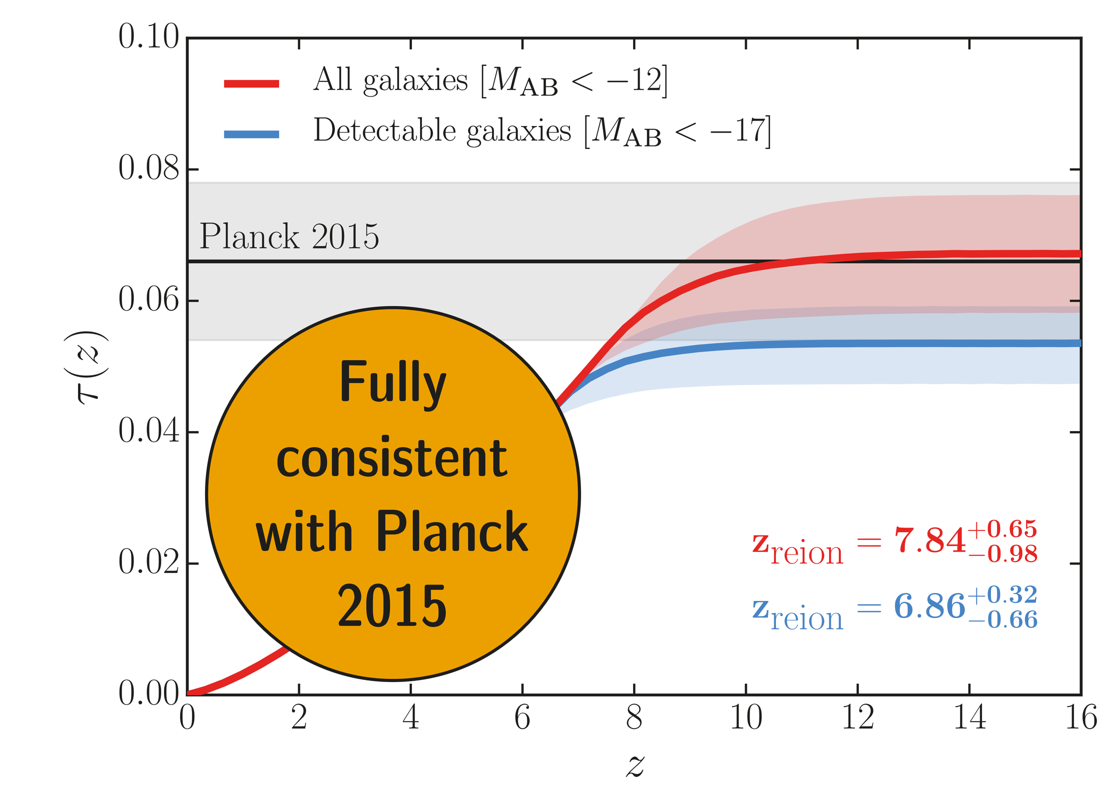
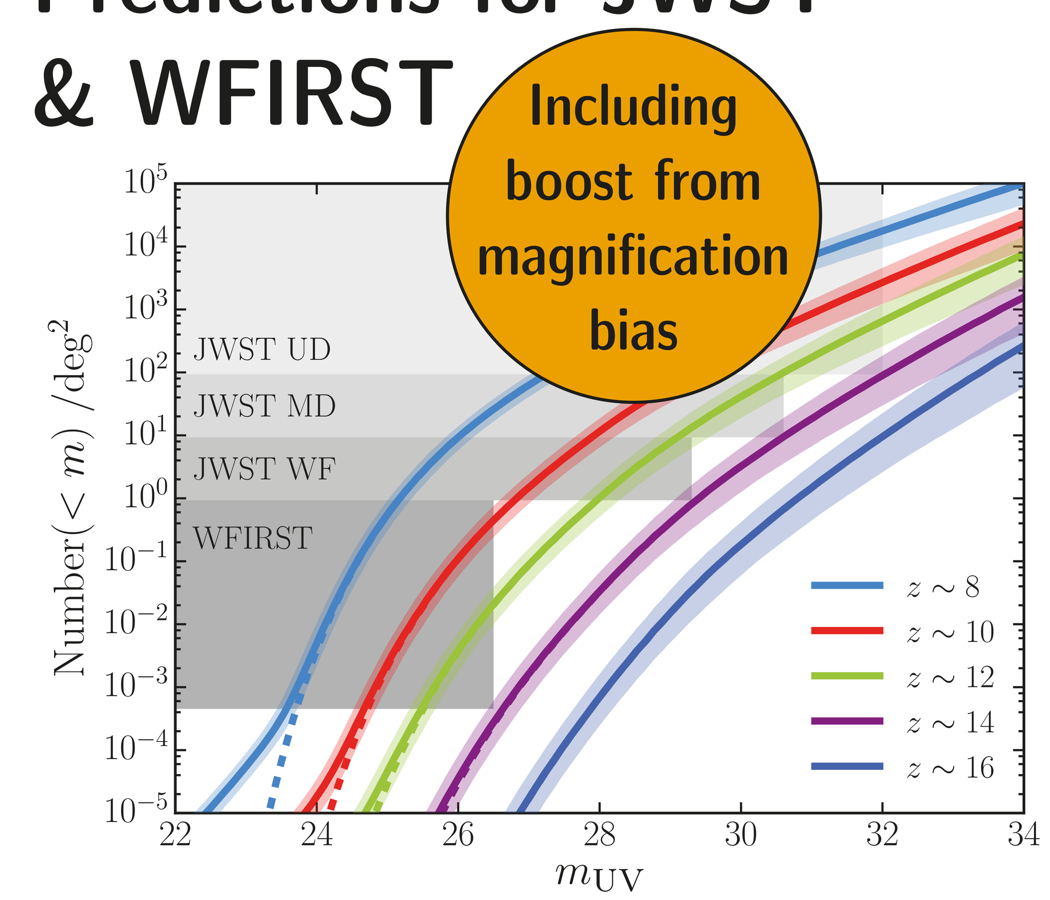
Implications for Reionization



Predictions for JWST & WFIRST



Luminosity & SFR density