Lyman-Break Galaxies in the Epoch of Reionization

Silvio Lorenzoni[1], Andrew J. Bunker[2], Stephen M. Wilkins[3], Joseph Caruana[4], Holly Elbert[2]

[1] IA-Lisbon, Observatório Astronómico de Lisboa, Portugal
[2] University of Oxford, Department of Physics, United Kingdom
[3] Astronomy Centre, University of Sussex, United Kingdom
[4] Leibniz-Institut für Astrophysik, Potsdam, Germany

instituto de astrofísica e ciências do espaço

FCT Fundação para a Ciência e a Tecnologia

SFRH / BPD / 89554 / 2012
UID/FIS/04434/2013

Thanks to the installation of Wide Field Camera 3 on the *Hubble Space Telescope* in Summer 2009, the search for star-forming galaxies at redshifts z ≥ 7, within the Epoch of Reionization, using the Lyman break technique has become possible. This technique rely on the large absorption produced by the Lyman-α forest clouds and the Lyman limit.

This study analyses the *Hubble* eXtreme Deep Field (XDF) and its flanking fields, the CANDELS data in the GOODS-South and -North regions and 4 parallel (non lensed) *Hubble* Frontier Fields (HFF).

From the observed surface density of galaxy candidates we can recover the Schechter Luminosity Function (LF) of z~7 (Fig. 3) and z~8 galaxies in the rest frame ultraviolet. These LFs show evolution from redshift 3 and 6, and also suggest evolution from z~7 and z~8 (Fig. 4).

The star formation rate density can be estimated from the rest frame UV luminosity density, that can be obtained integrating the LF. Ionizing UV photons from massive stars might be critical in reionization.

However, our work shows that under standard assumptions of IMF, escape fraction and clumping of the gas, the observed population of Lyman break galaxies (LBGs) produce insufficient flux to reionize the Universe (Fig. 5). As we can see in this figure, establishing the correct faint end slope is crucial to determine the ionizing photon budget: with current data we do not go much fainter than the knee of the LF at high redshift. The JWST will allow us to reach the needed depths to better understand the role of fainter galaxies in cosmic history, along with pushing galaxy searches to even higher redshifts and perform quicker and deeper spectroscopy.

For more information, see Lorenzoni et al. 2013, MNRAS, 429, 150, or look forward to Lorenzoni et al. in prep!

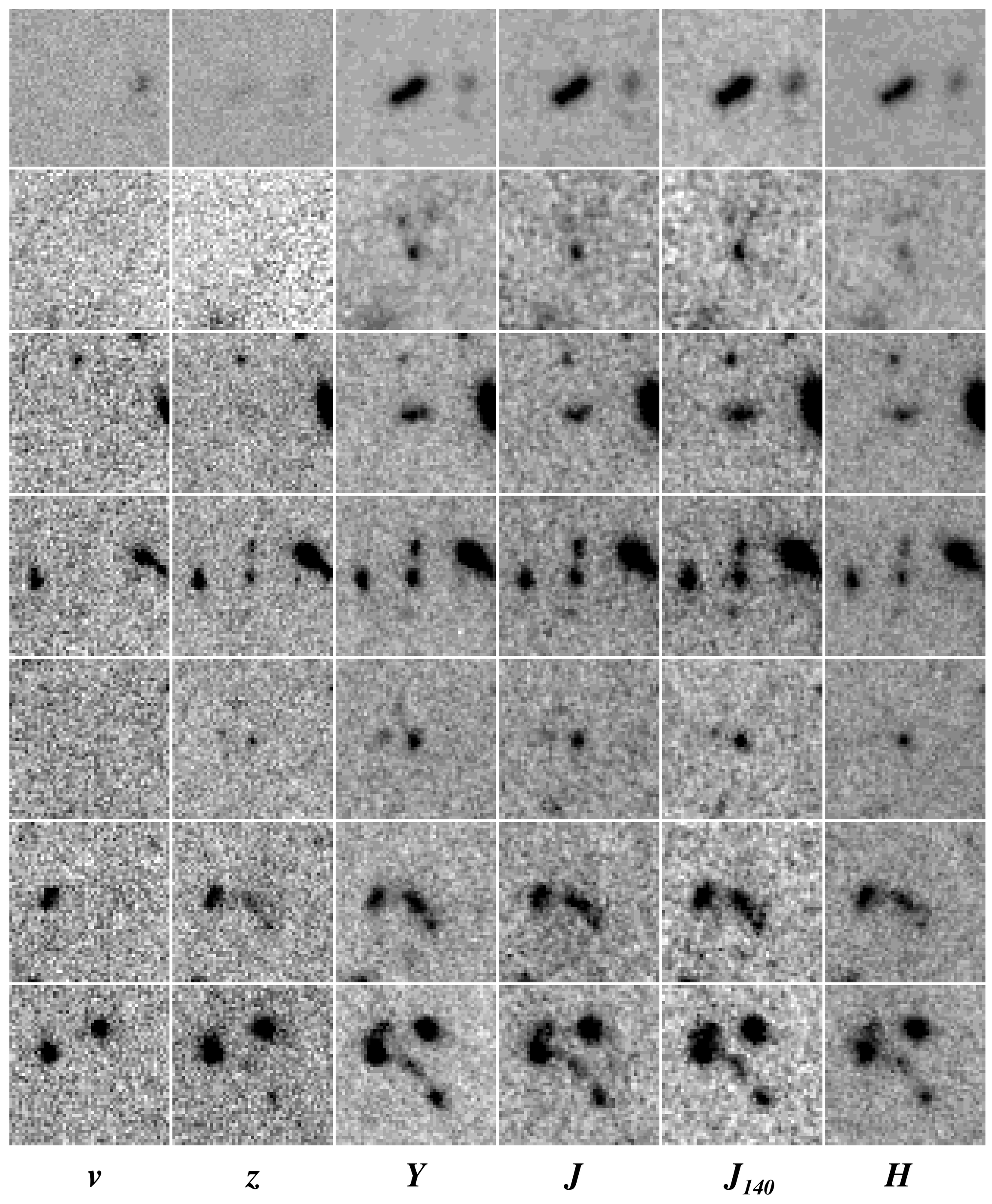

Figure 1. 2.4″×2.4″ thumbnail images of z~7 Lyman break galaxies in close pairs (<1" separation) or with elongated features. The Lyman-α emission quickly drops at z > 6, but in close systems one galaxy could "ionise the way" for Lyman-α emission from a background galaxy. If objects in close systems beyond z~6 show a higher fraction of Lyman-α than isolated ones, this would prove that the drop in Ly-α emission is due to the IGM rather than to the galaxies themselves.

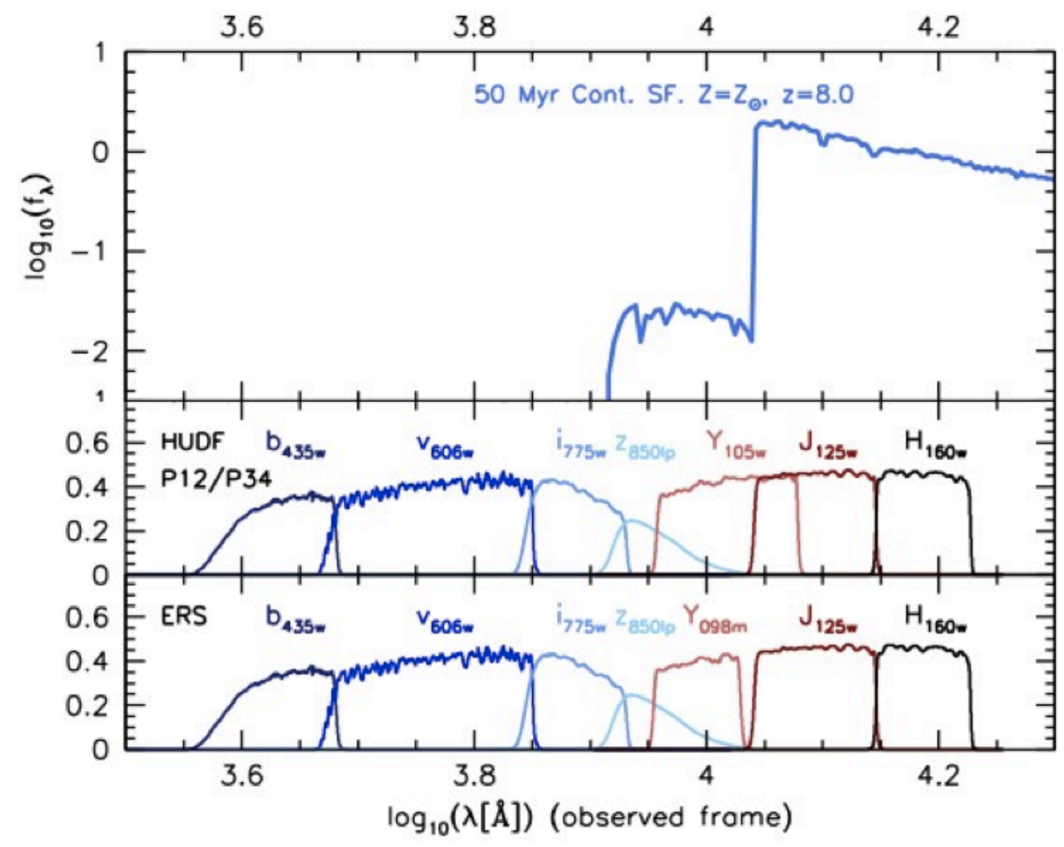

Figure 2. Top panel – Model spectral energy distribution of a redshifted z=8 star forming galaxy. Bottom panels – the transmission functions of the combination of ACS and WFC3 filters available to each field.

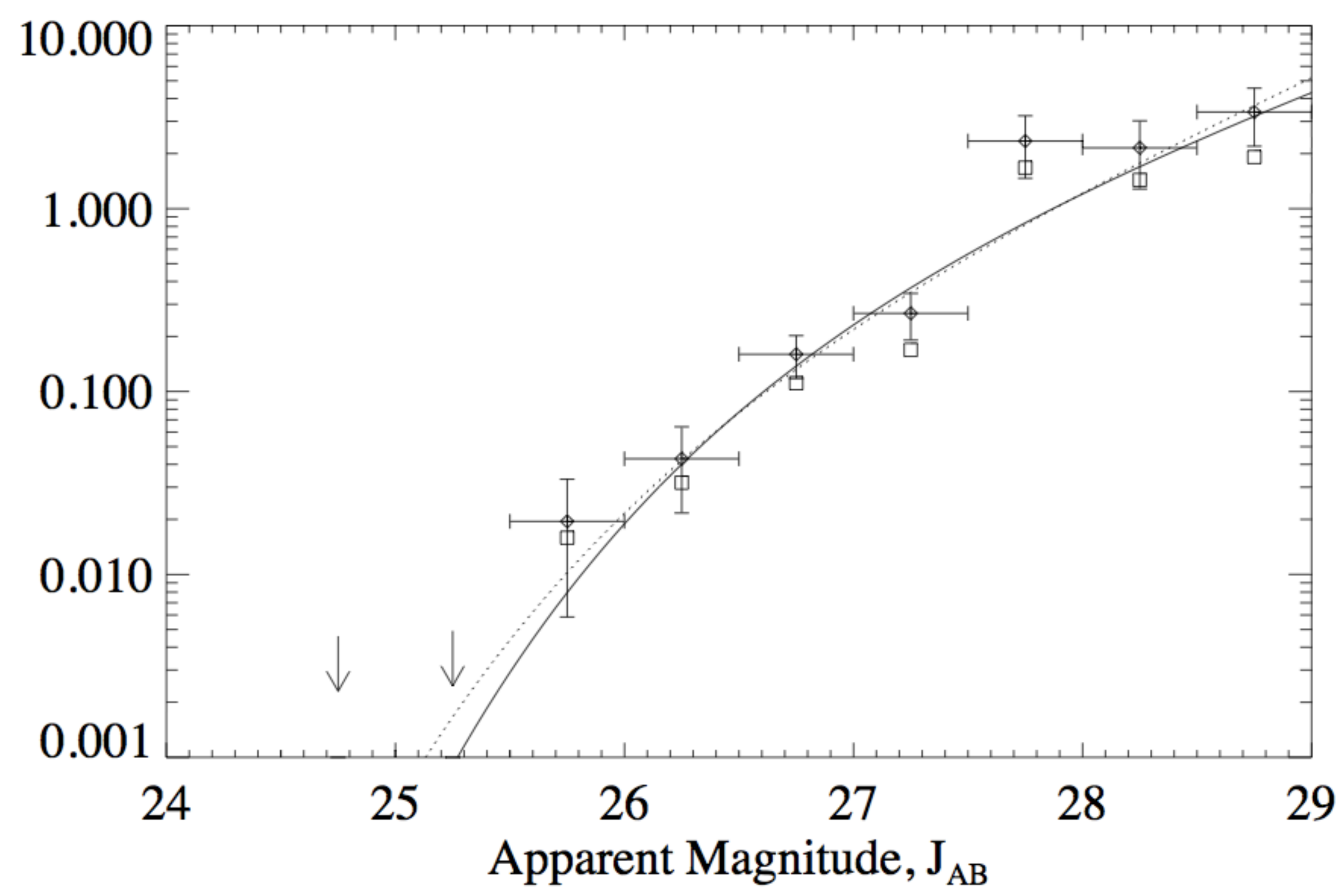

Figure 3. Schechter LF of z-drop selected sources at z ~ 7. The diamonds are the completeness-corrected observed surface densities and the squares are the raw observed surface densities.

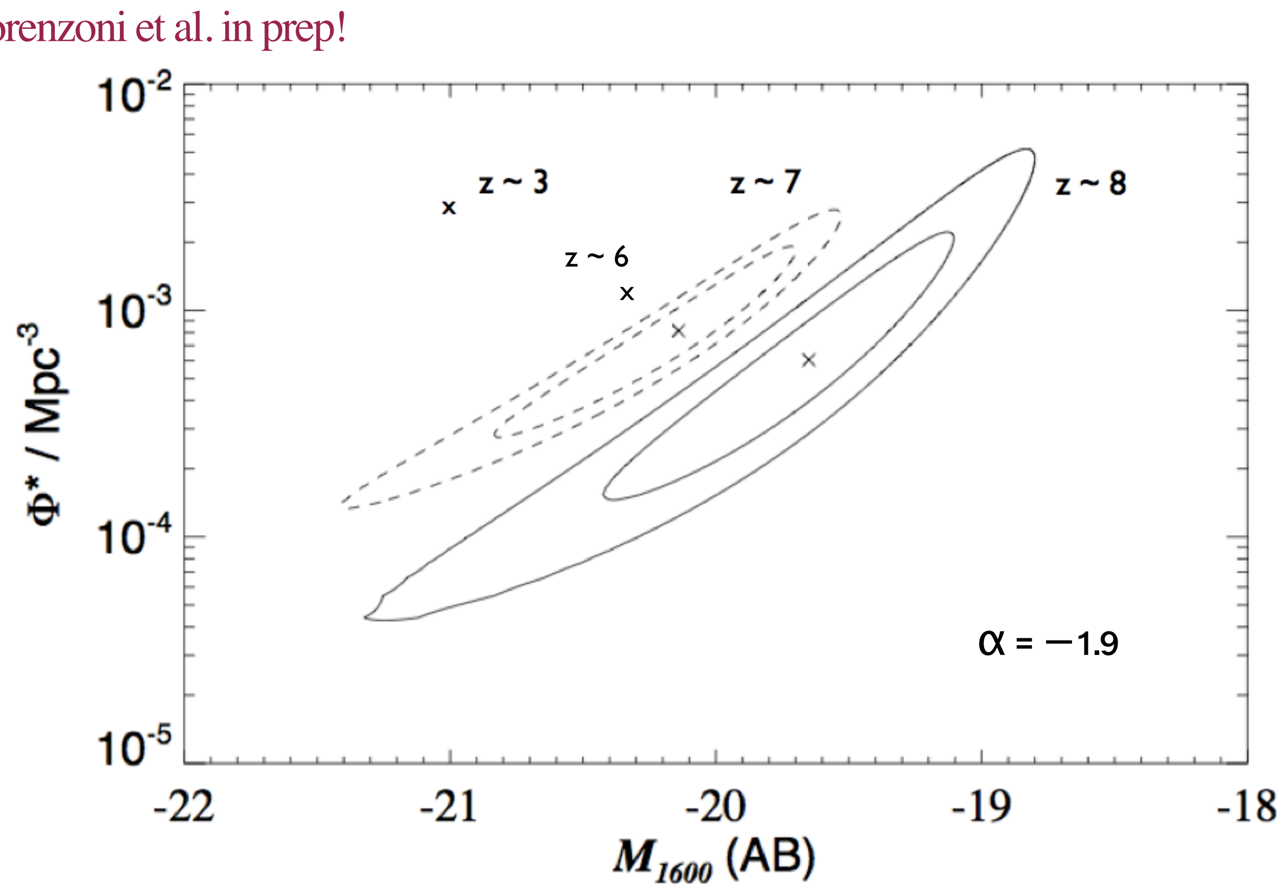

Figure 4. The likelihood contours for the luminosity function of z′-drops (dashed lines) and Y-drops (solid lines), showing the correlation between the fitted M* and ϕ* parameters for a Schechter function fit. Crosses mark the best fit values at different redshifts.

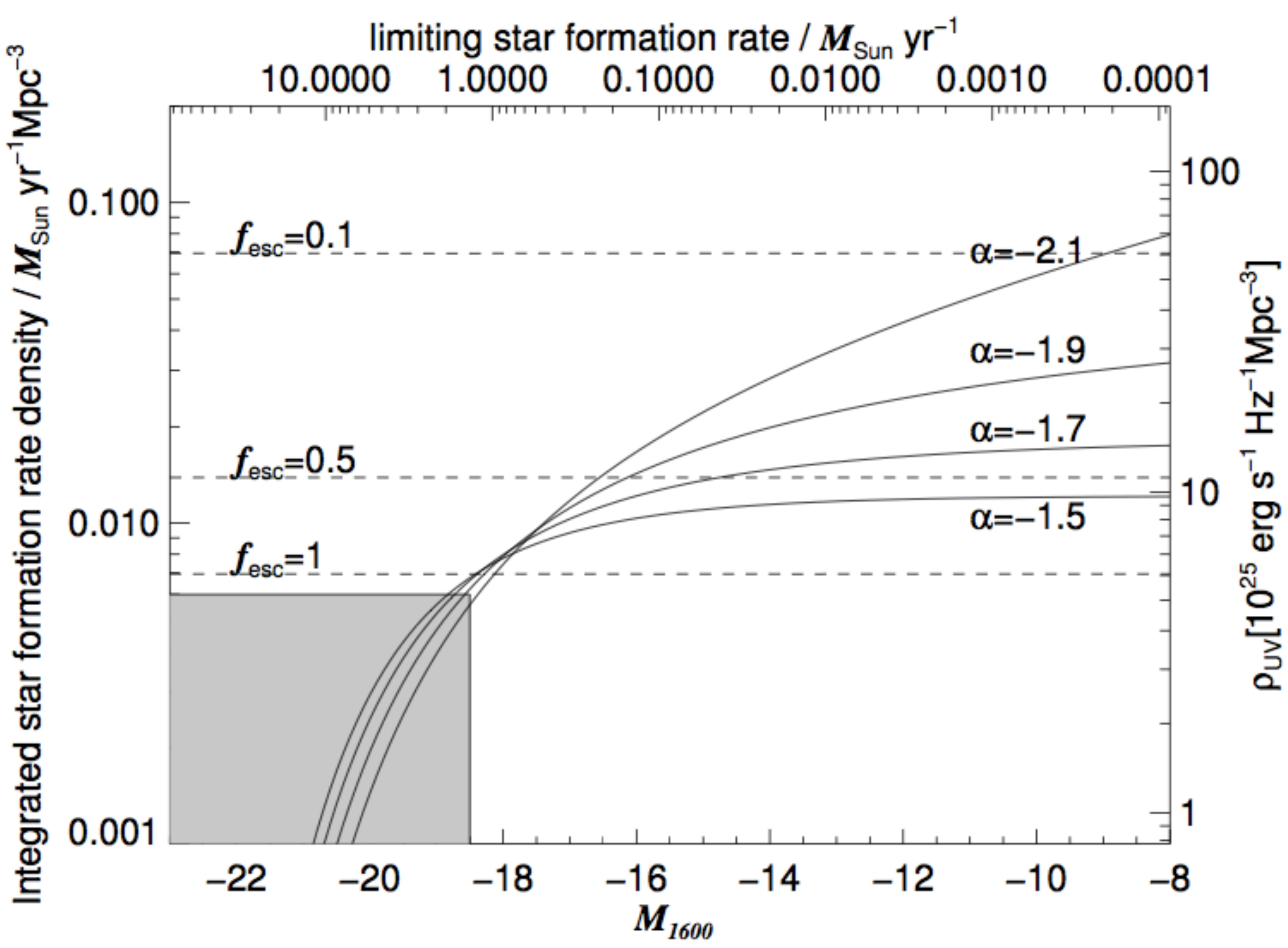

Figure 5. The solid lines are the total star formation rate density (left axis) or ionising flux density (right axis) inferred from the luminosity function fits for our Y-drop sample, integrating down to the limiting absolute magnitude in the rest-frame UV shown on the lower x-axis (in AB magnitudes). The dashed lines show the requirement to keep the Universe ionised at z ~ 7 for different escape fractions fesc. Where the solid lines cross the dashed lines, reionzation can be achieved. The shaded region is where the current deepest observations probe (the XDF).