Bright Emission Analogues of High ReDshift GalaxieS

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Introduction

Over the next decade, the James Webb Space Telescope (JWST) will observe the spectra of star forming galaxies in the early Universe. One of the key scientific aims will be to determine whether these galaxies were the primary source of photons necessary for reionization. In preparation for JWST, spectroscopic observations of young star forming galaxies in the local Universe, potential analogs of reionization-era galaxies, have been obtained. In this project, we have attempted to determine the ionizing conditions in one such sample of local star-forming galaxies, taken from Senchyna et. al. 2016.

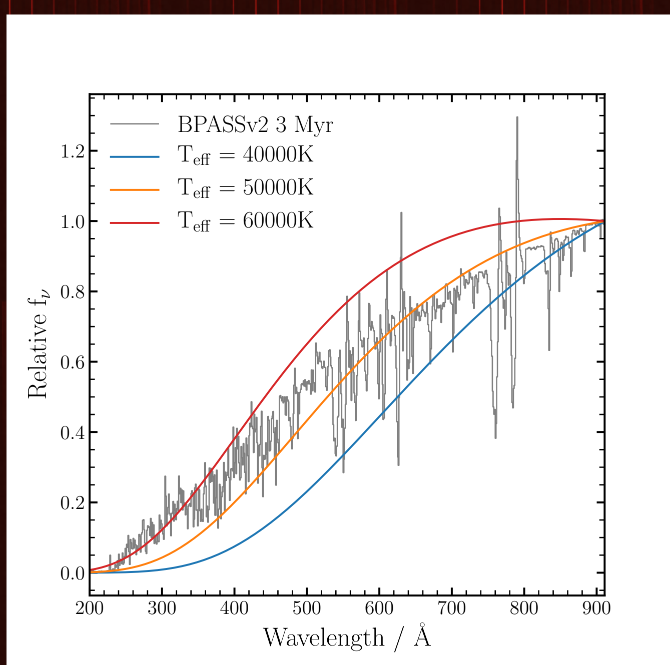

Figure 1 - *The above figure shows the ionizing continua (< 912A) of the three blackbody models compared to the BPASSv2-300bin 3 Myr constant star formation model with Z/Zo=0.1. The similarity of the results, at this metallicity, between the 50,000 K blackbody model and BPASS model are explained by the similarity in the shape of the ionizing continua.*

Results

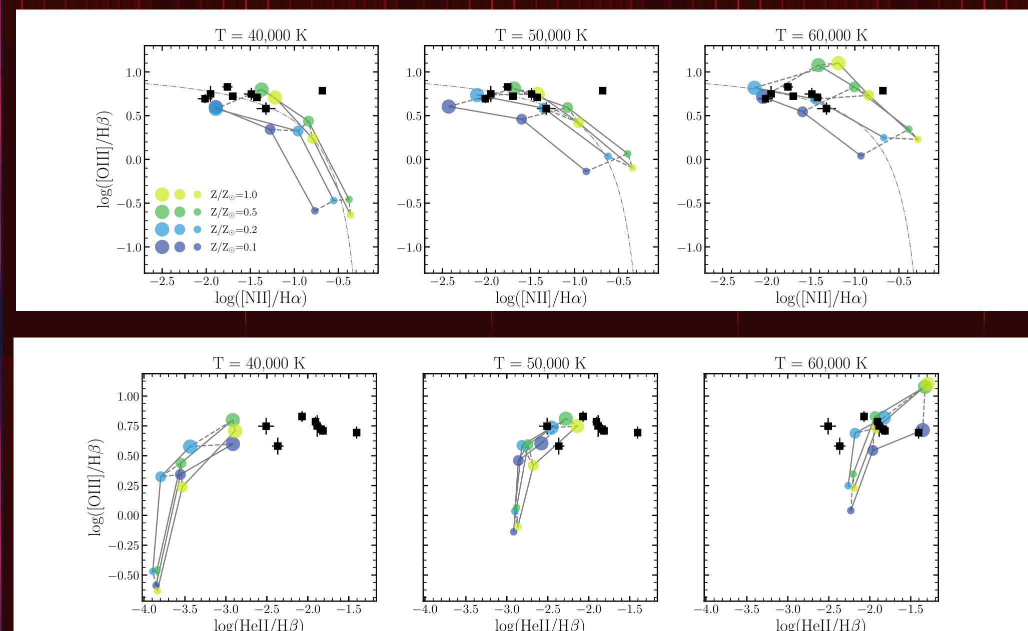

Figure 2 *- We ran a set of simple Cloudy models assuming input blackbody spectra with effective temperatures of 40,000K, 50,000K (maximum O star temperature) and 60000K (hotter than any observed O star). For each input spectrum we ran a grid of Cloudy models with logU = -3, -2, -1 and Z/Zo = 0.1, 0.2, 0.5, 1.0, assuming a constant hydrogen density of 100 cm-3. The results shown in the figure demonstrate that stellar temperatures as low as 40,000K are not compatible with the data, since they cannot reproduce the high HeII/Hb ratios. At a minimum the models require O star spectra with a high ionization parameter and sub-solar metallicity. However, interestingly, the highest HeII/Hb ratios can only be achieved with the 60,0000 K blackbody spectrum, hotter than any known O star.*

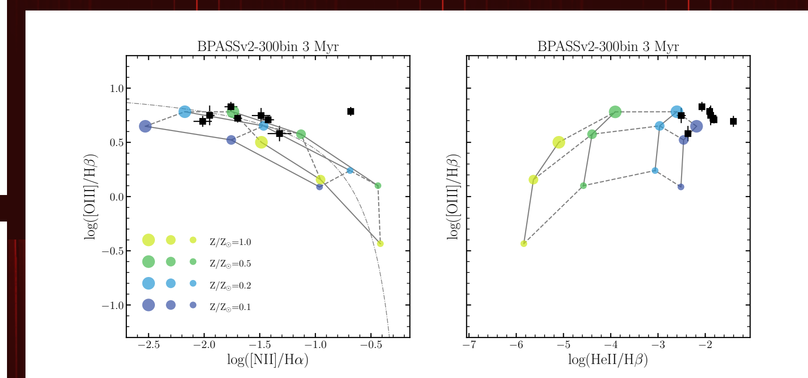

Figure 3 *- We also ran the same grid of models using a stellar SED extracted from the BPASSv2 models. For this SED we assumed a constant star formation over 3 Myr. In the BPT diagram, the results resemble the 50,000 K black body model, perhaps unsurprisingly since at 3 Myr the SED is dominated by hot O stars. Interestingly the HeII/Hb diagram illustrates how sensitive the ionizing continuum shape is to the assumed stellar metallicity, metallicities > 0.5 Z/Zo are clearly ruled out. Again, the models cannot reproduce the highest HeII/Hb ratios.*

Conclusion

Local bright emission analogues of high redshift galaxies require strict constraints on the ionizing conditions. The blackbody models used in Cloudy, suggest that only high blackbody temperatures (50,000 K) and high ionisation parameters (logU > -2) yield the comparable emission line ratios. The BPASSv2 models place similar constraints on the ionisation parameter, however also suggest an additional constraint on the metallicity (< 0.5 Z/Zo). The BPASSv2 models never yield appropriate HeII/Hb ratios found in the data. This could be produced by AGN activity increasing the largest HeII/Hb ratios.

References : Senchyna et al. (2016) - Senchyna . P, Stark. D, Vidal-Garcıa. A, Chevallard . J, Charlot. S et al. 2016, preprint (arXiv:1706.00881)