Predicting the number density of Hα-emitting galaxies

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Context & Motivation

- NASA's WFIRST mission aims to probe the nature of dark energy, which is thought to be driving the accelerated expansion of the Universe.
- WFIRST will do this by measuring the expansion history of the Universe by making precise measurements of baryon acoustic oscillations in the clustering signal of Hα-emitting galaxies.
- The uncertainty on the clustering measurement is sensitive to the number density of Hα-emitting galaxies that WFIRST will observe.
- Estimates of the number density of Hα-emitting galaxies from existing small area surveys show a large scatter of 20-50%.

Objective

We apply the galaxy formation model '*Galacticus*' [1] to a cosmological simulation in order to make predictions for the number of Hα-emitting galaxies that we expect to see with WFIRST.

Methodology

- Galacticus is a galaxy formation model that describes the astrophysical processes that govern galaxy formation. Dust attenuation, which has a big impact on the observed galaxy counts, was implemented using three different methods from the literature [2,3,4]. Emission line luminosities were computed using 'CLOUDY' [5].
- To calibrate Galacticus we compare the model predictions to observed counts from the *WFC3 Infrared Spectroscopic Parallels* (WISP) survey [6,7] using χ^2 minimization to identify the optimum parameters for the dust attenuation methods.
- WISP is an existing small area survey of Hα-emitting galaxies carried out with the Wide Field Camera 3 on the Hubble Space Telescope.

Table 1: Predicted number densities (in deg^{-2}) from Galacticus for a simulated WFIRST-like mission with redshift range $1 \leq z \leq 2$. Number densities are shown for the three different dust methods used in Galacticus.

Flux limit (erg s^{-1} cm^{-2})	Ferrara et al. [2]	Calzetti et al. [3]	Charlot & Fall [4]
1 x 10 $^{-16}$	7952 ± 439	12295 ± 1251	9942 ± 1596

References: [1] Benson 2012, New Astron. 17, 175-197; [2] Ferrara et al. 1999, ApJS 123, 437-445 [3] Calzetti et al. 2000, ApJ 533, 682-695 [4] Charlot & Fall 2000, ApJ 539, 718-731 [5] Ferland et al. 2013, Rev. Mex. Astron. Astrofis 49, 137-163 [6] Colbert et al. 2013, ApJ 779, 34-50 [7] Mehta et al. 2015, ApJ 811, 141-152.

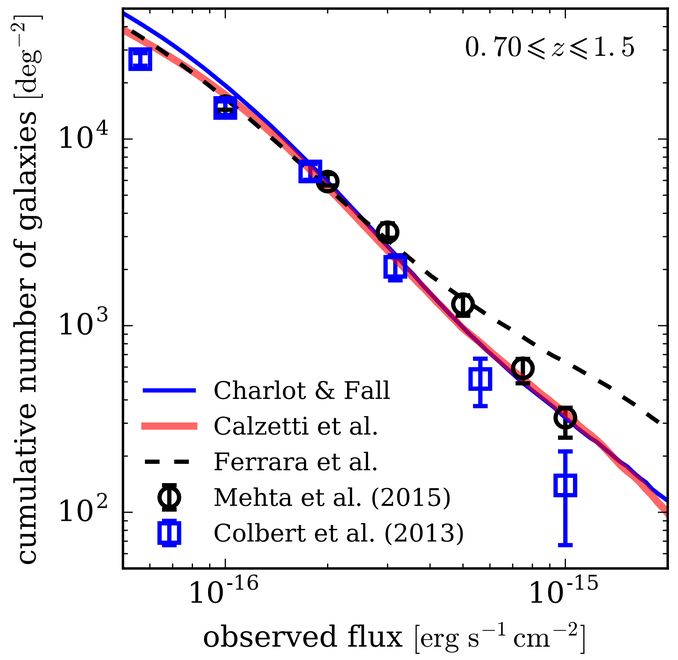
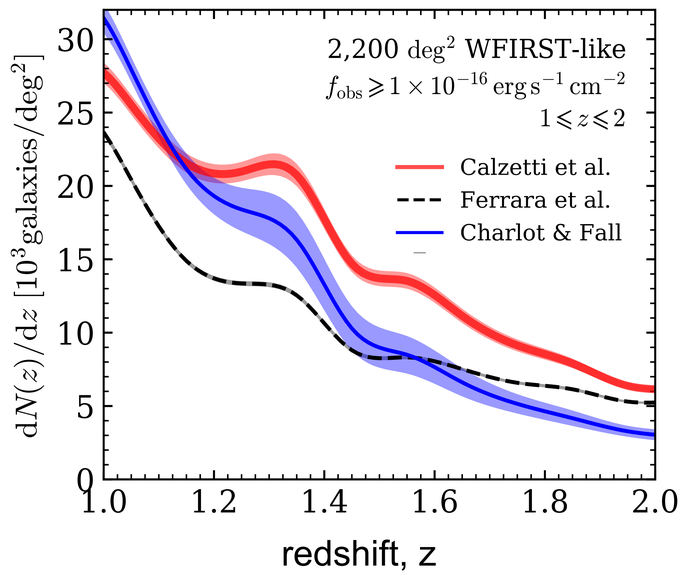


Fig. 1: Cumulative number counts of Hα-emitting galaxies as observed by WISP (data points) and as predicted by Galacticus model when using three models for attenuation of light by interstellar dust (Ferarra et al. 1999 [2]; Calzetti et al. 2000 [3]; Charlot & Fall 2000 [4]).

Fig. 2: Differential redshift counts predicted by Galacticus for a WFIRST-like survey spanning a redshift range $1 \leq z \leq 2$ with flux limit of 1×10^{-16} erg s^{-1}cm^{-2}. The various lines show the mean counts, using each of the three dust methods, and the shaded regions indicate one standard deviation.



Results & Conclusions

- With Galacticus we are able to reproduce, for the first time, the number counts of Hα-emitting galaxies from WISP (see Fig.1). The Calzetti et al. dust method provides the best fit to the data.
- We can predict the number density of Hα-emitting galaxies that we might expect to observe with WFIRST (see Fig.2 and Table 1).
- For full details see **Merson et al. (2018) MNRAS, 474, 177-196**.