NEURAL NETWORK EMULATORS FOR THE LYMAN-α FOREST

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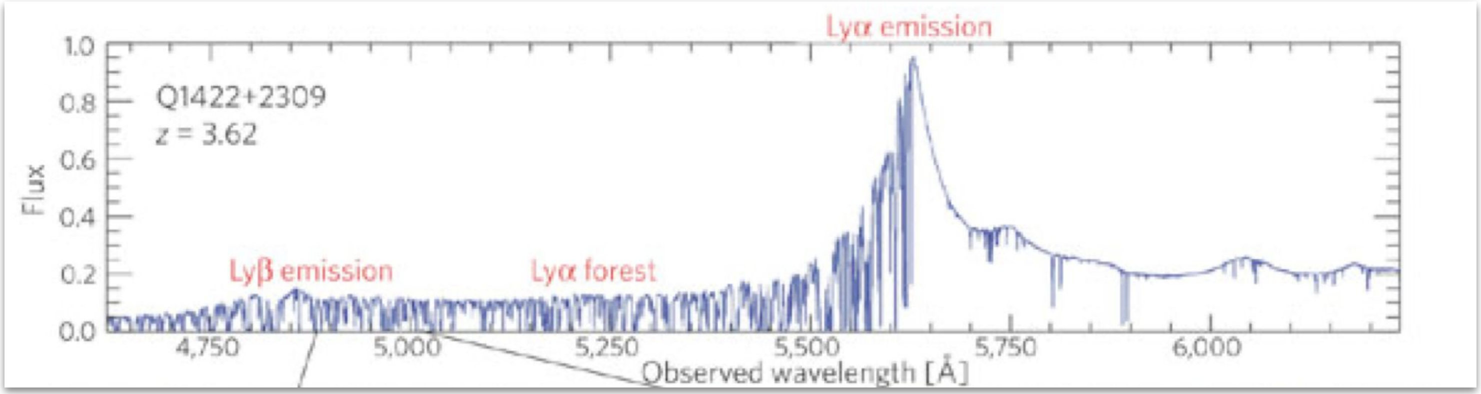
INTRODUCTION

The Lyman-α Forest is a series of absorption lines seen in the spectra of distant quasars, caused by the absorption of light by neutral hydrogen in the intergalactic medium.



We can do cosmological analyses of the Ly-α forest measuring correlations along the line-of-sight of each individual quasar (**P1D**, McDonald et al. 2004)

Interpreting the P1D and extracting cosmological constraints requires time-consuming hydro simulations and an emulator is required for cosmological inference.

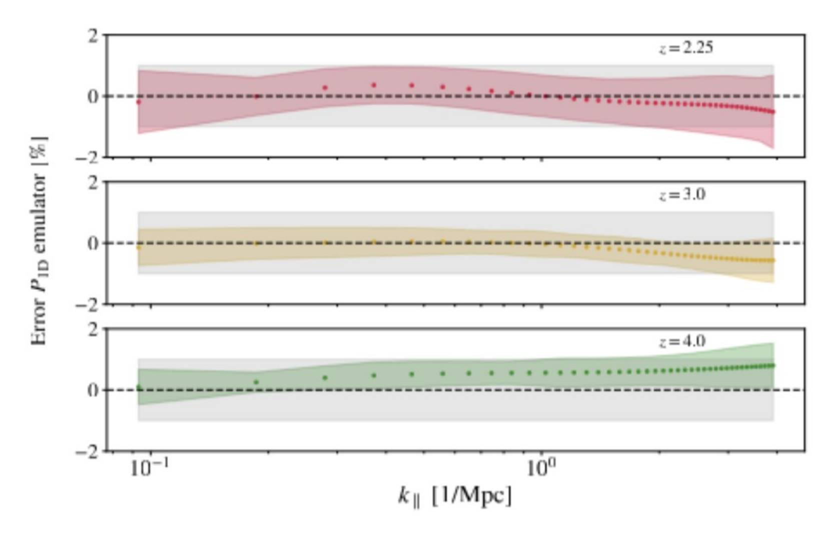
EMULATOR FOR THE 1D POWER SPECTRUM

The LaCE emulators predict the P1D as a function of the amplitude and slope of the linear matter power spectrum, together with astrophysical parameters modelling the IGM.

$n_p, \Delta_P, \langle F \rangle, k_F \sigma_T, \gamma$ - - - - → P1D

WHAT MAKES THE LaCE EMULATOR DIFFERENT?

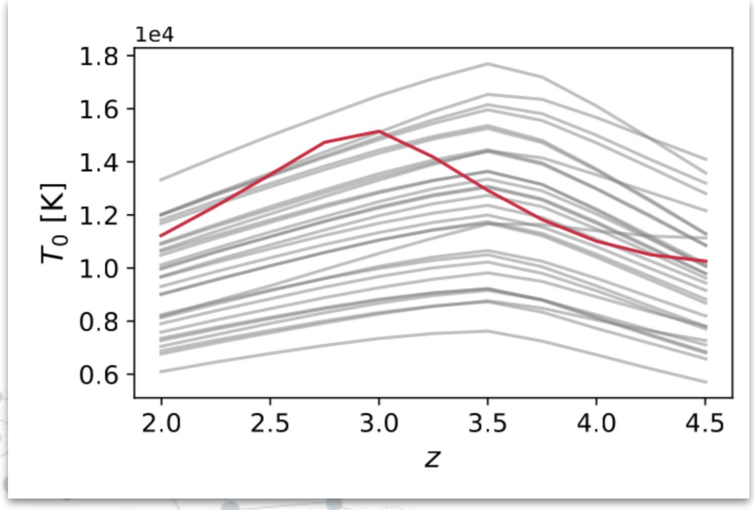
1. The LaCE emulators do not emulate as a function of redshift. All cosmological information is encoded in the slope and amplitude of the linear power. This flexibility enables the analysis of data with any desired redshift binning

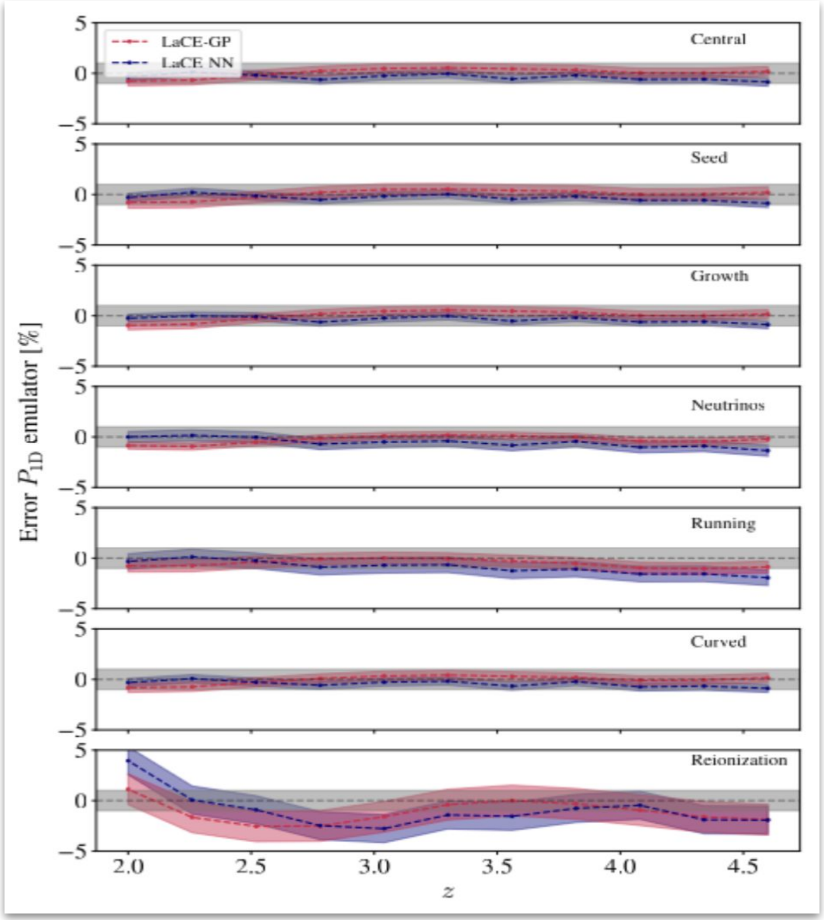


EMULATOR FOR THE 1D POWER SPECTRUM

2.

LaCE can predict the P1D of cosmologies not represented in the training set, e.g. different growth rate, curvature, or massive neutrinos. Also challenging simulations with different thermal histories.





WHAT'S NEXT?

We are currently working in a 3D Lyman-alpha power spectrum emulator.

$$P_{\rm F}(k,\mu) = b_{\rm F}^2 \left(1 + \beta_{\rm F}\,\mu^2\right)^2 D_{\rm NL}(k,\mu) P_{\rm L}(k)$$

$$D_{\rm NL}(k,\mu) = \exp\left[q\Delta^2 - q\Delta^2 \mu^{b_{\rm v}} \left(\frac{k}{k_{\rm v}}\right)^{a_{\rm v}} - \left(\frac{k}{k_{\rm p}}\right)^2\right]$$

$n_p, \Delta_p, \langle F \rangle, k_F \sigma_T, \gamma$ ------> P1D, P3D

[Arinyo-i-Prats+15]

Compute best-fitting parametric model to P3D + P1D measurements from simulations and train a normalizing flow to recover such parameters.

Using the Arinyo model we can model large scales without running large hydro sims. Parameters *b* and β model large scales and with the other parameters we can model non-linearities and gas physics.