

Spectral resolution is not important for modeling galaxy growth

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ABSTRACT

It is axiomatic that high resolution spectra yield better constraints on galaxy star formation histories (SFHs) than low resolution spectra or broadband photometry. We test this statement by comparing predictions for high-resolution spectra generated from galaxy SFHs constrained by only *ugrizJK_s* photometry and rest-optical $R \sim 100$ prism spectra to actual $R \sim 1000$ spectroscopy obtained post-facto. In a sample of **XXX** galaxies, we find median differences between predicted and inferred Lick indices of $<1\%$ for both starforming and passive galaxies in all indices except the Balmer lines—whose divergences are entirely explained by unmodeled emission features—and the CN₁ and G4300 features in passive galaxies, which diverge by 2% and 1.5%, respectively. As such, unless one can identify a scientific motivation to measure these features to similar or better precision when inferring galaxy SFHs, we find no utility in using high resolution spectroscopy to constrain SFH models, at least when the latter are sufficiently flexible to span a wide diversity of intrinsic growth trajectories. These findings cast serious doubt on the extent to which new projects to obtain such data at ever higher redshifts will address core outstanding questions in galaxy evolution in novel ways.

Key words: galaxies: surveys — galaxies: spectroscopy — spectroscopy: techniques

1 INTRODUCTION

A central ambition of the study of galaxy evolution is understanding stellar mass growth; i.e., galaxy star formation histories (SFHs). Spectral energy distributions (SEDs) are the key data in this work because they can be decomposed into combinations of distinct stellar populations of known ages. The resulting coefficients yield the amount of stellar mass a galaxy is inferred to have formed at the lookback time corresponding to each population’s age.

Stellar populations have different but not orthogonal SEDs. As such, the above decompositions are usually degenerate. Such degeneracies are compounded by age-independent effects like metallicity and dust reddening.

To alleviate those degeneracies, high resolution spectra ($R \sim 1000$ s) are often used in addition to galaxy broadband colors in the model fitting. The hope is that the details of absorption lines will potentially increase the contrast between stellar subpopulations, constrain metallicity, and so yield more accurate age/mass coefficients. The utility of these data is usually taken as axiomatic, but it is also readily testable.

This paper presents an experiment that shows there is very little information in high resolution spectra that enhance constraints on galaxy SFHs compared to inferences based on a combination of photometry and very low resolution ($R \lesssim 100$ s) prism spec-

tra.¹ We perform this experiment by using precomputed SFH inferences based on low resolution SEDs for a set of **XXX** systems at $\langle z \rangle = \mathbf{ZZZ}$ to produce predictions of each galaxy’s high-resolution spectrum, and comparing these predictions to actual high resolution observations taken post-facto. With the exception of the Balmer lines—whose divergence from predictions is readily ascribable to emission line infilling—we find differences to be of order **whatever they are**, suggesting **whatever we say they do**.

Below, Section 2 describes the data on which our experiment is based, Section 3 shows the comparisons between our high resolution spectral predictions and the high resolution data, and Section 4 describes the implications of these results. We use AB magnitudes and assume a Chabrier (2003) stellar initial mass function (IMF) with $(H_0, \Omega_M, \Omega_\Lambda) = (70 \text{ km s}^{-1} \text{ Mpc}^{-1}, 0.3, 0.7)$ throughout.

2 DATA

2.1 Master sample

This experiment is based on the *Carnegie Spitzer IMACS Survey* (CSI; Kelson et al. 2014). CSI provides Magellan-IMACS Low- and Uniform-Dispersion Prism spectroscopy for objects with

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¹ A future paper will extend this statement to photometry based inferences alone.

Spitzer [3.5] ≤ 21 in **XXX sq. deg.** from **THESE FIELDS**. Combined with supplemental *ugrizJK_s* photometry from the NEWFIRM archive (**CITE**) and Canada-France-Hawai‘i Telescope Legacy Survey (CFHTLS; **CITE**), these data were used to derive flexible SFHs for each galaxy as part of the redshift estimation process. The sample is complete to $\log M_* \sim 10.3$ at $z \sim 0.7$. The spectral resolution of the prisms varies from $R \sim \mathbf{XXX}$ to $R \sim \mathbf{YYY}$ at **wavelengths**, about **THIS MUCH WORSE** than the Sloan Digital Sky Survey (York et al. 2000).

Dressler et al. (2016, 2018) examine the CSI SFHs in detail. Dressler et al. (2018) provides a thorough treatment of SFH inference quality in its Appendix as assessed via simulations and comparisons of objects with repeat observations. We defer the reader to those texts for that information, but briefly review the SFH inference process here. *None of these details are important in the context of the experiment we detail below*, which should be repeated using other approaches.

The CSI spectrophotometry was modeled by assuming 5 blocks SFHs spanned

2.2 High-resolution spectroscopy

3 TESTING PREDICTIONS WITH HIGH RESOLUTION DATA

4 DISCUSSION

5 SUMMARY

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Facilities: Magellan/IMACS

Software: IDL (Coyote libraries; <http://www.idlcoyote.com/>), python (CarPy).

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