Outlier Detection in the DESI Bright Galaxy Survey

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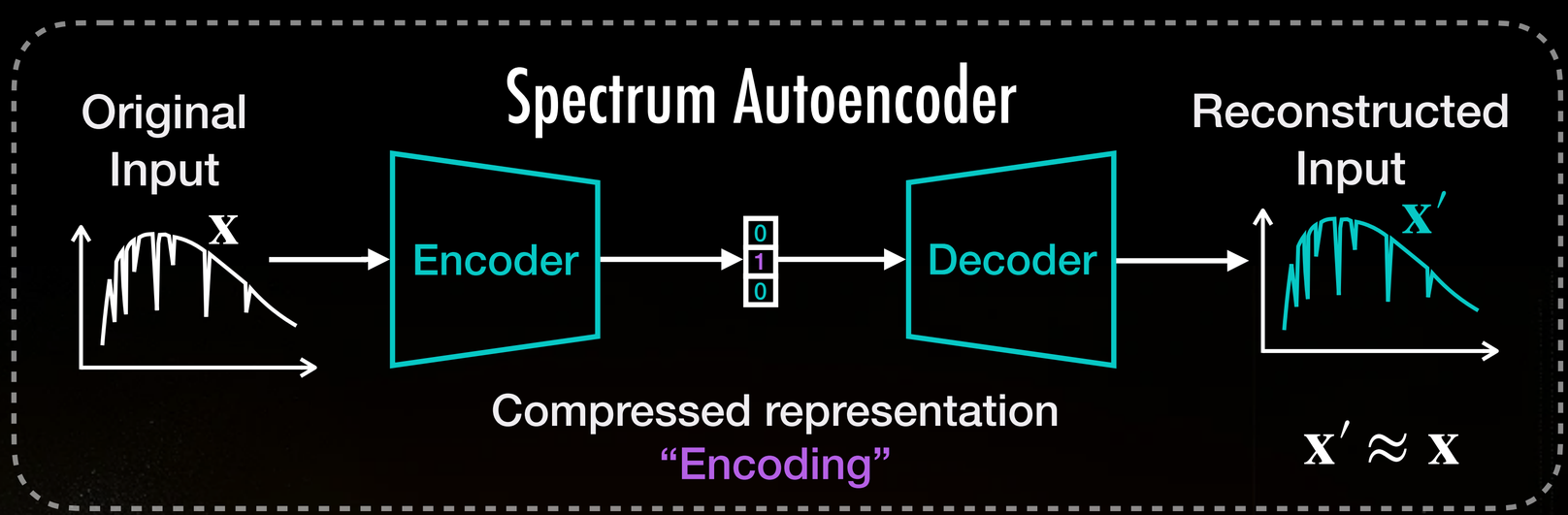
ABSTRACT

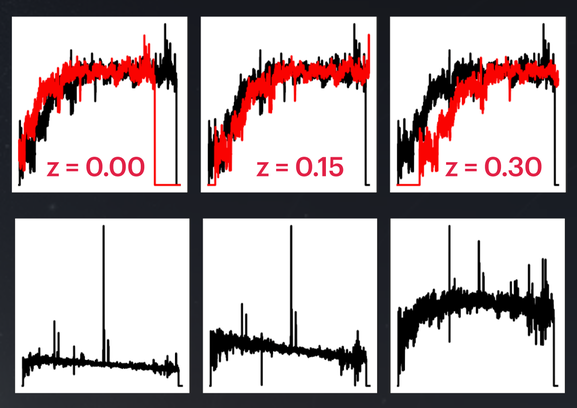
We present an unsupervised search for outliers in the Bright Galaxy Survey (BGS) data set from the DESI Early Data Release. This analysis utilizes an autoencoder to compress galaxy spectra into a compact, redshift-invariant latent space, and a normalizing flow to identify low-probability objects. The most prominent outliers show distinctive spectral features, such as irregular or double-peaked emission lines or originate from galaxy mergers, blended sources, and rare quasar types, including one previously unknown broad absorption line system.



Challenge: disentangle redshift from spectral type variation

Redshift Variation

$\lambda_{\text{obs}} = \lambda_{\text{rest}}(1+z)$



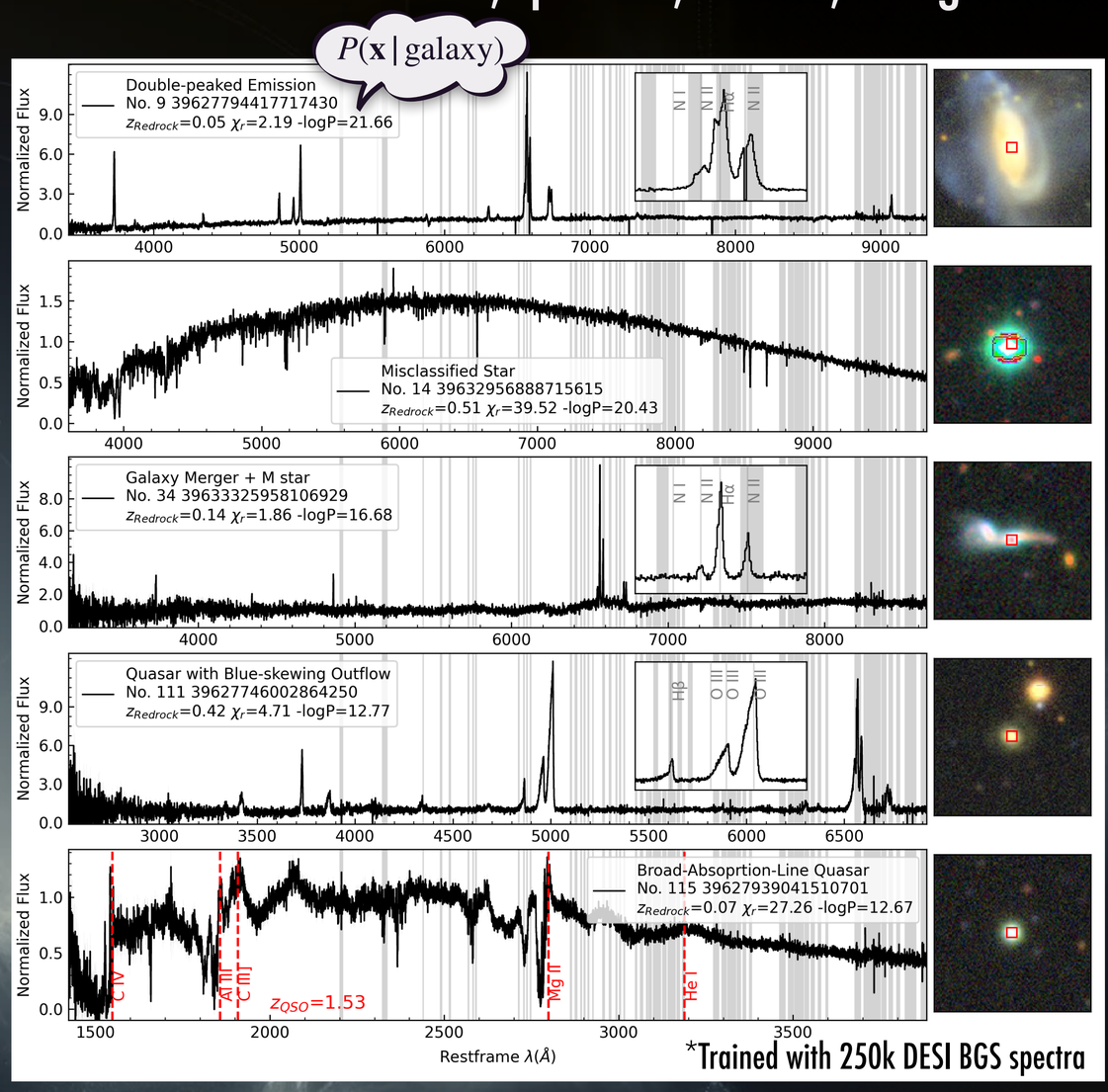
Spectral Type Variation

Not fully understood

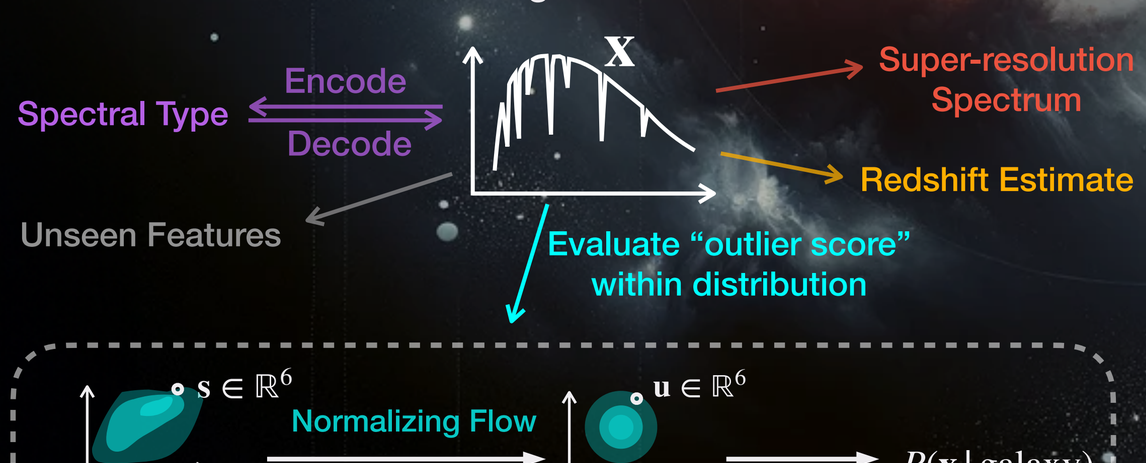
Our solution: introduce redshift-invariance to the encoding through a new loss term. (Liang et al. 2023a)

"Encourages physically similar spectra to cluster in latent space"

Identified outliers: stars, quasars, blends, mergers



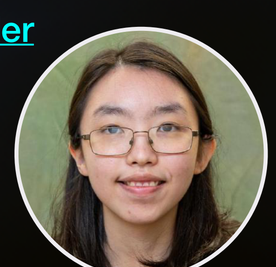
Redshift-invariant Encoding: what can we do with it?



Access our full catalog of outlier scores at:
https://github.com/pmelchior/spender

Reference

Melchior, Peter, et al. "Autoencoding Galaxy Spectra. I. Architecture." *The Astronomical Journal* 166.2 (2023): 74.
Liang, Yan, et al. "Autoencoding Galaxy Spectra. II. Redshift Invariance and Outlier Detection." *The Astronomical Journal* 166.2 (2023): 75
Liang, Yan, et al. "Outlier Detection in the DESI Bright Galaxy Survey." *The Astrophysical Journal Letters* 956.1 (2023): L6.



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