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Probabilistic Inference of Galaxy Properties from Multi-Modal Latent Space Representations

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Cosmological research in the era of deep, wide-area surveys such as Euclid and Rubin/LSST benefits greatly from combining datasets collected with different instruments. However, the large volume of data makes analysis increasingly challenging. To address this, we developed a package based on the Variational Autoencoder (VAE) architecture that enables compact representations of spectroscopic and photometric datasets in a common latent space. This framework allows us to infer probability distributions for key galaxy parameters—such as redshift and stellar population properties—by jointly modeling spectral and photometric modalities. Our method provides a scalable probabilistic approach to galaxy property inference across large photometric and spectroscopic datasets, and we have successfully applied it to spectroscopic data from DESI and photometric data from HSC within the HSC-SSP survey area.

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