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Unsupervised Learning of Galaxy Spectra

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The volume of astronomical data is growing at an unprecedented rate. Directly interacting with and interpreting vast amounts of high-dimensional data, such as galaxy spectra, has become increasingly challenging. To address this big-data challenge, dimensionality reduction techniques are essential for uncovering underlying patterns hidden within a dataset. In this talk, I will demonstrate how we reduce the dimensionality of galaxy spectra from the Dark Energy Spectroscopic Instrument survey using a technique called a variational autoencoder (VAE). A VAE can capture nonlinear features in the dataset and project high-dimensional data into a low-dimensional latent space. I will show that with a VAE, the information contained in galaxy spectra can be effectively represented by a few latent coefficients. We find that different types of galaxies, including passive galaxies, star-forming galaxies, and AGNs, are naturally separated in the coefficient space. Moreover, rare objects, such as Type II AGNs and double-peaked emission-line galaxies, emerge as outliers in this space. This highlights the power of dimensionality reduction in revealing key information from high-dimensional datasets. Finally, I will summarize our findings on linking the latent coefficients to the physical properties and morphology of galaxies, providing a machine-learning perspective on galaxy evolution and classification.

Section

Galaxy/Extragalactic

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Session Classification: Galaxies