# Playing Hide and Seek with Machine Learning:

## Detecting Anomalous Exoplanets in the Low-Dimensional Latent Space of Transit Spectra


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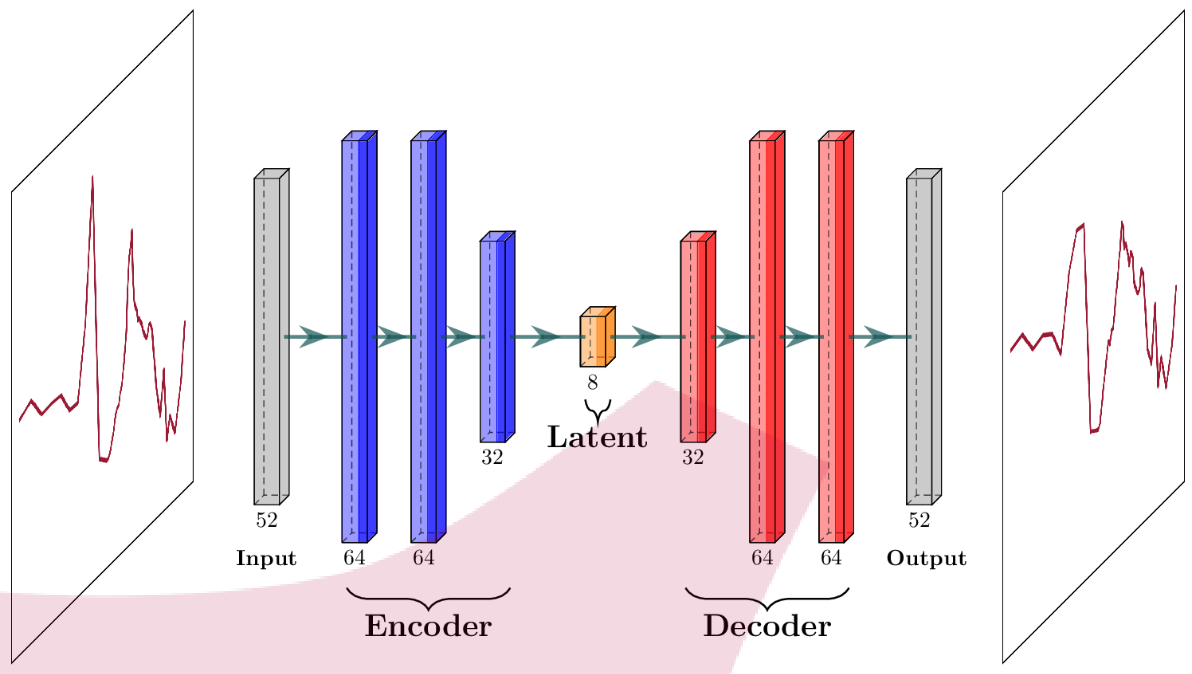
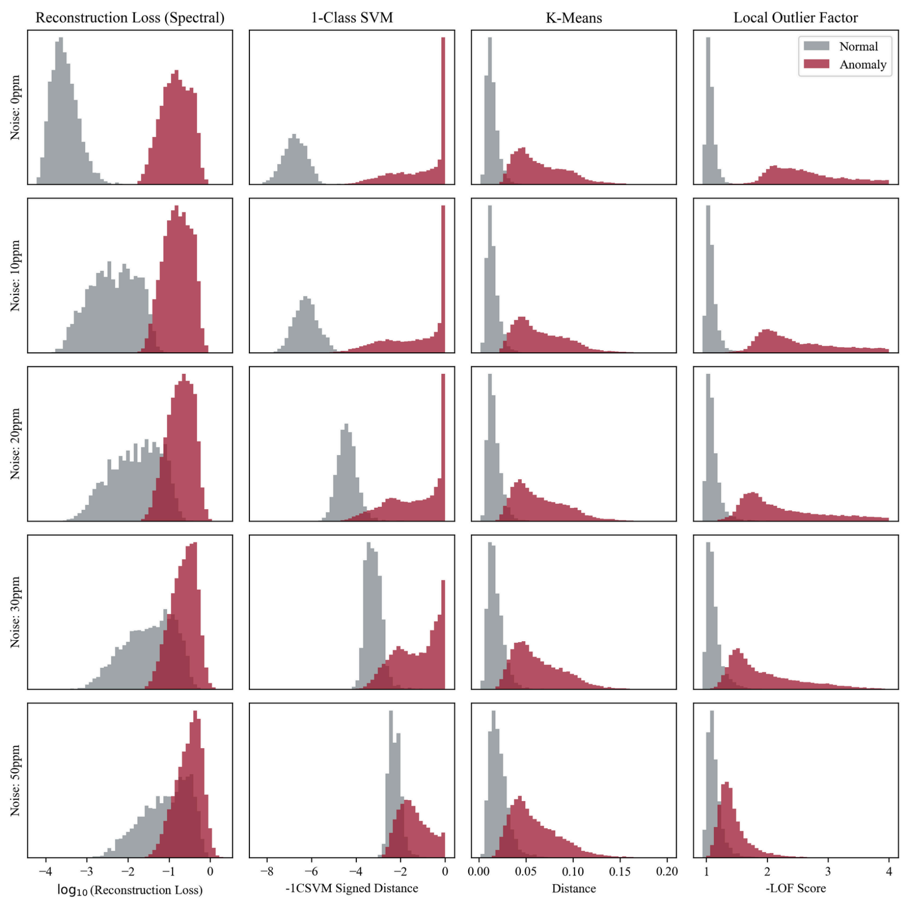
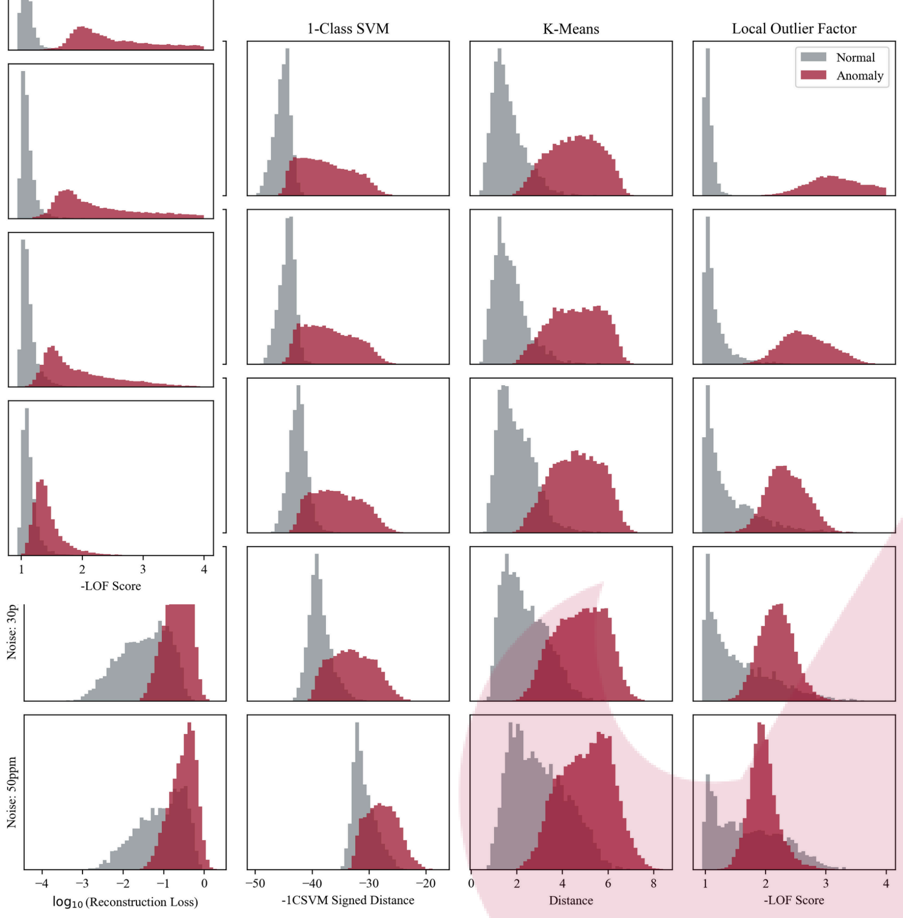
We explore anomaly detection with autoencoders to identify exoplanet atmospheres with unusual chemical signatures. Using the Atmospheric Big Challenge (ABC) dataset of 105,887 spectra, we introduce anomalies and apply autoencoder-based methods combined with classical anomaly detection algorithms (Reconstruction Loss, 1-Class SVM, K-means, LOF).

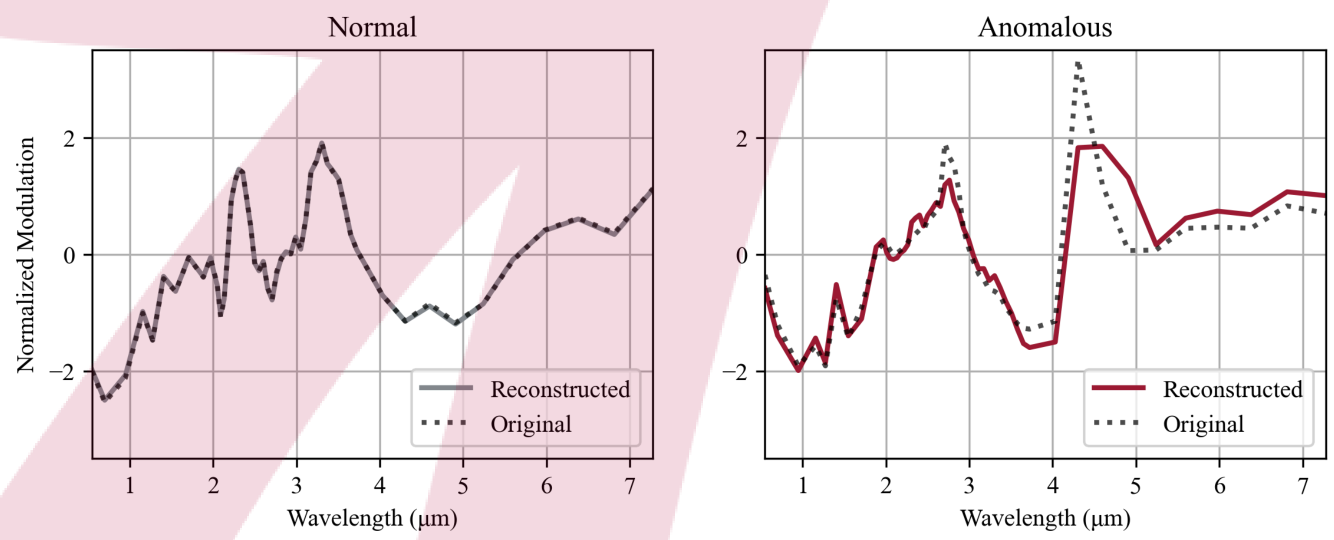



latent space

spectral space




Results show that anomaly detection in latent space consistently outperforms spectral space, with K-means in latent space achieving the best and most stable performance across noise levels.

| Noise (ppm) | Space | Reconstruction Loss | 1-Class SVM | K-means | LOF |
|---|---|---|---|---|---|
| 10 | Spectral | 0.9978 | 0.9731 | 0.9808 | 0.9960 |
| | Latent | - | 0.9994 | 0.9956 | **0.9995** |
| 20 | Spectral | 0.9565 | 0.9501 | 0.9724 | 0.9411 |
| | Latent | - | 0.9894 | 0.9921 | **0.9940** |
| 30 | Spectral | 0.8925 | 0.9132 | 0.9482 | 0.8418 |
| | Latent | - | 0.9641 | **0.9824** | 0.9785 |
| 50 | Spectral | 0.7910 | 0.8241 | 0.8835 | 0.6598 |
| | Latent | - | 0.8781 | **0.9536** | 0.9155 |