APOGEE
Field of View

JWST/NIRSpec
Field of View

Analyzing JWST Stellar Spectroscopy with Contrastive Learning Methods

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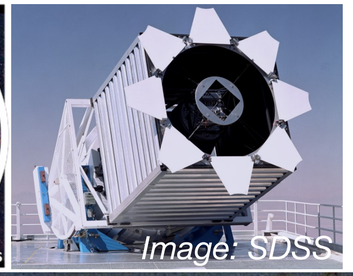
APOGEE Survey

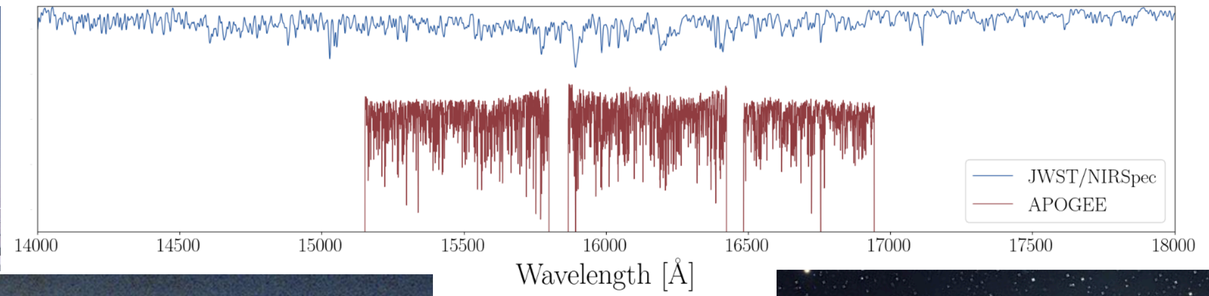
+ Acquiring spectra of $\mathcal{O}(10^{5-6})$ Milky Way stars, providing high-precision stellar chemistry and transforming our of the Galaxy's formation.
- Limited to bright stars in uncrowded regions.

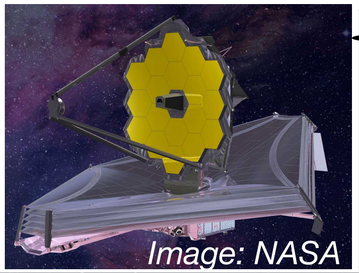
JWST/NIRSpec

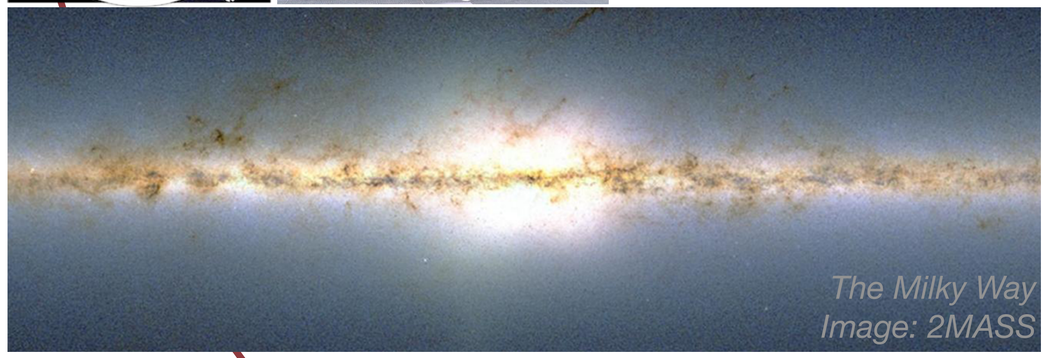
+ Unmatched sensitivity and angular resolution, extending the reach of stellar spectroscopy to fainter and further galaxies (e.g., Andromeda).
- Small $\mathcal{O}(10^{2})$ datasets with sparse training data.

When analyzing JWST/NIRSpec spectra,
how can we leverage both observational data and theoretical models?



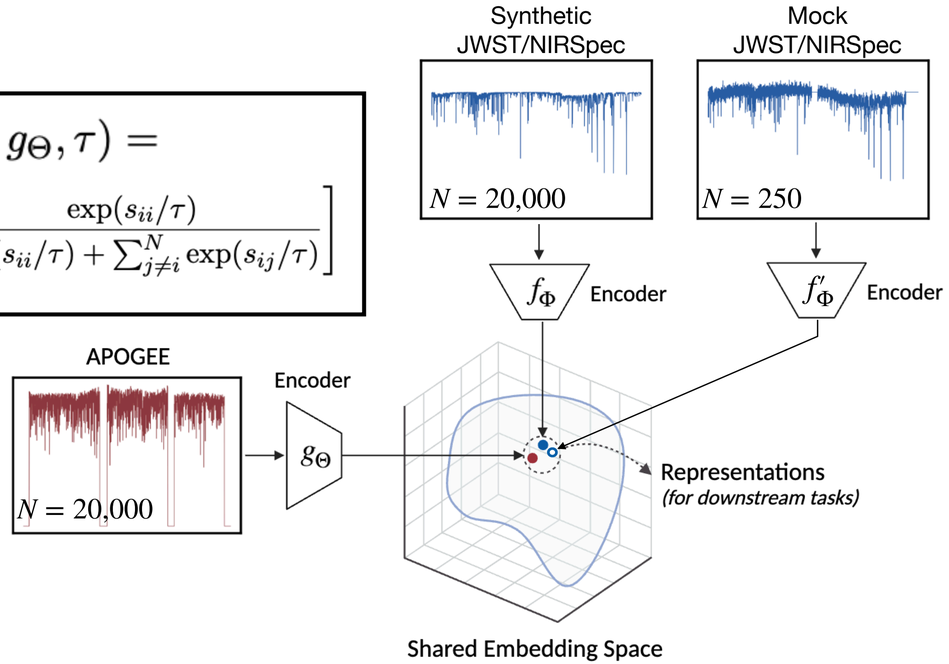






Encoding Pairs of JWST/NIRSpec & APOGEE Spectra Using Contrastive Learning

$$\mathcal{L}_{\text{InfoNCE}}(f_\Phi, g_\Theta, \tau) = -\mathbb{E}\left[\log \frac{\exp(s_{ii}/\tau)}{\exp(s_{ii}/\tau) + \sum_{j\neq i}^{N} \exp(s_{ij}/\tau)}\right]$$



Summary & Next Steps

- Applied contrastive learning to map APOGEE & JWST spectra to a shared physically-meaningful latent space.
- Recover T_{eff}, $\log g$, [Fe/H], and [X/Fe] to 50 K, 0.1 dex, 0.05 dex, and 0.05–0.10 dex precision from latent representations of the spectra.
- *To Do: Test fine-tuning on $\mathcal{O}(10)$ realistic spectra.*
- *To Do: Replace Mock JWST/NIRSpec specra with real observational data*

Mapping Latent Space to Physical Parameters for Stellar Property Recovery