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LADDER: Revisiting the Cosmic Distance Ladder with Deep Learning Approaches and Addressing Cosmological Tensions

Thursday, July 24, 2025 4:25 PM (25 minutes)

I'll present the prospects of reconstructing the "cosmic distance ladder" of the Universe using our novel deep learning framework, LADDER (Learning Algorithm for Deep Distance Estimation and Reconstruction). Trained on apparent magnitude data from the Pantheon Type Ia supernovae compilation, LADDER uses full covariance information among data points to deliver predictions with corresponding uncertainties. Extensive validation tests across multiple deep learning models confirmed LADDER as the best-performing one. I'll demonstrate some applications of this framework in cosmology, including its use as a model-independent tool for consistency checks for other datasets such as baryon acoustic oscillations (BAO), model-agnostic calibration of high-redshift datasets like gamma-ray bursts, and as a model-independent mock catalogue generator for future probes. Additionally, I will show how LADDER can serve as a model-independent recalibration tool for different BAO datasets, helping to alleviate the Hubble and clustering tensions. Our analysis highlights the value of model-independent techniques and underscores the need for cautious yet innovative machine learning applications in cosmological contexts.

This would be based on the following papers,
(1) Astrophys. J. Suppl. Ser. 273(2), 27 (2024); arXiv:2401.17029.
(2) arXiv:2412.14750.

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