Contribution ID: **17** Type: **not specified**

Scientia ex Machina: The Dark Energy Science Collaboration and the Astro-AI Revolution

Tuesday, 10 February 2026 11:20 (20 minutes)

We are living through parallel revolutions in time-domain astrophysics and artificial intelligence. Within a year of beginning operations, the Vera C. Rubin Observatory will find more transient sources than all previous surveys combined. We will be able to use these cosmic lighthouses as beacons to map how stellar populations evolve with redshift, how feedback from their deaths impacts their host galaxies, and probe the Hubble tension, dark energy, and beyond GR models. Realizing the promise of Rubin Observatory requires that we develop techniques that can rapidly combine time-series, spectra, images, coincident detections, gravitational wave strain measurements, and strong lensing magnification maps - "multi-modal"data - to discover, characterize and use these transient sources for inference. This need for fast analysis at Rubin Observatory-scale is driving the Dark Energy Science Collaboration (DESC) towards incorporating AI in nearly every stage of our pipelines, and this motivates research into building Foundation AI models for the time-domain sky. I will focus on work at the NSF-Simons AI for the Sky (SkAI) institute to build such a Foundation model - Supernova Explosions Learned by Deep ODE Networks (SELDON) - that is accurately forecasting transient light curve behavior, identifying anomalies, and inferring some of the physical properties of transients from light curves and spectra. And of course, it can still do classification much like literature ML efforts for transients. Finally, I will provide an overview of how DESC is preparing for analysis of early Rubin data, highlighting the extent to which AI methods have now become core components of our analysis, and chart where I think we will have to go in the next few years with the combination of Euclid, Roman, and other ground-based data.

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Session Classification: Ground-based