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"Hierarchical Bayesian Models for Type Ia Supernova Cosmology"

The accelerating expansion of the Universe was discovered by astronomers analyzing optical observations of the brightness time series (light curves) of faraway exploding stars (Type Ia supernovae) to determine cosmological distances. Current and future optical supernova surveys aim to determine the physical nature of the mysterious dark energy driving the acceleration. Supernova distances can be effectively determined by modeling the empirical relations between their peak luminosities, colors, and the shape of their light curves (time series) over multiple wavelengths. However, their accuracy is systematically limited by the dimming of their intrinsic luminosities by dust in the host galaxies of the supernovae, which makes them appear farther away. Hierarchical Bayesian models are very useful constructs for accounting for the latent physical mechanisms underlying the observed data while fitting for the properties of the population as well as the constituent individuals. I have constructed hierarchical Bayesian models for Type Ia supernova data incorporating multiple random effects and uncertainties, including host galaxy dust, measurement error, and intrinsic supernova variations across time and wavelength. I will describe applications of these models to improve the precision and accuracy of supernova distance estimates by (1) understanding the joint effects of intrinsic variations and dust, (2) incorporating infrared data, which is more transparent to dust, and (3) leveraging spectroscopic information to better constrain the intrinsic supernova colors.