

STATISTICAL ANALYSIS AND DATA MINING

Original Article

Modeling supernovae light curves: An application of hierarchical smoothing splines

C. Shane Reese , Brittany S. Spencer, Erika L. Ball

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Abstract

With large data collection projects such as the Dark Energy Survey underway, data from distant supernovae (SNe) are becoming increasingly available. As the quantity of information increases, the ability to quickly and accurately classify SNe has become essential. An area of great interest is the development of a strictly photometric classification mechanism. The first step in the advancement of modern photometric classification is the estimation of individual Supernova (SN) light curves. We propose the use of hierarchical Gaussian processes to model light curves. Individual SN light curves are assigned a Gaussian process prior centered at a type - specific mean curve which is also assigned a Gaussian process prior. Properties inherent in this Bayesian non - parametric form of modeling yield flexible yet smooth curves estimates with a unique quantification of the error surrounding these curve estimates. Specifying the hierarchical structure relates individual SN light curves in such a way that borrowing strength across curves is possible. This allows for the estimation of SN light curves in entirety even when data are sparse. Additionally, it also yields a meaningful representation of SN class differences in the form of mean curves. The differences inherent in these mean curves may eventually allow for classification of SNe.

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