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# PROPOSAL TITLE

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## ABSTRACT

## 1. INTRODUCTION

Actual intro sentence. Variables and transients have been crucial for a number of significant astronomical concepts. Variable stars such as Cepheids have allowed us to measure distances across the universe, from directly at galactic and Local Area scale, as well as indirectly through calibration for much larger scale distance indications - a Cepheid existing in the same galaxy as a type Ia supernova (SN) can constrain the luminosity of these supernovae. Supernovae themselves are vital standard candles for understanding the scale of the universe, as well as the end of stellar life cycles and feedback in galaxies (I think?).

Though much has been discovered about variables and transients though surveys and studies such as (EXAMPLES), there are many avenues which have not been explored (rework this entire sentence). For example, RR Lyrae variables are also good standard candles, but we do not understand all of the physical processes behind their periodicity (don't know if I should include this).

Variable and transients are both defined by a change in magnitude over a period of time. Variables undergo significant changes in apparent magnitude, usually periodic, but always remain visible to observations. While most stars can show small amounts of cyclic variability in their magnitude, stars specifically classified as variables are defined by much greater changes (need a number here?). Variables can be intrinsic or extrinsic in nature. The change in magnitude of intrinsic variables is a physical property of the object, for example, when a star expands and contracts and actually changes luminosity. During the expansion and contraction, the ionization and opacity of the star changes. Quasars are also intrinsic variables - these are not stars, but are the highly energetic regions around active galactic nuclei. Extrinsic variables are objects such as eclipsing binaries or planetary systems, where companions dim light on a regular basis (PercyVS). While these objects undergo a change in apparent magnitude, the physical luminosity of the individual objects does not change, differing them from intrinsic variables.

Transients, on the other hand, experience a large change in apparent magnitude and later dim to a magnitude that cannot be observed. (Going to need more to broach the difference between observational technicalities and things like SN here).

The Large Synoptic Survey Telescope (LSST) is a wide-field telescope with first light anticipated in 2021. LSST will be able to take full-sky images every 4 nights and produce over 200,000 pictures per year. The massive amount of data presents both incredible scientific opportunities and challenges. Since LSST will have full-sky images more than once per week, it will be especially well suited to the study of variables and transients. Transients like supernovae and fast radio bursts (FRBs) can be noticed quickly all across the sky and can be targeted for follow up observations. Variable Also, it's location in the southern hemisphere allows it to cover areas of the sky not seen by other full-sky surveys in the northern hemisphere such as CHIME.

- Why variables are interesting and important. Actually could probably call this as another 'Time Domain' thing again, I suppose?
- There are some we know so little about. Even include the 'this is what variables are' thing, and indicate that supernovae are a type of transient. They fall into their own category because they are particularly relevant for cosmology whereas other types of variables and transients are not, but SNe are still technically transients.
- The relevancy of LSST - what it is, what it will do specifically for variables, and what we need to work with this massive amount of data
- We want to use existing SN analysis software to try and work towards something more model independent that can fit light curves to variable templates and therefore produce sample light curves (right?)
- In the intro I can make a link to my 1501 work
- Goal: We will create templates of SEDs for different variables and transients, use SNana to simulate light curves, then fit (deform) the light curves to the templates. Are we able to tell the difference between different classifications? Can we construct or work towards something more model independent?
- Then, under proposal, what steps we're actually taking to move towards this goal.
- Here, somewhere, is where we will describe SNana and the light curve fitters in some detail, probably under 'work completed' or some version of that. Can probably include the FIGURE from SNCosmo of a fit to a SN.
- We also want to try applying cosmology to these objects.
- Will describe specifically what variables we want to look at (LBVs are an easy first choice).

- In the work done section, talk about the mag histograms and redshift limit, including a FIGURE here of one of them. Then describe that we will perform this same thing but for variables and transients for which we have magnitude distributions, **so we can see which kinds of variables LSST is actually going to pick up**.
- The thing we're eventually working towards is to be able to fit SNana light curves to our templates of variables and transients. The first step of this is going to be building the SED templates for different variables.

## 2. PROPOSAL

### 2.1. *Work Completed*

### 2.2. *Timeline*