How effective will the Large Synoptic Survey Telescope be for studying supernovae?

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Introduction

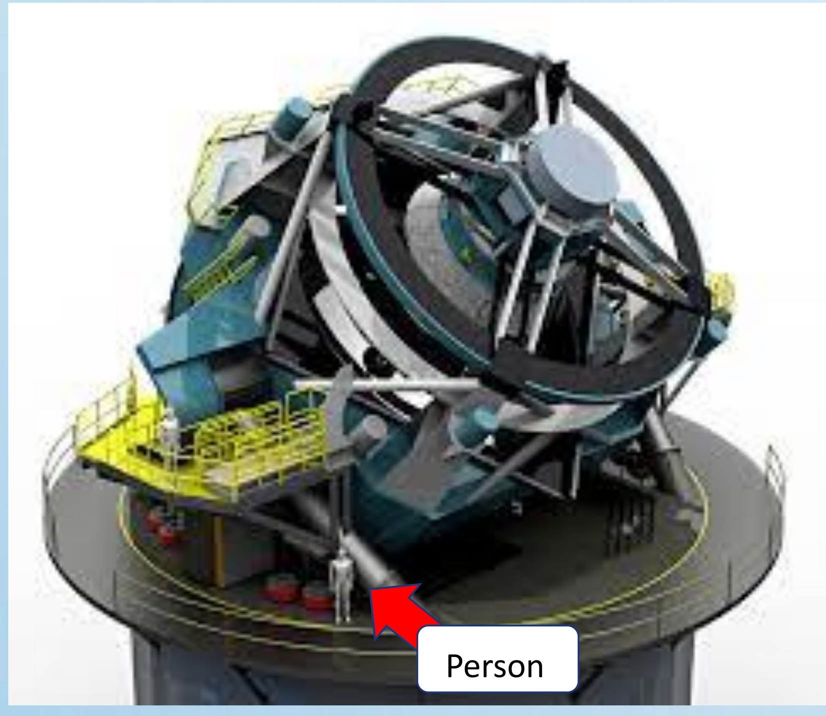
Throughout history, advances in technology have gone hand-in-hand with advances in our understanding of the universe.

Many major astronomical problems involve transients, events that take place over a short period, such as supernovae, and require a telescope that can observe changes over time in even the faintest objects in the sky.

The Large Synoptic Survey Telescope (LSST) has the potential to transform transient astronomy. LSST is a new ground-based telescope currently under construction in Chile, set to be completed in 2022.[1] The telescope's survey will allow it to revisit points in the sky often and at high depth, in order to monitor faint transients.

LSST will operate on a pre-programmed 10-year survey. The observation strategy, where the telescope will look at a certain time, must be determined in advance.

As many research areas are competing for this resource, the chosen observing strategy must balance the needs of different scientists.



Model of LSST
Image Credit: lsst.org

The Crab Nebula – A Supernova Remnant
Image Credit: NASA, ESA, J. Hester, A. Loll (ASU)

Supernovae

Supernovae are the explosive death of massive stars. From Earth we see these cataclysmic events as single stars that nearly outshine all of the other stars in their host galaxy before fading away in a matter of weeks. By observing this event, we can better understand the life and death of stars.

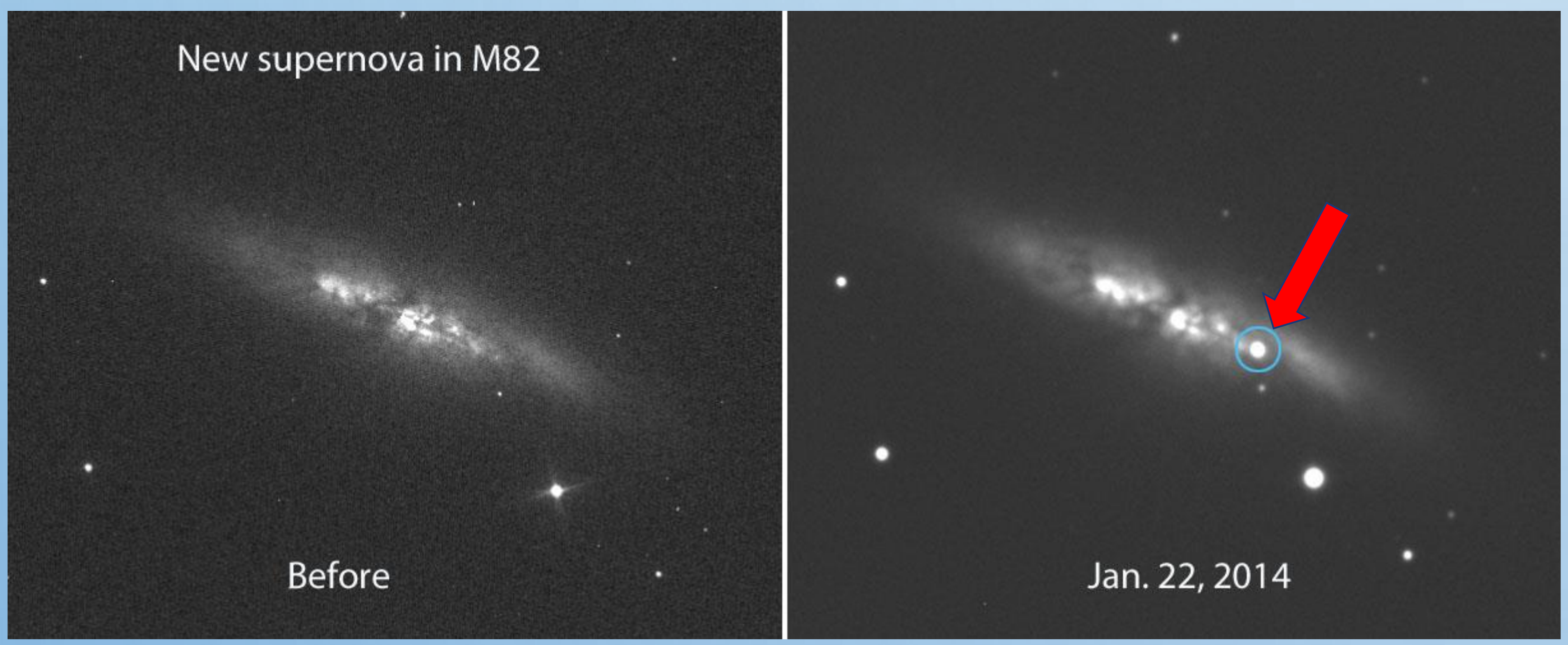


Image Credit: E. Guido, N. Howes, M. Nicolini

From images taken by a telescope, we can create a lightcurve, a graph of the supernova's brightness over time. From the lightcurve we can draw conclusions about the physical properties of the supernova. We quantified LSST's ability to provide sufficient sampling of supernovae lightcurves, dependent on the observing strategy chosen.

Methods

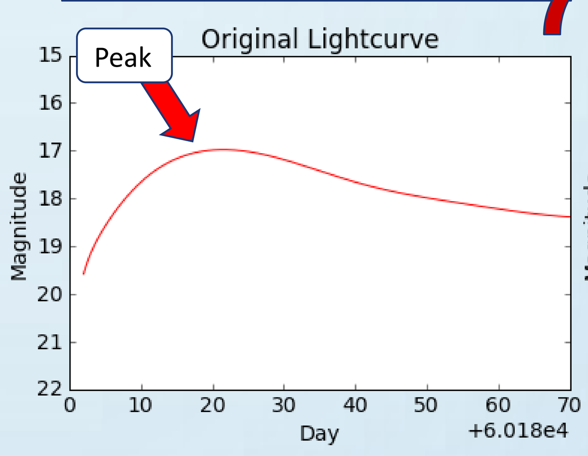
1. A template supernova was placed at a specified location in the sky, time during the telescope's survey, and distance from Earth.

2. Then we used the Operations Simulator, developed by LSST in order to test whether a given observing strategy would allow them to meet all of their science goals.[1] This simulation let us find the times at which LSST would observe our supernova.

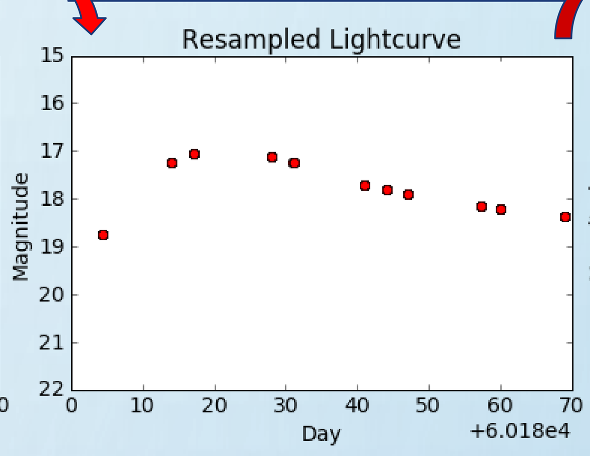
Poorly sampled combinations (those viewed less than four times in the first thirty days) were thrown out, as this data was insufficient for retrieval of the peak of the lightcurve. Note: This accounted for a large percentage of the supernovae (see results for more details).

3. For the remaining combinations, we fit a polynomial curve to the points. Then, we compared the peak of the fitted curve to the peak of the template.

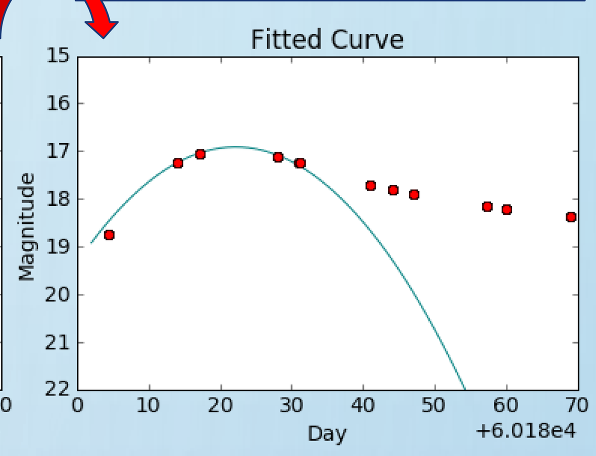
1. Template



2. Simulation



3. Fit a Curve

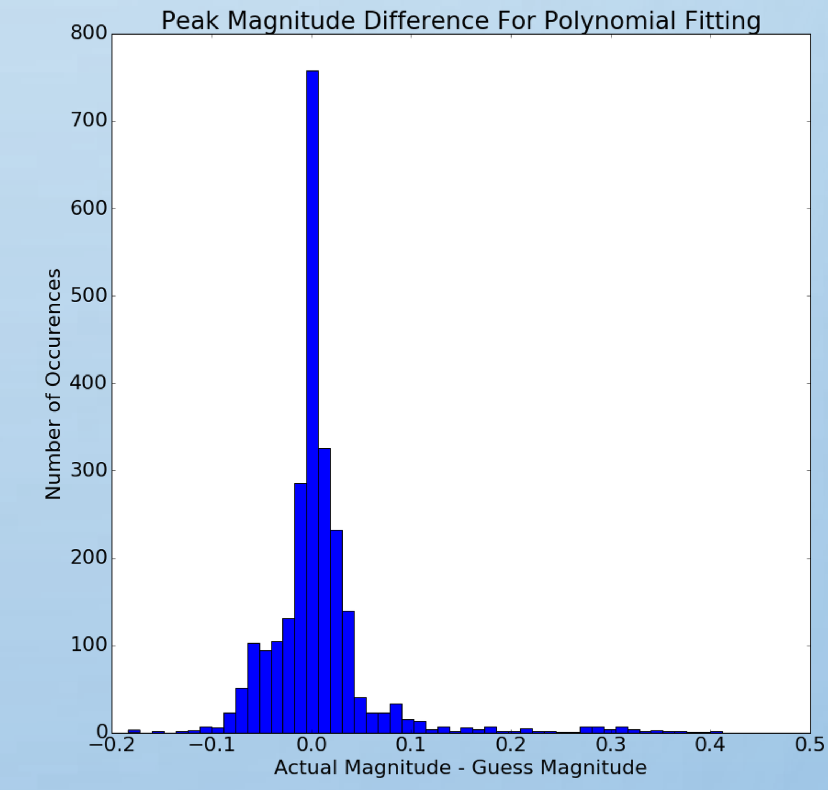


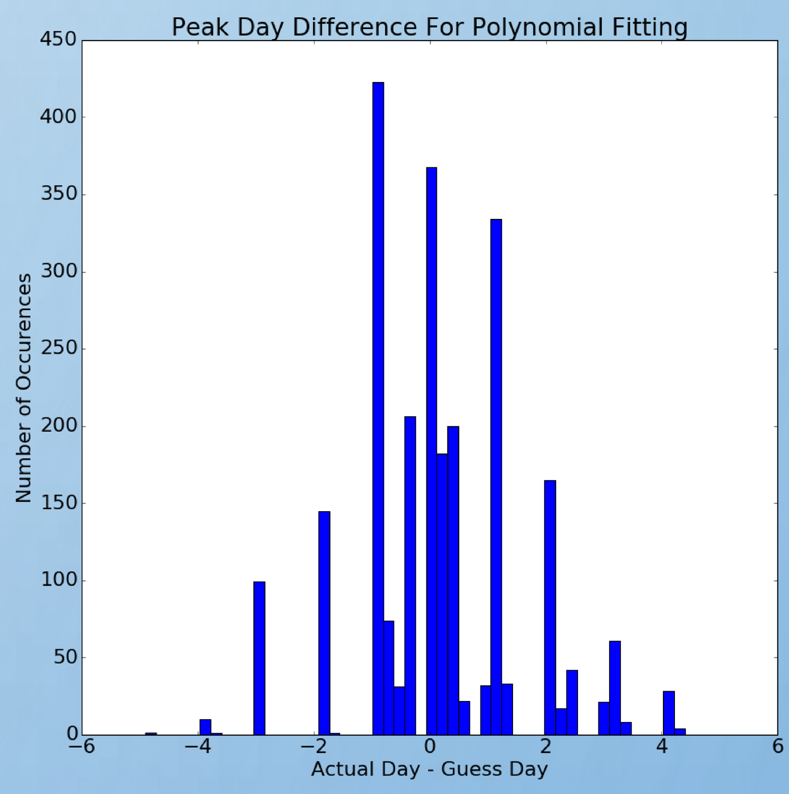
Results

In the main survey, approximately one percent of supernovae were considered sufficiently observed (at least 4 points in the first 30 days).

Of this one percent, approximately 97.5% were considered well-fit (the peak of the fitted polynomial was within a range of 0.5 magnitude and 5 days of the original).

Within the five deep-drilling fields (locations in the sky where the telescope is set to do a larger than average number of visits) we found that approximately 40% of supernovae were sufficiently observed and that 100% of those supernovae were considered well-fit.





Conclusions

Thus far, our results indicate that a low percentage of supernovae would be observed sufficiently to extract meaningful physical parameters, suggesting that improvements could be made to the observing strategy. This information will allow LSST to make an informed decision regarding observing strategy.

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References

1. LSST Science collaborations and the LSST Science Project, *LSST Science Book, Version 2.0*, LSST Science Collaboration, Tuscon, AZ, 2009. arXiv:0912.0201

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