PDC2017
Tokyo, Japan

IAA-PDC-17-02-08

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PROJECTED NEAR-EARTH OBJECT DISCOVERY PERFORMANCE OF LSST

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Keywords: *NEO Surveys, LSST, Telescopes, Data Processing*

ABSTRACT

We describe the methodology and results of an assessment study of the performance of the Large Synoptic Survey Telescope (LSST) in its planned efforts to detect and catalog near-Earth objects (NEOs).

LSST is a major, joint effort of the US National Science Foundation and the Department of Energy, with significant support from private donors. The project has a number of key science goals, and among them is the objective of cataloging the solar system, including NEOs. LSST is designed for rapid, wide-field, faint surveying of the night sky, and thus has an 8.4-meter primary mirror, with 3.2 Gigapixels covering a 9.5 deg^2 field of view. The system is projected to reach a faint limit of V~25 in a 30-second exposure visit in ideal conditions and to perform nearly 2.5 million visits in its 10-year baseline survey, which is slated to commence in 2022.

The baseline LSST survey approach is designed to make two visits to a given field in a given night, leading to two possible NEO detections per night. These nightly pairs must be linked across nights to derive orbits of moving objects. However, the presence of large numbers of false detections in the data stream leads to the

possibility of high rates of false tracklets, and the ensuing risk that the resulting orbit catalog may be contaminated by false orbits. NEO surveys to date have successfully eliminated this risk by making 3-5 visits per night to obtain confirming detections so that a single-night string of detections has a high reliability. The traditional approach is robust, at the expense of reduced sky coverage and a diminished discovery rate. The baseline LSST approach, in contrast, is potentially fragile to large numbers of false detections, but maximizes the survey performance.

One of our key objectives was to investigate the viability of two visits per night by conducting high-fidelity linkage tests on a full-density simulated LSST detection stream. We also sought to quantify the overall performance of LSST as an NEO discovery system, under the hypothesis that the NEO detections arising from the baseline LSST survey observing cadence can be successfully linked.

We used the latest instantiation of the LSST baseline survey and the most current NEO population model to derive the fraction of NEOs detected and cataloged by LSST from among the source population. As a part of this we developed a high-fidelity detection model that accurately represented the LSST focal plane and implemented a smooth degradation in detection efficiency near the limiting magnitude, rather than the usual step function. The study carefully modeled losses from trailed detections associated with fast moving objects, and we investigated other minor effects, such as telescope vignetting, and asteroid colors and light curves.

This presentation will describe the study results, including the projected linking efficiency and detection efficiency of the modeled LSST system.

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