Spinoff Science: The Catalina Real Time Survey

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The Catalina Sky Survey (CSS) is designed to find near-earth asteroids as part of NASA's Near Earth Objects Observation Program. The CSS is currently responsible for discovering about 70% of all NEOs over the past 3 years. This is accomplished using two telescopes in the Catalina Mountains north of Tucson, and one at Siding Spring Observatory in Australia. The success of the CSS is due to full-time access to dedicated telescopes, skilled observers who can provide appropriate responses to changes in weather conditions, and identification and reporting of potentially interesting objects in near real-time to facilitate follow-up to establish their orbits.

To detect moving objects, we visit standard fields four times separated by 10 – 15 minutes. After going through a data reduction pipeline, our detection software looks for patterns of objects consistent with linear motion after eliminating stationary background stars. Candidate moving objects with signal to noise ratios greater than 1.2 sigma over background noise and are not known objects, are presented to the observer who validates their reality and rejects false positives. Objects with NEO motion are then reported for follow-up. This near real-time process permits the identification of asteroids that may be hours way from impacting the earth, such as 2008 TC3.

In late 2007, we started a collaboration with the VOevent group at Caltech to see if our data could be mined to discover optical transients. Instead of looking for moving objects, stationary background objects are searched for brightness differences compared to a catalog. The catalog was constructed by co-adding and median filtering 24 selected images for each standard field. This results in a list of only stationary background stars with almost 5 times better S/N than threshold stars in single images. For this experiment, data from our Catalina Schmidt telescope was used because it covers most of the sky each month to V=19-20. Thumbnail images of objects that change by more than a magnitude are sent to Caltech for verification and identification. New objects are reported in the VOevent system and Astronomers Telegrams so that observers at large telescopes

can take data to identify the kind of object being observed. This optical transient survey has been named the Catalina Real Time Survey (CRTS).

Over the first 14 months of operation, CRTS has discovered:

>600 Optical transients
>140 Supernovae (more than dedicated SN surveys)
150 new cataclysmic variables (The Sloan Digital Sky Survey found 177 in 7 years)
15 Blazars
Hyperluminous supernovae. 2008fz is the most energetic SN known.
Other objects of unknown nature.

One reason for the success of CRTS is that we systematically cover the whole observable sky (except in the high star density galactic plane) as opposed to SN searches which target only known galaxy clusters.

To make the catalog, most of our survey data was put on disk, which now serves to provide pre-discovery data on light curves. We are now seeking to expand the OT survey to our other telescopes. There may be opportunities for students to similarly mine the CSS data set in various ways.

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