Transient Optical Sky Survey

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1 TOSS

The Transient Optical Sky Survey (TOSS) is a system of optical telescopes to survey the sky to a limit of 20th magnitude and to catalog transients by comparing the luminosity of observed objects from consecutive observing sessions. The plan is to make a map of the entire dark sky each night.

2 Motivation

A transient is any object in the sky which has varying luminosity with respect to time. TOSS will scan the sky for ANY detectable transient objects. The most common types of transients are: Near Earth Objects, Occultation caused by planets, Microlensing, Supernovae, Black Hole flares, Variable stars and the Optical components of gamma ray bursts.

3 An Example: Black Hole Flare

A black hole flare is the radiation caused by the accretion of captured gas of a tidally disrupted star by a Super Massive Black Hole. Figure 1 shows a conceptual drawing of a neutron star disrupted by a Super Massive Black Hole. Figure 2 shows a graph of the estimated number of flares of maximum magnitude m=17 at a distance up to 300 Mpc expected to be seen for a given fraction of sky observed.

4 TOSS Primary goals

The experiment is designed to observe the visible sky to about 20th magnitude per night. This is the goal of the final configuration. The immediate goal is to build the prototype which should also get to 20th magnitude but on a much smaller portion of the sky. The system is modular and scalable to achieve the final goal at a later stage.

5 TOSS basic characteristics

Earth Based: The observations are made nightly with duration of 6 hours and repeated following nights. Figure 3 shows a mount design that can be duplicated and/or scaled up to fit the needs of the project.

Telescopes: Low cost commercially available telescopes are used for the prototype – a 14 inch Celestron and a 16 inch MEADE. A set of 30 telescopes will have the capability to cover 1400 sq. deg of the sky per night. Each telescope has a field of view of 0.5 deg and is fixed in declination, tracking only in RA. The ultimate goal is to have the configuration be located in both hemispheres so that the entire visible sky is mapped. Figure 4 shows the optical layout of the telescope modules and the mount.

6 The calculations

1. In our large-field images, resolution far from the optical axis will not be diffraction-limited or sky-limited but rather limited by optical aberrations. Vignetting causes points away from optical axis to receive less illumination. Objects off axis will be spread over more pixels, increasing noise and therefore the point-spread function (PSF) has much larger radius in those regions. These effects reduce the signal to noise ratio. Images near the edge of the field of view are improved by post-processing via deconvolution to take the effect of the PSF into account. Figure 5 shows the point source spreading in MEADE 16”.

7 The housing

1. A dome tent enclosure was designed to accommodate the prototype TOSS structure on the roof of Broida (UCSB’s Physics Department Building). Figure 8 shows the construction of the tent.

8 The Site: White Mountain’s Barcroft Station

White Mountain was chosen for its high altitude (12,500-13,000 feet), low water vapor and short distance to Santa Barbara. The location was previously one of the candidates for the Keck telescopes. Remote access allows running of the telescopes when personnel are not available. Figure 9 and 10 show the Barcroft Station and Observatory. TOSS will be located either at the Station or the Observatory.

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