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TOPIC: Near-Earth Object (NEO) Discovery

HIGH CADENCE ALL-SKY SURVEY FOR THE DETECTION OF EARTH-THREATENING BOLIDES

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ABSTRACT

We present a concept for a high cadence all-sky survey for the purpose of detecting bolides which may threaten the Earth. A robust detection technique is required for any operational planetary defense system, and particularly for those which can operate in a terminal mode, like the PI ("Pulverize It") method proposed by Lubin et. al. In the proposed PI planetary defense system, Earth-threatening bolides would be intercepted and disrupted via hypervelocity kinetic impactors, generating a fragment cloud which distributes the energy of the parent bolide both spatially and temporally. The "PI in the Sky" bolide transient detection technique proposed here uses various mathematical models along with wide field images of the sky to conduct differential image analysis. This allows one to search for bolides in both the near-Earth regime, where the bolides detectably shift in position, as well as in the far-Earth regime, where bolides detectably change brightness due to their inherent rotation. We primarily use the Bramich mathematical model, which is used as a standard in transient detection along with a machine learning model to determine the nature of the object. The hardware we propose is a derivative of the Transient Optical Sky Survey (TOSS) system developed by Lubin's group in 2008. The platform is polar aligned and performs sidereal tracking with each telescope set at a fixed declination. The complete proposed system would consist of a large array of fast, wide field telescopes attached to a common mount and arranged in such a way as to maximize the viewable fraction of the sky. An array of such systems in both the northern and southern hemispheres would provide near full 4π steradian sky coverage and transient detection at a high cadence. A proof-of-concept system is being developed in order to design and test a complete data pipeline that will be deployed at one of the University of California Natural Reserve System (UCNRS) high altitude sites, such as the Owens Valley Laboratory or the White Mountain Barcroft site. This test system will be composed of both Celestron RASA and Planewave Delta Rho telescopes equipped with low noise and high readout speed CMOS sensors, such as the Sony IMX455 and IMX571. Initially, data will be collected in a declination strip scan mode capturing the sky in 3-degree wide sections, with future iterations having more telescopes deployed to capture a wider simultaneous view of the sky. Such a design is naturally scalable and cost-effective due to its modular nature and use of sensor technologies driven in cost by the consumer mobile phone market. We show that such a system can be utilized appropriately to detect Earth-threatening bolides

with warning times adequate for both the terminal and long warning time operational modes of the PI planetary defense method.

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Comments: N/A