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THE PAN-STARRS DATA ARCHIVE — AN INVALUABLE RESOURCE OF FAINT NEAR EARTH OBJECT DETECTIONS

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ABSTRACT

Pan-STARRS1 (PS1; observatory code F51) has been surveying the sky for over 9 years, and has accumulated a massive archive of images of the sky north of declination –50º, comprising over 1.1 million images and over 2.5 petabytes of data. Pan-STARRS2 (PS2; observatory code F52) was brought into regular operation during 2018, and is adding to the archive of deep wide-area images of the sky seen from Haleakala, Maui. PS1 spent a substantial amount of its time during its first four years of operation performing a multi-purpose survey of the sky north of –30º, and many of those observations were not optimized for NEO discovery. Beginning in 2014, the NASA Near-Earth Object Observation program has funded the bulk of the operating cost of Pan-STARRS, and observations have been optimized for Near-Earth Object (NEO) discovery.

The cameras in the Pan-STARRS telescopes utilize orthogonal transfer CCDs that

are not ideal for NEO discovery, because each CCD is composed of an 8x8 grid of 600x600 pixel cells. These cells have inactive areas between them. Moving objects, including NEOs, can move into the cell gaps in some exposures, preventing detection. Our current automated techniques require at least 3 detections from 4 exposures, so if two detections are lost, the moving object is not discovered. The CCDs are also noisier than the newer CCDs that are now commercially available, and these noise characteristics further hinder NEO discovery.

Pan-STARRS2 started its survey operations without the important middle cone baffle. Installation was delayed due to problems with the PS1 dome shutter. The cone baffle prevents light from entering the camera directly from the sky. During the period that the telescope operated without the baffle, many CCDs had their images compromised by starlight entering the camera directly.

For these reasons, the archival images from Pan-STARRS are rich in unreported moving object detections, including NEO detections. Many of the NEO detections will be cases where an NEO was detected only two times from four exposures. Others will be faint detections that cannot be extracted using current automated computer techniques. Some will be trailed detections that span cell gaps or move into cosmetically poor regions of the camera.

The Pan-STARRS data archive is particularly powerful for recovery of larger (H<22) NEOs. These objects are usually detected quite distant from Earth. This means that once a new larger NEO has been discovered, and an orbit has been established, it is possible that it may be recoverable in the archival data during the previous apparition when it was relatively bright, thereby providing a dramatic improvement in the quality of the orbit.

Examples of archival recovery will be presented. The archival observations will likely be particularly useful for cases of larger potentially dangerous objects that have collision probabilities that are of concern, by providing a quick tool to refine their orbits.

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