PDC2023
Vienna, Austria

Near-Earth Object (NEO) Discovery

The Pan-STARRS Search for Near-Earth Objects

Richard Wainscoat[1], Robert Weryk[2], Yudish Ramanjooloo[3], John Fairlamb[4], Mark Huber[5], Kenneth Chambers[6], Eugene Magnier[7], Thomas de Boer[8], Chien-Cheng Lin[9], and Hua Gao[10]

[1]*University of Hawaii, Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822, USA, rjw@hawaii.edu*
[2]*University of Western Ontario, Physics and Astronomy, 1151 Richmond Street, London ON N6A 3K7, Canada, weryk@hawaii.edu*
[3]*University of Hawaii, yudish@hawaii.edu*
[4]*University of Hawaii, fairlamb@hawaii.edu*
[5]*University of Hawaii, mhuber@ifa.hawaii.edu*
[6]*University of Hawaii, chambers@ifa.hawaii.edu*
[7]*University of Hawaii, eugene@ifa.hawaii.edu*
[8]*University of Hawaii, tdeboer@hawaii.edu*
[9]*University of Hawaii, cclin33@hawaii.edu*
[10]*University of Hawaii, hgao@hawaii.edu*

Keywords: *NEO discovery, NEO surveys*

ABSTRACT

Pan-STARRS consists of two 1.8-meter diameter telescopes located near the summit of Haleakala, Maui, Hawaii. Each telescope is equipped with a very large camera that images approximately 7 square degrees. The first telescope, Pan-STARRS1 (PS1), started operations in 2010, and since 2014 has spent much of its time in a dedicated search for Near-Earth Objects (NEOs). Pan-STARRS2 (PS2) started surveying for NEOs in 2018. The initial discovery rate for NEOs from PS2 lagged PS1 — this was caused by degradation of the secondary mirror coating. The secondary mirror was recoated in 2021, and since then, PS1 and PS2 have similar sensitivities and NEO discovery rates.

Each telescope images approximately 1,000 square degrees per night, obtaining a sequence of four 45-second exposures spaced over approximately 1 hour. A wide filter spanning 400–820 nm is used when the moon is down or only partially illuminated, and an *i*-band filter is used when the moon is bright. The typical limiting magnitude in dark conditions is approximately V=22. The limiting magnitude is strongly seeing dependent — nights with light winds usually deliver the sharpest images, allowing NEO candidates as faint as V=22.5 to be reported. Pan-STARRS delivers excellent astrometry of moving objects, with positional errors typically less than 0.05 arc seconds, increasing to approximately 0.2 arc seconds at the limiting magnitude. Pan-

STARRS has established itself as one of the leading surveys for Near-Earth Objects. A strength of Pan-STARRS is discovery of larger NEOs. Pan-STARRS presently discovers approximately 55% of NEOs with diameter >140 meters, and since it started operation, has discovered 11% of the estimated population of 25,500 NEOs with diameter >140 meters. The excellent image quality of Pan-STARRS has also made Pan-STARRS efficient at discovering comets.

Recent improvements made by Pan-STARRS include rapid reporting of NEO candidates, and self-follow up. NEO candidates are reported to the Minor Planet Center during the night, and objects that post to the NEO Confirmation Page are immediately followed up by Pan-STARRS whenever possible. This same-night follow up extends the orbital arc of newly discovered NEO candidates from ~1 hour to 3–4 hours. This arc extension provides strong constraints on the distance of the NEO candidate, and makes recovery easier.

The structure and noise characteristics of the Pan-STARRS detectors means that the archival images from Pan-STARRS contain many unreported moving objects. The archival images have provided many arc extensions for newly discovered NEOs, and their value will continue into the future.

****

Comments:

Oral presentation preferred