Observation of Small Solar System Objects with Spacewatch

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Abstract

Since beginning an automated full-time survey for Near-Earth objects in September 1990, the Spacewatch project has discovered 88 new Near-Earth asteroids (NEAs), 3 new comets, and 2 new Centaur asteroids. A Tektronix TK2048E CCD is used at the $f/5$ Newtonian focus of the 0.91-m Spacewatch Telescope of the University of Arizona on Kitt Peak. Our Moving Object Detection Program (MODP) is used to detect moving objects either by their consistent motion or their trailed appearance. MODP also identifies the locations of Hubble Space Telescope Guide Star Catalog stars in the image data so that automated astrometric solutions can be computed off-line. Combined with automatically measured positions of confirmed moving objects, another program determines the astrometric solutions and calculates the astrometric positions for every asteroid detected. Spacewatch typically identifies about 2000 main-belt asteroids each lunation while covering about 150 square degrees to a limiting magnitude of $V_{lim} \sim 20.9$. We report each of these measurements, usually only a single night for main-belt asteroids, to the Minor Planet Center where known and multiply detected objects are identified from the astrometric list. NEAs and other interesting objects are identified by their angular rates of motion near opposition at the time of discovery and are scheduled for astrometric follow-up on subsequent nights. Objects with exceptionally high rates of motion, called very fast moving objects have been detected in near real-time by the observer and followed for several hours to several days. These objects are the smallest yet detected and consolidated outside the Earth's atmosphere. Careful analysis of their discovery rates and orbits have indicated an enhancement of their magnitude-frequency distribution over that anticipated before their discovery – of about a factor of 40 for objects near absolute magnitude $H \sim 29$. Additionally, a subset of these small objects which have nearly circular orbits and perihelia near the orbit of Earth have been recognized as having significantly different orbits from those of the previously known NEAs. Their origin is still under debate, with possible sources including Earth or Lunar impact ejecta, Earth–Sun Trojans, or more complicated secular resonance interactions of NEA orbits with the giant planets combined with stochastic perturbational encounters with the inner planets. The large volume of asteroid detections allows magnitude–frequency studies of the detected main-belt asteroids and Jupiter Trojans. New discoveries of Comets and Centaur asteroids (whose orbits cross those of the outer planets) may allow us to study their magnitude–frequency distributions as well.