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Palomar Planet-Crossing Asteroid Survey (PCAS): Recent Discovery Rate

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ABSTRACT

The discovery rate of Near-Earth Asteroids (NEAs) has increased significantly in the last decade. As greater numbers of NEAs are discovered, worldwide interest has grown leading to new programs. With the introduction of CCD telescopes throughout the world, an increase of 1-2 orders of magnitude in the discovery rate can be anticipated. Nevertheless, it will take several decades of dedicated searching to accomplish a 95% completeness, even for large objects.

The discovery rate of Near-Earth Asteroids (NEAs, including Apollo, Amor, and Aten class asteroids) has increased significantly in the past decade, particularly in the last few years. As greater numbers of near-space objects have been found, some making relatively close approaches to Earth, there has been an attendant increase in the awareness of the potential they have for impacting Earth (e.g., Morrison, 1992). Tens of NEAs which have made, or will in the future make, very close approaches to the Earth have been recorded. It is the larger number of still undetected objects that has become a serious concern. Our immediate goal is to increase the number of known objects to improve estimates of the total population as a function of size of these objects. The ultimate goal, as outlined by Morrison (1992) is to inventory essentially all (>95%) NEAs larger than about 1 km in diameter. The latter goal is beyond the capability of present facilities, so new larger telescopes will be required to achieve completeness in a meaningfully short time, of the order of a decade.

Fifteen to twenty years ago the discovery of 1-2 Near-Earth Asteroids (NEAs) per year was typical from one systematic search program, Palomar Planet-Crossing Asteroid Survey (PCAS), and the incidental discovery from a variety of other astronomical programs. Sky coverage and magnitude were both limited by slower emulsions, requiring long exposures. The 1970s' sky coverage of 20 to 30 thousand sq. deg. per year led to about one NEA discovery every 13,000 sq. deg. (e.g., Helin and Shoemaker, 1979; Helin and Dunbar, 1984, 1990).

Looking at the years from 1987 through 1990, we find that by comparing 1987/1988 and 1989/1990 the worldwide discovery rate of NEAs went from 20 to 43, a little more than a twofold increase. More specifically, PCAS' results when grouped into the two year periods, show an increase from 5 discoveries in 1987/1988 to 20 in the 1989/1990 time period, a fourfold increase. Also, PCAS discoveries went from representing about 25 percent of the worldwide total to contributing roughly 50 percent of the discoveries worldwide in the 1989/1990 period. This trend continues into 1991, whereby PCAS is discovering about one NEA per month. As the discovery rate continues to increase, with significant contributions coming from McNaught/Steel in Australia, Gehrels, Scotti and Rabinowitz in Arizona, and the Shoemakers at Palomar, I anticipate a doubling again in discoveries in the 1991/1992 period. Of course, an important aspect of these more recent discoveries is the inclusion of objects fainter than sky magnitude 20-21, extending to objects as small as H magnitude

28 (1991 BA). At the same time, several very bright asteroids have been discovered which indicates that in the NEA population we have not achieved completeness even to an absolute magnitude H of 13-14. The PCAS discovery of (4954) Eric = 1990 SQ at H magnitude 12.5 surpasses (1627) Ivar as the brightest known asteroid in the NEA population. It is rather remarkable that our most recent NEA discoveries in 1990/1991 include the brightest, (4954) Eric, and the faintest, 1991BA, on record, certainly suggesting that a wide range of undetected objects still roam in earth-approaching and -crossing orbits. The surge of discoveries enjoyed by PCAS in particular is attributed to new fine grain sensitive emulsions, film hypering, more uniformity in the quality of the photograph, more equitable scheduling, better weather, excellent team members and coordination of efforts.

Greater worldwide interest in NEOs is leading to the establishment of new programs using existing telescopes; or by scanning photographic plates taken for other programs as well as reviewing archived plates for asteroid trails (Steel and McNaught, 1991). These efforts are producing excellent results. Spacewatch Telescope has recently created great excitement with the discovery of 1991 DA and 1991 VG as well as a growing list of NEAs (Gehrels, 1991; Rabinowitz, 1991).

We are currently considering upgrading the 18" Palomar Schmidt with an array of CCDs at the focal plane, and to be able to scan at faster-than-sidereal rate. With these modifications, we will be able to maintain our wide field sky coverage and also be able to extend our detection threshold to about sky magnitude 19.5-20.0. This upgrade should result in about a 5-fold increase in discovery rate. Nevertheless, in order to achieve completeness to 1 km or less diameter objects on a timescale of 1 decade, we will need to increase the discovery rate by about 2 orders of magnitude above today's rate, so new, larger telescopes will be required (Morrison, 1992).

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