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The Spacewatch Outer Solar System Survey

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Abstract. We present our results from a wide area search for the brightest and rarest members of the Transneptunian and Centaur/Scattered-Disk asteroid populations. Our data encompasses 1483.8 square degrees of sky taken with the Spacewatch 0.9 meter telescope on Kitt Peak between September of 1995 and September of 1999. We found five new Transneptunian asteroids, three new Centaurs, and two new Scattered Disk Objects. These objects are among the larger members of the population and their relative brightness will make them ideal candidates for physical observations.

1. Introduction

Because of limited telescope time, surveys always represent a trade off between wide sky coverage (useful for finding the large, bright, rare objects) and faint limiting magnitude (to find smaller objects). Despite the longer time required, there are advantages to covering a large area for the largest members of the TNO population. First, they are the objects most accessible to physical studies given the current state of spectroscopy. Second, there is an open question as to whether the mass of the Kuiper Belt is tied up in the largest or the smallest objects.

Spacewatch is a wide area survey which has a relatively bright limiting magnitude (V=21.8) using our 0.9 meter $f/5$ telescope on Kitt Peak. The detector on this telescope is a thinned, back illuminated 2048 $\times$ 2048 TK2048 EB1 CCD which, starting in June of 1995, has been filtered with a Schott OG-515 filter (which blocks only bluer light, leaving the rest of the system effectively unfiltered between 0.5 – 1.0 μm). Spacewatch has accumulated data from this telescope on Exabyte^{TM} tapes over the last ten years. We have recently undertaken a program of reprocessing and rearchiving our data onto DVD-RAM and created the opportunity to search for these distant objects.

2. Method

We selected 331 scans taken between September of 1995 and September of 1999 which cover 1483.8 square degrees of sky. Each scan consists of three passes taken over 90 minutes giving any location on the scan a one hour baseline for detected motions. A specially written motion detection code ("Twitch") was used to seek the small (3--15) arcsecond motions expected of Centaurs and

Transneptunians over this hour. Software efficiency as a function of observing conditions was tested so that we could effectively determine the effective area of each scan searched as a function of magnitude. Repetition of spatial coverage was determined using a model of how these distant Solar System objects move as a population mean and disperse with respect to each other.

3. Results

We discovered 5 new Transneptunians, three new Centaurs and two Scattered Disk Objects. In addition, we serendipitously detected five known objects. Combined with our area coverage as a function of magnitude and uniqueness, we give the principal results of this survey in Tables 1 and 2 (where m_V is range of mean visual magnitude, N is the number of asteroids detected, Area is the effective area surveyed in square degrees, and $\Sigma(< V)$ the cumulative surface density of objects brighter than the bin's faintest magnitude).

Table 1. Cumulative Sky Densities for Centaurs in the Survey.

m_V	N	Area	N/Area	$\Sigma(< V)$
20.5 - 21.0	1	559.1	0.002 ± 0.002	0.002 ± 0.002
21.0 - 21.5	2	359.2	0.006 ± 0.004	0.007 ± 0.004
21.5 - 22.0	1	103.0	0.010 ± 0.010	0.017 ± 0.011

Table 2. Cumulative Sky Densities for TNOs and SDOs.

m_V	N	Area	N/Area	$\Sigma(< V)$
20.0 - 20.5	1	522.1	0.002 ± 0.002	0.002 ± 0.002
20.5 - 21.0	3	478.8	0.006 ± 0.004	0.008 ± 0.004
21.0 - 21.5	5	306.7	0.016 ± 0.007	0.025 ± 0.008
21.5 - 22.0	2	87.8	0.023 ± 0.016	0.047 ± 0.018

Our brightest cumulative surface densities represent a range of m_V that is poorly represented in the literature. We extrapolate these values under the assumption of a 10,000 square degree ecliptic to estimate the number of each class in the ecliptic brighter than V=22.0: 100 Centaurs, 400 Transneptunians, and 70 Scattered Disk Objects.

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