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~~7-79691~~**Spacewatch Discovery of Near-Earth Asteroids**

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Abstract

Our overall scientific goal is to survey the solar system to completion -- that is, to find the various populations and to study their statistics, interrelations, and origins. The practical benefit to SERC is that we are finding Earth-approaching asteroids that are accessible for mining. Our system can detect Earth-approachers in the 1-km size range even when they are far away, and can detect smaller objects when they are moving rapidly past Earth. Until Spacewatch, the size range of 6 - 300 meters in diameter for the near-Earth asteroids was unexplored. This important region represents the transition between the meteorites and the larger observed near-Earth asteroids (Rabinowitz 1992).

One of our Spacewatch discoveries, 1991 VG, may be representative of a new orbital class of object. If it is really a natural object, and not man-made, its orbital parameters are closer to those of the Earth than we have seen before; its delta V is the lowest of all objects known thus far (J. S. Lewis, personal communication 1992).

We may expect new discoveries as we continue our surveying, with fine-tuning of the techniques.

Introduction

The data accumulated in the following tables are the result of continuing observation conducted as a part of the Spacewatch program. T. Gehrels is the Principal Investigator and also one of the three observers, with J.V. Scotti and D.L. Rabinowitz, each observing six nights per month. R.S. McMillan has been Co-Principal Investigator of our CCD-scanning since its inception; he coordinates optical, mechanical, and electronic upgrades. He is also the PI for the radial-velocity search for planets of other stars, which uses the remainder of the time, centered on full Moon, on the Spacewatch Telescope. M.L. Perry works with McMillan on various electronic and mechanical design problems, and he is responsible for electronic and mechanical maintenance of the Spacewatch Telescope. Scotti is responsible for the astrometry, working closely with B.G. Marsden, E.L.G. Bowell, and other colleagues for the follow-up of our discoveries and sometimes of others' discoveries as well. Rabinowitz makes improvements in the Solbourne/Sun Station system, and is our leading investigator of the statistics for near-Earth asteroids.

Proposed Work

We propose to continue using the Spacewatch Telescope during 18 nights per month, to find more candidates for mining. With the new CCD we have acquired we should nearly double our discovery rate.

Preliminary results we have already reported, namely that there is an excess by as much as a factor of 100 over the power-law extrapolation from our findings of the larger ones. The explanation of the excess is in terms of origin and evolution of the orbits.

Magnitude-frequency analysis may be made also for other populations such as for the mainbelt asteroids; we may do some of this depending on available time and/or funding, perhaps for a dissertation. There is an enormous database because Spacewatch finds nearly 2,000 mainbelt asteroids per month. All the data are preserved, and we propose, in fact, to make these generally available via e-mail to whoever wants them; a beginning of this has been made, with e-mail to the Minor Planet Center.

Spacewatch Discoveries, Until Summer 1991

Identification	Perihellion distance (AU)	Aphellion distance (AU)	Inclination (deg)	Diameter (km)	Date of Discovery (km)	Remarks
1989 UP	0.98	2.7	3.9	0.3	27 Oct. 1989	elongated; perihellion at Earth
1990 SS	0.89	2.5	19.4	0.9	25 Sep. 1990	
1990 TGI	0.77	4.2	9.1	4.6	14 Oct. 1990	discovered at 2.9 AU from Sun
1990 UN	0.81	2.6	3.7	0.09	22 Oct. 1990	H=23.5
1990 UO	0.30	2.2	29.3	0.4	22 Oct. 1990	perihellion at Mercury orbit
1990 UP	1.10	1.5	28.1	0.4	24 Oct. 1990	Amor; slow rotation
1990 VA	0.71	1.3	14.2	0.6	9 Nov. 1990	Aten; perihellion at Venus orbit
1991 AM	0.51	2.8	29.7	2.3	14 Jan. 1991	crosses Venus orbit
1991 BA	0.71	3.8	2.0	0.009	18 Jan. 1991	smallest object found so far
1991 BN	0.87	2.0	3.4	0.5	19 Jan. 1991	
1991 CB1	0.64	2.7	15.8	1.3	15 Feb. 1991	
1991 EE	0.84	3.6	9.8	1.5	13 Mar. 1991	
1991 FA	1.08	3.0	3.2	1.5	17 Mar. 1991	Amor
1991 FE	1.07	3.5	4.5	5.8	18 Mar. 1991	Amor
1991 JR	1.04	1.8	10.1	0.14	8 May 1991	Amor; associated with the ϕ -Bootid meteor stream
1991 LH	0.37	2.3	51.1	1.0	14 June 1991	

In addition to the discoveries, Spacewatch "rediscovered" (1865) Cerberus, P/Kopff, P/Taylor, P/Helin-Roman-Alu 1, and P/Hartley 1. Also, five objects were followed because of their apparent fast motion, but the eventual orbit indicated they were on the inside of the asteroid belt, and another two were in geocentric orbit.

Spacewatch Discoveries, to date

Identification	Perihelion distance (AU)	Aphelion distance (AU)	Inclination (deg)	Diameter (km)	Date of Discovery	Remarks
P/Spacewatch	1.54	4.8	10.0	--	8 Sep. 1991	1991x
1991 RJ2	1.26	3.2	9.0	0.7	2 Oct. 1991	Amor
1991 TT	1.00	1.4	14.8	0.03	6 Oct. 1991	
1991 TU	0.94	1.9	7.7	0.009	7 Oct. 1991	
1991 VA	0.93	1.9	6.5	0.02	1 Nov. 1991	
1991 VG	0.97	1.1	0.2	0.01	6 Nov. 1991	*
1991 XA	0.98	3.6	5.3	0.09	3 Dec. 1991	
1992 AD	8.7	32.3	24.7	>40	9 Jan. 1992	(5145) Pholus
1992 AE	1.13	2.2	5.8	2.9	10 Jan. 1992	Amor
1992 BA	1.25	1.4	10.5	0.4	27 Jan. 1992	peculiar orbit
1992 DU	0.96	1.4	25.1	0.05	26 Feb. 1992	
1992 HF	0.61	2.2	13.2	0.6	24 Apr. 1992	
Spacewatch	3.2	--	125.2	--	1 May 1992	1992h
1992 JG	1.30	3.9	5.6	1.5	2 May 1992	deep Mars crosser
1992 JD	1.00	1.1	13.6	0.05	3 May 1992	

*This may be an upper stage of an Apollo spacecraft, or, if natural, a new type of asteroid with orbit nearly the same as that of the Earth. In addition to the discoveries, Spacewatch rediscovered 3288 (an Apollo), 3122 (an Amor), P/Shoemaker-Levy 5, P/Gunn and (2060) Chiron (!) and made the first ground-based observation of a cometary dust trail (for P/Faye). 1991 RJ2 had been discovered by Helin in September, but it was then lost. We also obtained preliminary orbits for objects that looked promising, namely 1 Trojan, 1 Hilda, 1 Flora, 5 Mars-Crossers, and 3 Hungarias.

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The Spacewatch discoveries and astrometry are published in *Minor Planet Circulars*, *Spacewatch Reports*, *Spacewatch Announcements* (e-mail), and special ones also in *IAU Circulars*.