THE PALOMAR ASTEROID AND COMET SURVEY (PACS), 1982-1987; Carolyn S. Shoemaker and Eugene M. Shoemaker, U.S. Geological Survey, Flagstaff, Arizona 86001

In 1982, we began a new survey of special classes of asteroids and comets using the 46-cm Schmidt telescope at Palomar Observatory. This survey utilizes a stereoscopic technique that we developed to search large areas of the sky for moving objects. The immediate goal of the survey is to calculate accurately the population or flux of various classes of asteroids and comets by discovering, under well-defined conditions, a sufficient number of Earth-approaching and other planet-crossing asteroids, various classes of high-inclination asteroids, Trojan asteroids, and distant comets. The long-range purpose of this work is to understand the history of planet-crossing bodies and their interaction with planets and satellites. Our focus has been both on bodies that are presently on planet-crossing orbits and on asteroids that are thought to have been captured from swarms of planet-crossing bodies in the past.

The stereoscopic technique has allowed us to make major gains in the use of the 46-cm Schmidt telescope. Objects of interest are detected on pairs of films, each usually exposed for 4 or 6 minutes. The exposures of a given pair generally are separated by about 40 minutes. In a typical observing run, about 100 partly overlapping fields are photographed. Each field covers about 60 square degrees and, in the course of 8 observing runs a year, we have covered up to 40,000 square degrees of sky. Early in the survey we used Kodak IIa-D film; in the past year we switched to the newly available Kodak 4415 film. When hypersensitized, the 4415 film enables us to reach a threshold of B magnitude 18.5. The combination of much greater sky coverage and improvement in the threshold of detection, both of which are achieved with the use of short exposures and stereoscopy, has led to an order of magnitude increase in the discovery rate of asteroids and comets with the 46-cm Schmidt.

From the inception of PACS, we have obtained observations that permitted calculation of satisfactory preliminary orbits for more than 140 new asteroids, of which 20 are now numbered. Although we usually detect several hundred unnumbered asteroids on each observing run, limitations of manpower have precluded our measuring and reporting most of them. We have discovered 14 Earth-approaching asteroids (Table 1) and about 60 high-inclination asteroids, which include 31 asteroids in the Phocaea region of orbital element phase space, 13 in the Hungaria region, high-inclination Trojans, and 14 other asteroids that are either close to or have inclinations above the ν_6 secular resonance. Of the high inclination asteroids, 17 are Mars crossers; most of the others can approach Mars and probably have been derived from former Mars-crossing bodies. We interpret a few high-inclination asteroids to be extinct comets (Uranus-Neptune planetesimals) captured in stable orbits in the main asteroid belt.

In the fall of 1985, we searched the core of the L4 libration region to determine if we could discriminate Trojan asteroids with the stereoscopic technique. We discovered four new L4 Trojans, 3709 (1985 TL3), 1985 TE3, 1985 TF3, and 1985 TG3 (Table 1), and we obtained observations leading to the numbering of three previously discovered Trojans. On the basis of this test, we are planning a search with 4415 film that will cover the entire L4 and L5 libration regions. Our search, which will require several years, will utilize the standard fields of the PACS survey and should yield observations adequate for numbering about 100 new Trojans and a significant batch of new Hildas. We find it plausible that most Trojans and perhaps most Hildas may be derived from captured Jupiter-crossing, Uranus-Neptune planetesimals. We plan to test this hypothesis by examining in detail the dynamical structure and other properties of the Trojan swarms.

Comet discovery is another major objective of PACS; 11 new comets have been found to date. In contrast to most comets discovered in the past, the majority of comets discovered in PACS have fairly large perihelion distances; two are beyond the orbit of Jupiter. The goals of our comet search are to determine the perihelion distribution of long period comets to about 5 AU, to refine the population estimate of the Oort cloud, to determine the flux of both periodic and long period comets in the neighborhood of Jupiter, and to test whether capture of Oort cloud comets to short period can fully account for the Jupiter-family.

Table 1. Asteroids of special interest discovered in the Palomar Asteroid and Comet Survey

	H	Diam. km	Epoch	M	Peri.	Node	I	e	a	Arc days	Obs.	Orbit
Atens												
3554 Amun	16.2	2.0	870724	316.22403	359.30903	358.04473	23.36000	0.2803628	0.9736503	---	--	MPC11618
Apollos												
3671 Dionysius	16.5	~2	870724	337.04433	203.60137	81.82150	13.61060	0.5404753	2.1976590	---	--	MPC12138
1984 KB	16.4	1.4	841027	61.62574	334.87816	170.56242	4.63662	0.7622750	2.2210346	37	12	MPC 9030
1986 JK	19.0	~0.5	860619	357.29785	232.40866	62.23835	2.13951	0.6797186	2.8017387	103	43	MPC11147
1987 KF	16.0	~2	870529	29.54461	15.48073	107.56433	11.87129	0.0678835	1.8375868	26	16	MPC11998
1987 SY	17.5	~1	870922	46.01117	291.15157	311.72270	5.50806	0.5851108	1.4392358	20	10	MPC12440
1959 LM =1987 MB*	14.5	~3	870724	51.87088	235.14152	295.26840	6.76649	0.6373704	1.9802024	28 yr	19	MPC12139
*rediscovery												
Amors												
3199 Nefertiti	15.03	3	851201	194.85382	53.24906	339.45577	32.97512	0.2837208	1.5746595	---	--	MPC 9427
3553 Mera	16.8	~2	870724	53.88744	288.87369	231.97692	36.76271	0.3206869	1.6445847	---	--	MPC11617
1983 RB	16.0	~3	841027	141.71192	114.80819	168.88445	19.42719	0.5070001	2.2233403	55	18	MPC 8394
1985 TB	15.5	~3	860619	40.03800	66.96791	23.39052	26.81942	0.5674674	2.5751109	141	23	MPC10531
1985 WA	19.0	~0.5	860619	47.23757	350.87990	43.17465	9.74509	0.6016134	2.8456763	64	31	MPC10767
1987 SF3	19.0	~0.5	870922	10.13469	133.65604	187.12220	3.31417	0.5340295	2.2484648	25	5	MPC12440
1987 UA	17.5	~1	870922	353.39147	173.61357	197.59106	16.40445	0.2967418	1.7303153	27	6	MPC12440
Hildas												
3694 (1984 SH5)	10.4	~60	870724	121.39364	82.43510	311.18859	4.94870	0.1975307	3.9515148	---	--	MPC12312
Trojans												
3317 Paris	8.35	127	851201	348.27609	147.42493	135.32679	27.89639	0.1259800	5.1924388	---	--	MPC10036
3709 (1985 TL3)	9.5	~90	880827	38.21363	246.96651	186.48226	19.60912	0.0635566	5.2647810	---	--	MPC12438
1985 TE3	9.5	~90	851002	275.13	272.02	199.75	21.60	0.0905	5.1332	52	6	MPC11417
1985 TF3	10.0	~70	870724	60.95329	34.00108	342.60943	6.06954	0.1453284	5.1863506	36 yr	8	MPC11435
1985 TG3	10.0	~70	850912	358.02	64.49	307.72	11.68	0.0622	5.3024	29	8	MPC11417