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ORGANIZATION: The University of Arizona
Lunar and Planetary Laboratory

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OVERVIEW

During this grant period, the 1.8-m Spacewatch telescope was put into routine operation to search for asteroids and comets ranging in location from near-Earth space to regions beyond the orbit of Neptune. All of these classes of objects can be detected simultaneously with our uniform scanning procedures. We are studying NEOs, main belt asteroids, comets, Centaurs, and TNOs, as well as the interrelationships of these classes and their bearing on the origin and evolution of the solar system.

The Spacewatch 1.8-meter telescope is sensitive to V mag.$\leq$22.6 in sidereal scanning mode and is able to reach even fainter in longer "staring" exposures, with a field of view 0.5 degrees square. These faint limits make the operation of the Spacewatch 1.8-m telescope complementary to asteroid surveys being done by other groups. Specifically, EAs smaller than 100m in diameter and small main belt asteroids can be found, as well as more distant objects such as Centaurs/Scattered Disk Objects (SDOs) and Trans-Neptunian Objects (TNOs). The 1.8-m telescope is also being used to do recoveries and astrometry of recently-discovered asteroids that subsequently become too faint for the other groups before good orbits are established.

PURPOSE AND JUSTIFICATION

The purpose of the Spacewatch project is to explore the various populations of small objects throughout the solar system. Statistics on all classes of small bodies are needed to infer their physical and dynamical evolution. More Earth Approachers need to be found for spacecraft missions and to assess the impact hazard. (We have adopted the term "Earth Approacher", EA, to include all those asteroids, nuclei of extinct short period comets, and short period comets that can approach close to Earth. The adjective "near" carries potential confusion, as we have found in communicating with the media, that the objects are always near Earth, following it like a cloud.) Persistent and voluminous accumulation of astrometry of incidentally observed main belt

asteroids (MBAs) will eventually permit the Minor Planet Center (MPC) to determine the orbits of large numbers (tens of thousands) of asteroids. Such a large body of information will ultimately allow better resolution of orbit classes and the determinations of luminosity functions of the various classes. Comet and asteroid recoveries are essential services to planetary astronomy. Statistics of objects in the outer solar system (Centaurs, scattered-disk objects, and Trans-Neptunian Objects; TNOs) ultimately will tell part of the story of solar system evolution. Spacewatch led the development of sky surveying by electronic means and has acted as a responsible interface to the media and general public on that discipline and on the issue of the hazard from impacts by asteroids and comets.

BACKGROUND AND CURRENT STATUS

CCD scanning was developed by Spacewatch in the early 1980s and improvements to the technique are still being made by Spacewatch. Spacewatch was the first astronomical group to use drift scanning with a CCD, first to use CCDs to survey the sky for comets and asteroids, first to do astrometry on an asteroid with a CCD (1984 JZ on 1984 Apr. 28; numbered (3325) after our observation), first to do targeted astrometry of an EA with a CCD (1983 TB, now known as (3200) Phaethon, on 1984 Sep. 22), first to discover an asteroid with a CCD (the Trojan (3801) Thrasymedes), first to discover an EA with a CCD (1989 UP), first to discover an EA with software (1990 SS; now (11885)), first to discover a comet with a CCD (1991x; modern designation 125P/1991 R2), and first to discover an asteroid with a rotation period of less than two hours (1998 KY_{26}). At the time of this writing, Spacewatch still holds the records for discovering the smallest known asteroid (1993 KA_2; H=29), the closest known approach of any asteroid to the Earth (1994 XM_1; 105,000 km), the object with the most Earthlike orbit (1991 VG), and the asteroid most accessible to spacecraft among asteroids with accurately known orbits (the rapid rotator 1998 KY_{26}). As of 2001 Nov. 30, Spacewatch had discovered 254 EAs, 20 Centaurs or scattered-disk objects, 18 comets, 7 TNOs, and rediscovered one lost comet (P/Spitaler in 1993). Spacewatch has also made a total of 4,298 astrometric observations of comets, recovered 61 comets, and has reported 383,945 astrometric detections of asteroids, mostly in the main belt, including more than 47,850 for which provisional designations have been credited by the MPC to Spacewatch. A total of 5,735 positions of EAs have been reported by Spacewatch since 1984.

TECHNIQUE

Moving objects are discovered by scanning the sky with charge-coupled device (CCD) electronic imaging detectors on the 0.9-meter Spacewatch Telescope of the Steward Observatory and the 1.8-m Spacewatch Telescope of the Lunar and Planetary Laboratory, both located on Kitt Peak mountain in the Tohono O'odham Nation. The principles of Spacewatch observing have been described by McMillan and Stoll (1982), Frecker *et al.* (1984), Gehrels *et al.* (1986), McMillan *et al.* (1986), Gehrels (1991), Rabinowitz (1991), Perry and Frecker (1991), Scotti (1994), and

Jedicke (1996). The 1.8-m telescope and its accessories were described in the original proposal for this grant, and by Perry *et al.* (1998). Each Spacewatch scan consists of three passes over an area of sky using a CCD filtered to a bandpass of 0.5-1.0 μm (approximately V+R+I with an effective wavelength on typical asteroids of 0.7 μm). The effective exposure time for each pass with the 1.8-m telescope is 136 seconds multiplied by the secant of the declination. The area covered by each scan is 34 arcminutes in declination by about 27 time minutes in right ascension. The image scale is 1 arcsecond per pixel. Three passes take about 1.5 hours to complete and show motions of individual objects over a one hour time baseline. The limiting magnitude on slowly moving objects in good conditions with the 1.8-m telescope is about 22.6. The 1.8-m telescope is being used for survey scanning and followup in about equal proportions.

ACCOMPLISHMENTS

Milestones and Results with the Spacewatch 1.8-m Telescope: This is the largest telescope in the world dedicated full time to the search for previously unknown members of the solar system. It is housed in the David and Lucile Packard Building in the University of Arizona compound on Kitt Peak mountain in Arizona. Its 1.8-m aperture, sensitive CCD, and dedication to surveying will extend all of Spacewatch's exploration of the solar system to exciting new limits. Astrometric observations with this telescope began part time in March 2001. The first astrometry with this telescope reported to the MPC was made on April 13-18, and extended observing runs began in September 2001. On April 21 the first astrometry with this telescope to be listed in an MPEC (MPEC 2001-H26) was made of the EA 2001 HW_7. On May 24, 2001 the first astrometric recovery of a faint (V=22.6) EA was made with the 1.8-m Spacewatch telescope; this also appeared in an MPEC (2001-K33). The object was 2001 HB, a Potentially Hazardous Asteroid (PHA), recovery of which was urgently requested by the Spaceguard Central Node. The first EAs discovered with the Spacewatch 1.8-m telescope were 2001 UO and 2001 UB_5 on October 16 and 18, 2001, respectively. The unusually faint PHA 2001 SB_{170} was recovered at considerable effort with the 1.8-m telescope on Oct. 13 at V magnitude 23.3 at the urgent request of Spaceguard, resulting in the elimination of some predictions of future collisions of this object with the Earth. About 11,013 detections of asteroids and comets were made with the 1.8-m telescope between April 13 and Nov. 30, 2001. Astrometry with the 1.8-m in the April through November MPCs totals 379 object designations and 160 positional measurements of 52 EAs, including the EAs discovered with the 1.8-m telescope. Operation of the telescope by solo observers began on October 16 and improvements to the efficiency of operation of the telescope are continuing.

Image Analysis Software: Spacewatch's Moving Object Detection Program (MODP; Rabinowitz 1991) was constrained to process scans in real-time on a 1988-vintage computer. The necessarily simplified image detection and processing algorithms came with an efficiency cost. Jedicke and Herron (1997) placed MODP's efficiency at detecting asteroids at approximately 60%, which led to a substantial bias correction for their science analyses. Using more rigorous algorithms on a modern computer during this grant interval, Larsen developed a

MODP replacement dubbed IMPACT: Image Motion Package for Asteroids, Comets, and Transneptunians. IMPACT has an advantage over the peak-pixel detection algorithm in MODP in that it requires that several pixels above threshold be spatially correlated in order to qualify as a detected image. As a result, IMPACT can find fainter objects. Since 1999 Sept. 29 it has been in use at the telescope. It finds twice as many asteroids per scan, brings the efficiency for V<20 to above 90%, affords 0.2 mag more sensitivity, and can detect smaller angular displacements than MODP. An example of the latter capability is our discovery of the first comet of the year 2000 (C/2000 A1).

EDUCATION, PUBLIC OUTREACH, AND MEDIA CONTACT

These contributions by Spacewatchers are made without any compensation over and above their regular University salaries.

Gehrels' educational contributions for the interval 1998 Dec. 1 - 2001 Nov. 30 include annual trips to schools in the Tohono O'odham Nation (within which Kitt Peak is located). He also gave lectures on two occasions in Los Angeles to the Space Frontier Foundation, two lectures in Bangalore, two in Ahmedabad, one in Amsterdam for the International Aeronautics Federation, and on more than one occasion a presentation to Prince Bernhard of the Netherlands. He was specially invited to teach annually a UN Course at the Physical Research Laboratory in Ahmedabad, for graduate students from India, North Korea, Indonesia, Sri Lanka, Kazakhstan, Uzbekistan, Mongolia, Nepal and the Kyrgyz Republic. He gave talks in the planetaria of Amsterdam, Delhi, and Worli, at a grade school in Ahmedabad, and interviews for the new TV channel TARA in Ahmedabad and Mumbai. In 2001 October he gave a lecture at Spokane Community College in Washington State and a talk in Kurashiki, Japan about Spacewatch to the International Workshop on Collaboration and Cooperation among Near-Earth Object (NEO) Observers and Orbit Computers.

Gehrels also served on the Dean's P&T committee, the Graduate Degree Certification committee, and as a Marshall at Commencements. He teaches "Universe and Humanity, Origin and Future," and is developing a textbook for that.

Larsen invested considerable time training, coaching, employing, and tutoring students, especially the seven who are working or did work for Spacewatch: Natasha Carpenter, Nichole Danzl, Anne Descour, Arianna Gleason, Mike Read, Andrew Tubbiolo, and Ben Zuniga. Danzl and Gleason have discovered EAs, Centaurs, and TNOs, while Descour did a magnificent job of programming the IMPACT software interface. After obtaining her MS in Computer Science, she was hired by us as a full time Senior Systems Programmer. Read and Tubbiolo's work with computer hardware and electronics made it possible to modernize the data system at the telescope, and they are both now also trained solo observers. Larsen also helped Gleason create her poster for the internal LPL Conference in 2000.

Larsen hosted numerous visits by colleagues and fans of Spacewatch to the telescope, most notably to two groups from Raytheon Corp. and two groups of UA biologists. He gave a number of interviews for radio, TV, and news magazines. These included *The Arizona Daily Star's* science writer Jim Erickson and *Sky & Telescope's* Associate Editor Stuart Goldman on the topic of the discovery of the 17th moon of Jupiter, Jens Ramskov, Ph. D., of *Ingeniøren* (Engineering Weekly) of Denmark, Karelle Plummer, Jr. Exec. Producer of "Now Channel" in the UK, and Sofia Loverdou of "Greek Newspaper" on the topic of Spacewatch's rediscovery of the lost asteroid (719) Albert. Larsen was also interviewed by the University of Minnesota University Relations about naming minor planet (10172) after Prof. Roberta Humphreys. That was carried at least on the Tucson ABC-TV affiliate and published in *The Tucson Citizen, The Minneapolis Star*, and *The Minneapolis Tribune.* In addition, Larsen gave an email interview about NEAs to a freelancer, contributed to a press release by LPL's Agnieszka Przychodzen about Spacewatch research on Centaurs and TNOs, and gave an interview to Jorge Ianiszewski from *Circulo Astronomico* about Spacewatch's TNOs.

Larsen answered many questions from the general public received through access to our web site and contributed a piece to Benny Peiser's "CCNet" listserve on the asteroid impact hazard. Larsen's development of the Spacewatch web site (*http://www.lpl.arizona.edu/spacewatch*) was rewarded by awards from Key Resource, StudyWeb, and Scout Report Selection services.

Larsen also gave two talks at the U. S. Naval Academy in Annapolis, Va. and a colloquium at the Univ. of Minnesota. He is coaching a faculty member and midshipmen at the Naval Academy to observe asteroids with their small but modern telescope. As a successful graduate of University of Minnesota - Morris, Larsen was asked to reminisce about what their campus was like in the "dark ages" of 1985-1989. (His response included the fact that he had to walk 10 miles uphill to school each way in the snow.)

McMillan, Perry, Bressi, Scotti, and students Mastaler, Read and Tubbiolo, and Administrative Associate T. M. Lane of Spacewatch spent considerable time communicating with and training an astronomer from the Ulaan Baatar Observatory in Mongolia. The purpose of this education is to develop the capability for astronomers in Mongolia to observe asteroids.

McMillan serves extensively on NASA panels and workshops. During this grant period he served on panels reviewing proposals for observing time on the Keck telescopes in Hawaii and for funding from NASA's Planetary Astronomy Program. He also participated with Larsen in a national-level workshop to design the Large-aperture Synoptic Survey Telescope.

McMillan gave video interviews for Phoenix commercial TV, UA News Services, the Tucson affiliates of NBC-TV and PBS-TV, and the RSK program of Sanyo Broadcasting Co. of Japan. He did an interview with reporter/still photographer Kazuya Nagase of Kyodo News of Japan. He contributed to press releases and interacted extensively with the press on the topics of Spacewatch's rediscovery of the long-lost asteroid (719) Albert and the Spacewatch discoveries of S/1999 J1 (a satellite of Jupiter) and (20000) Varuna. McMillan and Montani hosted and

assisted a still photography crew for *Worth Magazine* at the Spacewatch telescopes. McMillan gave tours of the Spacewatch telescopes for participants of a Mars Conference, a meeting of chemists, an assemblage of UA Dept. Heads, an advisory board to the UA College of Science, the Japan Spaceguard Association, and (with Gehrels and Read) a United Kingdom Task Force on Near-Earth Objects. This latter helped that Task Force write a thorough and thoughtful report to Her Majesty's Government on the hazard of impacts by asteroids that was also well received internationally. McMillan's presentations at the Space Studies Institute in Princeton, NJ and the Colorado School of Mines in Golden, CO reached students and members of the general public in addition to professionals. With Therese Lane, Mike Read, and Jim Scotti he upgraded the Spacewatch web page, and granted permission for many organizations, including planetaria, to use images from the page for media productions. McMillan gave talks on Spacewatch to Prof. Steve Tegler's physics class at Northern Arizona University in Flagstaff, to the Saddlebrooke retirement community near Tucson, and a class of senior students at Tucson High Magnet School. McMillan also provided technical advice to two science fiction writers.

Scotti gave a guest presentation and question and answer session at Vail Middle School in 1999 May, two phone lectures and question and answer sessions with Edison High School (Fresno, CA), a public lecture in 2000 April at the Pima Air and Space Museum, and a presentation on Spacewatch to students from St. Cyril's school on February 9, 2001. Scotti's interaction with the press and general public extended from phone interviews and conversations, to film interviews, to live radio call-in shows, magazine articles, and numerous web/e-mail related interactions, including several for stories in newspapers or web publications. These were mostly for the (719) Albert story, but there were also some on the impact hazard. Scotti did radio interviews on "Let's Talk Stars" on KTKT with David Levy on Sept. 12, 2000 and June 19, 2001, on KXAM (Phoenix) with Dr. Sky (Steve Cates) on Nov. 24, 2000, and a video interview for the PBS series "Savage Planet". He was interviewed by Jim Erickson of *The Arizona Daily Star* for the (719) Albert story, by Dan Marries of KOLD TV 13 (Tucson) on Spacewatch that was motivated by a report of a possible meteorite fall, by Leslei Kean of public radio KPFA in Berkeley in August 2001 about 1991 VG, by Keay Davidson of the San Francisco Chronicle on asteroid research on February 7, 2001, by David Morgan from Reuters regarding a fireball and explosion reported in central Pennsylvania on July 25, 2001, and by BBC's Martin Renfern on June 11, 2001. Renfern also interviewed McMillan and Spacewatch student observer Arianna Gleason (who was on the mountain observing at the time). Scotti also reviewed a script for "Earth & Sky" by David Portree on EAs in May, 2001 and also answered a couple of questions he had. ("Earth & Sky" is a radio program funded by the NSF).

REFERENCES

Frecker, J. E., T. Gehrels, R. S. McMillan, W. J. Merline, M. L. Perry, J. V. Scotti, and P. H. Smith 1984. A CCD system for photometry of direct and spectroscopic images. *Proc. of the Workshop on Improvements to Photometry*, Eds. W. J. Borucki and A. Young, NASA CP-2350, 137-151.

Gehrels, T., B. G. Marsden, R. S. McMillan, and J. V. Scotti 1986. Astrometry with a scanning CCD. *Astron. J.* **91,** 1242-1243.

Gehrels, T. 1991. Scanning with charge-coupled devices. *Space Science Reviews* **58,** 347-375.

Jedicke, R. 1996. Detection of near Earth asteroids based upon their rates of motion. *Astron. J.* **111,** 970-982.
Jedicke, R. and J. D. Herron 1997. Observational constraints on the Centaur population. *Icarus* **127**, 494-507.
McMillan, R. S., T. Gehrels, J. V. Scotti and J. E Frecker 1986. Use of a scanning CCD to discriminate asteroid images moving against a background of stars. In *Instrumentation in Astronomy:* Proc. S.P.I.E. **627** (D. L. Crawford, Ed.), *VI 141-154.*
McMillan, R. S., and C. P. Stoll 1982. Software simulations of the detection of rapidly moving asteroids by a charge-coupled device. *Proc. SPIE* **331,** *Instrumentation in Astronomy IV,* 104-112.
Perry, M. L., T. H. Bressi, R. S. McMillan, A. F. Tubbiolo, and L. D. Barr 1998. The 1.8m Spacewatch telescope motion control system. *Proc. SPIE* **3351,** *Telescope Control Systems III,* 450-465.
Perry, M. L., and J. E. Frecker 1991. The drive system of the Spacewatch CCD-scanning telescope. *Bull. Amer. Astron. Soc.* **23,** 875.
Rabinowitz, D. L. 1991. Detection of Earth-approaching asteroids in near real time. *Astron. J.* **101,** 1518-1529.
Scotti, J. V. 1994. Computer aided near Earth object detection. in *Asteroids, Comets, and Meteors 1993,* A. Milani *et al.,* eds., Kluwer, 17-30.

SPACEWATCH PUBLICATIONS, 1998 Dec. 1 - 2001 Nov. 30

Spacewatch reported 209,236 astrometric detections (628,273 positions) of asteroids and comets to the IAU's Minor Planet Center in Cambridge, MA during this grant interval of 1998 Dec. - 2001 Nov. 30. Some of these the MPC has published in the *Minor Planet Circulars,* with a resulting 20,686 object designations. A total of 1,776 positional measurements (572 detections) were made of 297 Earth-Approachers (EAs), 71 of which were new Spacewatch discoveries reported in the *Minor Planet Electronic Circulars.* Spacewatch also discovered 6 Centaurs, 2 TNOs, 5 comets, and an outer satellite of Jupiter (the smallest known) since 1998 December 1.

Bhandari, N., and **T. Gehrels** 1999. Faint comets and asteroids over geologic history and their future hazards. *Space Research in India: Accomplishments and Prospects* (Ahmedabad, India: PRL Alumni Assoc.), Eds. M. S. Narayanan *et al.,* 315-334.

Bottke, W. F., **R. Jedicke,** A. Morbidelli, B. Gladman, J.-M. Petit 1999. Understanding the distribution of near-Earth asteroids. Abstract. *Bull. Amer. Astron. Soc.* **31,** 1116.

Bottke, W. F., **R. Jedicke,** A. Morbidelli, J.-M. Petit, and B. Gladman 2000. Understanding the distribution of near-Earth asteroids. *Science,* **288,** 2190-2194.

Bottke, W. F., A. Morbidelli, **R. Jedicke,** J.-M. Petit, H. Levison, P. Michel, and T. S. Metcalfe. 2002. Debiased orbital and size distributions of the near-Earth asteroids. *Icarus,* in press.

Bottke, W. F., A. Morbidelli, **R. Jedicke,** J.-M. Petit, H. F. Levison 2001. Debiased orbital and size distributions of the NEOs. Abstract. *Bull. Amer. Astron. Soc.* **33,** 1195.

Gehrels, T. 1999. A review of comet and asteroid statistics. *Earth, Planets, and Space* **51,** 1155-1161.

Gehrels, T. 1999. The Binzel Scale of asteroid hazards. *CCNet Digest http://abob.libs.uga.edu/bobk/cccmenu.html,* July 23.

Gehrels, T., and E. Echternach 1999. Beautiful but dangerous. *Zenit* **10:**416-423 (in Dutch).

Gehrels, T., and L. Ksanfomality 2000. The search for Earth-approaching comets and asteroids. *Solar System Research,* **34,** 37-48.

Gehrels, T., and P. Massey 2000. Discovery and confirmation of Comet P/2000 S4. *IAU Circ.* 7502.

Hergenrother, C. W., T. B. Spahr, M. Nelson, **A. E. Gleason,** and S. Nakano 2001. Precovery of Comet P/2001 J1 (NEAT). *IAU Circ.* 7635.

Hergenrother, C., M. Tichy, J. Ticha, and **J. V. Scotti.** 1999. Observation of Comet P/1999 RO28 (LONEOS). *IAU Circ.* 7253.

Jedicke, R., J. A. Larsen, and T. B. Spahr. 2001. Observational selection effects in asteroid surveys and estimates of asteroid population sizes. Chapter in *Asteroids III,* Ed. W. Bottke, A. Cellino, P. Paolicchi, and R. Binzel (Tucson: U. Arizona Press), in press.

Jedicke, R., A. Morbidelli, T. Spahr, J.-M. Petit, W. Bottke 2001. Earth and space-based NEO survey simulations: Prospects for achieving the Spaceguard goal. Abstract. *Bull. Amer. Astron. Soc.* **33,** 1138.

Larsen, J. A., and the Spacewatch Team 2000. The preservation and enhancement of the Spacewatch data archives. Abstract. *Bull. Amer. Astron. Soc.* **32,** 1018.

Larsen, J. A., A. E. Gleason, N. M. Danzl, A. S. Descour, R. S. McMillan, T. Gehrels, R. Jedicke, J. L. Montani, and J. V. Scotti 2001. The Spacewatch wide-area survey for bright Centaurs and Transneptunian objects. *Astron. J.* **121,** 562-579.

McMillan, R. S. 1999. The Spacewatch search for material resources near Earth. In *Space Manufacturing 12:Challenges and Opportunities in Space: Proceedings of the Fourteenth Space Studies Institute's Princeton Conference on Space Manufacturing, May 6-9, 1999,* B. Greber, Ed. (SSI Publishing, Princeton, NJ), 72-75.

McMillan, R. S. 1999. Why was the Earth-approaching asteroid 1998 OX4 lost, and was it a big deal to lose it? *CCNet Digest http://abob.libs.uga.edu/bobk/ccc/cc012499.html,* June 14.

McMillan, R. S. 1999. Spacewatch discovery and study of accessible asteroids. Abstract of paper presented at the *First Space Resources Roundtable* at the Colorado School of Mines in Golden, CO: Lunar & Planetary Institute (Houston) Contrib. No. 988 and

http://www.mines.edu/research/srr.

McMillan, R. S., M. L. Perry, T. H. Bressi, J. L. Montani, A. F. Tubbiolo, M. T. Read 2000. Progress on the Spacewatch 1.8-m telescope and upgrade of the Spacewatch 0.9-m telescope. Abstract. *Bull. Amer. Astron. Soc.* **32,** 1042-1043.

Montani, J., S. Kern and W. Shook 2000. Discovery and confirmation of Comet C/2000 A1 (Montani). *IAU Circ.* 7346.

Morbidelli, A., W. F. Bottke, **R. Jedicke,** B. Gladman, J.-M. Petit 1999. The debiased distribution of NEAs. Abstract. *B. A. A. S.* **31,** 1116.

Morbidelli, A., W. F. Bottke, **R. Jedicke,** P. Michel, E. F. Tedesco 2001. NEO albedo distribution and impact hazards. Abstract. *Bull. Amer. Astron. Soc.* **33,** 1137.

Ostro, S. J., P. Pravec, L. A. M. Benner, R. S. Hudson, L. Šarounová, M. D. Hicks, D. L. Rabinowitz, **J. V. Scotti,** D. J. Tholen, M. Wolf, R. F. Jurgens, M. L. Thomas, J. D. Giorgini, P. W. Chodas, D. K. Yeomans, R. Rose, R. Frye, K. D. Rosema, R. Winkler, & M. A. Slade. 1999. Radar and optical observations of asteroid 1998 KY_{26}. *Science,* **285,** 557-559.

Scotti, J. V., T. Kohima, T. Seki, C. Jacques, P. J. Shelus, A. Sugie, A. Asami 1999. Observation of Comet C/1999 D1 (Hermann). *IAU Circ.* 7112.

Scotti, J. V. 1999. Recovery of Comet P/1999 R2 (Ge-Wang). *IAU Circ.* 7255.

Scotti, J. V. 2000. Discovery of comet P/2000 Y3. *IAU Circ.* 7552.

Scotti, J. V., T. B. Spahr, **R. S. McMillan, J. A. Larsen, J. Montani, A. E. Gleason and T. Gehrels** 2000. Discovery and Confirmation of Jovian Satellite S/1999 J 1. *IAU Circ.* 7460.

Supernova Cosmology Project, **R. S. McMillan, T. Gehrels, J. A. Larsen, J. L. Montani, J. V. Scotti, N. Danzl and A. Gleason** 1999. Discovery and confirmation of Supernovae 1999be and 1999bf. *IAU Circ.* 7134.

Tubbiolo, A. F. 2000. Discovery of comet C/2000 Y1. *IAU Circ.* 7544.

Williams, G. V., **J. A. Larsen, R. S. McMillan, J. V. Scotti,** M. Hicks, and R. Fevig 2000. Rediscovery and Confirmation of Asteroid (719) Albert = 2000 JW_8. *IAU Circ.* 7420.

Minor Planet Electronic Circulars, 1998 Dec. 1 - 2001 Nov. 30:

Minor Planet Electronic Circulars (MPECs) are considered peer-reviewed publications, and the observers who contribute to MPECs are to be considered the authors. Sometimes, however, observers other than Spacewatchers contribute to an MPEC. To allow for that possibility, the Spacewatch contribution is merely cited as being "In" a given MPEC. Those MPECs titled here "Discovery of..." are those in which the discovery was credited to Spacewatch by the Minor Planet Center's flag "*" appended to the discovery observation. MPECs may be viewed at *http://cfa-www.harvard.edu/mpec/RecentMPECs.html*.)

Bressi, T. H., A. Descour, A. Tubbiolo. 2001. Discovery on 1.8-m telescope of Amor Asteroid 2001 UB_5. In *MPEC* 2001-U33.

Bressi, T. H. 2001. Discovery of Apollo Asteroid 2001 WJ_4. In *MPEC* 2001-W48.

Danzl, N., A. Gleason. 1999. Discovery of Trans-Neptunian Objects 1995 SM_{55}, 1995 TL_8, and 1996 GQ_{21}. In *MPEC* 1999-L24.

Danzl, N., A. Gleason. 1999. Discovery of Scattered-Disk Objects 1995 SN_{55} and 1998 TF_{35}. In *MPEC* 1999-L25.

Danzl, N. 1999. Discovery of Trans-Neptunian Object 1996 TC_{68}. In *MPEC* 1999-L27.

Danzl, N. 1999. Discovery of Trans-Neptunian Object 1998 SM_{165}. In *MPEC* 1999-M31.

Danzl, N., J. L. Montani, J. V. Scotti. 1999. Discovery of Apollo Asteroid 1999 TT_{16}. In *MPEC* 1999-U02.

Danzl, N., J. Montani. 2000. Discovery of Comet C/2000 OF A1 (Montani). In *MPEC* 2000-A46.

Descour, A. S., T. H. Bressi, A. F. Tubbiolo. 2001. Discovery of Amor Asteroid 2001 UQ_{163}. In *MPEC* 2001-V46.

Descour, A. S., J. A. Larsen, R. S. McMillan, J. V. Scotti. 2000. Discovery of Scattered-Disk Object 2000 OF_8. In *MPEC* 2000-P03.

Descour, A. S., J. A. Larsen, J. V. Scotti. 2001. Discovery of Apollo Asteroid 2001 QF_{96}. In *MPEC* 2001-Q40.

Gehrels, T. 2001. Astrometry of Potentially Hazardous Apollo Asteroid 2001 SO_{73}. In *MPEC* 2001-U18.

Gehrels, T., A. E. Gleason, R. S. McMillan, J. L. Montani, J. A. Larsen. 2001. Discovery of Scattered-Disk Object 2001 BL_{41}. In *MPEC* 2001-B44.

Gehrels, T., J. Larsen. 1998. Discovery of 1998 YF_{10}. In *MPEC* 1998-Y34.

Gehrels, T., R. S. McMillan, J. L. Montani, A. E. Gleason. 2000. Discovery of Amor Asteroid 2000 FJ_{10}. In *MPEC* 2000-G04.

Gehrels, T., J. V. Scotti. 2000. Discovery of 1996 RX_{33}. In *MPEC* 2000-Q11.

Gehrels, T., J. V. Scotti. 2001. Discovery of Amor Asteroid 2001 FC_7. In *MPEC* 2001-F20.

Gehrels, T., J. V. Scotti. 2001. Discovery of Apollo Asteroid 2001 HP_{11}. In *MPEC* 2001-F28.

Gehrels, T., J. V. Scotti, J. Larsen, R. S. McMillan. 2000. Discovery of 2000 HR_{24} = 1995 XH_5. In *MPEC* 2000-J50.

Gehrels, T., J. V. Scotti, R. S. McMillan. 2000. Discovery of Amor Asteroid 2000 UR_{13}. In *MPEC* 2000-U46.

Gehrels, T., J. V. Scotti, J. L. Montani. 2000. Discovery of Amor Asteroid 2000 YJ_{66}. In *MPEC* 2001-A20.

Gehrels, T., J. V. Scotti, J. L. Montani, A. E. Gleason. 2000. Recovery of 1995 TL_8. In *MPEC* 2000-Q15.

Gehrels, T., J. V. Scotti, J. L. Montani, J. A. Larsen, R. S. McMillan, A. E. Gleason, M. T. Read, A. F. Tubbiolo. 2001. First NEA Discovery with Spacewatch 1.8-m Telescope, Amor Asteroid 2001 HG_{31}. In *MPEC* 2001-H48.

Gehrels, T., J. V. Scotti, J. L. Montani, J. A. Larsen, R. S. McMillan, A. E. Gleason, M. T. Read, A. T. Tubbiolo, T. H. Bressi, A. S. Descour. 2001. Observation of PHA 2001 HB. In *MPEC*. 2001-K33.

Gleason, A. E. 1999. Discovery of Trans-Neptunian Object 1998 SN_{165}. In *MPEC* 1999-N17.

Gleason, A. E. 2000. Observation of 2000 KD_{41}. In *MPEC* 2000-K39.

Gleason, A. E. 2001. Discovery of Potentially Hazardous Apollo Asteroid 2001 KF_{54}. In *MPEC* 2001-K41.

Gleason, A. E. 2000. Recovery of 2000 BH_{19}. In *MPEC* 2000-R31.

Gleason, A. E., T. Gehrels. 2001. Discovery of Amor Asteroid 2001 KU_{66}. In *MPEC* 2001-K49.

Gleason, A. E., J. A. Larsen, J. L. Montani, B. P. Zuniga. 2000. Discovery of Amor Asteroid 2000 TQ_{64}. In *MPEC* 2000-U13.

Gleason, A. E., R. S. McMillan, J. L. Montani. 2000. Discovery of Apollo asteroid 2000 BO_{19}. In *MPEC* 2000-C19.

Gleason, A. E., R. S. McMillan, J. L. Montani, M. T. Read. 2000. Discovery of Potentially Hazardous Apollo Asteroid 2000 BO_{28}. In *MPEC* 2000-C24.

Gleason, A. E., J. L. Montani. 1999. Discovery of Amor Asteroid 1999 RH_{33}. In *MPEC* 1999-R37.

Gleason, A. E., J. L. Montani. 2001. Discovery of Trans-Neptunian Object 2000 YW_{134}. In *MPEC* 2001-B03.

Gleason, A. E., M. T. Read, J. L. Montani. 2000. Discovery of Amor asteroid 2000 AG_{205}. In *MPEC* 2000-B05.

Gleason, A. E., J. V. Scotti. 2000. Discovery of Amor Asteroid 2000 GB_2. In *MPEC* 2000-G24.

Gleason, A. E., J. V. Scotti, J. A. Larsen. 2000. Discovery of Trans-Neptunian Object 2000 GN_{171}. In *MPEC* 2000-M01.

Gleason, A. E. among 19 other observers at six other observatories. 2001. Precovery of Comet P/2001 J1 (NEAT). MPEC 2001-K43.

Jedicke, R., J. V. Scotti, T. Gehrels. 2000. Discovery of 1996 AS_{20}. In *MPEC* 2000-V09.

Larsen, J. 1998. Discovery of 1998 YG_{10}. In *MPEC* 1998-Y35.

Larsen, J. A. 1999. Discovery of Apollo Asteroid 1999 CQ_2. In *MPEC* 1999-C17.

Larsen, J. A. 1999. Discovery of Apollo Asteroid 1999 FJ_{21}. In *MPEC* 1999-F34.

Larsen, J. A. 2000. Observation of 2000 GR_{127}. In *MPEC* 2000-G44.

Larsen, J. A. 2000. Discovery of Apollo Asteroid 2000 GX_{127}. In *MPEC* 2000-G49.

Larsen, J. A. 2000. Astrometry of Apollo Asteroid 2000 GX_{127}. In *MPEC* 2000-H02.

Larsen, J. A. 2000. Observation of 2000 XF_{44}. In *MPEC* 2000-X30.

Larsen, J. A. 2001. Observation on 1.8-m telescope of Mars Crosser Asteroid 2001 SH_{262}. In *MPEC* 2001-S41.

Larsen, J. A. 2001. Observation on 1.8-m telescope of Apollo Asteroid 2001 SN_{289}. In *MPEC* 2001-W06.

Larsen, J. A., T. H. Bressi. 2001. Discovery of Apollo Asteroid 2001 VC_{76}. In *MPEC* 2001-W15.

Larsen, J. A., A. S. Descour. 2001. Discovery of Amor Asteroid 2001 BB_{40}. In *MPEC* 2001-B40.

Larsen, J. A., A. S. Descour. 2001. Discovery of Apollo Asteroid 2001 UO. In *MPEC* 2001-U23.

Larsen, J. A., A. S. Descour, A. E. Gleason. 2000. Discovery of Amor Asteroid 2000 TV_{28}. In *MPEC* 2000-T28.

Larsen, J. A., A. S. Descour, J. V. Scotti. 2001. Discovery of Amor Asteroid 2001 QE_{96}. In *MPEC* 2001-Q39.

Larsen, J. A., A. E. Gleason. 1999. Discovery of Amor Asteroid 1999 WK_{11}. In MPEC 1999-X10.

Larsen, J. A., R. Kowalski, C. Bayus, **J. V. Scotti.** 1999. Discovery of Apollo Asteroid 1999 HP_{11}. In MPEC 1999-J19.

Larsen, J. A., R. S. McMillan. 2001. Recovery on 1.8-m telescope of Aten Asteroid 2001 WO_{107}. In *MPEC* 2001-V58.

Larsen, J. A., R. S. McMillan, A. Gleason. 2000. Recovery of 1997 EH_{29}. In *MPEC* 2000-J15.

Larsen, J. A., R. S. McMillan, A. E. Gleason. 2001. Discovery of Apollo Asteroid 2001 DR_8. In *MPEC* 2001-D12.

Larsen, J. A., R. S. McMillan, J. V. Scotti. 2000. Rediscovery of Long-Lost Amor Asteroid (719) Albert = 2000 JW_8. In *MPEC* 2000-J37.

Larsen, J. A., J. L. Montani, A. E. Gleason. 2000. Astrometry of Amor Asteroid 1998 NU. In *MPEC* 2000-R57.

Larsen, J. A., J. V. Scotti. 2000. Discovery of Amor Asteroid 2000 VH_{61}. In *MPEC* 2000-W02.

Larsen, J. A., J. V. Scotti, R. Smith. 1999. Discovery of Amor Asteroid 1999 FP_{59}. In *MPEC* 1999-G18.

Larsen, J. A., M. Read. 2001. Observation on 1.8-m and 0.9-m telescopes (respectively) of Apollo Asteroid 2001 WH_1. In *MPEC* 2001-W61.

Larsen, J. A., A. F. Tubbiolo. 2001. Discovery of Aten Asteroid 2001 FO_{127}. In *MPEC* 2001-F57.

Larsen, J. A., A. F. Tubbiolo. 2001. Discovery of Apollo Asteroid 2001 VF_{75}. In *MPEC* 2001-W02.

McMillan, R. S. 2000. Observation of 2000 GQ_{132}. In *MPEC* 2000-J19.

McMillan, R. S. 2001. Astrometry of Amor Asteroid 2001 FC_7. In *MPEC* 2001-G30.

McMillan, R. S., A. S. Descour, T. H. Bressi, A. F. Tubbiolo. 2001. Discovery of Amor Asteroid 2001 US_{16}. In *MPEC* 2001-U53.

McMillan, R. S., J. A. Larsen. 2000. Discovery of Apollo Asteroid 2000 WN_{63}. In *MPEC* 2000-W59.

McMillan, R. S. and J. A. Larsen. 2000. Discovery of Trans-Neptunian Object 2000 WR_{106}. In *MPEC* 2000-X02.

McMillan, R. S., J. A. Larsen. 2000. Discovery of Amor Asteroid 2000 WK_{107}. In *MPEC* 2000-X10.

McMillan, R. S., J. Larsen. 2001. Recovery on 1.8-m telescope of Apollo Asteroid 1999 OR_3. In *MPEC* 2001-V62.

McMillan, R. S., J. L. Montani. 2001. Discovery of Apparent Apollo Asteroid (later resolved to be WIND Spacecraft) 2001 DO_{47}. In *MPEC* 2001-D28.

McMillan, R. S., J. V. Scotti. 2000. Recovery of 1993 GD. In *MPEC* 2000-J28.

McMillan, R. S., J. V. Scotti. 2000. Astrometry of Apollo Asteroid 1998 HL_{49}. In *MPEC* 2000-G15.

McMillan, R. S., J. V. Scotti. 2001. Discovery of Potentially Hazardous Apollo Asteroid 2001 FA_{58}. In *MPEC* 2001-F37.

McMillan, R. S., J. V. Scotti, A. E. Gleason. 2001. Discovery of Apollo Asteroid 2001 GP_2. In *MPEC* 2001-H04.

McMillan, R. S., A. F. Tubbiolo. 2001. Discovery of Amor Asteroid 2001 UU_{16}. In *MPEC* 2001-U54.

Montani, J. 2000. Observation of 2000 QC_{34}. In *MPEC* 2000-R07.

Montani, J. 2000. Recovery of 1998 OR_2. In *MPEC* 2000-S25.

Montani, J. 2000. Prediscovery of 2000 WC_{67}. In *MPEC* 2000-X03.

Montani, J. L. 2001. Discovery of Amor Asteroid 2001 HH_{31} (=1997 WC_{54}). In *MPEC* 2001-H49.

Montani, J. L., A. E. Gleason. 2000. Discovery of Apollo Asteroid 2000 FM_{10}. In *MPEC* 2000-G07.

Montani, J. L., A. E. Gleason. 2000. Discovery of Amor Asteroid 2000 FP_{10}. In *MPEC* 2000-G10.

Montani, J., J. Larsen 1998. Discovery of Apollo Asteroid 1998 US_{18}. In *MPEC* 1998-U30.

Montani, J. L., J. A. Larsen, A. E. Gleason. 2001. Discovery of Apparent Apollo Asteroid 2001 BK_{41}. In *MPEC* 2001-B43.

Montani, J. L., J. Larsen, J. V. Scotti. 2000. Recovery of 1996 GQ_{21}. In *MPEC* 2000-K23.

Montani, J., J. V. Scotti. 1998. Discovery of Apollo Asteroid 1998 SH_2. In *MPEC* 1998-S10.

Montani, J., J. V. Scotti. 1998. Discovery of Apollo Asteroid 1998 VD_{35}. In *MPEC* 1998-W26.

Montani, J., J. V. Scotti. 1998. Discovery of Apollo Asteroid 1998 WL_4. In *MPEC* 1998-W27.

Montani, J. L., J. V. Scotti. 1999. Discovery of Apollo Asteroid 1999 ED_5. In *MPEC* 1999-F04.

Montani, J. L., J. V. Scotti. 2001. Astrometry Yielding Revised Status as Mars Crossing Asteroid of Previously Classified (Apollo) Asteroid 2001 BK_{41}. In *MPEC* 2001-C03.

Montani, J. L., J. V. Scotti, A. F. Tubbiolo. 2000. Discovery of Amor Asteroid 2000 OA_{51}. In *MPEC* 2000-P20.

Montani, J. L., A. F. Tubbiolo. 2000. Discovery of Aten Asteroid 2000 SZ_{162}. In *MPEC* 2000-T04.

Read, M. T., A. E. Gleason. 2001. Discovery of Scattered Disk Object 2001 FZ_{173}. In *MPEC* 2001-G33.

Scotti, J. V. 1999. Discovery of Apollo Asteroid 1999 SK_{10}. In *MPEC* 1999-T18.

Scotti, J. V. 2000. Discovery of Comet P/2000 Y3. In *MPEC* 2000-Y47.

Scotti, J. V. 2001. Discovery of Potentially Hazardous Apollo Asteroid 2000 YN_{291}. In *MPEC* 2001-A11.

Scotti, J. V. 2001. Astrometry of Apollo Asteroid 2000 YO_{29}. In *MPEC* 2001-A12.

Scotti, J. V. 2001. Observation of 2001 OZ_{13}. In *MPEC* 2001-P14.

Scotti, J. V. 2001. Discovery of Apollo Asteroid 2001 QM_{142}. In *MPEC* 2001-Q51.

Scotti, J. V. 2001. Observation of 2001 SQ_3. In *MPEC* 2001-S08.

Scotti, J. V. 2001. Observation of 2001 SJ_9. In *MPEC* 2001-S14.

Scotti, J. V. 2001. Observation of 2001 SK_9. In *MPEC* 2001-S15.

Scotti, J. V. 2001. Discovery of 2001 SO_{73}. In *MPEC* 2001-S20.

Scotti, J. V. 2001. Recovery of 1999 JU_6. In *MPEC* 2001-T34.

Scotti, J. V. 2001. Observation of Amor Asteroid 2001 UP_{27}. In *MPEC* 2001-V63.

Scotti, J. V., N. L. Chabot, **N. Danzl.** 1999. Discovery of Amor Asteroid 1999 VX_{15}. In *MPEC* 1999-W15.

Scotti, J. V., T. Gehrels. 2000. Discovery of Mars Crossing Asteroid 2000 WE_6. In *MPEC* 2000-W14.

Scotti, J.V., A. E. Gleason. 2000. Discovery of Amor asteroid 2000 BG_{19}. In *MPEC* 2000-C12.

Scotti, J. V., A. E. Gleason, N. Danzl. 1999. Discovery of Amor Asteroid 1999 FQ_5. In *MPEC* 1999-F20.

Scotti, J. V., A. E. Gleason, J. Montani, M. Read. 2000. TNO (2000 EC_{98}). In *MPEC* 2000-

E64.

Scotti, J. V., J. A. Larsen. 2000. Discovery of Mars-Crossing Asteroid 2000 GQ_{127}. In *MPEC* 2000-G43.

Scotti, J. V., J. A. Larsen, B. May, D. Maggs. 1999. Discovery of Scattered-Disk Object 1999 TD_{10}. In *MPEC* 1999-T46.

Scotti, J. V., J. A. Larsen, M. T. Read. 2001. Discovery of Amor Asteroid 2001 HW_7. In *MPEC* 2001-H26.

Scotti, J. V., R. S. McMillan, A. E. Gleason. 2000. Discovery of Potentially Hazardous Apollo Asteroid 2000 BF_{19}. In *MPEC* 2000-C11.

Scotti, J. V., J. Montani. 1998. Discovery of Amor Asteroid 1998 WT_{30}. In *MPEC* 1998-X29.

Scotti, J. V., J. L. Montani. 1999. Discovery of Amor Asteroid 1999 EO_3. In *MPEC* 1999-E26.

Scotti, J. V., J. L. Montani. 1999. Discovery of Amor Asteroid 1999 TU_{16}. In *MPEC* 1999-U03.

Scotti, J. V., M. T. Read. 2000. Discovery of Amor Asteroid 2000 CR_{101}. In *MPEC* 2000-D07.

Scotti, J. V., M. T. Read. 2000. Discovery of Amor Asteroid 2000 PQ_{27}. In *MPEC* 2000-Q14.

Scotti, J. V., M. T. Read, J. A. Larsen. 2000. Discovery of Amor Asteroid 2000 GT_{127}. In *MPEC* 2000-G45.

Scotti, J. V., and A. F. Tubbiolo. 2000. Recovery Astrometry of Apollo Asteroid 1996 TY_{11}. In *MPEC* 2000-W08.

Scotti, J. V., A. F. Tubbiolo. 2001. Discovery of 2001 SQ_{73}. In *MPEC* 2001-S25.

Tubbiolo, A. F. 2001. Observation of 2001 NX_{17} = 2000 JV_{63}. In *MPEC* 2001-O45.

Tubbiolo, A. F. 2001. Discovery of Amor Asteroid 2001 UD_{18}. In *MPEC* 2001-U68.

Tubbiolo, A. F. 2001. Observation of 2001 VG_5. In *MPEC* 2001-V50.

Tubbiolo, A. F., A. S. Descour, T. H. Bressi. 2001. Discovery of 2001 UQ_{163}. In *MPEC* 2001-V46.

Tubbiolo, A. F., A. E. Gleason. 2000. Discovery of Comet C/2000 Y1. In *MPEC* 2000-Y06.

Tubbiolo, A. F., A. E. Gleason, J. A. Larsen, N. L. Carpenter. 2000. Discovery of Amor Asteroid 2000 YG_4. In *MPEC* 2000-Y30.

Tubbiolo, A. F., J. Larsen 2001. Discovery on 0.9-m and 1.8-m telescopes (respectively) of 2001 VF_{73}. In *MPEC* 2001-W02.

Tubbiolo, A. F., R. S. McMillan. 2001. Discovery of 2001 UU_{16}. In *MPEC* 2001-U54.

Tubbiolo, A. F., R. S. McMillan, A. Descour, T. Bressi. 2001. Discovery of Amor Asteroid 2001 US_{16}. In *MPEC* 2001-U53.

Tubbiolo, A. F., J. L. Montani, T. Gehrels, R. S. McMillan. 2000. Discovery of Amor Asteroid 2000 LK_{10}. In *MPEC* 2000-L35.

Tubbiolo, A. F., J. V. Scotti, J. L. Montani. 2000. Discovery of Aten Asteroid 2000 LG_6. In *MPEC* 2000-L28.

Tubbiolo, A. F., J. V. Scotti, M. T. Read. 2000. Discovery of Amor Asteroid 2000 PH_8. In *MPEC* 2000-P42.

Williams, G. V., **J. A. Larsen, R. S. McMillan, J. V. Scotti.** 2000. Rediscovery of Long-Lost Amor Asteroid (719) Albert = 2000 JW_8. In *MPEC* 2000-J37.