SJAA EPHEMERIS

Eye on the Universe

by Lew Kurtz

Ernie Piini gave a great talk on his trip to see the total solar eclipse in India last October. He had some wonderful slides too. If you get Astronomy magazine, you saw one of Ernie's pictures on the cover of the March issue!

Ed Erbeck was elected to the office of **Vice President** at the March board of directors' meeting. Bob Brauer retained the office of President, Bob Elsberry continues as treasurer, and Jim Van Nuland starts another year as secretary extrodinaire.

Bylaws. Bob Brauer, Bob Madden, and I have revised the club's bylaws. We felt some changes were needed so that the bylaws would reflect the way we currently do things. We bought a book and some software from Nolo press and then modified the provided bylaws to reflect how SJAA conducts its affairs. Copies of the bylaws will be available at the April and June general meetings and on SJAA's home page. Or send me a note (number and address are on page 5) and I'll send a copy to you. We will hold a vote at the July general meeting (held on June 29 - yes June) on whether or not to accept the new bylaws.

Reminder: the 16th Annual Bay Area Astronomical **Auction and Swap Meet** will be on May 4 at Houge Park. Doors open at 12:00 noon for set up. Swap meet also starts at 12:00 noon. Auction starts at 4:00 pm. 10% commission goes to SJAA. Maximum commission is $50 per item. Page 7 has a map to Houge park and an Auction Registration form.

The Astronomical Society of the

continued on page 5, see **Eye**

SJAA Hotline: **408-559-1221**
24 hour News and Information
Home page url **http://www.rahul.net/resource/sjaa**

- **Apr 6**: General meeting at Houge Park, 8:00. Craig Wandke will be talking about Moon. Board meeting, 6:30 pm is open to all members.
- **Apr 7**: Daylight savings time begins.
- **Apr 13**: Star party at Fremont Peak state park. Sun sets 7:39 pm, 14% Moon rises 4:33 am.
- **Apr 17**: Partial Solar eclipse, Antarctica (I expect a lot of trip reports on this one! - Ed.)
- **Apr 20**: Star party at Henry Coe state park. Halls Valley Astronomical Group at Grant Ranch. Sun sets 7:46 pm, 11% Moon sets 10:41 pm.
- **Apr 26**: Houge park star party. Sun sets 7:53 pm, 62% Moon sets 2:55 am.
- **Apr 27**: Observational Astronomy Class, Houge Park, **8 pm. Note later time.**
- **May 4**: Swap Meet and Auction at Houge Park, 12:00 pm.
- **May 11**: Star party at Fremont Peak state park. Sun sets 8:08 pm, 26% Moon rises 3:11 am. Halls Valley Astronomical Group at Grant Ranch.
- **May 18**: Star party at Henry Coe state park. Sun sets 8:11 pm, 3% Moon sets9:24 pm.
- **May 24**: Houge park star party. Sun sets 8:17 pm, 46% Moon sets 1:27 am.
- **May 25**: Observational Astronomy Class, Houge Park, 8 pm.
- **Apr 6**: General meeting at Houge Park, 8:00. Slide Equipment, and member night. Board meeting, 6:30 pm is open to all members.

Mirror, Mirror (part 1)

by Doug Ferrell

Have you ever wondered if you could (or should) try to make your own telescope mirror; wondered if it would be worth the effort? If so, then I can identify with your perspective. I first pondered the idea just over a year ago myself. Since that time I have met many interesting people (both in person and "virtually") and have almost finished my first mirror, a 10" f/5.2 paraboloid for a Newtonian which you WILL see at Fremont Peak and other public events later this year. With this article and others to follow I hope to inspire you to try your hand at mirror making.

Living in a large urban area like we do has its advantages (something has to offset the light pollution). In late 1994 I discovered one of these while wandering around an open air festival in Oakland China Town. Several members of the Eastbay Astronomical Society had telescopes set up to view the Sun and Venus(?). Having just gotten my first "real" telescope (a 10" f/4.5 used and modified Coulter--thanks, Mark) I had to have a look. On a nearby table were some flyers, one of which was for the Chabot Observatory and Science Center's (COSC) telescope makers' workshop--the seed was planted. (Note: COSC is not related to Chabot College and is located farther north).

Within a couple of months I had bought a 10" pyrex blank from a club member (thanks, Bob) and had cast a grinding tool from dental plaster. On my first visit to the workshop I met Paul Zurakowski who encouraged me by saying that I should be able to finish the

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mirror with about 30 to 50 hours of work. A few minutes later and I was rough grinding under the supervision of Earl Watts! I had become an amateur telescope maker (ATM).

Today, after just about 50 hours of work (including a few mistakes) I am within a few minutes of my goal: 1/8 wave wavefront or better. With a local resource like the Chabot workshop (which Paul Zurakowski has run for more than 25 years) it is possible to build your dream scope from scratch. The workshop is open almost every Friday night from 7-10pm and is located off of I-580 in the Oakland hills just north of San Leandro. You can call the Observatory for directions or if you have WWW access, try Mark Van de Wettering's homepage at http://www.webspace.com/markv for a digital map (as well as a lot of interesting information on astronomy and ATM). Stop by and watch the mirror makers in action then check out Chabot's Planetarium and Observatory (with a 20 inch Warner and Swasey refractor). The observatory gift shop also sells mirror kits in case you've gotten the bug already.

While most people start with a 6", 8", or maybe 10" newtonian as their first project, there really aren't many limitations beyond that. While working on my mirror I have seen many interesting projects underway including Cassegrainians, tilted component telescopes, SCTs, and even a Maksutov. There are currently several Newtonians under way (from 6" to 16") as well as a few other less common projects. The walls are dotted with photos of instruments of all types made by amateurs at Chabot. A homemade mirror can be a great parent/child project during the cloudy winter months.

So, what sort of tools and equipment does the ATM (Amateur Telescope Maker) need? Surprisingly little, in fact. Other than the mirror kit itself (including a blank, a tool, and the ginding / polishing compounds) only a few items are necessary: a piece of plywood or particle board with three small wooden cleats to hold the mirror during grinding and polishing, a pair of small C-clamps to hold the board in place on the grinding table, paper towels (mirror making is wet and messy work), a water spray bottle, and some newspaper. The test and measurement equipment is available at Chabot (you can also make your own with a little effort). Mirror kits are available from several other sources (check the classifieds in "Sky and Telescope" or "Astronomy" or come to the SJAA swap meet in May).

The basic method of mirror making is quite simple. The mirror blank and tool are ground against each other with a slurry of grinding compound and water between them. Tiny glass chips are removed from the surfaces and the bottom one becomes convex (the tool) while the other (the mirror) develops exactly the opposite concavity. By altering the grinding stroke and relative position of the mirror and tool, the shape of the curved surface can be controlled quite precisely. There are four stages in the process: rough grinding, fine grinding, polishing, and figuring.

Rough grinding is the messiest and noisiest phase. This is when most of the glass is removed from the blank to form the concavity. The grit used is usually #80 or #60 (grits are graded like sandpaper). This process usually takes a few hours depending on mirror size and focal length--larger and faster mirrors require more glass to removed than smaller or slower ones. It took me about five and a half hours to "hog out" my 10" f/5.2 mirror.

Fine grinding is the next phase and involves producing an ever smoother surface on the mirror (I spent about 11 hours fine grinding my mirror). Progressively finer grits are used in the grinding slurry usually ending with powder fine 9 or 5 micron sized "grit". The goal at each grit size is to remove the "grain" or roughness left by the previous grit size until the glass surface becomes almost glassy smooth. Below a certain point the glass surface will not become smoother by grinding it against a hard tool. At this point it is time to begin polishing the mirror.

If everything has gone well the surface of the mirror is now a spheroid. That is to say that its surface corresponds to a circular region on the outside of a large sphere. I've put it off as long as possible, but I'll have to resort to a little math now. Remember that with mirrors, the angle of reflection is equal to the angle of incidence. So, measuring the focal length of our mirror we can conclude that the radius of curvature of its reference sphere must be twice its focal length. My 10" f/5.2 would have a radius of curvature of 2 x (10 x 5.2) or 104 inches. That is to say that the surface of my mirror (at this stage) would exactly match the outside of a sphere 104 inches in radius if I were to hold it against such an object. Using a little 3D geometry we can calculate the depth, called the sagitta, of the center of the mirror concavity relative to the edge as well as the volume. This is useful information for testing purposes.

Since we cannot produce a smoother surface with our grinding tool, we switch to a time tested method using pitch (either coal tar or tree sap based). A pitch "lap" is poured on top of the grinding tool (or on a different tool in case we have to back up and regrind for some reason). Pitch has the interesting and useful property that over a short time (a few seconds) it acts like a solid, but over a longer time (a few tens of seconds) it actually flows. Optical grade pitch is rated on a temperature scale which defines its viscosity, so we can choose the best pitch for our local climate (it does matter).

Since the pitch flows, it will continually adjust itself to conform to the changing shape of the mirror surface and be in intimate contact with the mirror surface at all times. We polish mirrors on a pitch lap with a slurry of water and polishing compound (usually cerium oxide or ferrous oxalate, rouge, powder). The compound gets imbedded in the pitch and the pitch is in near perfect contact with the glass and magically (after several hours of hard work) the mirror becomes gradually "smooth as glass." There are several theories about how and why this happens--I'll let you read about it. In any case it becomes very difficult to actually see the surface and reflections in the mirror are

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clear--we're almost done!

The final (and often quickest) stage is known as figuring the mirror. During polishing we have, hopefully, maintained our spheroidal surface shape. Unfortunately a sphere is not, except in very slow mirrors, a good shape for astronomical instruments. The term spherical abberration is used to describe a mirror which is too close to sphere in shape to form sharp images. The surface we actually want on our mirror is a paraboloidal one. A paraboloid has the property that all on-axis light rays are focused perfectly within the airy disk diffraction limit (plus any effects of secondary obstruction). Off axis rays become more and more "smeared" the farther off axis they are. The smearing is known as coma and is more pronounced for faster mirrors than for slower ones.

But not to worry, our paraboloid is just around the corner from a spheroid (the larger the focal ratio, the closer to a spheroid the paraboloid is). Figuring is basically polishing using a different stroke (or set of strokes). After a few minutes of figuring, the mirror is tested to see in what way and how much its surface shape has been changed. This is essential as it does not take long to change the spheroid into something else. It is much better to slowly sneak up on the paraboloid than to rush and overshoot the final figure. Figuring a slow mirror (a 6" f/8 for instance) may only take a few minutes! My mirror now tests to a surface figure of about 1/12 of a wavelength of green light (that's 1/12th of 0.000022 inches). Remember that the angle of reflection is equal to the angle of incidence so that any surface error is doubled on the reflected wavefront. My mirror, then, has about a 1/6 wave wavefront (which is not quite as good as I'd like). Most "small" mirrors that come out of the Chabot lab have at least a 1/8 wave wavefront. Last week a 1/10 wave wavefront 8" f/6 and a 1/5 wave wavefront 16" f/5 were completed.

If you want to get a head start on the fun some well written books are available on the subject. Richard Berry's _Build Your Own Telescope_ is a great place to begin. It includes plans for several complete telescopes from 4" to 10" as well as chapters on mirror making and optical testing. For a more complete and detailed coverage of mirror making try Jean Texereau's _How to Make a Telescope_, 2nd Edition. While some of the telescope mechanical design information is outdated, the rest of this book is excellent. Both of these volumes can be purchased from local sources or mail order for about $25 apiece in hardback. There are other texts on telescope making (some no longer in print), but I think these two are a good start. Be sure to check your S&T back issues for interesting ATM articles.

Next time I will cover some of the preparatory steps and the grinding experience. I hope that by now I have at least piqued your interest. If I am lucky and have time to go to Chabot I may have a completed mirror (sans coating) by then! Feel free to stop by the Chabot workshop some Friday evening to talk telescopes and see what is involved in this interesting facet of our hobby.

Galileo Mission Status
March 14, 1996

Public Information Office
Jet Propulsion Laboratory
California Institute of Technology
National Aeronautics and Space Administration
Pasadena, CA 91109
Phone 818-354-5011

Shortly after noon Pacific Time today NASA's Galileo spacecraft fired its German-made main rocket engine for the third and last time to complete the set-up for its 11-orbit tour of Jupiter's system.

Operating on a sequence of computer commands sent to the spacecraft a week ago, Galileo turned yesterday morning to the correct orientation for the rocket firing and then increased its spin rate to 10.5 rpm yesterday afternoon to stabilize the spacecraft during today's burn. The rocket firing started at 12:01 p.m. PST today, and stopped at 12:25 p.m. Tomorrow the craft will spin down and return to its normal orientation, with its antenna pointed toward Earth.

The rocket engine, part of a propulsion system built by Messerschmitt-Bolkow-Blohm and furnished by the German government as a partner in the Galileo project, delivers 400 newtons or about 88 pounds of thrust.

Acting on the 1-1/2-ton spacecraft for about 24 minutes, this force increased Galileo's speed in its orbit around Jupiter by about 377 meters per second or 842 miles per hour, nearly doubling its speed at the outer end of the orbit.

Now Galileo is aimed for an 844-kilometer (524-mile) encounter with the satellite Ganymede on June 27. Equally important, Galileo will not pass so close to Jupiter as it would have otherwise, resulting in much less radiation exposure from the planet's trapped radiation belts. It passed through the intense inner radiation zone last December of necessity to accomplish the probe mission, and had no problems then, but the spacecraft was not designed for multiple passes through that hazardous region.

Today the spacecraft is 19.3 million kilometers (12 million miles) from Jupiter, just past the farthest point in its orbit. Starting Saturday Galileo will begin to fall, and pick up speed, back toward Jupiter. Earth and the spacecraft are now less than 840 million kilometers (about 520 million miles) apart, as Jupiter and Earth approach each other in their solar orbits. As a result, Galileo's radio messages now take only 46 minutes, 19 seconds to get here.

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San Jose Astronomical Association
5380 Pebbletree Way
San Jose, CA 95111-1846

Cassini Program Status Report
March 1, 1996

Public Information Office
Jet Propulsion Laboratory

The University of Iowa's Radio and Plasma Wave Science Subsystem (RPWS) became the first science instrument to be installed on the Cassini spacecraft last month while several other instruments from other institutions around the country arrived at JPL for test and integration onto the Saturn-bound spacecraft. RPWS data will be used to determine the planet's rotation rate and help characterize Saturn's interior, magnetic field, lightning and the planet's interaction with charged particles flowing from the Sun.

After the RPWS integration, the Cassini Ground System successfully supported the first operational transfer of data from the instrument to the principal investigator's site at the University of Iowa. This new method, using the Science Operations and Planning Computer (SOPC) provided by the Distributed Operations Interface (DOI) Element, allows the science team for each instrument to remotely control, test and receive data from their instrument without leaving their home institution, resulting in significant cost and time savings to the program.

Instruments delivered to the Cassini Program last month included the Composite Infrared Spectrometer (CIRS) from the Goddard Space Flight Center; the Imaging Science Subsystem (ISS) from JPL, the UVIS from the University of Colorado, Boulder, the Magnetospheric Imaging Instrument Subsystem (MIMI) from Applied Physics Laboratory of Johns Hopkins University, and the Magnetic Field Investigation (MAG) from the Imperial College of Science and Technology in London, England.

The Cosmic Dust Analyzer (CDA) Engineering Model (EM) Instrument completed qualification thermal vacuum testing at Heidelberg, Germany. The Cassini Radar Subsystem (RADAR) Digital Assembly (DSS) successfully passed protoflight vibration testing.

The Attitude and Articulation Control Subsystem/AACS Flight Computer (AACS- AFC) A/B side integration has been completed. The integration of the engineering model (EM) Propulsion Module Subsystem, Electronics Assembly (PMSEA) with the A side Valve Drive Electronics has been completed. The B side is in process.

The Radio Frequency Subsystem (RFS) has successfully completed all system integration and capability tests with the Deep Space Network (DSN) and is being prepared for electromagnetic compatability and interference tests.

The Propulsion Module Assembly was completed and successfully underwent tests to ensure it was leak-proof.

In Europe, work on the Huygens Probe progressed with the integration of the Descent Imager Spectrometer Radiometer (DISR), the Aerosol Collector Pyrolyser (ACP), the Huygens Atmospheric Instrument (HASI), the Surface Science Package (SSP), and the Command and Data Management Unit (CDMU).

In the area of mission science planning, the world's experts on planetary rings met last month to discuss ring particle distribution estimates to be used by Cassini trajectory designers to specify a safe flight path during the spacecraft's four-year orbital tour of the Saturn system. The program also approved a minimum flyby altitude of Saturn's moon Titan of 950 kilometers, (about 590 miles) except for six passes that could have altitudes as low as 850 km (about 530 miles) for data gathering by the Ion and Neutral Mass Spectrometer (INMS).

Cassini-developed technologies and management approaches being used by other projects made news in the past month, among them:

-The Near Earth Asteroid Rendezvous (NEAR) spacecraft was successfully launched, carrying the Cassini-developed Deep Space Transponder (DST), Command Detector Unit (CDU) and the Inertial Reference Unit (IRU).

-The Mars Pathfinder spacecraft, which uses Application-Specific Integrated Circuits (ASICs) and a micro-miniature radio transponder developed by the Cassini Program, was readied for final thermal-vacuum testing last month prior to shipment to Cape Canaveral for launch later this year.

-The Mars Volatiles and Climate Surveyor (MVACS) Project has decided to use the Receivable/Deliverable portion of the Cassini Management Information System (CMIS), which has been of critical importance in keeping the program on schedule and under budget.

Several instrument deliveries and integrations are scheduled for Cassini this month. The spacecraft will be shipped to Cape Canaveral, FL, in late April 1997 for an October 1997 launch.

The address for the Cassini Program's home page is
http://www.jpl.nasa.gov/cassini

Ulysses Mission Status
March 1, 1996

Public Information Office
Jet Propulsion Laboratory

The Ulysses spacecraft is on its way to the orbit of Jupiter, where it will loop around and return to the Sun. All operations and science experiments continue to go well in this first-ever journey out of the ecliptic plane. NASA's tracking facilities near Madrid, Spain and at Goldstone, Calif., are monitoring the spacecraft about 12 hours each day.

Today Ulysses is about 45 degrees north of the Sun's equator, traveling at a heliocentric velocity of about 57,000 kilometers per hour (35,000 miles per hour) with respect to the Sun.

Ulysses will reach Jupiter's distance of 5.4 astronomical units (about 800 million kilometers or 500 million miles) from the Sun on April 17, 1998. Once there, the spacecraft will loop around and return to high latitude regions of the Sun. In September 2000, the spacecraft will begin its second solar orbit, which will take it over both poles of the Sun.

Telescope Loaner Status
by Paul Barton

No.	Scope Description	Borrower	Due Date
1	4.5" Newt/P Mount		**available**
3	4" Quantum S/C	(in storage-call)	**available**
6	8" Celestron S/C	Steve Wincor	4/9/96
7	12.5" Dobson	Tim Sanstrom	5/9/96
8	14" Dobson		**available**
15	8" Dobson	Bob Elsberry	5/9/96
18	8" Newt/P Mount	Jerry Lovelace	4/6/96
19	6" Newt/P Mount		**available**
21	10" Dobson	Rich Navarrete	5/3/96
23	6" Newt/P mount	Shelly McAleese	5/11/96
25	8" Dobson	Bob Ashford	5/26/96
26	11" Dobson		**available**
27	13" Dobson	(in storage)	**available**
28	13" Dobson	(in storage)	**available**

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Pacific (ASP) is seeking amateur and professional astronomers and advanced astronomy students to participate in project ASTRO, an innovative program that matches astronomers with 4th-9th grade teachers in Bay Area schools and community centers who want to enrich their astonomy and science teaching. The first aplication deadline (for preferred placement) is April 22nd, although applications will be accepted after this date. For more information and an application form, contact Crystelle Egan, Project Assistant, at the ASP: 415-337-1100; leave a message at 415-337-9210; or send e-mail to jrichte@cello.gina.calstate.edu. This is the program that Bob Ashford participates in. He gave a talk on his experiences at one of SJAA's general meetings late last year, and (if my memory serves correctly) he was mentioned in an Astronomy article about project ASTRO within the last couple of years.

The ASP's Universe '96 will be held in Santa Clara this year. Contact Bob Havlen or Lonny Baker at 415-337-1100, rhavlen@stars.sfsu.edu or lbaker@stars.sfsu.edu for more info.

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Astro Ads

Astro Ads are free to all noncommercial advertisers selling astronomically related products or services. Please send your ad directly to the Editor, (my address is in the next column).

Moon Message

About 1966 or so, a NASA team doing work for the Apollo moon mission took the astronauts near Tuba City where the terrain of the Navajo Reservation looks very much like the Lunar surface. With all the trucks and large vehicles were two large figures that were dressed in full Lunar spacesuits.

Nearby, a Navajo sheep herder and his son were watching the strangecreatures walk about, occasionally being tended by personnel. The two Navajo people were noticed and approached by the NASA personnel. Since the man did not know English, his son asked for him what the strange creatures were and the NASA people told them that they are just men that are getting ready to go to the moon. The man became very excited and asked if he could send a message to the moon with the astronauts.

The NASA personnel thought this was a great idea so they rustled up a tape recorder. After the man gave them his message they asked his son to translate. His son would not.

Later, they tried a few more people on the reservation to translate andevery person they asked would chuckle and then refuse to translate. Finally, with cash in hand someone translated the message, "Watch out for these guys, they come to take your land."

--Charles Phillip Whitedog, Ojibway and Network Manager, Multimission Ground Systems Office (Mission Control), Jet Propulsion Laboratory, NASA

Members are encouraged to submit articles for publication in the SJAA Ephemeris. Send articles to Lew Kurtz (via e-mail to lewkurtz@aol.com; or a text file on a 3-1/2" diskette, or typed or hand written to 1336 Bobolink Circle, Sunnyvale, CA, 94087). Articles received by the 10th will be put in the following month's newsletter. Please include your name and phone number.

COMET COMMENTS, March 8, 1996

by Don Machholz

Five comets are visible in our skies this month. One- **Comet Hyakutake (C/1996 B2)**- is the brightest comet in twenty years! In late March it passes near Earth. As it continues in toward Sun it will remain a naked-eye object, sporting what should be a fairly bright tail in the evening sky. By mid-April it will be low in the western sky after sunset.

The first **Comet Hyakutake (1995 Y1)** remains in the morning sky while **Comet Szczepanski** fades in the evening sky. **Periodic Comet Kopff** brightens in the southern morning sky, it nears **Comet Hale-Bopp** in June.

I have just finished writing an 82-page book for those wishing to make the most of Comet Hale-Bopp's visit to our skies. Containing 64 maps and 21 figures, it prepares both the beginner and the seasoned astronomer for the comet. Entitled "An Observer's Guide to Comet Hale-Bopp", it is available by sending $12.00 plus $2.00 shipping and handling to MakeWood Products, P.O. Box 1716, Colfax, CA. 95713. For First Class Mail the S&H totals $3; for overseas Air Mail it is $6. Phone orders, using a credit card, are accepted at (916) 346-8963.

EPHEMERIDES

C/1995 Y1 (Hyakutake)

DATE 00 UT	R.A. 2000	Dec	EL	Sky	Mag
03-28	21h21.9m	+25°17'	51°	M	9.2
04-02	21h39.5m	+26°58'	50°	M	9.4
04-07	21h55.9m	+28°27'	49°	M	9.6
04-12	22h11.3m	+29°44'	49°	M	9.9
04-17	22h25.6m	+30°53'	50°	M	10.1
04-22	22h38.8m	+31°53'	50°	M	10.3
04-27	22h51.1m	+32°47'	51°	M	10.5
05-02	23h02.5m	+33°35'	52°	M	10.7
05-07	23h13.1m	+34°18'	53°	M	10.9

C/1995 O1 (Hale-Bopp)

DATE 00 UT	R.A. 2000	Dec	EL	Sky	Mag
03-28	19h41.6m	-19°54'	74°	M	8.4
04-02	19h42.9m	-19°33'	78°	M	8.3
04-07	19h44.0m	-19°11'	83°	M	8.2
04-12	19h44.7m	-18°48'	88°	M	8.1
04-17	19h45.0m	-18°26'	93°	M	8.0
04-22	19h45.1m	-18°03'	97°	M	7.9
04-27	19h44.7m	-17°40'	102°	M	7.8
05-02	19h43.8m	-17°16'	107°	M	7.7
05-07	19h42.6m	-16°52'	112°	M	7.5

22P/Kopff

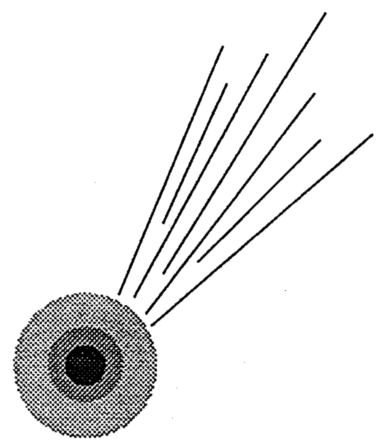
DATE 00 UT	R.A. 2000	Dec	EL	Sky	Mag
03-28	17h26.8m	-16°55'	106°	M	10.5
04-02	17h36.4m	-16°53'	108°	M	10.2
04-07	17h45.9m	-16°49'	111°	M	10.0
04-12	17h55.2m	-16°43'	113°	M	9.7
04-17	18h04.3m	-16°36'	116°	M	9.5
04-22	18h13.0m	-16°28'	119°	M	9.2
04-27	18h21.5m	-16°19'	122°	M	8.7
05-02	18h29.5m	-16°10'	125°	M	8.5
05-07	18h37.2m	-16°02'	127°	M	8.3

C/1996 B1 (Szczepanski)

DATE 00 UT	R.A. 2000	Dec	EL	Sky	Mag
03-28	09h34.5m	-01°10'	137°	E	8.9
04-02	09h28.1m	-04°58'	131°	E	9.2
04-07	09h23.9m	-08°07'	125°	E	9.5
04-12	09h21.6m	-10°43'	121°	E	9.8
04-17	09h20.7m	-12°56'	116°	E	10.0
04-22	09h21.0m	-14°51'	112°	E	10.3
04-27	09h22.3m	-16°31'	109°	E	10.6
05-02	09h24.5m	-17°59'	106°	E	10.8
05-07	09h27.5m	-19°19'	102°	E	11.1

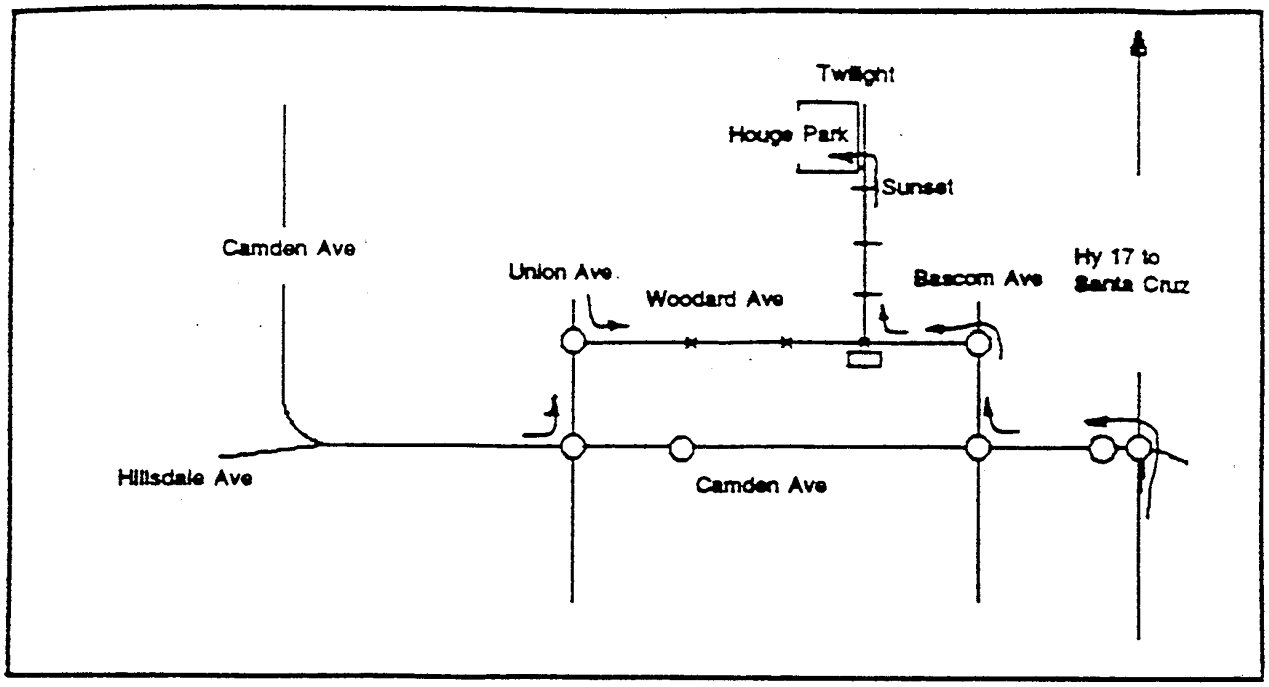
C/1996 B2 (Hyakutake)

DATE 00 UT	R.A. 2000	Dec	EL	Sky	Mag
03-28	04h21.9m	+80°21'	90°	E	1.1
04-02	03h12.5m	+52°31'	56°	E	2.1
04-07	03h05.9m	+43°44'	45°	E	2.5
04-12	03h00.6m	+39°02'	37°	E	2.5
04-17	02h55.0m	+35°47'	30°	E	2.1
04-22	02h47.4m	+32°29'	23°	E	1.3
04-27	02h37.0m	+27°59'	15°	E	0.1
05-02	02h25.9m	+20°52'	6°	E	-0.3
05-07	02h21.7m	+12°19'	10°	M	0.8



Elements

Object	Hyakutake(95Y1)	Szczenpanski	Haykutake(96B2)	Hale-Bopp	Kopff
Peri. Date	1996 02 24.28973	1996 02 06.89903	1996 05 01.40305	1997 04 01.12081	1996 07 02.1998
Peri. Dist (AU)	1.054576	1.4486192	0.23014060	0.9141160	1.5795617
Arg/Peri (2000)	046.35126°	151.44413°	130.18992°	130.58985°	162.83487°
Asc. Node (2000)	195.75924°	345.41073°	188.05114°	282.47097°	120.91329°
Incl (2000)	054.46584°	051.90616°	124.90012°	089.42765 °	004.72143°
Eccentricity	1.0	0.9899357	0.9998449	0.9951019	0.5440739
Orbital Period (yrs)	Long Period	1727	57,000	3000	6.45
Source	MPC 26543	MPEC1996-C02	MPC 26724	MPC 26723	MPC 22032



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	Addr			Zip
Item # from SJAA	Qty	Min Bid	Donation 10% min	Description (40 - 50 Characters)

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