



The Refractor

The Bulletin of the Eastbay Astronomical Society

Founded in 1924 at Chabot Observatory, Oakland, California

Volume 72
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June 1996

Peeking into the Sun: Helioseismology from SOHO

Saturday, 1 June, 7:30 p.m.

Physics Classroom, Chabot Observatory

Lecture: Space Science Classroom

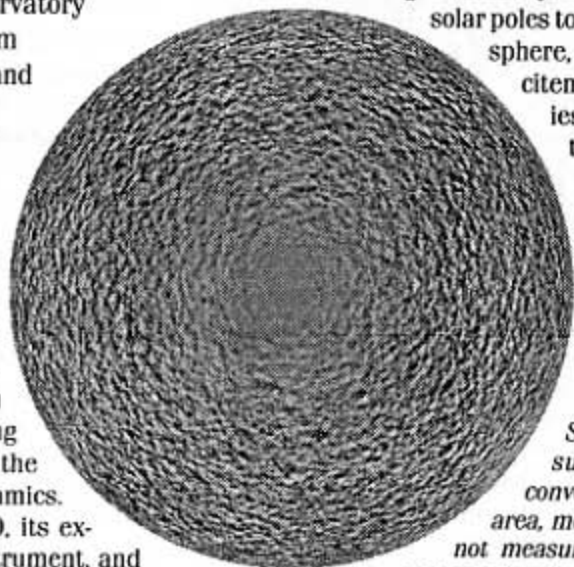
4917 Mountain Boulevard, Oakland

Philip H. Scherrer

Professor of Physics

Stanford University

The Solar and Heliospheric Observatory (SOHO) spacecraft was launched on 2 December 1995, a joint project of the European Space Agency and NASA. One of the experiments on SOHO, the Michelson Doppler Imager (MDI) is observing solar oscillations as a tool to probe the Sun's interior structure and dynamics. Prof. Scherrer will describe SOHO, its experiments, its launch, the MDI instrument, and some initial MDI results.



This is a MDI Dopplergram map of the motion of the solar photosphere—the visible surface of the Sun. Motions toward the observer are dark and the motions away are light colored. An average of 30 maps corrected for the Sun's rotation, this image clearly shows supergranulation of Earth-sized convective cells. In the "smooth" central area, motion of the cells is horizontal and so not measurable by Doppler technology, which senses only advancing or receding motion.

With a doctorate from the University of California at Berkeley in 1973, Philip Scherrer has been at Stanford since 1974. He studied solar magnetic fields and surface motions, and in 1975 began his work in helioseismology. He has served as Director of the Wilcox Solar Observatory since 1983, and since 1988 is the Principal Investigator of Solar Oscillations Investigation with the Michelson Doppler Imager on the SOHO mission.

SOHO is on location in space near the L-1 Lagrangian point, where the Earth's and the Sun's gravitational forces balance, some one million miles sunward from the Earth. This vantage point enables solar astronomers to observe the Sun continuously, with no intervening "night". SOHO was specifically designed to observe the Sun during a "quiet" period near the bottom of its 11-year sunspot cycle, when solar disturbances are at a minimum and the undisturbed solar atmosphere and interior could best be studied.

Other important information comes from SOHO's Large-angle Spectroscopic Coronagraph (LASCO), which images solar plumes as far as 30 solar radii from the surface of the Sun. (The radius of the Sun is about 440,000 miles.) Guenther Brueckner of the Naval Research Laboratory, Washington, D.C., is the principal investigator for LASCO.

Making recent news is the Extreme-Ultraviolet Imaging Telescope (EIT). Initial observations reveal unexpected activity on the Sun and the best views yet of the sources of strange, chaotic "plume" structures that extend from the solar poles to high altitudes within its outer atmosphere, or corona. To the surprise and excitement of scientific investigators, movies made from the ultraviolet data show that there is continuous motion and action everywhere on the Sun. The sequences of images, combined

into movies, show polar plumes standing in the solar wind, with their bases, never before characterized, as seething regions of wildly gyrating magnetic fields and turbulent solar gases.

Polar plumes are thus a natural laboratory to explore two of the main objectives of the SOHO mission. These goals are to learn how the Sun's corona is heated to about 3.6 million degrees Fahrenheit and why the solar wind in some places reaches speeds of almost two million miles per hour. The plume data may even shed light on the third main goal of SOHO, to determine what occurs below the solar surface to generate the strong flows and intense magnetism that produce solar disturbances such as sunspots and solar flare explosions.

Join us for

DINNER WITH THE SPEAKER

5:28 p.m., 1 June 1996

PEARL OF SIAM RESTAURANT

5498 College Avenue, Oakland (510 / 420-8600)

Please call Betty Neall at 510 / 533-2394 by Friday, 31 May to confirm your place. Please be on time to allow ample time for dinner and to facilitate a prompt meeting time of 7:30 p.m.

Please welcome these new EAS members:

Richard and Scott Fanning

Elaine Ginnold

Francis N. Kidiga



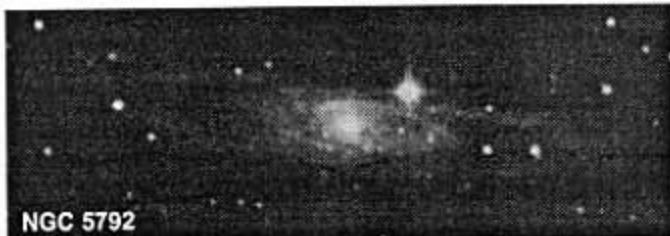
Probably the most intriguing features of

The Constellation Libra

are the names of the two principal stars. They are Zubenelgenubi and Zubeneshamali. These names mean the "southern claw" and the "northern claw" and they refer not to the scales of the modern constellation, but to the claws of Scorpius, the neighboring creature to the east. The loss of these claws from an original double constellation is unknown, but it is quite evident that the claws did indeed belong to the scorpion who stung Orion and who was banished to the sky opposite the mighty hunter so the two should never again confront each other. Of the ancient stars there is no longer a γ -Scorpii; the star that once had that name has been known as σ -Librae since Roman times.

Libra is the seventh zodiacal group of stars and finds its meager prominence in early summer. Lying between Virgo and Scorpius, its four brightest stars form a skewed diamond pattern. The idea of scales to represent this part of the zodiac may have derived from its location, equally north and south of the Sun's path. Or it may have been the nearly equal brightness of the first two stars of the group, α -Librae, Zubeneshamali, and β -Librae, Zubenelgenubi. But there is some question as to this, for the Greek philosopher and astronomer Eratosthenes in the third century BC listed α -Librae as brighter than Antares. Another theory states that the Romans invented the concept at a time when Libra stood at the autumnal equinox, and Libra marked the time when days and nights were of equal length.

Zubeneshamali is a star of unusual color, said to be the only green naked-eye star. Zubenelgenubi is an interesting star, too. Rather, it is two stars, at the limit that the human eye can resolve, just under four arcminutes. The fainter of the pair is of fifth magnitude, while the brighter (magnitude 2.8) is itself a spectroscopic double. This is an interesting target for viewing with binoculars or telescope. Another interesting star is δ -Libra,



NGC 5792

a good example of an Algol-type eclipsing binary star. It ranges in brightness from 4.8 to 5.9 with a period of 2.3 days.

Most of the deep-sky objects in Libra are faint. NGC 5897 is a loosely organized globular cluster of faint stars at a distance of 45,000 light years. In the northwestern end of the constellation is a magnitude 12 spiral galaxy seen edge-on, NGC 5792.

Why Is It So Dark at Night?

The night sky is filled with stars, each a sun in its own right. If the Universe is unbounded (or even just "sufficiently large"), every line of sight should eventually encounter a star, and the whole sky should be ablaze with light. So, as any child might ask, Why is it so dark at night?

This question was raised by many astronomers, including Kepler and Halley, but most famously by Heinrich Olbers in 1826. Ever since, it has been known as Olbers' Paradox. The search for a solution to the riddle of the "Dark of Night" leads us into some of the most fascinating portions of cosmology. "The Dark of Night" begins Friday, 14 June, at the Rotary Chabot Planetarium. Performances are also scheduled for Saturday, 22 June, and Friday, 28 June.

The planetarium program on Friday, 31 May will conclude the presentations of the show "African Skies".

Programs begin at 7:30 p.m. Following the presentation, the public is invited to view through the telescopes of the observatory from about 9 p.m., weather permitting. The Starry Nights Gift Shop is open for ticket sales at 7 p.m.

The Oregon Star Party

is an astronomy adventure featuring quality deep-sky viewing. All ages enjoy camping among ponderosa, juniper, and sage. This year, the excitement will take place from August 15 to 18.

Indian Trail Spring in the Ochoco Mountains has a panoramic horizon at a 5000-ft. elevation, with excellent sky transparency, steady air, and almost zero light glow from Bend, 60 miles to the west. Daytime activities include solar viewing, a swap meet, guest speakers, and the opportunity to enjoy the wilderness.

For information about fees, camping accommodations, food services, vendor opportunities and such, you can telephone Chuck Dethloff at (503) 357-6163, or contact him by e-mail at dethloff@uofport.edu. Registration fees will be higher if not postmarked on or before August 6, 1996.

EAS Officers

President: Carter Roberts	(510) 524-2146
Vice President: Phil Crabbe II	(510) 655-4772
Secretary: Kevin Cox	(510) 528-2181
Treasurer, Membership: Don Stone	(510) 733-6738

An ephemeral phenomenon

is about to take place overhead in the Bay Area if all goes according to NASA's plans for Space Shuttle Endeavour's flight STS-77. Admittedly, those plans are often subject to a change in the weather, but launch was exactly on schedule on May 19, 1996, at 0330 PDT. The inclination of the orbit will be 39°, and the altitude of the orbit will be 153 nautical miles (176 statute miles). The duration of the mission is expected to be ten days, 37 minutes, which indicates a landing at Kennedy Space Center on Wednesday, May 29 at 0407 PDT. What this means is that on its final pass over the United States to a touch-down in Florida, the Shuttle will be almost directly overhead at 235,000 ft altitude, traveling at 15,500 miles per hour. There is the very real likelihood that this will be a re-entry well worth watching!

This is a special event for Northern California, since only infrequently is the Shuttle placed in this particular inclination. Normally the orbiters are in either a 28° or a 57° pattern. For the re-entry path to be over the Bay Area, the landing must be scheduled for Kennedy Space Center in Florida, as indeed most Shuttle flights are. Edwards Air Force Base near Mojave is the secondary site. Also, the landing must be at a time when skies are dark here, in order that the Shuttle may be seen.

When STS-73 Columbia made its re-entry last November, EAS members watched in awe, as we reported in the December *Refractor* (see the photo by Carter Roberts in that issue). Dave Rodrigues was one of those. Looking forward to the STS-77 event, Dave says,

"This space shuttle re-entry should not be missed by *anyone!*"

It is, without any doubt, one of the most spectacular astronomical sights I have ever witnessed. The Shuttle looks like a pinkish-red automobile flare shooting across the sky in about three minutes, leaving a whitish smoke trail behind. Its magnitude has been estimated at minus seven!"

Brian Day and Garrick Mitchell of the Peninsula Astronomical Society report that they observed the November event from Yosemite National Park's Sentinel Meadow. "The sky was clear, and the Moon had just disappeared behind the cliffs. The Shuttle's initial approach from the west was obscured by the northern wall of the valley. By the time the Shuttle popped up over the edge, it was moving very quickly and appeared quite bright. As seen down Tenaya Canyon, the Shuttle remained easily visible as it passed far to the east. The glowing white trail was initially quite bright and was still easily visible 15 minutes afterwards. An added treat came roughly five minutes after the Shuttle had gone past. The early-morning silence of the meadow was suddenly broken by the Shuttle's classic double-boom reverberating off the granite walls. The silence of the meadow was then broken again by the yells and cheers of the two of us."

How should you plan to see this rare occurrence?

According to Dave Rodrigues, on the day of the landing, set your alarm for an hour before landing. Check CNN or KCBS or another news source to confirm that the shuttle has fired its retro rockets. Subtract 22 minutes from the estimated touch-

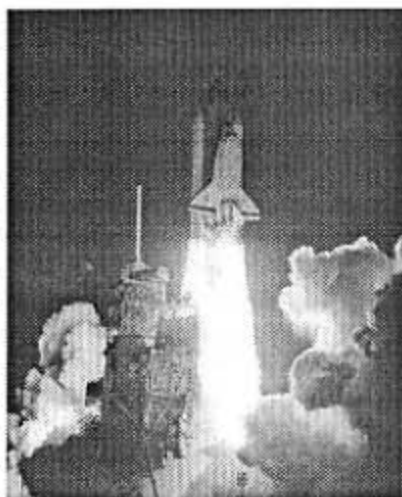
down time. That is when it should appear from the Bay Area (allow another 5 or 10 minutes for contingency). It will be in the west, headed east. Should NASA delay the landing for one orbit it will appear in the southwest, going southeast. If the sky is clear and you are looking up at the right time, you will see it. The Shuttle is so bright it can be observed from anywhere. It is more exciting to watch it through binoculars as it whizzes against a field of stars.

We will try to notify as much of the public as possible through news releases and interviews. Please help to spread the word to your friends. Whether they are astronomically inclined or not, they will be forever grateful.

Endeavour STS-77 is under the command of

John H. Casper with Curtis L. Brown, Jr., as Pilot. Mission Specialists are Daniel Bursch, Mario Runco, Jr., Marc Garneau, and Andrew Thomas. The mission is devoted to opening the commercial space frontier. During the flight the crew will perform microgravity research aboard the commercially operated Spacehab module.

Designed to meet a need for additional experiment space in the Orbiter, the Spacehab pressurized module made its first flight aboard STS-57 in 1993. Carried in the payload bay and accessed through an airlock, the laboratory increases by four times the available space where astronauts can work. The module is 13½ feet in diameter and about nine feet long. The module and the airlock together occupy less than one-third the length of the Orbiter's payload bay, leaving ample room for primary experiments.



STS-77 Endeavour clears tower, Sunday, May 19, 3:30 a.m. PDT.

The Spacehab module will carry twelve payloads

on flight STS-77 in the areas of biotechnology, electronic materials, polymers and agriculture. The Goddard Space Flight Center Spartan-207 satellite will be deployed to test the Inflatable Antenna Experiment, which will lay the groundwork for future technology development in inflatable space structures.

Other in-flight experiments include the Global Positioning System Attitude and Navigation Experiment to determine to what accuracy the GPS can supply attitude information to a space vehicle; the Vented Tank Resupply Experiment to test improved methods for in-space refueling; and the Liquid Metal Thermal Experiment to evaluate performance of liquid metal heat pipes in microgravity conditions. Also, a Passive Aerodynamically Stabilized Magnetically Damped Satellite payload will demonstrate the principle of aerodynamic stabilization in the upper atmosphere. Cameras on the Shuttle will record PAMS satellite as it is deployed and track its movements. cas

The Festival at the Lake

will be held from Friday, 7 June through Sunday, 9 June. This year there has been a major reorganization with activities split between two downtown Oakland locations. All Kids activities will remain in Lakeside Park, but in a location out on the point just above the lake. Once again the EAS will help bring Chabot to the attention of the public as we show people the Sun and otherwise assist with the Chabot Observatory & Science Center booth. Mike Reynolds has ordered a T-scanner so we should be able to provide hydrogen-alpha views of the Sun. This portion of the Festival will be open from 11 a.m. to 7 p.m. each day. Volunteers are needed to help out on all three days. Carter Roberts will again be coordinating this activity. If you would like to help out, contact him at (510) 524-2146 or (415) 329-5319 or see him at the EAS lecture meeting on 1 June. Bringing science to the public is always a satisfying experience. Note that this year there will only be one COSC booth with all activities from the previous two booths combined there.

Dave Barry: Wild but fuzzy view of comet-watching

I guess everybody wants to hear about how I almost got killed by a possibly supernatural being. This happened about a month ago, and I blame Comet Hyakutake.

Comet Hyakutake was, of course, the most recent spectacular, breathtaking, once-in-a-lifetime astronomical event that nobody could see except astronomers. Every few years, when they figure we've forgotten the last alleged comet, the astronomers get together at a big party sponsored by the Telescope and Binocular Manufacturers Association, and after several hours of drinking gin straight out of bottles they "discover" a new comet, which they predict will be an awesome display of celestial fireworks clearly visible from inside closed refrigerators.

And, of course, we in the news media, ignoring the fact that nobody ever saw any of the previous "comets," write breathless front-page stories about the new one, including instructions on how to locate it in the sky, knowing full well that neither we nor our readers have the vaguest idea about how to find celestial bodies.

But people try to see the comet anyway. They stand out in the dark for hours, looking hopefully in random directions, ultimately to be rewarded, if they're lucky, with a spectacular, breathtaking, once-in-a-lifetime view of a bug walking across the lens of their newly purchased telescope or binoculars.

In search of the comet

My point is that we've been burned so many times that anybody who bought into the Comet Hyakutake hype had to be a total moron. Like me, for example.

I can't explain it. One minute I was reading the comet story in the Miami Herald, and the next minute, like Charlie Brown getting suckered into trying to kick the football yet another time, I was saying to my son: "Rob, let's go see the comet!"

So that night we drove way out into the Everglades, which the Herald article said would be a good place for comet-viewing because it's away from Miami, with its bright lights, shiny

jewelry, gunfire, etc. We pulled off the highway onto an overgrown dirt road, and after a short way we stopped and got out.

It was very dark and as I stood and gazed up at the vast, star-studded universe, I was struck by a question that has tantalized the human race for thousands of years.

"Rob," I said, "do you think there are alligators around here?"

"Why do you think I'm on the roof of the car?" he replied.

You know how when you're in the wilderness at night, you get to thinking that wild animals are watching you? I was definitely getting that feeling. And I wasn't worried about just alligators; the Everglades is also a popular stomping ground for snakes, spiders, panthers, and sharp billed birds that could wade up behind a person in the dark and peck him until he bled to death from his ankles.

I knew these animals were out there, because every now and then, one of them would scream. I don't know why they were screaming; perhaps they just found out they were on the endangered species list. Or perhaps they simply enjoyed making me nervous.

First panther: Look! Another moron trying to see the alleged "comet." Make that noise you make, Ralph.

Second panther: OK, here goes: AIEEEEEEEEE!!!

First panther: Good one! He's climbing onto the car roof with his son!

I'll tell you what else I started thinking about: the goatsucker. You may have read about the goatsucker: This is a fanged, reptilian, red-eyed creature that sucks all the blood out of goats and other barnyard animals. It was first reported in Puerto Rico, where it is known as Chupacabras, which is Spanish for "attorney."

No, seriously, it's Spanish for "goatsucker," and some people are claiming that it's responsible for recent animal deaths in the Miami area. (Sooner or later, everybody comes to Miami, and I include Madonna in that statement.) The scientific community insists that it's just a dog, but of course the scientific community also claims that it can see comets, so I'm leaning toward the goatsucker theory.

Anyway, there we were, in the dark, surrounded by screaming animals, and I will frankly admit that Comet Hyakutake was no longer our highest priority.

"There it is!" I said, pointing to a smudge in the sky that could have been a breathtaking, once-in-a-lifetime astronomical event, or a moth.

"Yes!" agreed Rob, and after allowing it to take our breath away for maybe 12 seconds, we climbed down off the roof and got into the car (Rob did this without ever touching the ground) and motored back toward the friendly twinkling muzzle flashes of Miami.

Just so you know: Astronomers are already promoting the next alleged comet, which is scheduled to arrive in 1997 and which they are calling—and I am not making this up—Comet Hale-Bopp. I have already seen a breathless news story that says, "Some astronomers predict its amazing glow will light up the Earth's night sky."

Maybe so. Maybe there really is a comet; maybe you should go out and look for it. All I'm saying is, wear garlic.

Dave Barry, syndicated through Tribune Media Service.

Comet Comments *By Don Machholz*

Comet Hale-Bopp (C/1995 O1) and Periodic Comet Kopff are within a few degrees of each other in the southern morning Milky Way. Both should be visible in binoculars. Much fainter is Periodic Comet Schwassmann-Wachmann 1, which often shines at magnitude 16. It has recently outburst, attaining magnitude 11. Try to get out to see it before it fades. You'll find it in the evening sky, south of Regulus.

I have published an 84-page guide describing comets, and Comet Hale-Bopp in particular. This book provides observing hints, suggests special projects, and uses 60 maps to help anyone find the comet on any night through 1998. It is available by mail for only \$12 plus \$2 for shipping and handling; California sales tax is \$0.87. Order *An Observer's Guide to Comet Hale-Bopp* from MakeWood Products, P.O. Box 1716, Colfax, CA 95713, or charge your order by Visa or MasterCard at (916) 346-8963. Another of my books, *Messier Marathon Observer's Guide* is also available for the same price.

Date (00UT)	R.A. (2000)	Dec.	Elong.	Sky	Mag.
C/1995 O1 (Hale-Bopp) [Sagittarius-Scutum]					
05-27	19h32.5m	-15°11'	133°	M	7.1
06-01	19h28.6m	-14°44'	139°	M	6.9
06-06	19h24.2m	-14°17'	144°	M	6.8
06-11	19h19.3m	-13°50'	150°	M	6.7
06-16	19h13.8m	-13°21'	155°	M	6.6
06-21	19h07.8m	-12°52'	161°	M	6.5
06-26	19h01.5m	-12°23'	165°	M	6.4
07-01	18h54.7m	-11°53'	168°	M	6.3
22P/Kopff [Sagittarius]					
05-27	19h02.4m	-15°46'	140°	M	7.7
06-01	19h07.2m	-15°52'	144°	M	7.5
06-06	19h11.2m	-16°00'	148°	M	7.2
06-11	19h14.6m	-16°14'	152°	M	7.4
06-16	19h17.2m	-16°33'	156°	M	7.1
06-21	19h19.2m	-16°58'	160°	M	7.0
06-26	19h20.7m	-17°28'	165°	M	7.0
07-01	19h21.7m	-18°03'	169°	M	6.9
29P/Schwassmann-Wachmann 1 [Sextans]					
05-27	10h18.5m	+05°15'	89°	E	12?
06-01	10h19.8m	+05°09'	84°	E	12?
06-06	10h21.4m	+05°01'	80°	E	12?
06-11	10h23.1m	+04°52'	75°	E	12?
06-16	10h25.0m	+04°42'	71°	E	12?
06-21	10h27.0m	+04°31'	67°	E	12?
06-26	10h29.3m	+04°18'	63°	E	12?
07-01	10h31.7m	+04°05'	59°	E	12?

Elements for C/1995 O1 (Hale-Bopp):

Perihelion: 0.9140971 AU [1997 04/01.14561]; Arg. (2000): 130.59227°

Ascending node(2000): 282.47087° Eccentricity: 0.9950784
Inclination (2000): 089.42807° Orbital period: 3000 years

Elements for 22P (Kopff):

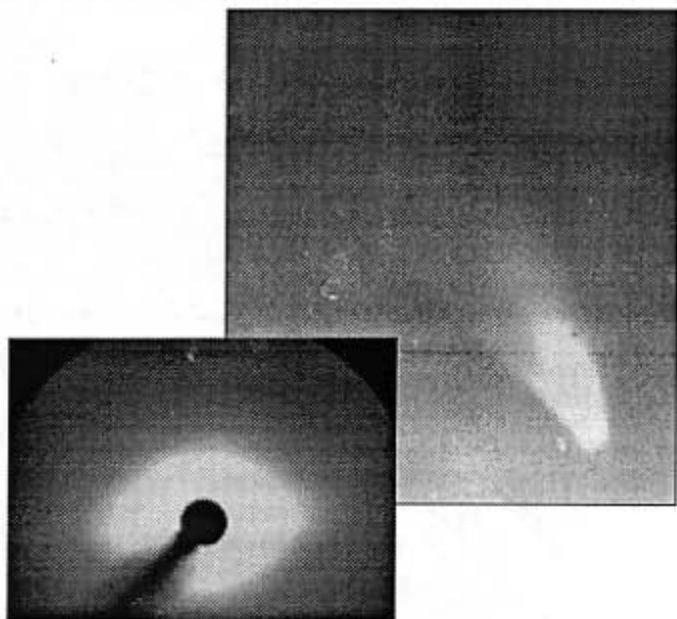
Perihelion: 1.5795617 AU [1996 07/02.19980]; Arg. (2000): 162.83487°

Ascending node(2000): 120.91329° Eccentricity: 0.5440739
Inclination (2000): 004.72143° Orbital period: 6.45 years

Elements for 29P (Schwassmann-Wachmann 1):

Perihelion: 5.7484583 AU [1989 09/09.63574]; Arg. (2000): 046.24130°

Ascending node(2000): 312.82689° Eccentricity: 0.0440579
Inclination (2000): 009.38499° Orbital period: 14.75 years



Two More Looks at Hyakutake

have been captured by the LASCO coronagraph aboard the SOHO spacecraft. The comet view at right was taken in white light on May 2, one day following perihelion.

On May 1 there was a coronal mass ejection (CME) seen while Comet Hyakutake was also in the field of view. This provided a spectacular single image of a comet against the background of an explosive solar event in which hot gases are expelled and accelerated by the corona's magnetic field to travel through the interplanetary medium. A strong reaction between such a solar cloud and particles of the comet's tail is expected when Hyakutake crosses the Sun's equatorial plane. This image was created by subtracting an image prior to the CME from one during the CME.

The Large-Angle Spectroscopic Coronagraph is operated by the Naval Research Laboratory, the Max Planck Institute, the University of Birmingham, and the Laboratoire d'Astronomie Spatiale. Please see the story on page 1.

As the comet speeds away from the Sun it has been reported seen from Loomberah, Australia. On the morning of 10 May it demonstrated no tail, but its small coma did shine with a magnitude about 3.

Articles and photos for *The Refractor* are encouraged. Deadline for the July issue is June 19, 1996. Items may be submitted by mail to the editor, Ellis Myers, 215 Calle La Mesa, Moraga, CA 94556. Files on disk should be ASCII PC format, 3.5-inch 1.4M. Internet e-mail address is emyers@a.crl.com. For further information please call (510) 284-4103. Note the e-mail address has changed.

DATELINE JUNE

- 26 1730 Charles Messier, born
29 1868 George Ellery Hale, born, founder of Yerkes,
Mt. Wilson and Palomar Observatories
1 1888 Lick Observatory dedicated
3 1948 Hale 200-inch telescope dedicated at Palomar
16 1963 Soviet Vostok 6, Valentina Tereshkova, first
woman in space
18 1983 First American woman in space, Sally Ride
1 1996 Full Moon, 13:48 PDT - 20:48 UT
8 1996 Last Quarter Moon, 04:06 PDT - 11:06 UT
15 1996 New Moon, 18:37 PDT - 01:37 UT 16 June
20 1996 Summer Solstice, 19:23 PDT - 02:23 UT 21 June
23 1996 Mercury, Venus $1\frac{1}{2}^\circ$ apart in morning sky
23 1996 First Quarter Moon, 22:23 PDT - 05:23 UT 24 June
30 1996 Blue Moon, 20:58 PDT - 03:58 UT 1 July

UPCOMING EVENTS

- 1 June. EAS lecture meeting.
Philip Scherrer. Peeking into the Sun.
13 June. EAS board meeting.
15 June. NCHALADA. Chabot.
7-9 June. Festival at the Lake.
22-23 June. Astronomical Society of the Pacific.
Universe '96. Santa Clara.
6 July. EAS lecture meeting.
10 August. Fremont Peak Star-B-Que.
18 October. COSC Ground-breaking, 10 a.m.
19 October. Astronomy Day.

Planetarium shows at Chabot. Fridays and Saturdays, 7:30 p.m.
Information, (510) 530-5225.

The Dark of Night
The Sky Tonight
Convicted by the Sun,
Acquitted by the Moon

June

1	7	8	14	15	21	22	28	29

The next meeting of
NCHALADA
Saturday, 15 June, 9:30 a.m.-5:00 p.m.
at Chabot Observatory

The Aether and Its Many Uses

Observatories as Planned and Built



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