



The Refractor

The Bulletin of the Eastbay Astronomical Society

Founded in 1924 at Chabot Observatory, Oakland, California

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Pluto and Its Companions at the Edge of the Solar System

9 July, 7:30 p.m.

Chabot Administration Building
4917 Mountain Boulevard, Oakland

Dr. Dale P. Cruikshank

NASA Ames Research Center

NASA is currently planning a mission to Pluto in which two small spacecraft will be launched in 1999 or 2000, to fly by the planet and its satellite Charon in the year 2007. This mission will complete the preliminary reconnaissance of all the planets in the Solar System, and will open a window on an extraordinary planet-satellite system. Meanwhile, Earth-based studies of Pluto and Charon continue, with new discoveries related to the planet's atmosphere and the ices on its surface.

Other very new discoveries of small bodies in Pluto's region of the Solar System suggest a population of organic-rich bodies called the Kuiper Belt Planetesimals. These are related to the comets and to the icy planetesimals from which Pluto, Charon, Triton, and other bodies formed.

In his presentation, Dr. Cruikshank will review our latest results on Pluto and its satellite (and the Pluto Fast Flyby mission), as well as the current understanding of the organic-rich asteroids Pholus and 1992 QB1.

Dale Cruikshank is an astronomer in the Astrophysics Branch at NASA's Ames Research Center. He completed his graduate studies at the University of

Arizona, with a Ph.D. in 1968. He came to NASA six and a half years ago, after 17 years on the faculty of the University of Hawaii. His principal research interests are on the small bodies of the Solar System, including the mineralogical compositions of the asteroids, the ices of Pluto, Triton, comets, and the organic-rich bodies of the outer Solar System. Cruikshank is an Associate Editor of *Icarus*, and is the editor of a University of Arizona Press book, *Neptune and Triton*, soon to appear.

Join us for

DINNER WITH THE SPEAKER

prior to the meeting

5:30 p.m., 9 July 1994

PEARL OF SIAM RESTAURANT

5498 College Avenue (510 / 420-8600)

Oakland (2½ blocks from Rockridge BART)

Please call Betty Neall at 510 / 533-2394 before Friday 8 July to confirm your place at dinner. But you're welcome to come anyway, everyone will have a fine Thai dinner and you'll enjoy meeting with Dr. Cruikshank and talking to your colleagues. Come! Eat! Enjoy!

Coming July 16 to a Planet Near You

For five days in July, fragments of Comet Shoemaker-Levy 9, discovered in March 1993, will collide with the planet Jupiter. It is not the first time that a comet has hit another Solar System object, but it is the first time that such a meeting has been predicted and then observed.

The comet was probably very normal until it passed about 16000 miles from the cloud tops of Jupiter on July 7, 1992. This placed it in orbit around Jupiter, it also fragmented it into several pieces. At discovery nine months later, it appeared as a "string of pearls". Even now, the comet is continuing to evolve, some of the pieces have further divided, others have disappeared.

It is presently unknown what effect these fragments will have on the planet Jupiter. They will hit the planet, which is eleven times larger in diameter than Earth (with over 300 times the mass of Earth), at 37 miles per second. But the pieces are rather small, no larger than three miles in diameter and may be similar to lightly-packed snowballs.

Continued on page 2



For Your Eyes Only

Take your binoculars into the darkest sky you can find on a clear midnight in July and look to the south to find the constellation Sagittarius. Whether the Archer is shooting an arrow into the heart of Scorpius, or whether the Teapot is pouring boiling water over the arachnid's sting, either way the scorpion is in big trouble. Southernmost of the zodiacal constellations, Sagittarius has two asterisms that easily identify it. Although in traditional mythology in many cultures it is associated with a bow and arrow, the more common modern cue to this constellation is the Teapot formed by the central stars. The stars in the handle of the teapot, together with Kaus Borealis at the top of the dome, comprise the Milk Dipper. The Milky Way runs through the western portion of Sagittarius, and the center of our Galaxy lies just inside the boundary of the constellation west of the Teapot's spout.

It is unfortunate for those of us living in California that we cannot look at Sagittarius in the same way that one can observe its glory from Yulara, Australia, for example. For in the southern hemisphere, this constellation is high overhead in July, August and September in the evening hours, and the beauty of the star clusters and nebulae dominates the heavens. Fifteen Messier objects are home in Sagittarius, including M8, the Lagoon Nebula, subject of Nancy Cox's Hubble Space Telescope project as described in the last two issues of *The Refractor*. You should be able to find the Lagoon Nebula with a small telescope or binoculars at Declination $-24^{\circ}23'$, R.A. 18h03.8m. A major feature of Sagittarius, a large cloud of glowing hydrogen associated with a star cluster, M8 may even be seen with the unaided eye from a dark-sky site.

Perhaps a little easier to see is the smaller M17, the Horseshoe Nebula, also called the Swan Nebula. Another

COSC Opens Member Program

The Chabot Observatory and Science Center has announced its first-ever membership drive, which will offer a way for the community to support the Center's on-going programs. In particular, people will have the opportunity to contribute in a meaningful way to the development of the new facilities. The membership program will be launched with a very big carrot for donors. Those who join during 1994 will be Founding Members with a number of privileges otherwise unavailable. EAS members are particularly encouraged to join at this time, so they can demonstrate their continuing interest in science education.

New members of COSC will receive an exclusive invitation to the special events planned for the Jupiter-Comet collision-watch in July. Of particular interest will be the satellite-feed from NASA from the dark-side of the planet. Founding Members will also receive a quarterly newsletter, a membership card and pin, free admission to the Science Center, Starry Nights Gift Shop discounts, and invitations to special events. Memberships are available at several levels: Individual, \$25; Family, \$35; Student under age 18, \$7.50; Teacher, \$20. Memberships at higher levels, from \$100 to \$1000 and more, will benefit from additional incentives, such as lunches with the Directors, and a selection of private special events.

Comet Shoemaker-Levy 9 (From page 1)

Jupiter will be situated high in the south at evening twilight, setting around midnight local time. Observers are encouraged to watch Jupiter, even during daylight, at the times of collision and for the hours afterwards. The comet will approach from the south, and hit Jupiter at about -44 degrees (south) latitude. For comparison, the Red Spot is at -20 degrees. The impact points will not be visible from Earth; they will be just beyond the rising edge.

major object is M22, a magnificent globular cluster of tenth-magnitude stars, so compact that they can be seen in almost any telescope. M55 is an outstanding cluster of thousands of faint stars. Double stars in Sagittarius include Beta and Mu, while Zeta is a triple and Eta a quadruple.

This month both Uranus and Neptune can be found in Sagittarius. These planets can both be observed with a small telescope or with binoculars, if you know fairly well where to look. In fact, because Uranus is at opposition and thus favorably placed for viewing, and because it shines at a magnitude of 5.6, it may even be visible to the naked eye from a dark site. Identify it by its tiny blue-green disk.

A Short Story of an Eclipsed Eclipse

By Ellis Myers

Some months ago I decided to combine a trip to see the 10 May 1994 annular eclipse with an Elderhostel experience. My wife and I had been on several of these study courses before and I had even written an article linking Elderhostel and astronomy, which appeared in

Sky & Telescope [February 1991]. Scanning the catalog, we found a location at Carlsbad, New Mexico, within the path of annularity and less than an hour's drive from the midline. Sponsored by the New Mexico Community Foundation, the program included Caves: Chambers of Wonders, Native Peoples in the Chihuahuan Desert, and Remembering Frontier New Mexico. We signed up.

"Aha!" my wife exclaimed, "I'll bet they schedule the field trip to the caverns on Tuesday!" "Oho!" I returned, "They couldn't possibly!" We called the coordinator: "What eclipse?" she asked. "Yes, the bus to Carlsbad Caverns will leave at 9 a.m. Tuesday. The group will take the 10 a.m. tour." [Annularity would be at 10:12!]

At the orientation session on Sunday, the eclipse was discussed, and I admonished the group on safety requirements for viewing. When asked how many wanted to delay the cave tour so they could watch the eclipse, only one couple expressed any interest. I had scared them by suggesting the possibility of blindness without a proper solar filter. But, as we shall see, that was not to be a factor.

After a beautiful Monday morning with a clear and warm deep-blue Southwestern sky, the afternoon brought clouds, and the evening brought thunder and lightning. On Tuesday we awoke to a cloudy and threatening morning, but, undaunted, we drove north to our chosen vantage point near Roswell to be ourselves directly in syzygy with Earth, Moon and Sun. Along the way our windshield wipers were intermittently busy, then more so. We arrived at a rest stop along Highway 285 about an hour before annularity. We set up our 3-inch Oracle scope at the edge of a ramada. About 20 cars were there too, and license plates showed that astronomy buffs had driven from as far as Oregon and Ontario to see this impending phenomenon.

The sky darkened—because the clouds were black, and not because the Sun's light was demonstrably diminished. There were cries of "There's a hole in the clouds—there it is!" I clicked off a few frames with the camera. But the Sun was only three-quarters covered. We waited.

From the field of desert scrub we heard the melodious song of a Western Meadowlark. No other birds were curious enough to join our gathering.

The Biggest Collision in History

The Rotary-Chabot Planetarium has been capturing and captivating large audiences with its recent show *The Biggest Collision in History*. It's a show you won't want to miss, but you'd better hurry, because the collision that's being talked about is the one beginning July 16 when Comet Shoemaker-Levy 9 will encounter Jupiter. There are lots of questions about exactly what can be expected, and planetarium director Norm Sperling has written and produced a program that aims to answer some of those questions.

Nominal show times for the planetarium are Friday and Saturday evenings at 7:30, and the presentations are followed with the opportunity for sky viewing through the telescopes of Chabot Observatory. However, because of the imminent event and the great interest about it, additional shows will be given. As interest continues, *The Biggest Collision in History* will be presented each night during the week of July 11, and on at least until the end of July. Call Starline at (510) 530-5225 for recorded information about this show and other presentations. Tickets are on sale at 7 p.m. at the Starry Nights Gift Shop, or can be ordered in advance by telephone. Call (510) 530-3480 and charge by VISA or MasterCard. Prices are \$4 for adults, \$2.50 for students age 6-17. EAS members receive free admission.

Fraknoi's Catastrophes

A program entitled *Cosmic Catastrophes: Colliding Comets, Exploding Stars, and Cannibal Galaxies* with astronomer and popular lecturer Andrew Fraknoi will be offered Sunday, July 3, at 2:30 and 7:30 p.m. in the Main Theater at Foothill College. The nontechnical program will be illustrated with images from the Hubble Space Telescope and from other sources. Admission is \$10 adults; \$8 seniors and students; \$6 children. For information or for reservations, call (415) 948-4444. Foothill College is at 12345 El Monte Road in Los Altos Hills.

Andrew Fraknoi will preview the collision of Comet Shoemaker-Levy 9 with Jupiter and discuss what such impacts have meant for the development of all the planets. Then he will turn to even larger examples of cosmic violence, including supernovae and cannibal galaxies. No background in science or math will be assumed, and everyone over age 13 is cordially invited.

Another black cloud approached from the south, and I optimistically knew that it would pass by before annularity was ended. It didn't. At the exact moment of second contact, the clouds let loose. We had lost the race.

Only the Meadowlark seemed cheerful.

A Quarter Century of Progress

In May, 1961, President John F. Kennedy stated "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing [a man] on the Moon and returning him safely to Earth." In July 1969

the crew of Apollo 11 brought that pledge to fulfillment. Neil Armstrong's "small step for a man" was not only a giant leap for mankind, but it was indeed a symbol of Kennedy's goal, which he had outlined: "Now is the time to take longer strides—time for a great new American enterprise—time for this nation to take a clearly leading role in space achieve-

ment, which in many ways may hold the key to our future on Earth." The Apollo 11 venture was as clearly a reiteration of Robert Goddard's philosophy: "Aiming at the stars, both literally and figuratively, is the work of generations, but no matter how much progress one makes there is always the thrill of just beginning."

At 06:32 PDT on 16 July 1969 a Saturn 5 lifted the Apollo 11 spacecraft into a temporary orbit 115 miles above the Earth's surface. Then, at a perfectly timed moment, the S-4B stage ignited for 5.9 minutes to boost the velocity of the vehicle to 24,300 miles per hour on a trans-lunar trajectory. After coasting toward the Moon for 4 and a half days, the spacecraft entered a lunar orbit 62 to 75 miles above the surface. Then, with the lunar module Eagle detached from the command module Columbia, Armstrong and Aldrin fired their descent-stage rocket engine, heading for their touchdown site in the Sea of Tranquility at a reduced speed of about 60 miles per hour. At an altitude of 450 feet, the astronauts took manual control in order to select carefully a precise landing spot, avoiding hazardous, rocky areas. The Eagle had landed at 13:17:41 PDT. Because of post-landing checkout and the time needed to put on life-support backpack systems in the tiny Eagle, it was not until 07:56:20 PDT when Armstrong first set his boots on the Moon.

The astronauts executed several duties during their short, 21½ hour stay, including collecting rock and soil samples and setting up three scientific experiments. One of these experiments consisted of deploying an array of 100 reflectors whose purpose was to bounce laser beams from Earth stations, providing accurate data concerning the Moon's position with respect to Earth. The experiment was successful; within a few days, Lick Observatory had pinpointed the landing site, using the 120-inch reflector.

Following a smoothly executed, but complicated, liftoff and rendezvous maneuver, Armstrong and Aldrin rejoined Collins in Columbia, then jettisoned Eagle and began their homeward trek. They splashed down in the Pacific Ocean 900 miles southwest of Hawaii on 24 July.

They were greeted aboard the carrier Hornet by President Richard Nixon. From Hawaii, the trio and their Moon samples were flown to Houston, where they were quarantined for 21 days safeguarded against the remote possibility of lunar bacteria.

This month marks the 25th anniversary of the excitement of the Apollo 11 success and

we can be reflective of what a generation of space exploration has meant to our world.

The Planets in July

Mercury	Gemini	Before dawn
Venus	Leo	Evening sky
Mars	Taurus	Morning sky
Jupiter	Virgo	All night
Saturn	Aquarius	Rises late evening
Uranus	Sagittarius	All night
Neptune	Sagittarius	All night
Pluto	Libra	All night

Japan Joins US in Space

NASA's STS-65 is scheduled for launch on Friday, July 8, aboard Columbia. The mission is the International Microgravity Laboratory and will conduct more than 80 science experiments during the two-week flight. Thirteen nations are represented in the studies, which include effects of weightlessness on humans, animals and plants, and also crystal growth experiments related to protein structure and to metallurgy. Among the seven member crew, led by Commander Richard Hieb, is Japan's first woman astronaut, Chiaki Mukai, a cardiologist, will serve as payload specialist.

The orbit for Columbia will achieve an altitude of 184 miles at an inclination of 28.45 degrees. The mission is expected to land on July 22 at Kennedy Space Center.

Take a Peek at Fremont Peak

August heralds another fantastic social event for all amateur and professional astronomers and their families as the Astronomical Association of Northern California, together with the Fremont Peak Observatory Association, hosts a Star-B-Que at Fremont Peak. We will have more information in next month's issue of *The Refractor*, but for now keep open the weekend of August 13th for this popular event.

The barbeque will keep everyone well satisfied in the late afternoon on Saturday, in preparation for the star party in the evening, featuring the 30-inch telescope and clear, bright skies. This will be a great time to meet other astronomy enthusiasts and compare telescopes, or just to gaze at the stars from this remarkable site.

Comet Comments *By Don Machholz*

Comet Mueller (1993p) has dimmed by three magnitudes recently. Periodic Comet Brooks 2 (1994j) was recovered in early May by both A. Nakamura and T. Seki of Japan. Then at magnitude 18, the comet should brighten to magnitude 14 by October. The orbital period is 6.9 years. On May 14 Carolyn Shoemaker discovered another comet on films exposed through the 0.46-meter Schmidt at Mt. Palomar. Comet Shoemaker 4 (1994k) has an orbital period of 15.5 years and will reach perihelion in late October at 2.92 AU. It will not get much brighter.

Date (00UT)	R.A. (2000)	Dec.	Elong.	Sky	Mag.
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Periodic Comet Shoemaker-Levy 9 (1993e Nucleus 8)

06-28	14h08.7m	-12°29'	118°	E	13.7
07-01	14h08.9m	-12°27'	115°	E	13.7
07-04	14h09.2m	-12°25'	113°	E	13.7
07-07	14h09.7m	-12°24'	110°	E	13.7
07-10	14h10.2m	-12°23'	107°	E	13.7
07-13	14h11.0m	-12°22'	104°	E	13.7
07-16	14h11.8m	-12°21'	102°	E	13.7

Nucleus #8 will collide with Jupiter, July 20.64 UT.

Periodic Comet Tempel 1

06-27	13h30.0m	-07°32'	108°	E	8.9
07-02	13h38.4m	-09°33'	106°	E	9.0
07-07	13h47.6m	-11°33'	104°	E	9.1
07-12	13h57.5m	-13°31'	103°	E	9.1
07-17	14h08.1m	-15°37'	101°	E	9.2
07-22	14h19.3m	-17°19'	99°	E	9.4
07-27	14h31.2m	-19°06'	98°	E	9.5
08-01	14h43.6m	-20°49'	96°	E	9.6

Periodic Borrelly

06-27	02h20.5m	-16°48'	72°	M	13.3
07-02	02h32.2m	-16°07'	73°	M	13.0
07-07	02h44.1m	-15°24'	74°	M	12.7
07-12	02h56.1m	-14°40'	75°	M	12.5
07-17	03h08.2m	-13°57'	76°	M	12.2
07-22	03h20.3m	-13°13'	78°	M	11.9
07-27	03h32.6m	-12°30'	79°	M	11.6
08-01	03h45.0m	-11°44'	80°	M	11.4

Comet McNaught-Russell (1993v)

06-27	14h53.1m	+59°02'	87°	E	11.7
07-02	15h02.8m	+56°43'	88°	E	11.9
07-07	15h11.7m	+54°24'	88°	E	12.2
07-12	15h20.1m	+52°06'	89°	E	11.9
07-17	15h28.1m	+49°51'	89°	E	12.2
07-22	15h35.7m	+47°38'	89°	E	12.4
07-27	15h43.2m	+45°28'	89°	E	12.6
08-01	15h50.5m	+43°21'	89°	E	12.8

Here are given the latest available predicted times for collision of the various fragments of Comet Shoemaker-Levy 9 with the planet Jupiter.

Nucleus Number	Identity Letter	Collision Time (PDT)	Collision Position on Meridian (PDT)
21	A	July 16, 12:55	July 16, 15:48
20	B	July 16, 20:07	July 16, 22:59
19	C	July 16, 23:58	July 17, 02:50
18	D	July 17, 04:17	July 17, 07:08
17	E	July 17, 08:36	July 17, 11:28
16	F	July 17, 17:43	July 17, 20:36
15	G	July 18, 00:55	July 18, 03:45
14	H	July 18, 12:41	July 18, 15:31
12	K	July 19, 03:34	July 19, 06:22
11	L	July 19, 15:34	July 19, 18:22
9	N	July 20, 03:19	July 20, 06:09
8	P	July 20, 08:22	July 20, 11:12
7	Q	July 20, 13:10	July 20, 15:58
6	R	July 20, 23:00	July 21, 01:45
5	S	July 21, 08:50	July 21, 11:35
4	T	July 21, 11:14	July 21, 13:58
2	V	July 21, 21:05	July 21, 23:48
1	W	July 22, 01:38	July 22, 04:20

Comet Takamizawa-Levy (1994f)

06-27	12h03.4m	+51°55'	69°	E	10.2
07-02	11h52.7m	+48°23'	65°	E	10.4
07-07	11h45.5m	+45°19'	61°	E	10.7
07-12	11h40.7m	+42°39'	57°	E	10.9
07-17	11h37.4m	+40°19'	53°	E	11.2
07-22	11h35.3m	+38°16'	49°	E	11.4
07-27	11h34.0m	+36°26'	45°	E	11.6
08-01	11h33.4m	+34°48'	41°	E	11.8

Comet Takamizawa (1994i)

06-27	12h28.4m	-13°18'	97°	M	10.8
07-02	12h17.7m	-13°40'	90°	M	11.0
07-07	12h09.1m	-14°03'	83°	M	11.2
07-12	12h02.2m	-14°26'	77°	M	11.3
07-17	11h56.7m	-14°51'	72°	M	11.5
07-22	11h52.4m	-15°18'	66°	M	11.6
07-27	11h49.0m	-15°46'	61°	M	11.7
08-01	11h46.4m	-16°15'	57°	M	11.8

Articles and photographs are welcomed for *The Refractor*. Deadline for the August issue is July 18, 1994. 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, for 3.5-inch 1.4M or 5.25-inch 360k. Internet e-mail address is emyers@crl.com. For further information please call (510) 284-4103.

DATELINE JULY

- 4 1054 Chinese record supernova, precursor to Crab Nebula
6 1687 Isaac Newton published *Principia*
18 1921 John Glenn, born Cambridge, Ohio
16 1969 Apollo 11 launched. Neil A. Armstrong, Edwin E. Aldrin, Jr., Michael Collins.
20 1969 Neil Armstrong and Buzz Aldrin, first men on the Moon
20 1976 Viking 1 landed on Mars
- 8 1994 New Moon, 14:37 PDT = 21:37 UT
5 1994 Crescent Moon 0.3° south of Mars, 22:00 PDT
15 1994 First Quarter Moon, 18:12 PDT = 01:12 UT 16 July
16 1994 First fragment of Comet Shoemaker-Levy 9 to strike Jupiter, 12:55 PDT = 19:55 UT
22 1994 Last fragment of Comet Shoemaker-Levy 9 to strike Jupiter, 01:38 PDT = 08:38 UT
22 1994 Full Moon, 13:16 PDT = 20:16 UT
30 1994 Last Quarter Moon, 05:40 PDT = 12:40 UT

UPCOMING EVENTS

- 8 July.** EAS Board Meeting.
9 July. EAS Lecture. **Pluto and Its Companions at the Edge of the Solar System.** Dr. Dale Cruikshank.
16-22 July. Expected impact of Comet Shoemaker-Levy 9 on Jupiter.
10 August. EAS Outreach, Bort Meadow.
13 August. AANC Star-B-Que, Fremont Peak.
27-28 August. Festival in Chinatown.
4 September. EAS Star Party, Fremont Peak.
10 September. EAS Lecture.
3 November. Total solar eclipse. South America.
17 November. Penumbral lunar eclipse.



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