



# The Refractor

The Bulletin of the Eastbay Astronomical Society

Founded in 1924 at Chabot Observatory, Oakland, California

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## Neutrino Astronomy

8 January, 7:30 p.m.

Administration Building of Chabot Science Center  
4917 Mountain Blvd., Oakland

Dr. Eric Norman, *Senior Staff Physicist*  
*Lawrence Berkeley Laboratory*

### The Sudbury Neutrino Detector: Looking at the Stars from the Bottom of a Mine

Most of what we know about the planets, stars and galaxies that make up our universe has been discovered through observations of electromagnetic radiation, *i.e.*, photons. Our eyes are sensitive to a very narrow band of the electromagnetic spectrum that we call the visible region. To extend our "vision" into regions we can't directly see, astronomers have built radio, infrared, x-ray and gamma-ray telescopes that detect photons of widely different wavelengths. Since photons are easily absorbed by matter, much of the universe is still shrouded from our view. For example, the light that comes to us from the Sun is emitted from its surface, while the sources of the Sun's energy are nuclear-fusion reactions which take place only at its hidden core. However, there is another type of radiation that is produced by many astronomical objects which is much more penetrating than the photon. This object is called the neutrino. Since neutrinos pass through matter so easily, observations of neutrinos allow us to look directly into the centers of stars. In the last thirty years, a new branch of astronomy has developed to study these elusive particles. In this talk, Dr. Norman will review the observations that have already been made in the field of neutrino astronomy and will discuss plans for future neutrino telescopes.

Dr. Norman is a local product, graduated from Skyline High School in 1968. He received his AB at Cornell in 1972 and his MS and PhD from the University of Chicago in 1978. He was an assistant professor at the University of Washington from 1978 to 1983 and at Seattle University 1983-84. Since then he has been a Divisional Fellow and Senior Staff Physicist at Lawrence Berkeley Laboratory where he attempts to molest neutrinos.

There will be no dinner with the speaker before this month's lecture meeting. Please remember that our new starting time is

**7:30 p.m.**

During the portion of the meeting before introduction of Dr. Eric Norman, our guest speaker, Alan Gorski will present a video of the recent lunar eclipse.

*"The conversion of hydrogen into helium in the center of the Sun not only accounts for the Sun's brightness in photons of visible light; it also produces a radiance of a more mysterious and ghostly kind: The Sun glows faintly in neutrinos, which, like photons, weigh nothing and travel at the speed of light. But neutrinos are not photons. They are not a kind of light. Neutrinos, like protons, electrons and neutrons, carry an intrinsic angular momentum, or spin, while photons have no spin at all. Matter is transparent to neutrinos, which pass almost effortlessly through the Earth and through the Sun. Only a tiny fraction of them is stopped by the intervening matter. As I look up at the Sun for a second, a billion neutrinos pass through my eyeball. Of course, they are not stopped at the retina as ordinary photons are but continue unmolested through the back of my head. The curious part is that if at night I look down at the ground, toward the place where the Sun would be (if the Earth were not in the way), almost exactly the same number of solar neutrinos pass through my eyeball, pouring through an interposed Earth which is as transparent to neutrinos as a pane of clear glass is to visible light... But neutrino astronomy is very new. For the moment we stand amazed at having created a tool that can peer directly into the blazing heart of the Sun. As the sensitivity of the neutrino telescope improves, it may become possible to probe nuclear fusion in the deep interiors of the nearby stars."*

Carl Sagan in *Cosmos*.

### Little Neutral One

The late 1920s and early 1930s were years of exciting research in the physics laboratories around the world. Many discoveries were to be made, and people such as Millikan, Compton, Dirac, the Joliot-Curies, and Chadwick were there to make them. One problem of concern was that electrons emerging from radioactive decay possessed a spectrum of energies, rather than a single energy equivalent to the loss of mass in the reaction. In 1931 Wolfgang Pauli suggested the existence of a particle having energy but no mass or charge. It was Enrico Fermi who gave the name neutrino, Italian for "little neutral one."

### Event Horizons

Something like a Blue Moon! Two EAS meetings in one month. On 5 February the lecture will be presented by Hans De Moor. In talking about "How to Use Your Telescope" he may induce you to study the skies of winter with renewed enthusiasm. And on Saturday, 26 February 1994, the **EAS Annual Banquet** will celebrate our past (two days beyond our 70th anniversary) with a look to the future as Dr. Mike Reynolds describes "The New Chabot." The dinner will be at the Oriental Tea House in San Leandro. Plan now to enjoy a sumptuous Chinese buffet. We plan to begin gathering at 5:30 p.m. with dinner following at 6:00 p.m.

**Astroimage**, Saturday, 5 March 1994. This event combines the Astrophoto and Electronics Oriented Astronomy events that formerly took place on alternating years. It is to be an annual event, usually around the first Saturday of March with the date dependent on Moon phase. We have not been told exactly where this one will be located but it usually migrates between Fullerton and Thousand Oaks.

Deadline for the February issue of *The Refractor* is January 21, 1994. Items may be submitted by mail to the editor, Ellis Myers, 215 Calle La Mesa, Moraga, CA 94556 or by fax to (510) 841-1329. 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) 841-5702 (days), or (510) 284-4103 (evenings).

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## MESSAGES FROM THE BEYOND

*Sky & Telescope* reports that an amateur astronomer has discovered a bright nova in the constellation Cassiopeia. The erupting star first appeared on a photograph taken about 11:30 UT on December 7, but the discovery was not announced until after making a confirming observation on December 11. The star is currently magnitude 6½ but it was at least 3½ magnitudes fainter on a pre-discovery photograph made two days beforehand. As of the 16th, the nova's light was still around magnitude 6½. Located at RA 23h41.8m, Declination +57°31' in 2000 coordinates, this new star is about four degrees southwest of the bright star β-Cassiopeiae and well-placed for observing throughout much of the night.

### Comet Comments By Don Machholz

Four comets remain visible in our skies, one more was recovered: On November 20 during the course of the Second Palomar Survey, Jean Mueller discovered 1993s, Comet Mueller. An early orbit indicates it may brighten to magnitude 14 in more than a year. It has a perihelion distance of 2.3 AU.

Date (00 UT)	R.A. (2000)	Dec.	Elong.	Sky	Mag.
Comet Mueller (1993a)					
01-03	21h25.9m	+21~40'	58~	E	9.2
01-08	21h32.0m	+19~23'	53~	E	9.2
01-13	21h37.9m	+17~19'	49~	E	9.3
01-18	21h43.7m	+15~29'	44~	E	9.4
01-23	21h49.2m	+13~49'	40~	E	9.4
01-28	21h54.6m	+12~19'	36~	E	9.5
Comet Mueller (1993p)					
01-03	22h57.1m	-07~02'	60~	E	10.1
01-08	23h00.1m	-08~55'	55~	E	10.0
01-13	23h03.5m	-10~42'	50~	E	9.9
01-18	23h07.4m	-12~24'	46~	E	9.7
01-23	23h11.7m	-14~01'	41~	E	9.6
01-28	23h16.3m	-15~36'	37~	E	9.4
Periodic Comet Encke					
01-03	22h29.4m	+03~12'	59~	E	9.3
01-08	22h29.0m	+02~38'	53~	E	8.9
01-13	22h27.5m	+01~54'	48~	E	8.4
01-18	22h24.1m	+00~46'	41~	E	7.8
01-23	22h16.8m	-01~04'	34~	E	7.2
01-28	22h02.9m	-04~08'	25~	E	6.4
Periodic Comet Schwassmann-Wachmann 2					
01-08	08h39.1m	+17~26'	160~	M	11.0
01-13	08h36.5m	+17~49'	166~	M	11.0
01-18	08h33.5m	+18~15'	172~	M	11.0
01-23	08h30.2m	+18~42'	178~	M	10.9
01-28	08h26.8m	+19~09'	177~	M	10.9

## NASA Begins Development of First Asteroid-Orbiting Mission

NASA has begun full-scale development of the first spacecraft to rendezvous with and orbit an asteroid. The Near Earth Asteroid Rendezvous (NEAR) mission received funding [\$66.2 million] in the 1994 budget and will be the first in NASA's Discovery program of small-scale space exploration missions to be launched.

NEAR is scheduled for launch in February 1996 aboard a Delta 2 rocket with estimated arrival at the asteroid Eros in late December 1998. NEAR will orbit Eros for a year at altitudes as low as 15 miles (24 km). Eros will be the smallest solar system body ever orbited by a spacecraft. The mission offers scientists their first long-term, close-up look at an asteroid. The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland., will build and operate NEAR.

The mission's scientific goal is to determine Eros's size, shape, mass and magnetic field and to measure for the first time an asteroid's detailed composition and surface structure. Asteroids are thought to include debris left over from the earliest days of planetary formation 4.5 billion years ago. NEAR could answer import and ev new ap, Dr. Willia. NASA's Soli "This mission scientific quest do it far more co have in the past. logical advances and innovations in spacecraft and instrument design, as well as a new philosophy in robotic exploration of the solar system embodied in the Discovery program."

During its journey, NEAR will fly by a small Main Belt asteroid named Illya in August 1996. It also will swing by Earth for a gravity boost in January 1998. NEAR's instruments include an x-ray/gamma ray spectrometer, a magnetometer, a near infrared imaging spectrograph and a multi-color camera fitted with a CCD imaging detector capable of photographing details on Eros's surface as small as one meter in diameter. A laser altimeter is aboard to assist in spacecraft navigation.

This column is defective.

## DATELINE JANUARY

- 7 1610 Jupiter moons discovered, Galileo Galilei  
17 1706 Benjamin Franklin, born  
17 1786 Comet Encke first observed, Pierre Mechain, France  
1 1801 Ceres, first asteroid, Giuseppe Piazzi, Italy  
2 1920 Isaac Asimov, born Petrovichi, Russia  
31 1958 Explorer 1, first US satellite in orbit  
27 1967 Virgil (Gus) Grissom, Edward H. White, Roger B. Chaffee killed in Apollo spacecraft fire  
31 1971 Apollo 14, third Moon landing, Alan Shepard, Stuart Roosa, Edgar Mitchell  
12 1986 Columbia STS 61-C, Robert Gibson, Charles Bolden, Jr., George Nelson, Franklin Chang-Diaz, Steven Hawley, Robert Cenker, and Bill Nelson, first congressman in space  
28 1986 Challenger STS 51-L, Francis (Dick) Scobee, Michael Smith, Ronald McNair, Ellison Onizuka, Judith Resnik, Gregory Jarvis, Sharon Christa McAuliffe; exploded 73 seconds after liftoff  
3 1994 Quadrantid meteor shower peak  
4 1994 Last Quarter Moon, 16:00 PST  
11 1994 New Moon, 15:10 PST  
19 1994 First Quarter Moon, 12:27 PST  
27 1994 Full Moon, 17:23 PST

## UPCOMING EVENTS

**8 January.** EAS Lecture: **Dr. Eric Norman.** Neutrino Astronomy. Please note that this will be the second Saturday in January, owing to the New Year holiday. Please note also, that our new starting time will be 7:30 p.m.

**14 January.** EAS Board Meeting

**29 January.** NCHALADA Discussion

**5 February.** EAS Lecture: **Hans De Moor.** How to Use Your Telescope

**26 February.** EAS Annual Banquet: **Mike Reynolds.** The New Chabot

**16 April.** Astronomy Day

**10 May.** Annular eclipse

**25 -30 June.** Astronomical Society of the Pacific Meeting, Flagstaff, Arizona

Mike Reynolds describes "The New Chabot dinner will be at the Oriental Tea House (Leandro). Plan now to enjoy a sumptuous buffet. We plan to begin gathering at dinner following at 6:00 p.m.

AstroImage, Saturday, 5 Mar continues the Astrophoto and Astronomy events that benefit alternating years. It is to be at Eastbay Astronomical Society, Inc. 4917 Mountain Boulevard Oakland, CA 94619

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