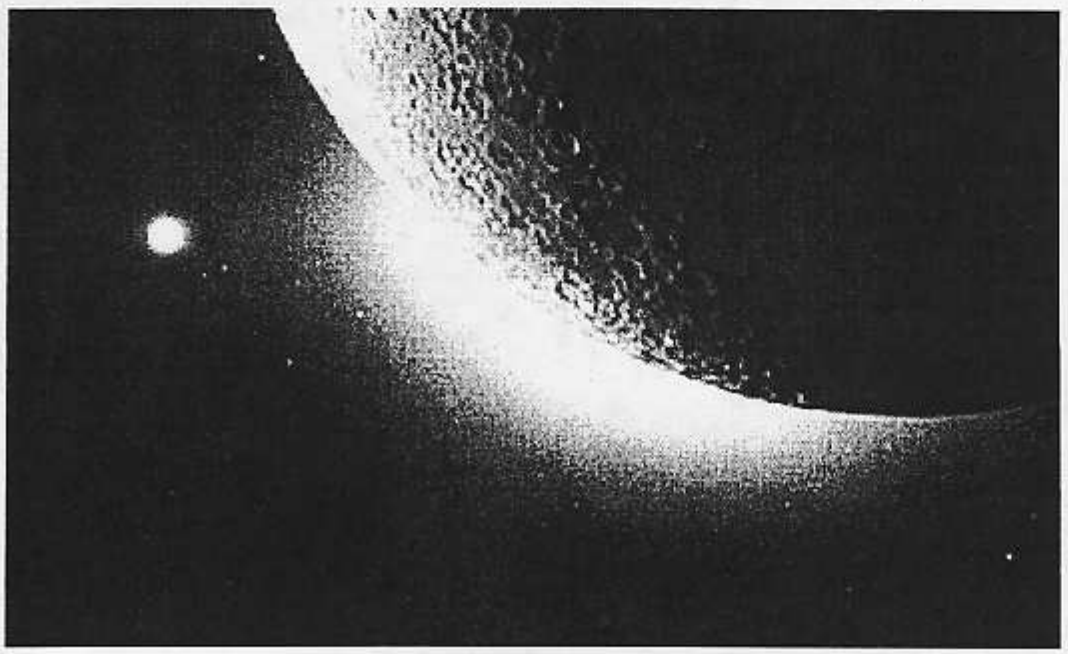
# Reflections

## of the University Lowbrow Astronomers

June 1996

### Earthshine, Starshine

*Credit: The Clementine Project*



This dramatic image of the Moon's edge against a background of distant stars is from a perspective impossible for groundbased telescopes. It was taken by a star tracker camera onboard the Clementine spacecraft. The Solar Corona, the Sun's outer atmosphere, is visible shining brightly behind the lunar limb while the Moon's surface is illuminated by Earthshine, sunlight reflected from the Earth to the Moon. As pictured, the part of the Moon in shadow is the lunar farside, the side not visible from Earth. The highly successful unmanned Clementine probe explored the Moon from lunar orbit during March and April of 1994. Its star tracker cameras were normally used for celestial navigation, producing wide angle images showing relative positions of stars.

## The University Lowbrow Astronomers

is a club of Astronomy enthusiasts which meets on the third Friday of each month in the University of Michigan's Physics and Astronomy Building (Dennison Hall, Room 807). Meetings begin at 7:30 pm and are open to the public. Public star parties are held twice a month at the University's Peach Mountain Observatory on North Territorial Road (1.1 miles west of Dexter-Pinckney Road; further directions on page 9) on Saturdays before and after the new Moon. The party may be cancelled if it's cloudy at sunset. For further information, call 480-4514.

## Important Dates

**This Month:**

**June 8 - Public Star Party** at Peach Mountain Observatory
**June 15 -Public Star Party** at Peach Mountain Observatory
**June 21 - Meeting** at 807 Dennison - Speaker: Phil Schafer on "Astronomy and Philatelics"

**Next Month:**

**July 13 - Public Star Party** at Peach Mountain Observatory
**July 19 - Meeting** at 807 Dennison - Topic and subject to be determined
**July 20 - Public Star Party** at Peach Mountain Observatory

# Will a Nearby Supernova Endanger Life on Earth?

*by Michael Richmond*
*[last revised August 8, 1995]*
*submitted by Bill Razgunas*

Since this topic seems to come up every year or so, I decided to try to work out some of the dangers quantitatively. Let me list the various sources of danger I've considered.

1. optical and near-optical light
2. X-rays from the explosion itself
3. X-rays from the supernova remnant
4. gamma rays*
5. neutrinos
6. energetic particles*

I haven't been able to find much information on those items marked with "*", but I'll tell you what I know. My current best guess is that items 2 and/or 4, energetic photons, are the most dangerous to those nearby.

**1. Optical and near-optical light**

After a very brief (but significant? I don't think we know enough to say for sure) "flash", the optical output of SNe rises over a period of several weeks, peaks for a few days (types Ia, Ib) to a few months (type IIP), then fades relatively slowly. The absolute magnitudes of of supernovae at peak, like everything else, vary according to the astronomer who answers the question :-), but rough values are

| Object | peak M(V) | distance at which object would have same apparent V mag as Sun |
|---|---|---|
| Sun | +4.8 | 1 AU |
| type Ia | -19.0 | 58,000 AU = 0.3 pc |
| type II | >= -18.5 | <=46,000 AU = 0.2 pc |

Clearly, SNe must be very close to affect the Earth via optical photons.

**2. X-rays from the explosion**

I could find data for X-rays from type II SNe only, but I'll make estimates for Ia as well. Satellites detected <= 80x10^(-12) erg/(cm^2-s) in the 6-28 keV range from SN 1987A (which was probably less luminous than most). Let me guess that, over the entire X-ray range, at peak, about 800x10^(-12) erg/(cm^2-s) would be observed from SN 1987A.

The Sun, on the other hand, during a large flare, emits around 0.35 erg/(cm^2-s) in the same X-ray band. In order to produce the same X-ray flux as a large solar flare, then, SN 1987A would have to be closer by the sqrt(0.35/[800x10^(-12)]), or at a distance of ~2 pc.

Another type II SN which was detected in X-rays was SN 1993J, in M81. The ASCA satellite measured a flux of about 1x10^(-11) ergs/(cm^2-s) in the range 1-10 keV. Using the same value as above for the X-ray flux of the Sun during a large flare, we find that the SN would have to be moved closer by a factor of 190,000 to equal the solar flare; that would correspond to a distance of about 20 pc (from its actual distance of 3.6 Mpc).

Models of type Ia SNe (Shigeyama et al., A&AS 97, 223 [1993]) predict X-ray luminosities of around 10^42 erg/sec at peak. This is about 10-100 times as luminous as SN 1993J, and so a type Ia SN could be 3-10 times farther away (60-200 pc) and still equal a solar flare.

I suspect that X-rays (and gamma-rays, see below) are the most deadly of a nearby SN's effects.

**3. X-rays from the supernova remnant**

As material in the ejecta slams into the surrounding ISM, it produces shock waves that can heat material up to millions of degrees and produce X-rays. For example, the SNR Cas A, at a distance of about 3kpc, has a flux of something like 5x10^(-15) erg/(cm^2-s) according to X-ray satellites (I had to assume a LOT about the size and efficiency of the instruments here, so I'm probably way off, but it won't matter). Comparing again with the flux from a solar flare, we find that Cas A would have to be located less than 0.001 pc from the Earth to produce the same flux. Now, this flux would be very long-lasting, but even so, is clearly less important than the X-rays produced in the explosion.

**4. Gamma-rays from the explosion** (much based on words of wisdom from David Palmer - thanks, Dave!)

One way to estimate the effect of SNe in gamma-rays is to compare the amount of power they produce in gamma-rays ALONE with that from the Sun at ALL wavelengths:

| | power | distance at which power is equal to Sun's total |
|---|---|---|
| Sun | 10^33 erg/s (all wavelengths) | 1 AU |
| SN II | 10^39 erg/s (gamma + X-rays) | 1200 AU ~ 0.006 pc |
| SN Ia | 2x10^41 erg/s (gamma + X-rays) | 17000 AU ~ 0.08 pc |

In somewhat more detail: both X-rays and Gamma-rays from SN 1987A were due to the decay of radionucleides, primarily Co56 fgrom the Ni56->Co56->Fe56 decay chain. Gamma rays, primarily at 0.847 and 1.238 MeV were downgraded by Compton scattering in the envelope (keeping the envelope hot and luminous) and then emerged at lower energies in the X-ray and gamma-ray range. The unscattered photons at 0.847 and 1.238 were also seen.

In greater detail: observations of the flux in X-rays and gamma rays from the Sun reveal that most of the energy is in the X-rays, with relatively small fractions in the gamma-ray regime. Using data from Colhane et al. (Solar Physics 153, 307 [1994]), Baoz et al. (Solar Physics 153, 33 [1994]) and McConnell et al. (Adv. Space Res., v 13, n 9, 245 [1993]), I find

Energy from Sun during flares

| Satellite | energy range | duration | total power (erg/cm^2) |
|---|---|---|---|
| Yohkoh | 20-? keV | 10 sec | 350 |
| COMPTEL (GRO) | 1-10 MeV | 900 sec | 0.01 |
| GAMMA-1 | > 30 MeV | 600 sec | 0.0002 |

By comparison, the flux in the 847 and 1238 keV lines due to the decay of Ni-56 in a type Ia SN is estimated to be (data from Ruiz-Lapuente et al., ApJ 417, 547 [1993]) at a distance of 1000

SN Ia ~1 MeV ~60 days ~40,000

This is significant -- a type Ia SN, at the distance of 1000 pc, dumps as much gamma-ray radiation onto the earth as 1,000 solar flares. Even when the Sun is at the peak of its activity cycle, I don't think it flares ten times a day, so, even at a kiloparsec, a type Ia SN would outshine the Sun in gamma rays.

However, while I _do_ know that we easily survive even the greatest solar flares, I don't know how a large increase in the gamma-ray flux over a period of several months would affect the earth's atmosphere. Steve Thorsett, in a preprint "Terrestial Implications of Cosmological Gamma-Ray Burst Models," quotes sources which suggest that considerably more than 100,000 erg/(cm^2) in gamma-rays are needed to destroy the ozone layer, so it seems that a type Ia would have to be closer than 1 kpc to cause significant damage.

**5. Neutrinos**

The neutrino flux from SN 1987A was about 5x10^10 cm^(-2) in a burst a few seconds, which is similar to that from the Sun (6.5x10^10/(cm^2-s))!

Calculation due to Robert W. Spiker, U. of Virginia:

> This was part of a question on my PhD qual exams two years ago. The answer I got was about an AU. Here's how I did it:
>
> Total energy released in a SN in neutrinos is E_\nu \sim 10^53 ergs.
>
> Cross section for interaction is \sigma = 10^{-44}cm^2.
>
> Minimum lethal dose is 1000 rads = 10^5 ergs of energy absorbed per gram of body weight = 8 x 10^9 ergs absorbed for a body weight of 80 kg in order to die a horrible death. (This number I was given.)
>
> Energy absorbed = Energy passing thru * cross section * path length * number density of absorbing body
>
> I figure the typical body presents 1 square meter of area and has a path length of 30 cm (so we can look at the pretty star as it blows).
>
> Number density of the body I chose to be 1 g cm^[-3]/ 6 m_H; that is, density equal to water (we float) and mean molecular weight of about 6 (mostly H but lots of C, N, and O I figured).
>
> The energy passing thru = "flux" * area = 10^53 ergs / (4 \pi d^2) * 1 m^2 so the distance needed to absorb a lethal dose is
>
> d^2 = (E_\nu A \sigma n l) / (4 \pi E_{lethal})
>
> which if you plug in as I did comes to 1 AU.

I think it's safe to say that the neutrino dangers are small compared to others.

However, perhaps the simple calculations above are missing some important points. A paper appeared on the Astrophysics Preprint Server (May, 1995) that claims neutrinos can indeed be dangerous at larger distances. The paper is called "Biological Effects of Stellar Collapse Neutrinos", is written by J. I. Collar (University of South Carolina), and was submitted to Phys. Rev. Lett.

Here's the abstract:

Massive stars in their final stages of collapse radiate most of their binding energy in the form of MeV neutrinos. The recoil atoms that they produce in elastic scattering off nuclei in organic tissue create a radiation damage which is highly effective in the production of irreparable DNA harm, leading to cellular mutation, neoplasia and oncogenesis. Using a conventional model of the galaxy and of the collapse mechanism, the periodicity of nearby stellar collapses and the radiation dose are calculated. The possible contribution of this process to the paleontological record of mass extinctions is examined.

You can find more information by looking up astro-ph/9505028 at http://xxx.lanl.gov/archive/astro-ph.

**6. Cosmic-ray particles**

This possiblilty is one that may be important, but I just don't know enough to calculate HOW important. Here's what I could find:

The solar wind, at the distance of the Earth, has a density of about 9 protons/cm^3, velocity ~470 km/s (and the particles have a temperature around 10^5K). Let me take as a measure of the impact on the Earth's atmosphere the product of density and (velocity*velocity): 2x10^16 in cgs units (protons/cm-s^2). Now, let me consider the material in the expanding shell of ejecta from a type II SN; assume a total mass of 5M(solar), an expansion velocity of 5,000 km/s and a shell thickness of 0.01 times it radius (I'll bet that the real thickness is greater, but this increases the impact). Then, assuming that the shell expands uniformly and ignoring all the material swept up in its path (which really IS significant over scales of >~ 1pc), I find

| shell radius | time since explosion | proton density | density*velocity*velocity |
|---|---|---|---|
| 1 pc | 200 yr | 30 cm^3 | 7x10^18 |
| 10 pc | 2000 yr | 0.03 cm^3 | 7x10^15 |

*Supernova, con't*

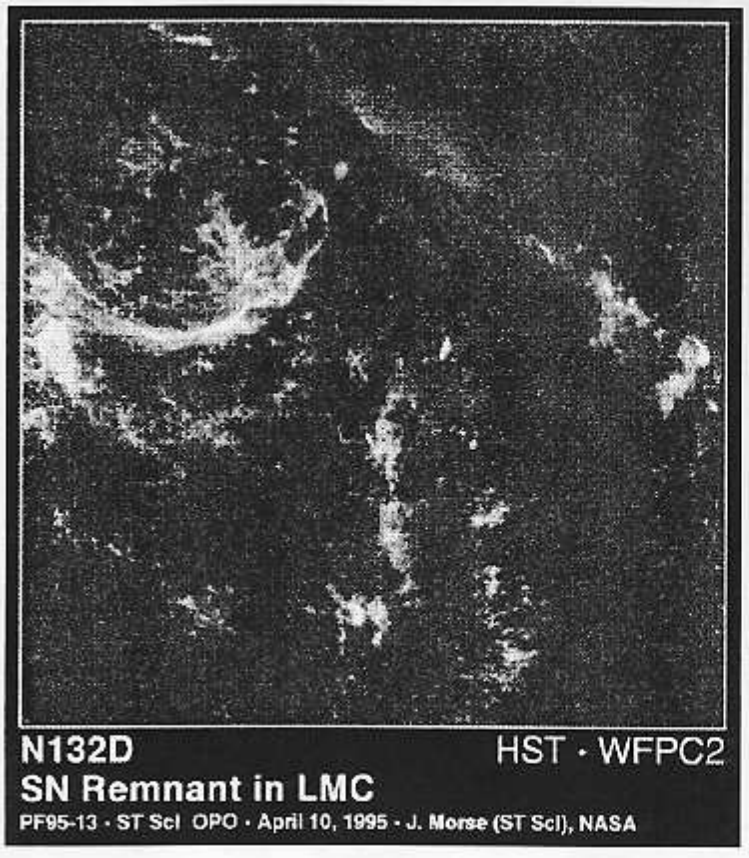
So, this vastly over-simplified model predicts that the ejecta material will be comparable to the solar wind at a distance of a few parsecs. Again, I have no idea how much stronger the "SN wind" must be than the solar wind for it to pose a danger.

However, I've left out the issue of the energy of the particles. It has been hypothesized that SN remnants are sites of cosmic-ray acceleration, which could produce a smaller population of MUCH more energetic particles than in the typical ejecta shell. Those very-high-energy particles could have a significant impact despite their small numbers. Since I know zero about acceleration mechanisms, or the effect of the energy of cosmic-ray particles on their interaction with the Earth's atmosphere, I'll just stop here.

Conclusion: I suspect that a type II explosion must be within a few parsecs of the Earth, certainly less than 10 pc, to pose a danger to life on Earth. I suspect that a type Ia explosion, due to the larger amount of high-energy radiation, could be several times farther away. My guess is that the X-ray and gamma-ray radiation are the most important at large distances.

Additional reading:
Larry Marschall provides a general overview of supernovae and their properties in "The Supernova Story."

Steve Thorsett considers the possibilities that a local gamma-ray burst source, at the center of our own Milky Way galaxy, if some models are correct, might affect adversely life on earth. See his paper in ApJ Letters, vol. 444, page L53 (1995).



**N132D** HST · WFPC2
**SN Remnant in LMC**
PF95-13 · ST ScI OPO · April 10, 1995 · J. Morse (ST ScI), NASA

# Doomed Star, Eta Carinae

*from the Astronomy Picture of the Day files*

**Eta Carinae** HST · WFPC2
PRC96-23a · ST ScI OPO · June 10, 1996
J. Morse (U. CO), K. Davidson, (U. MN), NASA

Eta Carinae may be about to explode. But no one knows when - it may be next year, it may be one million years from now. Eta Carinae's mass - about 100 times greater than our Sun - make it an excellent candidate for a full blown supernova. Historical records do show that about 150 years ago Eta Carinae underwent an unusual outburst that made it one of the brightest stars in the southern sky. Eta Carinae, in the Keyhole Nebula, is the only star currently thought to emit natural LASER light. This just-released image taken last September resulted from sophisticated image-processing procedures designed to bring out new details in the unusual nebula that surrounds this rogue star. Now clearly visible are two distinct lobes, a hot central region, and strange radial streaks. The lobes are filled with lanes of gas and dust which absorb the blue and ultraviolet light emitted near the center. The streaks remain unexplained.

*Editor's Note: The Astronomy Picture of the Day service can be accessed at* http://antwrp.gsfc.nasa.gov/apod/astropix.html. *They also have a nice searchable archive of all the pictures available.*

**Do or do not. There is no try.**
**- Yoda**

# The Good, the Bad, and the Mediocre

*by Doug Scobel*

There's good news, bad news, and mediocre news. The good news is that Sky Publishing now gives discounts on CCD Astronomy magazine for astronomy club members. The mediocre news is that the discount is only $2.00 ($20.00 instead of $22.00 for a year). The bad news is that they have also hiked the price of Sky and Telescope magazine subscriptions for club members from $24.00 a year to $27.00. It still represents a substantial discount from normal prices, though.

While we're on the subject of magazine subscriptions, please, please, PLEASE provide me with your renewal notice when renewing your subscription through me. It will make my life easier and the publisher will process it faster as well.

Speaking of Sky Publishing, I have been informed that you do not have to go through me to get the 10% discount on items ordered out of their catalog. Simply mention that you are a member of the University Lowbrow Astronomers when ordering (they provide a place on the order form when ordering by mail) and you are entitled to the discount. However, if more than one of you have stuff to order, then combining it all into one order through me may (or may not) save shipping costs.

One last item. If you need to be reimbursed for anything by the club, then you MUST give me receipts showing the cost of the items, and preferably what the items are. This is necessary for record keeping (i.e., IRS) reasons. Also, please be prompt. Don't let weeks or even months go by before asking me for reimbursement, as it will only lead to inaccuracies. We've been getting a little lax in this area (I won't mention any names) and I need to tighten things up a little.

# When I Heard the Learn'd Astronomer

*by Walt Whitman*
*submitted by John Causland*

When I heard the learn'd astronomer,
When the proofs, the figures, were ranged in columns before me,
When I was shown the charts and diagrams, to add, divide, and measure them,
When I sitting heard the astronomer where he lectures with much applause in the lecture-room,
How soon unaccountable I became tired and sick,
Till rising and gliding out I wander'd off by myself,
In the mystical moist night-air, and from time to time,
Look'd up in perfect silence at the stars.

# Supernova Basics

*by Jonathon Keohane*

One of the most energetic explosive events known is a supernova. Most supernovae occur at the end of a star's lifetime, when its nuclear fuel is exhausted and it is no longer supported by the release of nuclear energy.

If the star is particularly massive, then its iron core will collapse and in so doing will crush itself. For a massive star collapse the only things in nature that are strong enough to stop this gravitational collapse are neutrons — and even these are sometime fail depending on the mass of the iron core.

When the core is lighter than about 5 times the mass of our sun, it is believed that the neutrons are successful in halting the collapse of the star creating a neutron star. Neutron stars can sometime be observed as pulsars, X-ray Binaries, or alone as in the case of the supernova remnant Puppis A.

When the core is heaver than about 5 times the mass of our sun, nothing in the known universe is able to stop the collapse of the core, so it completely falls into itself, creating a black hole, which is an object that is so dense that even light cannot escape its gravitational grasp. Though we cannot see black holes directly, we can observe their effects as X-ray binaries.

The core is only the very small center of an extremely large star that had been making many (but not all) of the elements that we find here on earth for many Millions of years. When the core collapses, an enormous blast wave is created with the energy of about 10 Octillion (28 zeros) mega-tons. This will plow the star's atmosphere into interstellar space, as it becomes a supernova remnant.

During these explosions, many elements are made that can be created no where else that we know of in nature. The supernova not only makes these heavy elements, but scatters them out in to the interstellar medium so that they can later form other stars, planets and everything on Earth -- including ourselves.

There are some supernovae (type Ia), which result not from one massive star collapsing, but occur in a binary star system between a giant star and a white dwarf, where mass flows from the giant star to the white dwarf, eventually the white dwarf cannot support itself and then collapses. The process continues much as is described above from then on.

While many supernovae have been seen in nearby galaxies, they are relatively rare events in our own galaxy, happening once a century or so on average. The last nearby supernova occured in 1680, but it was thought to be a star at the time and caused a discrepancy in the observer's star catalogue which historians only resolved after the discovery of the resulting supernova remnant this century. The two just before that were observed by the great astronomers Tycho and Kepler in 1572 and 1604 respectively.

# Comet Comments

*by Don Machholz*
*submitted by Kurt Hillig*

Comet Hale-Bopp (C/1995 O1) is now visible to the unaided eye at least to some eyes. The rest of us will have to be content with binocular views of the comet for awhile longer. This comet will likely be a naked-eye object for more than a year, the Northern Hemisphere will see it through mid-May, 1997. This affords an opportunity to conduct an experiment, and to set a personal record: for how long you can follow the comet without optical aid. In 1985-6 Halley's Comet was seen for about seven months, and early in the last century the Great Comet of 1811 was a naked-eye object for about nine months. Simply record the first night you view Comet Hale-Bopp with the unaided eye, and, sometime next May, your last naked-eye viewing. The comet is presently 3.2 AU from us and 4.1 AU from the sun.

Meanwhile Periodic Comet Kopff is visible in the same part of the sky, but you'll need a pair of binoculars or a small telescope in order to see it. Other comets that we have been watching have now faded or moved south.

EPHEMERIDES

C/1995 O1 (Hale-Bopp)

| DATE(00UT) | R.A. (2000) | DEC | El. | Sky | Mag |
|---|---|---|---|---|---|
| 06-16 | 19h13.8m | -13o21' | 155o | M | 6.6 |
| 06-21 | 19h07.8m | -12o52' | 161o | M | 6.5 |
| 06-26 | 19h01.5m | -12o23' | 165o | M | 6.4 |
| 07-01 | 18h54.7m | -11o53' | 168o | M | 6.3 |
| 07-06 | 18h47.7m | -11o23' | 168o | E | 6.2 |
| 07-11 | 18h40.5m | -10o54' | 165o | E | 6.1 |
| 07-16 | 18h33.3m | -10o24' | 160o | E | 6.0 |
| 07-21 | 18h26.0m | -09o55' | 154o | E | 5.9 |
| 07-26 | 18h18.9m | -09o26' | 149o | E | 5.8 |
| 07-31 | 18h12.0m | -08o59' | 142o | E | 5.7 |
| 08-05 | 18h05.5m | -08o32' | 136o | E | 5.7 |
| 08-10 | 17h59.4m | -08o07' | 130o | E | 5.6 |

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22P/Kopff

| DATE(00UT) | R.A. (2000) | DEC | El. | Sky | Mag |
|---|---|---|---|---|---|
| 06-16 | 19h17.2m | -16o33' | 156o | M | 7.1 |
| 06-21 | 19h19.2m | -16o58' | 160o | M | 7.0 |
| 06-26 | 19h20.7m | -17o28' | 165o | M | 7.0 |
| 07-01 | 19h21.7m | -18o03' | 169o | M | 6.9 |
| 07-06 | 19h22.3m | -18o41' | 174o | M | 6.9 |
| 07-11 | 19h22.7m | -19o22' | 177o | E | 6.9 |
| 07-16 | 19h23.2m | -20o04' | 175o | E | 7.0 |
| 07-21 | 19h23.8m | -20o45' | 171o | E | 7.1 |
| 07-26 | 19h24.8m | -21o25' | 166o | E | 7.2 |
| 07-31 | 19h26.2m | -22o03' | 162o | E | 7.3 |
| 08-05 | 19h28.2m | -22o36' | 157o | E | 7.4 |
| 08-10 | 19h30.8m | -23o05' | 153o | E | 7.6 |

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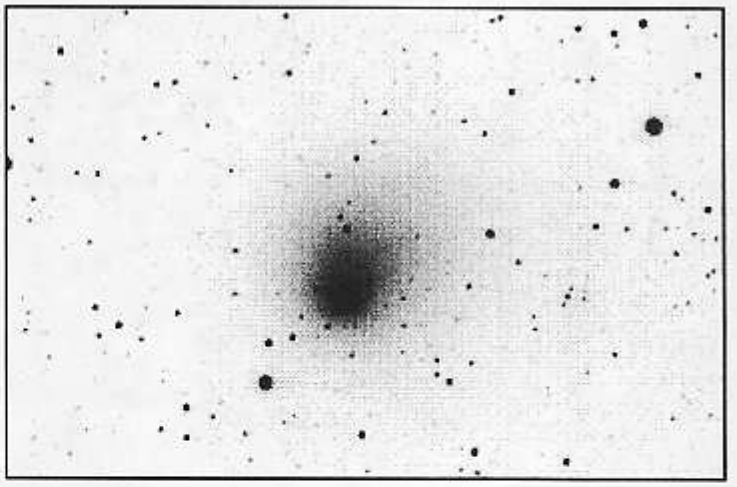
ELEMENTS

| Object | Hale-Bopp | Kopff |
|---|---|---|
| Peri. Date: | 1997 04 01.14561 | 1996 07 02.19980 |
| Peri. Dist (AU): | 0.9140971 AU | 1.5795617 AU |
| Arg/Peri (2000): | 130.59227 deg. | 162.83487 deg. |
| Asc. Node (2000): | 282.47087 deg. | 120.91329 deg. |
| Incl (2000): | 089.42807 deg. | 004.72143 deg. |
| Eccen: | 0.9950784 | 0.5440739 |
| Orbital Period: | 3000 yrs. | 6.45 yrs. |
| Ref: | MPC 26879 (3-26) | MPC 22032 (1991) |

*Editor's Note: there are many fine comet pages on the World Wide Web. The two following addresses will help you get started.*
http://newproducts.jpl.nasa.gov/comet/index.html *and*
http://encke.jpl.nasa.gov/

# Comet Hale-Bopp

*Credit: David Hanon, Georgia*



Negative image of Comet Hale-Bopp. The image was taken with a 180mm f/9 refractor and ST-8 ccd camera. The mean time of exposure was 09:40 UT on 4/28/96. The image is the result of (20) 30 sec exposures. The image scale is just under 30 min across.

# Skywatcher's Diary

*compiled by Robert C. Victor, Abrams Planetarium*

**Monday, June 17**
Half an hour after sunset the young Moon is very low in WNW. The crescent with horns pointing south appears like a bowl tipped nearly on its side. From Michigan, the Moon is 48 hours old and 22 degrees from the Sun, so it's bright and relatively easy despite its very low altitude. But don't be late!

**Tuesday, June 18**
An hour after sunset the 3-day-old crescent Moon is very low, about 15 degrees N of west. Look for the Gemini Twins, Pollux and Castor, 14 to 19 degrees to Moon's upper right.

Using binoculars an hour before sunup on Wednesday, if you have an unobstructed view toward ENE, try for Mercury rising 3 degrees below Mars. Look for the Pleiades 6 degrees above Mars. Within next half hour, try for Venus rising 8 degrees lower left of Mercury. Most difficult is Aldebaran 4 degrees below Mercury and 6 degrees upper right of Venus.

**Wednesday, June 19**
Two asteroids are now within easy reach of binoculars. Tonight we'll hunt for Ceres, the largest asteroid. Wait until nightfall, when the sky is very dark, then locate the reddish first-magnitude star Antares, low, east of due south. It is flanked by two 3rd-mag. stars, Sigma Scorpii 2 degrees to upper right, and Tau, just over 2 degrees to lower left. To the upper right of Antares, nearly 6 degrees past Sigma, is 2nd-mag. Delta Scorpii, the middle and brightest star of a slightly curved, nearly vertical line of three stars marking the Scorpion's head. The top star, 3rd-mag. Beta, is 3 degrees upper left of Delta. Just 1.6 degrees left of Beta is 4th-mag. Nu. Tonight and Thursday, the 7.5-mag. asteroid Ceres passes within 0.5 degree above Nu.

**Thursday, June 20**
Summer begins tonight at 10:24 p.m. EDT. An hour after sunset, the 5-day-old crescent Moon is in west with Regulus, heart of Leo, about 7 degrees to its upper left.

At nightfall we'll use binoculars to locate Vesta. Although it has faded from six weeks ago, it remains the brightest asteroid. Locate the first-mag. bluish star Spica in SW, 33 degrees below the even brighter zero-mag. yellow-orange star Arcturus. Also find Antares, the reddish first-mag. star low, a little E of due south. Between Spica and Antares, not far above the midpoint of the line connecting them, find two stars of 3rd magnitude, Alpha and Beta in Libra. They are just west of due south at nightfall, with Beta 9 degrees upper left of Alpha. Next, find the 4th-mag. star Mu in Virgo, 9 degrees upper right of Beta and nearly 11 degrees upper right of Alpha. For the rest of this week, asteroid Vesta is within 3 degrees lower left of Mu Virginis, and just inside one corner of the triangle formed by Alpha and Beta Librae and Mu Virginis.

**Friday, June 21**
An hour after sunset, the fat crescent Moon is in WSW, with Regulus, heart of Leo, 8 degrees to its right. Tonight through Tuesday, the Moon is in excellent view through binoculars and telescopes. Near the terminator (day-night boundary), the Sun is just rising over the lunar landscape, causing the Moon's surface features to cast very long shadows, exaggerating the heights of crater walls, mountains, and ridges, and the depths of craters. Tonight in the lunar northern hemisphere, the broad expanse of the Sea of Serenity lies astride the terminator, and the Sun is just rising on the craters Aristoteles and Eudoxus. Tonight and Saturday, if the sky is clear, Michigan State University Observatory will be open after the Abrams Planetarium showing of "Through the Eyes of Hubble."

**Saturday, June 22**
One-and-a-quarter hours before sunrise, look low in ENE for the Pleiades cluster with Mars 9 degrees to its lower left. Binoculars give the best view of what follows, if you have a clear view of the horizon. By an hour before sunup can you see Mercury rising 6 degrees to Mercury's lower left? In another 10 minutes, look for Venus 1.6 degrees to Mercury's lower right, and Aldebaran 4 degrees to Venus' right. Bright Jupiter is easy to see in SW. If you can still see Saturn in SE, that"s five planets in view simultaneously! Venus, Mars, and Aldebaran will get higher and easier to see each morning, while Mercury gets lower.

**Sunday, June 23**
Around sunset, the Moon is approaching First Quarter phase, its right half illuminated and showing spectacular detail in binoculars and telescopes. Along the terminator tonight are the walled plain Archimedes in the lunar north, and the close trio of craters Ptolemaeus, Alphonsus, and Arzachel just south of the Moon's center. South of Archimedes, the Apennine "mountain range" casts long shadows over the Mare Imbrium plain.

Using binoculars, watch the ENE horizon an hour before sunup Monday for the rising of Mercury, Venus, and Aldebaran. Venus is 6 degrees to Mars' lower left, Aldebaran is 6 degrees to Mars' lower right and 4 degrees right of Venus. Mercury is within 3 degrees left of Venus. As sunrise approaches, binoculars show the crescent Venus only 6 percent lit.

**Monday, June 24**
An hour after sunset, first-magnitude Spica is in SSW, 10 degrees left of the Moon. Wait a few hours until Jupiter passes due south, and use binoculars to see Comet Hale-Bopp about 10 degrees almost directly above Jupiter. The comet, predicted to be about 7th magnitude now, is moving WNW about 1/3 of a degree per day and will pass 0.6 degree north of a 5.4-mag. star on the morning of June 27.

**Tuesday, June 25**
An hour after sunset, the waxing gibbous Moon is in SW with Spica about 4 degrees to its lower right.

An hour before sunrise on Wednesday, look for brilliant Venus just risen in ENE. Mars is about 4-1/2 degrees above it, and Aldebaran just over 3 degrees to Venus' right. Now through

*Diary, con't*

July 10, Venus lingers no farther than Aldebaran than it is now, while both will get higher and easier to see!

**Wednesday, June 26**
An hour before sunrise for the rest of June, watch Mars and Venus remain 4 degrees apart, with Mars passing upper left of Venus. Aldebaran is 3 degrees right of Venus on Thursday; they'll be within 2.4 degrees July 2-4.

**Thursday, June 27**
For good quality telescopes: Overnight tonight, from 2:22 a.m. to4:38 a.m. EDT (11:22 p.m. to 1:38 a.m. PDT), the shadow of Jupiter's satellite Io appears as a tiny black dot marching across the planet's disk from the planet's east limb to the west. Io itself follows its shadow by 9 minutes; start watching well before 2:31 a.m. EDT (11:31 p.m. PDT) to follow Io as a "star" approaching Jupiter until it merges with the east limb.

**Friday, June 28**
One hour after sunset, Moon is in SSE with Antares, heart of the Scorpion, 8 degrees to its lower right. By three hours before sunup on Saturday, they're still 8 degrees apart, but in the SW with Antares to Moon's lower left.

**Saturday, June 29**
An hour after sunset, Moon is in SE to SSE. Antares is 16 degrees to Moon's right, while bright Jupiter is very low in SE, 20 degrees to Moon's lower left.

**Sunday, June 30**
Tonight's "Blue Moon" (second Full Moon this month) rises before sunset and is low in SE as the sky darkens. Note Jupiter about 6 degrees below the Moon. They'll be up for the rest of the night, closing to just over 4 degrees apart by dawn on Monday.

**Monday, July 1**
Watch for the Moon's rising in ESE early this eveing -- within 20 minutes after sunset across the northern U.S., and within 35 minutes after sunset from Miami and SanDiego. The Moon is just past Full, and Jupiter is about 12 degrees to its upper right.

*Editor's Note: The Abrams Planetarium also publishes a Sky Calendar each month. A sample calendar for May 1996 is available at* http://www.pa.msu.edu/abrams/may96skycal.html *For a printed sample, send a long, self-addressed stamped envelope to:*

June Sky Calendar
Abrams Planetarium
Michigan State University
East Lansing, MI 48824

# What's a Blue Moon, Anyway?

*by Philip Hiscock*
*submitted by Kurt Hllig*

The phrase "blue moon" has been around a long time, well over 400 years, but during that time its meaning has shifted around a lot. I have counted six different meanings which have been carried by the term, and at least four of them are still current today.

The earliest uses of the term are in a phrase remarkably like early references to "green cheese". Both were used as examples of obvious absurdities about which there could be no argument. Four hundred years go, if someone said, "He would argue the moon was blue", the average 16th-centuryman would take it the way we take "He'd argue that black is white." The earliest citation is a 1528 poem "Rede Me and Be Not Wroth": "Yf they say the mone is blewe/We must believe that it is true."

This understanding of a blue moon's being absurd (the first meaning) led eventually to a second meaning, that of "never". To say that something would happen when the moon turned blue was like saying that it would happen on Tib's Eve (at least before Tib got a day near Christmas assigned to her).

But of course, there are examples of the moon's actually turning blue; that's the third meaning: the moon's visually appearing blue. When the Indonesian volcano Krakatoa exploded in 1883, its dust turned sunsets green and the moon blue all around the world for the best part of two years. In 1927, a late monsoon in India set up conditions for a blue moon. And the moon here in Newfoundland was turned blue in 1951 when huge forest fires in Alberta threw smoke particles up into the sky. Even by the 19th century, it was clear that although visually blue moons were rare, they did happen from time to time. So the phrase "once in a blue moon" came about. It meant then exactly what it means today: that an event was fairly infrequent, but not quite regular enough to pinpoint. That's meaning number four, and today it is still the main one.

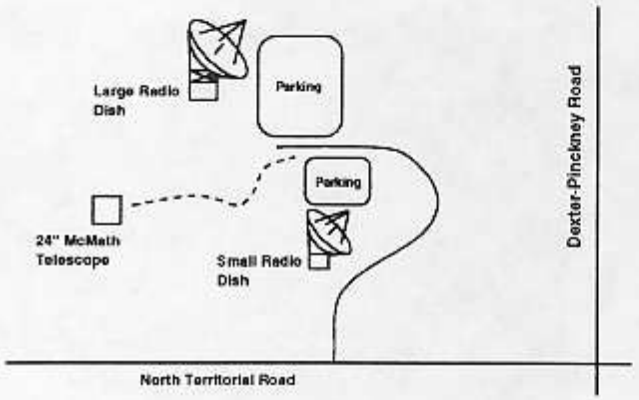
I know of six songs which use "blue moon" as a symbol of sadness and loneliness. In half of them, the poor crooner's moon turns to gold when he gets his love at the end of the song. That's meaning number five: check your old Elvis Presley or Bill Monroe records for more information.

Finally, in the 1980s, a sixth meaning was popularized (chiefly by the game Trivial Pursuit): the second full moon in a month. The earliest reference cited for this is The Maine Farmers' Almanac for 1937. Rumour has it that when there were two full moons in a calendar month, calendars would put the first in red, the second in blue.

# Places

**Dennison Hall**, also known as The University of Michigan's Physics and Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. It is found in Ann Arbor on Church Street about one block north of South University Avenue. The meeting is held in room 807.

**Peach Mountain Observatory** is the home of The University of Michigan's 25 meter radio telescope as well as the University's McMath 24 inch telescope which is maintained by the Lowbrows. The observatory is located northwest of Dexter. The entrance is on North Territorial Road, 1.1 miles west of Dexter-Pickney Road. A small maize-and-blue sign marks the gate. Follow the gravel road one mile to a parking area near the radio telescopes. Walk along the path between the two fenced in areas (about 300 feet) to reach tthe McMath telescope building.




# Times

Monthly meetings of the Lowbrows are held on the 3rd Friday of each month at 7:30 PM in 807 Dennison Hall. During the summer months, and when weather permits, a club observing session at Peach Mountain will follow the meeting.

Computer subgroup meetings are held on the first of each month, rotating among member's houses. See the calendar on the cover page for the location of next meeting.

Public Open House/Star Parties are held on the Saturday before and after each new Moon at the Peach Mountain Observatory. Star Parties may be canceled if the sky is cloudy at sunset or the temperature is below 10 degrees F. Call 480-4514 for a recorded message on the afternoon of a scheduled Star Party tocheck on the status. Many members bring their telescopes and visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitos - bring insect repellent, and it does get cold at night so dress warmly!

# Dues

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students. This entitles you to the monthly REFLECTIONS newsletter and the use of the 24" McMath telescope (after some training). Dues can be paid to the club treasurer Doug Scobel either at the monthly meeting or by mail at:

Doug Scobel
1426 Wedgewood Drive
Saline, MI 48176

# Magazines

Members of the University Lowbrow Astronomers can get a discount on these magazine subscriptions:

*Sky and Telescope:* $27 / year
*Astronomy:* $20 / year
*Odyssey:* $16.95 / year
*CCD Astronomy:* $20 / year

For more information contact the club Treasurer. Members renewing subscriptions are reminded to send your renewal notice along with your check when applying through the club Treasurer.

# Newsletter Contributions

Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call the Newsletter Editor Laura Meluch or e-mail to meluch@alumni.engin.umich.edu to discuss length and format. Announcements and articles are due by the first Friday of each month. Articles should be mailed to:

Laura Meluch
522 Second Street
Ann Arbor, MI 48103

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| | Mark Vincent | 663-7813 |
| Treasurer: | Doug Scobel | 429-4954 |
| Observatory Director: | Bernard Friberg | 761-1875 |
| Newsletter: | Laura Meluch | 747-6998 |
| Publisher: | Lorna Simmons | 525-5731 |
| Keyholder: | Fred Schebor | 426-2363 |

## From the Editor . . .

Hello again! A hearty thanks to those who submitted articles for this month's newsletter. As for the rest of you . . .

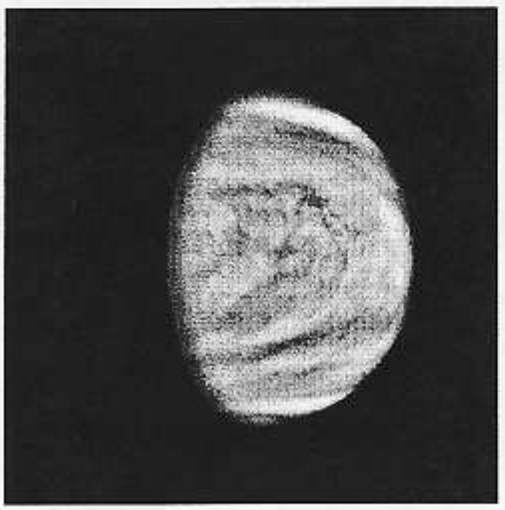
A few notes on making submissions: remember that if the information or article you submit is copyrighted (which most published things are), I cannot use it without permission from the author/publisher. I will, by all means, try to get permission to do so, but be aware that it may not always be possible. Also, I'm not too picky about the format you make submissions in. Over the Internet is great, but even hand written will do just fine. Just let me know, and we can arrange for drop-off/pick-up of your submission.

And as always, keep those cards and letters coming!

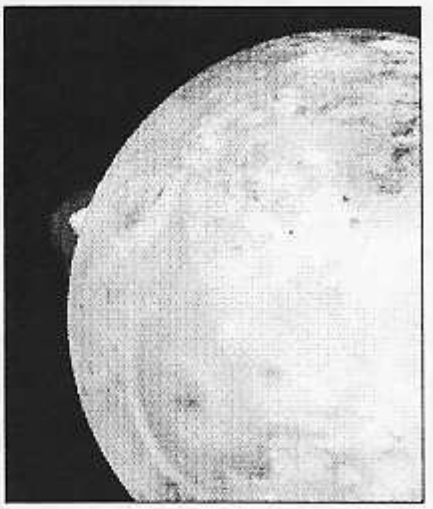
## At the Last Meeting

The locks on the 24" telescope will be changed soon. Please refresh your skills, so you can obtain the new combinations.
We are collecting signatures for a "Lowbrow Manifesto." Please attend the next meeting to read and sign it.
New club library policy: if you want to borrow a book, bring one along to leave.

## More June Skies Objects



Venus and its cloud covering
credit: NASA, Galileo spacecraft



Jupiter's Moon Io, with Loki's plume at the limb
credit: NASA, Voyager I

University Lowbrow Astronomers
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Check your membership expiration date on the mailing label!