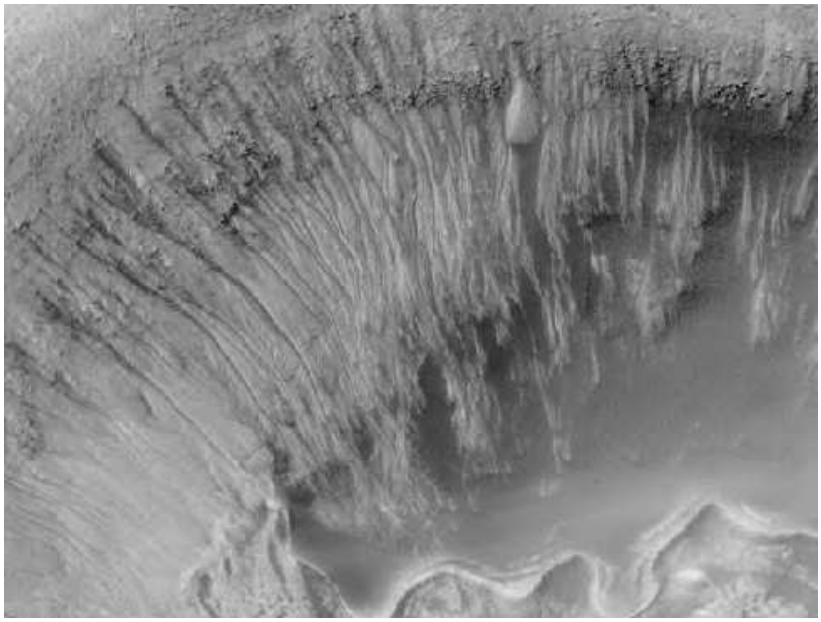
REFLECTIONS REFRACTIONS

of the University Lowbrow Astronomers

July 2000

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 130 or 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-Pinkney Road; further directions at the end of the newsletter) on Saturdays before and after the new Moon. The party may be canceled if it's cloudy or very cold at sunset. For further information call (734) 480-4514.



Newton Crater: Evidence for Recent Water on Mars
Credit: Malin Space Science Systems, MGS, JPL, NASA **Explanation:** What could have formed these unusual channels? Inside a small crater that lies inside large Newton Crater on Mars, numerous narrow channels run from the top down to the crater floor. The above picture covers a region spanning about 3000 meters across. These and other gullies have been found on Mars in recent high-resolution pictures taken by the orbiting Mars Global Surveyor robot spacecraft. Similar channels on Earth are formed by flowing water, but on Mars the temperature is normally too cold and the atmosphere too thin to sustain liquid water. Nevertheless, many scientists now hypothesize that liquid water did burst out here from underground Mars, eroded the gullies, and pooled at the bottom as it froze and evaporated. If so, life-sustaining ice and water might exist even today below the Martian surface -- water that could potentially support a human mission to Mars. Research into this exciting possibility is sure to continue!

This Month:

July 14 - Meeting at 130 Dennison - "Lowbrows on Astro-photography".
July 21 & 22 - Astronomy on the Beach at Kensington Metropark.
July 24 - 30 - Southeastern Michigan Unorganized Regional Festival of Stargazers, aka: "SMURFS", Hillman, MI. Contact http://www.aldeberan.com/astronomy/smurfs00.html for more info.

Next Month:

August 4 - Lowbrows at Leslie Science Center. Contact Bernard Friberg for details.
August 5 - Public Star Party at Peach Mountain Observatory - Comet Linear S4 south of M61, mag 7.
August 18 - Meeting at 130 Dennison - D.C. Moons will present a lecture on Terraforming.
August 26 - Public Star Party at Peach Mountain Observatory - Neptune & Uranus in Capricorn, Saturn & Jupiter up after mid-night.
September 22 - 24 - Astrofest 2000 at Camp 4H Shaw-Waw-Nas-See near Kankakee Illinois. Contact http://www.chicagoastro.org/ for more info.

Astronomy on the Beach Kensington Metropark

Telescopes along Kent Lake, photograph by Greg Burnett

Astronomy on the Beach is for everyone interested in astronomy. Families are welcome.

It will be held Friday July 21, 2000 and Saturday July 22, 2000 from 5:00 PM to 12:00 midnight at Kensington Metropark located near Brighton Michigan. A vehicle permit is required ($2.00 on Friday and $3.00 on Saturday). The event will take place at Martindale Beach inside Kensington Metropark.

Food can be purchased at the Metropark consession stand. Events include:

- Featured speakers
  Friday - Dr. Thomas Zurbuchen, University of Michigan, Department of Atmospheric, Oce anic and Space Physics.
  Saturday – Jack Lousma, NASA Astronaut.
- Comet making demonstration.
- Telescopes – If it is clear you will see Sunspots, Comet Linear S4, galaxies, and star clusters.
- Talks on introductory astronomy, the constellations, telescopes and light pollution, all aimed at the general public, no previous knowledge assumed.
- Displays of astronomy products including books, binoculars, eyepieces, computer software.

Sponsors

- Kensington Metropark is operated by the Huron-Clinton Metropolitan Authority.
- The Nature Company and the Discovery Channel Store.
- Rider's Hobby Shops.
- GLAAC (the Great Lakes Association of Astronomy Clubs). GLAAC consists of the following member organizations:

  Amateur Astronomers of Jackson.
  The Detroit Astronomical Society.
  The Eastern Michigan University Astronomy Club.
  The Ford Amateur Astronomy Club.
  The Genessee Astronomical Society.
  The Northern Cross Observatory.
  The Oakland Astronomy Club.
  The Royal Astronomical Society of Canada - Windsor Centre.
  The Seven Ponds Astronomy Club.
  The Sunset Astronomy Club.
  The University Lowbrow Astronomers.
  The Warren Astronomical Society.

For questions about "Astronomy on the Beach," contact Dave D'Onofrio at <Dave1ACT@aol.com> or Kensington Metropark at 1-800 477-3178.

Here Comes Comet Linear

Credit: Science @ NASA
http://spacescience.com/headlines/y2000/ast05jul_1m.htm?aol

Comet Linear is expected to become a faint naked-eye object similar in appearance to the Andromeda Nebula as it glides by the Big Dipper this month.

July 5, 2000 -- Later this month a fuzzy blob will glide across the sky near the Big Dipper. Called "C/1999 LINEAR S4", or LINEAR-S4 for short, it's the brightest comet to come along in more than 3 years.

Comet LINEAR-S4 was discovered on September 27,

1999, by the Lincoln Near Earth Asteroid Research program in New Mexico. It appears to be a first-time visitor to the inner solar system traveling in an orbit that will return it beyond distant Pluto after it passes 114 million km from the Sun on July 26, 2000.

"Estimating how bright this comet will become is tricky," says an astronomer at the NASA Marshall Space Flight Center. "Comet LINEAR hasn't been here before so we can't use past experience as a guide."

Astronomers have been monitoring LINEAR-S4 since its discovery last year. The comet has brightened slowly but steadily and it is now a 9th magnitude object visible through binoculars. Experienced comet-watchers expect LINEAR-S4 to continue brightening until it peaks at 4th to 6th magnitude on July 23, 2000. That's when the comet will make its closest approach to Earth at a distance of 56 million km. (Note: When the brightness of an object equals 6th magnitude, it is about as bright as the faintest stars visible to the unaided eye on a dark night. A 4th magnitude star is approximately 6 times that bright.)

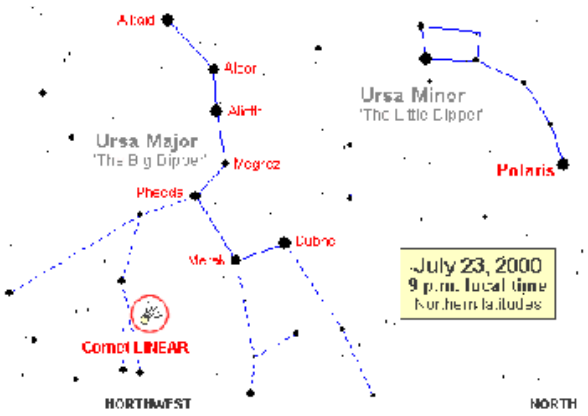
If these projections are correct, LINEAR-S4 will put on a modest show compared to the great comets of 1996 and 1997, Hyakutake and Hale-Bopp. At its brightest in March 1996, Hyakutake was a 1st magnitude object sporting a tail that stretched 60 degrees across the sky. Comet LINEAR-S4 will probably be 20 to 100 times dimmer than Hyakutake and its tail will look more like an elongated smudge than a sky-rending blaze of light.

Nevertheless, comet LINEAR-S4 could be a beautiful sight as it moves through the relatively star-poor area around the Big Dipper in late July. In fact, if the comet reaches 4th magnitude it will probably resemble another popular fuzzy blob, our nearest neighboring galaxy, the Andromeda Nebula. Experts stress that predicting what LINEAR-S4 will do is more of an art than hard science. The comet might fail to develop or it could be far more striking than expected.

Comet Linear Finder Chart -- July 23, 2000

Next column: Comet LINEAR-S4 is expected to reach peak brightness around July 23, 2000. Skywatchers in the northern hemisphere should look for the comet near the Big Dipper around 9 p.m. local time approximately 30 degrees above the northern horizon. Although the comet will appear to be stationary when viewed for a short time, it is actually moving 8 degrees per day with respect to background stars. (The bowl of the Big Dipper is 10 degrees across.) The comet will move past the Big Dipper in just a few days. To view finder charts for other dates, visit Sky & Telescope and CometLinear.com. **Note for Southern Hemisphere observers:** when comet LINEAR is brightest on July 23 it will be impossible to view from most southern latitudes as it rises just a few degrees above the horizon during the day. In August the fading comet will be a good target for southern telescopes for a few hours after sunset.

LINEAR-S4 is expected to become a naked-eye object around July 17, 2000, when it brightens to 6th magnitude. Even if the comet eventually reaches



4th magnitude, it will be invisible in light polluted urban areas. Dark skies are essential. For comet watchers, this is a good time for a vacation in the country!

The comet will fade after its closest approach to our planet on July 23rd and by the end of July, LINEAR-S4 it will be too dim for naked-eye observations. It will remain a good target for binoculars and small telescopes well into September. On August 20th, telescopic observers in the southern hemisphere will be treated to a rare sight when the 7th magnitude comet passes almost directly in front of the Sombrero galaxy M104. [See Sky & Telescope for more information.]

http://comets.amsmeteors.org/comets/lcomets/1999s4.htmlBy the end of 2000, LINEAR-S4 is expected to be a faint 13th magnitude object, fading as it races back to the outer solar system. Comets like LINEAR-S4 may originate in the Oort Cloud, a giant reservoir of comets 50,000 AU from the Sun. (One AU is an Astronomical Unit, 149.6 million km, equal to the average distance between the Earth and Sun.) Although the Oort Cloud is speculative, many astronomers believe that it exists and is populated with icy relics from the formation of the solar

system more than 4 billion years ago. Occasionally a galactic gravitational perturbation tweaks the orbits of the Oort comets and sends some of them plunging toward the Sun. Comet LINEAR-S4, with its highly elliptical long-period orbit, is probably one of these. After it passes by the Sun later this month it may not return for millions of years, if ever.

Although we probably won't see comet LINEAR-S4 again after this summer, it's almost certainly not the last "Comet LINEAR." The LINEAR project has discovered more than 40 new comets since 1998 and shows no signs of slowing.

Will this Comet LINEAR be worth watching? Only time will tell. The best way to find out is to go outside and look!

Making a Splash on Mars

Credit: Science @ NASA

On a planet that's colder than Antarctica and where water boils at ten degrees above freezing, how could liquid water ever exist? Scientists say a dash of salt might help.

June 29, 2000 -- Last week when scientists revealed dramatic new pictures of flood-like gullies on Mars, the big surprise wasn't that the Red Planet might harbor water. Researchers have known for years that water exists there. There are trace quantities of water *vapor* in Mars' atmosphere and substantial amounts of water *ice* at the martian poles. There may even be enough frozen water beneath Mars' surface to fill a large ocean if melted. What was amazing is that water may be present as a *liquid* very near the planet's surface and occasionally on top of the surface when underground deposits burst forth for a brief flash flood.

"We have conditions on Mars that seem to forbid liquid water very close to the surface," said Michael Carr of the USGS at the June 22, 2000, NASA press conference. "At high latitudes [where the gullies are located], the temperatures are 70 to 100 degrees centigrade below freezing. It's incredibly cold. We expect the ground to be frozen 3 to 6 km deep."

The low temperature of Mars conspires with the planet's thin atmosphere (it's 100 times thinner than Earth's) to make water possible in only two forms: solid ice and gaseous vapor. A cup of liquid water transported Star Trek-style to the surface of Mars would instantly freeze or boil (depending on the local combination of temperature and pressure). Researchers think that the water which carved the martian gullies probably boiled explosively soon after it erupted from underground

"The air pressure is so low on Mars that even in the most favorable spots, where the pressure is higher than average, liquid water is restricted to the range 0 to +10 °C," says Bob Haberle of the NASA/Ames Research Center. "Fresh water on Mars begins to boil at 10 °C. Here on Earth we can have water anywhere between 0 and 100 °C -- that range is reduced by a factor of ten on Mars."

If the thought of boiling water at 10 degrees °C seems bizarre, simply consult a high-altitude cookbook for a reality check. On mountaintops where the air pressure is low, water boils at a lower temperature than it does at sea level. (At 9000 ft a 'three-minute' boiled egg takes about five minutes to fully cook!) Mars simply takes the principles of high-altitude cooking to an extreme.

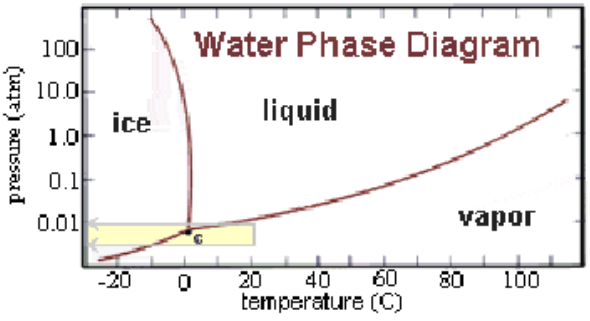
Below: Water on Mars. **A:** A 3D view of the Martian north pole created from Mars Global Surveyor laser altimeter data. The cap is composed mainly of solid water ice. [more] **B:** Wispy clouds of water ice hover over the Kasai Vallis region of Mars. [more] **C:** Ground frost (or snow) consisting of water ice at the Viking 2 landing site on Utopia Planitia.
Although any liquid water exposed to Mars' low-pressure atmosphere is likely to boil, vapor is not the most important repository of martian H_2O. If all the vapor in the present-day atmosphere rained down

on one spot, it would barely fill a small pond. On the other hand, the martian poles contain lots of water in the form of a solid. The north polar cap, composed primarily of water ice, is 1200 km across and up to 3 km thick in some places. The water volume there is about 4% of the Earth's south polar ice sheet. Even more water ice is thought lie deep underground. So, the big question is not whether water exists on Mars -- it does -- but rather is there liquid water despite the planet being so cold? The prospects for life on Mars, both human and martian, hinge on the answer.

"First of all, you have to remember that the average atmospheric pressure on Mars is very close to the triple point of water," explains Richard Hoover, an astrobiologist at the Marshall Space Flight Center. "You only have to increase the pressure a little bit to make liquid water possible."

The 'triple point' is the combination of pressure (6.1 millibars) and temperature (0.01 °C) at which water can exist simultaneously in all three states: a solid, a liquid and a gas (see the 'phase diagram' below). On Earth, our experience with the triple point is usually limited to ice skating. The temperature of ice on a skating rink is just a fraction of a degree from the triple point. A little bit of pressure on the solid ice can cause it to transform to a liquid. The weight of a skater applied to the ice along the blade of the skate therefore creates a thin layer of liquid water that lubricates the blade and makes gliding possible.

On Mars the globally-averaged surface pressure of the planet's atmosphere is only slightly less than 6.1 millibars. "That's the average," says Haberle, "so some places will have pressures that are higher than 6.1 millibars and others will be lower. If we look at sites on Mars where the pressure is a bit higher, that's where water can theoretically exist as a liquid."



Above: A phase diagram of water. The 'triple point' (labeled "C" in the diagram) is the temperature and pressure where all three types of water can exist at once. In the diagram, note that liquid water cannot exist below 6.1 millibars. This fact is significant because the atmospheric pressure at the martian surface hovers just below that value. Any water that might form on a warm afternoon from melting water would quickly disappear in the desiccated martian atmosphere.

The Triple Point of Water
A Martian Coincidence?

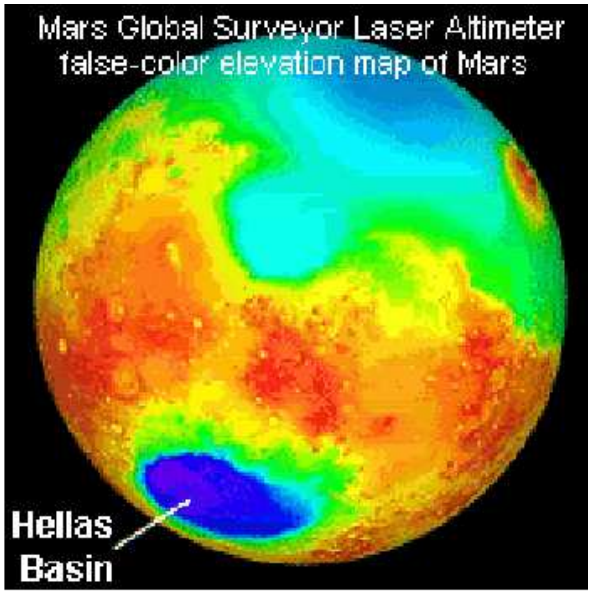
The atmospheric surface pressure on Mars is remarkably close to the triple point pressure 6.1 millibars. Is that a coincidence? Some scientists think not. If the global pressure were higher and liquid water was widespread on Mars's surface, CO2 in the atmosphere would dissolve in water and react with silicate rocks, trapping atmospheric carbon dioxide in carbonate minerals. This process would thin out the atmosphere until the pressure dropped below the triple point. Thus, the martian atmosphere could be self-limiting in this respect.

Haberle has developed a sophisticated climate model for Mars based in part on Mars Global Surveyor topography data. A simple version of the model is the basis for daily martian weather forecasts at the Ames Mars Today web site.

"I used the model to look for regions that meet the minimum requirements for liquid water -- above the triple point and below the boiling point," explained Haberle. "According to the model, the highest surface pressure, 12.4 millibars, occurs at the bottom of the Hellas Basin (a low-lying area created by an ancient asteroid strike). The problem is that the boiling temperature there is only +10 °C. It can't get very hot or the water will boil away."

Evaporation of water in contact with Mars' dry atmosphere is also a problem, says Haberle. "Liquid water can be stable against freezing and stable against boiling, but unstable with respect to evaporation. The situation is analogous to Earth's oceans. Liquid water on the surface does not freeze ... or boil, yet it can evaporate if the atmosphere is not saturated with water vapor. [more information]

"There are 5 five distinct regions where we might sometimes find surface water: in the Amazonis, Chryse and Elysium Planitia, in the Hellas Basin and



the Argyre Basin. Together they comprise about 30% of the planet's surface. That's not to say that liquid water really does exist in those places, just that it could."

Conditions would be favorable for liquid water only during the martian day. The temperature falls precipitously at night, so any liquid would re-freeze. At the Viking lander sites, for example, instruments registered temperatures as high as -17 C in the air and +27 °C in the soil on sunlit summer days. After sunset, thermometer readings plunged back to -60 °C or below.

Above: The massive Hellas impact basin in the southern hemisphere of Mars is nearly 9 kilometers deep and 2,100 kilometers across. The air pressure at the bottom of the basin is about twice the global average. In this false-color image based on measurements from the Mars Global Surveyor laser altimeter, red and white colors denote high elevations and blue denotes low.

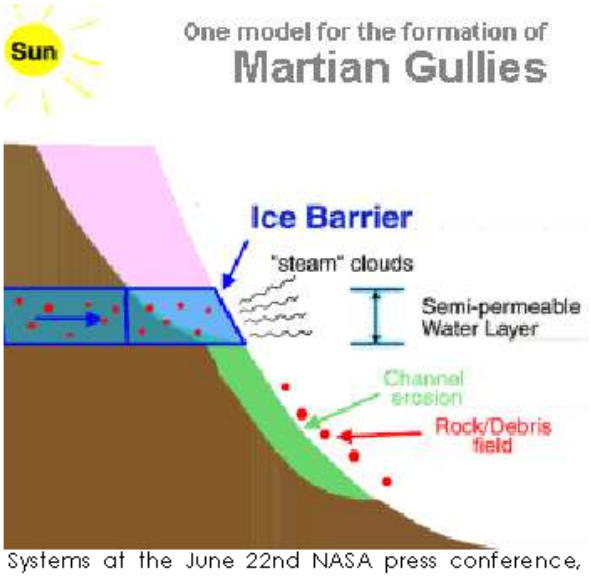
Follow the Salt...

"One thing we have to be careful of is our everyday experience that water always freezes at zero degrees," noted Hoover. "It doesn't. Water containing dissolved salts freezes at a significantly lower temperature. Don Juan Pond in Antarctica is a good example. It's a high salinity pond with liquid water at temperatures as low as -24 °C."

"Salts have the potential to significantly lower the freezing point of water," agrees Steve Clifford of the Lunar and Planetary Institute. "Indeed, there are some combinations of salts that can lower the freezing point by as much as 60 °C. However, thermodynamic and chemical stability arguments (arising from work by Benton Clark) suggest that, on Mars, the most potent freezing point-depressing brines are likely to be based on NaCl (common table salt)."

A recent analysis of a Martian meteorite by Arizona State University scientists suggests that ancient martian oceans -- if they existed -- contained a mix of salts similar to those in Earth's oceans today. That wasn't the first clue that Mars was salty, though. In 1976 the two Viking landers analyzed martian soil and found that it probably contained 10 to 20 percent salts. Martian rocks, like those on Earth, react to form salt and clay minerals when exposed to water. On our planet this process gives rise to a variety of brines in the western salt lakes of North America. The detailed chemistry of the brines depends on the composition of local rocks.

Above: This cartoon, which is based on a figure presented by Dr. Ken Edgett of Malin Space Science



Systems at the June 22nd NASA press conference, shows one way that gullies might form on Mars. Underground liquid water behind a barrier of ice erupts for a short-lived flash flood, creating the characteristic channels and aprons of martian gullies. The ice plugs are formed on the shadowed slopes of craters and ravines. Salts dissolved in the water behind the

plug could help it stay liquid.

... and go with the flow

Another way to help keep water liquid -- on Mars or Earth -- is to keep it moving.

"If you know a hard freeze is coming where you live, what's the first thing you do?" asks Hoover. "You turn your faucets on a little to let water trickle out. This way your pipes won't freeze."

The same principle applies on Mars where salty water could be moving through subterranean aquifers. "Ice is a crystal," explains Hoover, "and it's harder to form crystals when the water is flowing."

Last year, Hoover visited the Matanuska Glacier in Alaska to search for cold-loving microorganisms living in and around the ice.

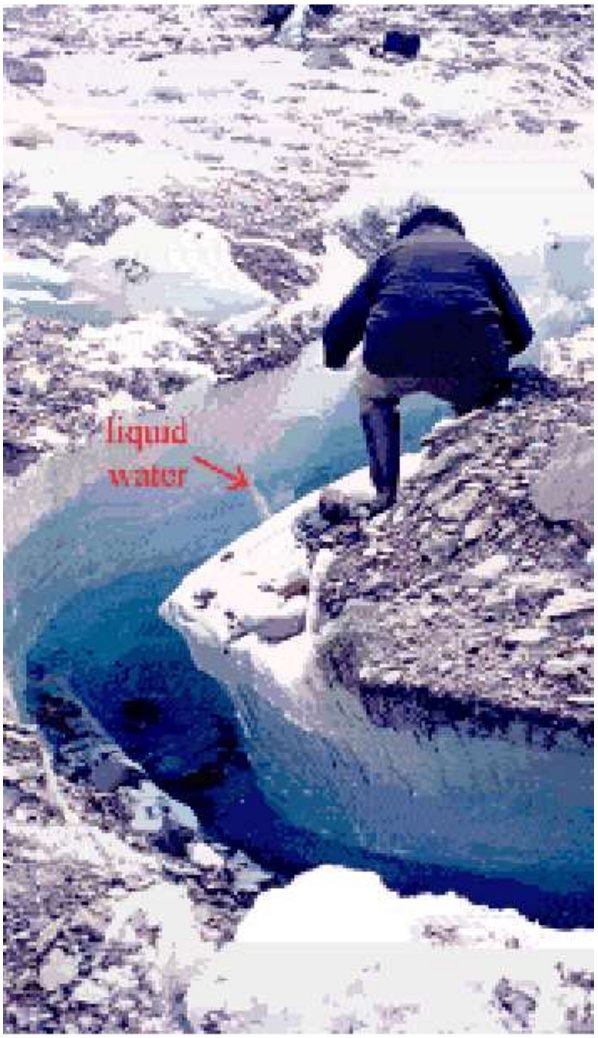
"I chose the Matanuska Glacier to visit because it's accessible and has dark rock in contact with ice," says Hoover. "The sun shining on the rock causes the ice to melt. There are pools of liquid water where microorganisms grow in abundance. There is something very interesting and exciting about this picture of me taking samples from the edge of a moulin (a water-carved crevasse). Most of what we see is ice and the air temperature is below freezing, yet there is liquid water pouring out of the glacier. How is that possible? The water had broken free further back up the glacier where sunlit rocks melted the ice. Then it flowed beneath the ice until it broke through a hole in the wall of the ice. Everything the liquid water came in contact with was freezing, yet the moving water did not freeze.

"I have also seen liquid water running from snow melting on dark rocks heated by sunlight in Antarctica, even though the air temperature was below -20 °C."

Above: Sampling ice from a moulin in the tongue of Alaska's Matanuska glacier. Orange moss can be seen growing on broken rock debris on ice ledge. (Photos Courtesy Richard B. Hoover)

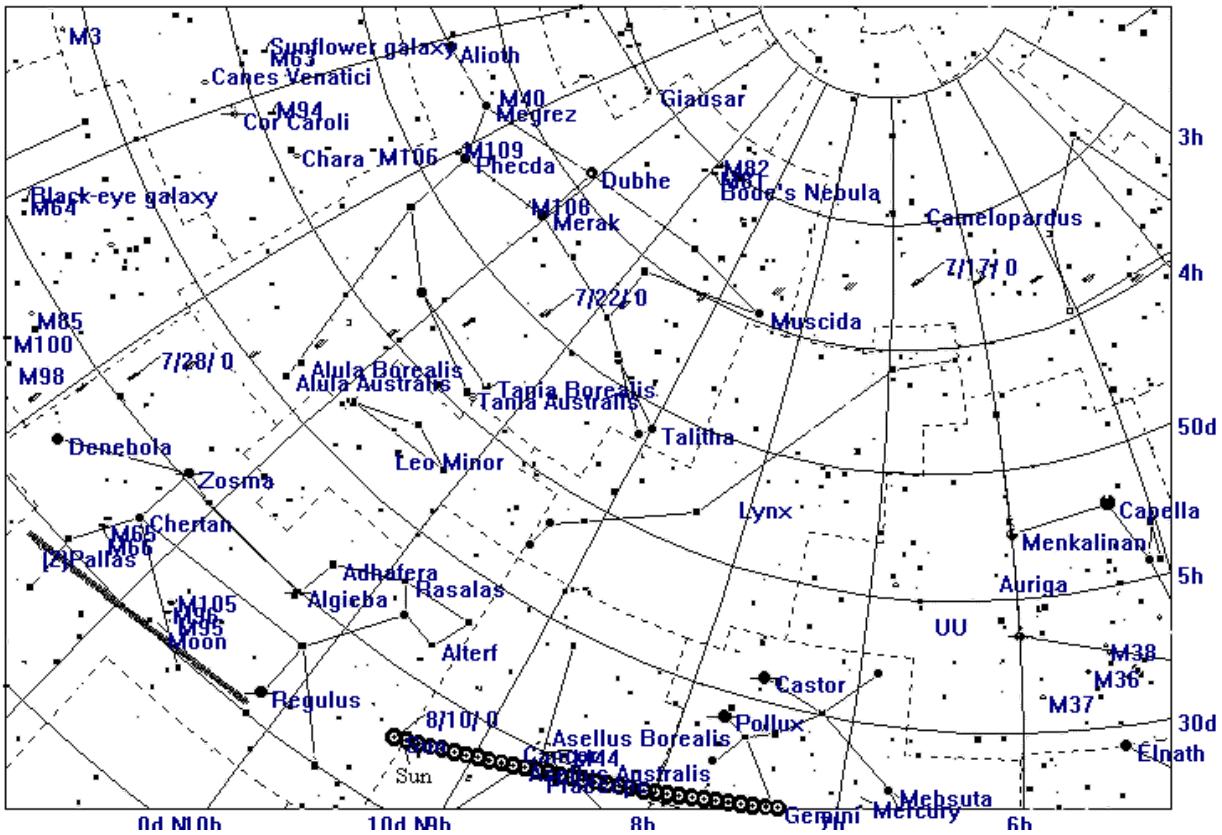
There are many places on Earth where liquid water and ice co-exist in sub-zero conditions, says Hoover. The most famous example is Lake Vostok, an expanse of water roughly the size of lake Ontario lying 4 km beneath the Antarctic ice sheet. The ice sheet acts as a blanket, shielding the lake from Mars-like temperatures at the surface.

Will explorers one day discover oases like Lake Vostok beneath icy terrain on Mars? No one knows. But instead of "Follow the Water," the mantra of future colonists on the red planet might well be "Follow the Salt."

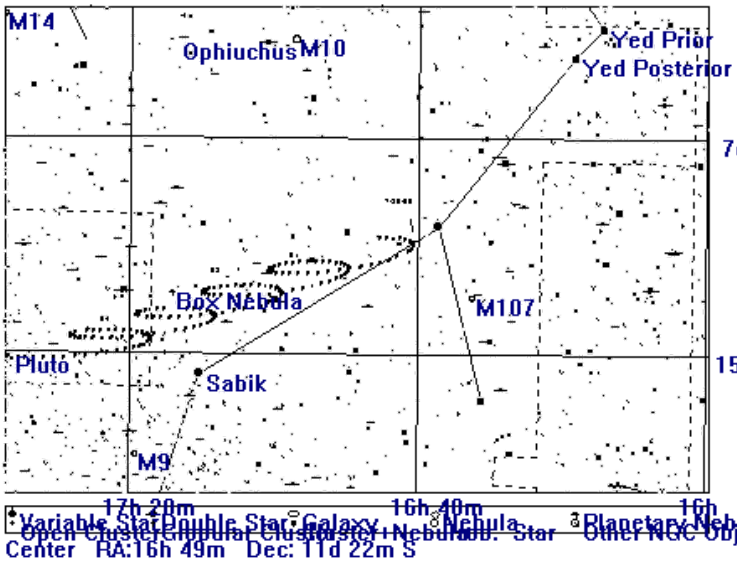


Comet Linear S4 -- 1 day interval at 10:30 pm

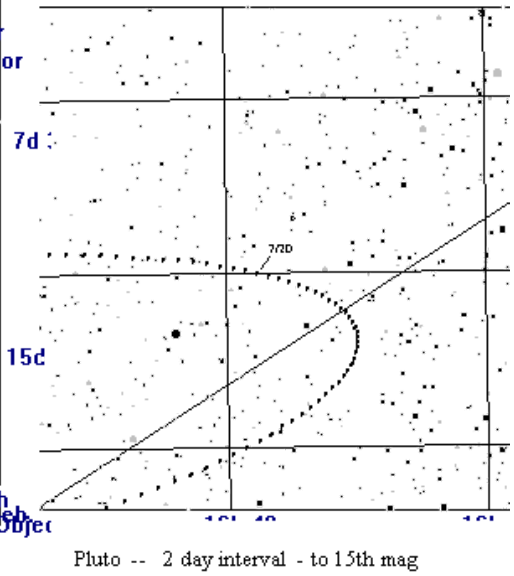
The Sky Software



Pluto in 2004 2003 02 01 2000



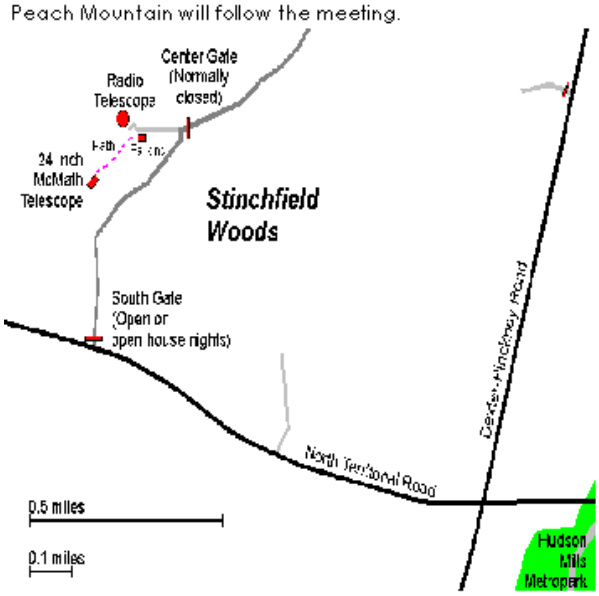
Pluto -- 10 day interval



Pluto -- 2 day interval - to 15th mag

Places and Times:

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



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 the McMath telescope building.

Public Star Parties:

Public Open House/Star Parties are held on the Saturday before and after each new Moon at the Peach Mountain Observatory. Star Parties are 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 to check on the status. Many members bring their telescopes and visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitoes - bring insect repellent, and it does get cold at night so dress warmly!
Amateur Telescope Making Group meets monthly, with the location rotating among member's houses. See the calendar on the front cover page for the time and location of next meeting.

Membership:

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students and seniors (age 55/+). 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 Charlie Nielsen at the monthly meeting or by mail at this address:
6655 Jackson Road #415
Ann Arbor MI 48103

Magazines:

Members of the University Lowbrow Astronomers can get a discount on these magazine subscriptions:
Sky and Telescope: $29.95 / year
Astronomy: $29.00 / 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. Make the check payable to "University Lowbrow Astronomers".

Newsletter Contributions:

Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call or E-mail to Newsletter Editors at:

Bernard Friberg (743)761-1875 Bfriberg@aol.com
Chris Sarnecki (734)426-5772 chrisandi@aol.com

to discuss length and format. Announcements and articles are due by the first Friday of each month.

Telephone Numbers:

President: Mark Deprest (734)662-5719
Vice Presidents: Dave Snyder (734)747-6537
Paul Walkowski (734)662-0145
Doug Warshow (734)998-1158
Treasurer: Charlie Nielsen (734)747-6585
Observatory Director: Bernard Friberg (734)761-1875
Newsletter Editors: Chris Sarnecki (734)426-5772
Bernard Friberg (734)761-1875
Parking: Lorna Simmons (734)525-5731
Keyholders: Fred Schebor (734)426-2363
Mark Deprest (734)662-5719

Lowbrow's Home Page:

http://www.astro.lsa.umich.edu/lowbrows.html
Dave Snyder, webmaster
http://www-personal.umich.edu/~dgs/lowbrows/

Monthly Meeting
July 14, 7:30 pm
Room 130 Dennison Hall
Physics & Astronomy Building
The University of Michigan

Various Members

Presents

"Lowbrows on Astro-photography"

Photo by Clay Kessler - Taken June 10, 2000 at Stargate Observatory with a 5" f9 refractor, G11, Canon F1, Canon 2X telextender. Film: Fuji NHG II - 800. Exposure: 1/125 second.

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Lowbrow's WWW Home Page:
www.astro.lsa.umich.edu/lowbrows.html

Check your membership expiration date on the mailing label !