

CANOPUS

The Astronomical Society of Southern Africa

Johannesburg Centre

Monthly Newsletter for June 2001

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**The Sir Herbert Baker Library, 18a Gill Street, Observatory, Johannesburg
P.O.Box 93145, Yeoville, 2143**

Editorial

Have you noticed how prominent Mars is now-a-days (or should I say now-a-mornings??). I've been watching with interest as it approached Antares so that I could compare the two in terms of size and colour. There really is no comparison except maybe as regards colour, and as Mars approaches opposition, the heart of the Scorpion seems to fade a little as the Red Planet glares balefully down at us from overhead in the early morning sky. Venus tries to steal the limelight, but this month we're going to ignore her and concentrate on Mars as it makes one of it's closest approaches in many years. Don't worry - if you don't get a good look this time round - the next opposition is even closer.

So with the above little introduction to our outboard neighbour, I have searched the NASA internet sites for suitable articles, and found many appropriate ones for inclusion in these pages.

We have three articles covering different aspects of Mars and the observation thereof, as well as several other small items on various topics of space exploration in general such as black holes and phantom torsos!

We had a very informative talk on Planispheres at our meeting on the 9th of May. Not only did we get to see various sorts of these very handy devices, but Claire gave us some insights into the hows and whys of designing and making your own planisphere kits.

Eben van Zyl has submitted a very interesting mathematical proof of the age of the universe. Don't be put off by the thought of the mathematics involved - it is not at all complex and even I understood the rationale and found Eben's evidence quite compelling. Read and enjoy it.

No specific variable of the month for June, but Delta Sco is still looking pretty interesting and now appears to be the second brightest star in Scorpius.

Some sad news arrived last week. Alan Cousins, a past president of the ASSA and a Gill medal awardee, died peacefully in his sleep just a few months before celebrating his 98th birthday. He will be missed by his many friends in the ASSA and we offer our condolences to his family.

The Editor - *chris@penberthy.co.za*

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Notice of Meeting

The **June** meeting of the Johannesburg Centre of the Astronomical Society will be held in the Sir Herbert Baker Library, 18a Gill Street, Observatory, on Wednesday the 13th of June, 2001 at 20:00.

Topic:

Eclipses explained

by: **a medley of speakers**

Future Meetings

July 16th (Saturday)

August 8th

September 12th

A.G.M.

Eclipse Experiences

Optical Devices

Bring 'n Braai afterwards

Miscellany of Speakers

T.B.A.

If you have any ideas for topics or subjects that you feel should be presented at future meetings of the Johannesburg Centre, please contact one of the Committee members, or email us with the details thereof.
The Editor.

Dark Sky Viewing

On the Saturday nearest New Moon at Tom Budge's Farm in the Magaliesberg. *Remember that this is by arrangement only* as most observers will be following specific viewing programmes and if you don't have your own 'scope, you should contact one of the observers (e.g. at the monthly meeting) to arrange some eyepiece time with them.

23rd June

21st July

18th August

15th September

13th October

17th November

Year End Star Party 2001

"T.B.A."

8th December (*provisionally*)

Public Viewing (*weather permitting*)

Public viewing nights are on the Friday nearest First Quarter, and are held at the Old Republic Observatory, 18a Gill Street, Observatory, Johannesburg. Starting time around 19:30. There will be no Public viewing in April as the appropriate Friday falls on a Public Holiday.

Please note that the Public viewing nights are held subject to suitable weather conditions.

29th June

27th July

24th August

21st September

19th October

23rd November

Annual General Meeting.

We are proposing once again to hold the A.G.M. on a Saturday to encourage members to attend and enjoy a bring 'n braai as soon as the Society business is finished (hopefully no more than an hour). We will also be opening the "Mars Bar" and the Domes and hope some of you will bring your 'scopes along as the time of the year (if not the lighting) lends itself to clear viewing.

The meeting starts 18:00, and the society reports and election of the new committee should take no longer than an hour - we should be braaing and socialising shortly thereafter.

If there are any alternative suggestions regarding the date and format of this year's A.G.M. please let the committee know (SOON) so that we may discuss them and maybe use your ideas instead.

Please give some thought to which persons you would like to elect to committee for the 2001/2 period and make sure that they themselves are willing to serve before you nominate them.

Jo'burg Centre Outings for 2001

Your Committee is making arrangements for several outings during the year. Amongst these are some old favourites as well as a couple of new ones which should prove interesting.

Nylsvlei - we have a booking for the weekend of the 14th - 16th September for 30 people.

You may contact Ed Finlay on 083-449-1103 if you wish to book a place on this outing.

Boyden - We are busy attempting to negotiate a suitable weekend with Martie Hoffman.

Haartebeeshoek - Saturday 21st of July at 16:00. (Just be by the main gate from about 15:45).

Please contact Wolf Lange on 849-6020 or 636-4725 to supply numbers & remember to bring along briquettes/fire starters/matches as well as eats & drinks for the braai afterwards.

A visit to the Suikerbosrand Nature Reserve.

Tswaing Crater - still trying to set up a day visit under the guidance of Prof. Reimold

Other ASSA Centres (e.g. the Pretoria Centre) - and try to see if we can organise some joint ventures.

Telescope Making Classes

Would you like to make your own telescope?...or finish off a partially finished one? Well your opportunity has arrived (once again). Join the Telescope Making Class being held under the guidance of Brian, Evan and Chris. Contact Brian on 803-8291 if you are interested.

Eclipse Book Auction

One of Brian Fraser's Eclipse tourists has donated 14 special, out-of-print and never to be reprinted, Eclipse books to the Society and your committee has decided to allow members to submit bids to purchase these rare items.

These books are commercially worth between R120 and R150 depending on the Rand/Dollar exchange rate but it could be argued that they are worth more as they will no longer be available in bookshops.

If you are interested in purchasing one of these books, please submit your bid, by post or by hand to a committee member in a sealed envelope and these will be collected to be opened at the June monthly meeting. Cut-off time for the arrival of bids is 20:00 on the evening of 13th June 2001. (*Best not to trust the postal service!*)

The envelopes will be opened during the meeting, and ranked according to the bids presented. The lucky purchasers will be advised (by phone if not at the meeting) and will then have to make payment to the Jo'burg Centre's within 3 days. If this is *NOT* done, the person will forfeit their right to purchase which will then be allocated to the next person on the list.

Please supply your name and contact details on your bid, as well as the price that you are willing to pay for the book.

Please do not send cash with your bid.

For further details contact a committee member as per the table under the Editorial.

THE AGE OF THE UNIVERSE

(Here follows a mathematical proof of the age of the universe)

It has been found that the bodies comprising the Solar System accreted somewhere about 4,6 milliard years ago ($4,6 \times 10^9$) from the material spewed out by the last maximum of supernova explosions which, according to D N Schramm in his "The Age of the Elements" took place 5 milliard years ago (5×10^9). From this material the Sun and the stars in its neighbourhood (the third generation of stars) together with their planets, including the Earth and everything on it were formed and life originated and developed and evolved until today the Earth can boast a technological civilisation, a civilisation which has the capability of destroying all life on the planet. We are therefore supernova material! We once had a temperature of hundreds of millions of degrees!

Schramm also found that a first maximum of supernova explosions took place 9 milliard (9×10^9) years ago. He worked this out by research on the ages of radioactive elements such as uranium, thorium, radium, etc. These elements undergo spontaneous disintegration whereby they eject particles such as nuclei of helium ${}^2\text{He}$ as well as protons, electrons and gamma-rays. The rates of decay of these elements are not in the slightest affected by external conditions such as temperature and pressure. Each of these radioactive elements has a fixed half-life period - the time required for half of its atoms to decay, e.g. uranium has a half-life period of $4,56 \times 10^9$ years; thorium $1,34 \times 10^9$ years, radium 1590 years, according to J D Stranathan in "The Particles of Modern Physics". Since these half-life periods are constant, the ages of the deposits of radioactive ores can be very accurately measured, by measuring the amounts of decayed products (in all cases base lead) found in the ores. Uranium in the Lunar rocks dated the material from the Maria as $4,6 \times 10^9$ years and that of the Lunar Highlands as $3,9 \times 10^9$ years. The greatest age that has been found for Earth rocks is $3,9 \times 10^9$ years, as old as the Lunar Highlands. The Lunar Maria have a greater age because their surfaces consist of lava which welled up when massive bodies crashed on to the Moon, thereby flooding the surrounding highlands and submerging them.

By means of the redshift of the spectral lines the distances of far-off galaxies and quasars have been determined. If the distance of a quasar is, for example 5×10^9 light-years, then that quasar must be at least 5×10^9 years old. When the redshift of the spectral lines has been determined, the distance can be calculated by using Einstein's equation and Hubble's Law. Einstein's equation gives the speed of recession of the far-off object. All distant objects are receding from us and Hubble's Law states that the speed of recession is proportional to the distance.

The redshift can be easily determined because it is the fraction by which the spectral lines have been shifted to the red end of the spectrum. If the spectrum line shows a wavelength of λ whereas the wavelength at rest is λ_0 then the redshift is given simply by:

$$z = \frac{\lambda - \lambda_0}{\lambda_0}$$

If quasar 3C 273, for example has a redshift $z = 0,16$, then Einstein's equation gives:

$(1 + z)^2 = \frac{c + v}{c - v}$ where c is the speed of light (300 000 km per sec.) and v is the speed of recession of the body. The redshift of quasar 3C 273 is 0,16. Therefore

$$(1 + 0,16)^2 = \frac{c + v}{c - v}, \text{ i.e. } (1,3456)(c - v) = c + v.$$

Therefore $0,3456 c = 2,3456 v$. Thus:

$$\frac{v}{c} = \frac{0,3456}{2,3456} = 0,147 = 14,7\% \text{ of the speed of}$$

light.

Quasar 3C 273 therefore has a speed of recession of 14,7 percent of the speed of light i.e. 0,147 x 300 000 km per sec.

Hubble's Law states $V = H_0 D$ where V the speed of recession and H_0 is the Hubble constant. Various values have been found for the for the Hubble constant, from 55 to 100 km per sec. per megaparsec. Let us use a good average of 75 km per sec. per megaparsec.

$V = H_o D$, $\therefore D = \frac{V}{H_o}$ where $V = 0.147 \times 3000\ 000$ and $H_o = 75$ km per sec. per megaparsec.

We have to multiply by 3,26 to convert parsecs into light years and divide by 1000 to obtain milliards. Therefore:

$$D = \frac{V}{H_o} = \frac{0,147 \times 3000000}{75} \times \frac{3,26}{1000} = 1,917 \text{ milliard}$$

light years. Distance divided by speed is equal to time, i.e. the time that the light has been on the journey from the quasar to us.

The age of the quasar therefore CANNOT BE LESS THAN THIS AMOUNT OF TIME.

So we have $1,917 + 0,147 = 13,04$ milliard years. We see that this value is obtained for all the quasars listed in the table and this value 13,04 is therefore the age of the universe in milliards of years (10^9).

If we use $H_o = 55$ we obtain an age of 17,78, and if we use H_o equal to 100 we obtain an age of 9,78 milliard years. This latter value allows very little time for the first stars to develop to the supernova stage which took place 9×10^9 years ago. The most reasonable value for the age of the universe is therefore 13 milliard years (13×10^9).

Quasar	Redshift	Speed of recession % c = S	Distance 10^9 l.y. = D	Time = Age D ÷ S
PG 0804+76	0,19	9,5	1,239	13,04
3C 273	0,16	14,7	1,917	13,04
3C 48	0,37	30,5	3,997	13,10
3C 295	0,46	36,1	4,707	13,04
3C 345	0,59	43,3	5,646	13,04
PKS1127-14	1,19	65,5	8,541	13,04
3C 446	1,40	70,4	9,180	13,04
PHS 1616-77	1,71	76,0	9,910	13,04
3C 9	2,00	80,0	10,432	13,04
PHL 957	2,69	86,0	11,214	13,04
DHM0054-28,4	3,61	91,0	11,860	13,03

From the table we see that the speed of recession increases as the redshift increases. Also that the distance gets nearer and nearer to the value 13,04. When the speed of recession equals the speed of light, the distance will be 13,04 milliard light years!

Jan Eben van Zyl

The Phantom Torso

NASA Science News for May 4, 2001

An unusual space traveler named Fred is orbiting Earth on board the International Space Station. His job? To keep astronauts safe from space radiation.

If you have access to the World Wide Web, you can find the full story at the following URL:

http://science.nasa.gov/headlines/y2001/ast04may_1.htm?list40309

GENETICALLY MODIFIED EARTH PLANTS WILL GLOW FROM MARS

University of Florida scientists hope to send smart plants into space

By Paul Kimpel

GAINESVILLE, Fla. -- In what reads like a story from a 1950s science fiction magazine, a team of University of Florida scientists has genetically modified a tiny plant to send reports back from Mars in a most unworldly way: by emitting an eerie, fluorescent glow.

If all goes as planned, 10 varieties of the plant could be on their way to the Red Planet as part of a \$300 million mission scheduled for 2007.

The plant experiment, which is funded by \$290,000 from NASA's Human Exploration and Development in Space program, may be a first step toward making Mars habitable for humans, said Rob Ferl, assistant director of the Biotechnology Program at UF.

Ferl and a team of molecular biologists chose as their subject the Arabidopsis mustard plant. They picked it, Ferl said, because of three attributes that make it ideally suited for the Mars mission: Its maximum height is 8 inches, its life cycle is only one month and its entire genome has been mapped. Moreover, in December 2000 it became the first plant to have its genetic sequence completed.

To create the glow, the team will insert "reporter genes" into varieties of the plant, which will express themselves by emitting a green glow under adverse conditions on Mars. Each reporter gene will react to an environmental stressor such as drought, disease or temperature. For example, one version will glow an incandescent green if it detects an excess of heavy metals in the Martian soil; another will turn blue in the presence of peroxides. In fact, one of the reporter genes itself is somewhat otherworldly, having come from the depths of the ocean.

"What makes the plants glow blue is a protein derived from an incandescent jellyfish whose DNA is spliced into the mustard plant," Ferl said. "The implanted DNA then synthesizes the iridescent blue protein in the plant, which expresses itself under stress."

Ferl's team, in collaboration with Andrew Schuerger, a manager of Mars projects at the Kennedy Space Center-based Dynamac Corp., is competing with other biologists to receive the NASA contract for the Mars trip.

But both men, who also are professors at UF's Institute of Food and Agricultural Sciences, have worked with NASA before. In 1999, Ferl sent 40 reporter-gene plants into orbit aboard the space shuttle. On that flight, gravity had an adverse effect on the plants' ability to utilize water, a condition called "space adaptation syndrome."

The scientists are using that experience to engineer smarter plants.

"Just like humans, plants must learn how to adapt to a new environment," Ferl said. "We are using genetics to create plants that have the ability to give us data we can use to help them survive."

The 2 1/2-year Mars mission -- nine months traveling 286 million miles each way and one year stationed on the planet -- would work like this: The seeds of the plant would make the trip aboard a spacecraft similar to NASA's Mars Odyssey, which was launched April 7. Upon arrival, the landing vehicle's robot would scoop up a portion of Martian soil, and the scientists will analyze it using the robot and a specialized camera. After modifying the soil with fertilizers, buffers and nutrients, the scientists will germinate the seeds and grow the plants in a miniature greenhouse on the landing vehicle.

Despite working with alien soil they know little about, the biologists are optimistic about the experiment.

"I'm confident we can grow plants if we know the pH levels and the oxidizing agents in the Martian soil," Schuerger said. "We'll test the soil before planting, and then we can raise or lower pH, flush excess salts and add nutrients as needed."

As for long-term plans, Ferl and Schuerger have worked together on a concept called "terraforming" or "ecosynthesis," which would use plants to reduce the carbon dioxide in the Martian atmosphere and produce oxygen for life processes. Although the plants are genetically engineered to detect -- and then adapt to -- certain environmental stressors, terraforming presents additional obstacles.

Schuerger said that on Mars, daily temperatures range from a high of 45 degrees Fahrenheit at noon to a low of minus 170 degrees at night.

Also, the planet's moisture content is 0.3 percent, which is extremely low.

But Ferl, Schuerger and the rest of the team are taking all bettors.

"I have no doubt that we can get plants to survive on Mars," Ferl said. "When we do, we will have shown that Earth-evolved life is capable of thriving in distant worlds, and we will have set the stage for human colonization."

The Great Mars Rush

NASA Science News

Hurting toward Mars at 22,000 mph, Earth is heading for its closest encounter with the Red Planet in a dozen years.

Once in about every fifteen years a startling visitant makes his appearance upon our midnight Skies --a great red star that ... mounting higher with the deepening night, blazes forth against the dark background of space with a splendor that outshines Sirius and rivals the giant Jupiter himself. -- from Mars by Percival Lowell (1895)

May 15, 2001 -- By the time you finish reading this sentence, you'll be 50 kilometers closer to the Red Planet.

Earth and Mars are converging at 10 km/s (22,000 mph) as the pair head for a close encounter next month. On June 21st Mars will lie just 68 million km from Earth -- the nearest it's been in a dozen years.

"The next few months will be a great time to look at Mars," says astronomy professor George Lebo, a NASA Summer Faculty Fellow at the Marshall Space Flight Center. "You won't need a telescope to see it. By early June Mars will outshine everything except Venus, the Moon, and the Sun itself."

Mars is already a brilliant morning star. Early rising observers in the northern hemisphere can spot the Red Planet about 30 degrees above the southern horizon. Sky watchers south of the equator will see Mars arcing high overhead before dawn. In either hemisphere, the planet is easy to pick out near the spout of the teapot-shaped constellation Sagittarius. Mars is bright and doesn't twinkle like a real star -- its steady copper-hued gaze is unmistakable.

In the weeks ahead the Red Planet will grow even brighter as it approaches opposition on June 13th, the date when Earth and Mars are lined up on the same side of the Sun. Astronomers call the arrangement opposition because Mars and the

Sun will lie on opposite sides of our planet's sky. Mars is at opposition once every 26 months.

If the orbits of Mars and Earth were perfectly circular, then the distance between two planets would be least at the moment of opposition. But that's not the case. Earth's orbit is slightly elliptical and the Martian orbit is substantially more so. As a result, our closest approach to Mars won't happen until eight days later on June 21st.

By that time Mars will no longer be a morning star -- it'll be a dazzling "all-nighter," rising near sunset and reaching its highest point in the sky at midnight. Modest telescopes will reveal normally invisible details including Martian clouds and icy polar caps. See Sky and Telescope's "A Grand Return of Mars" for more information.

Throughout the coming months Mars will linger in a region of the sky that's home to the very center of our galaxy. This will be a treat for dark sky observers who can see the faint Milky Way, a hazy band of stars that bisects the sky along the galactic plane. The Milky Way cuts through Sagittarius and brightens near the spout of the teapot -- right by Mars! There lies the galactic center, the lair of a supermassive black hole around which our entire pinwheel galaxy spins.

Despite their proximity in the sky, Mars and the galactic center are really very far apart. A spacecraft from Earth traveling at light speed would arrive at the Red Planet in only a few minutes. Reaching the inner regions of our galaxy would take an extra 30,000 years!

If spacecraft could travel at the speed of light, we could visit Mars any time we wished. However, NASA's advanced propulsion systems aren't yet that advanced. We have to choose our opportunities carefully and visit Mars when the planet is nearby -- in other words, at opposition.

NASA's latest Mars probe, 2001 Mars Odyssey, blasted off on April 7th and it's hurtling toward the Red Planet even faster than we are. Earth's

approach will slow and then reverse as Mars reaches opposition in June, but Mars Odyssey will continue until it enters Mars orbit on October 24th. During the probe's two and a half year mission, it will monitor space radiation, seek out underground water, and identify interesting minerals on the Martian terrain.

Because of Mars' eccentric orbit, not all oppositions are alike. At the next one, on August 28, 2003, Mars and Earth will be just 56 million km apart -- closer than any opposition since 1924. It will be the perfect time to send a new batch of robotic explorers to Mars. Indeed,

NASA plans to launch a pair of Mars Exploration Rovers in 2003, and the European Space Agency will send a lander of its own, the Beagle 2, which will ride to Mars on board the Mars Express Mission.

Favorable oppositions of Mars recur with a 15-to-16 year cycle. Perhaps the series of close encounters 15 years from now could be our first opportunity to send humans to the Red Planet!

Meanwhile, don't miss the ongoing show. Mars is out there now, fiery red and beckoning from your own back yard!

BLACK HOLES MAY TAKE SPACE FOR A SPIN

NASANews

RELEASE:01-86

As if black holes weren't menacing enough, astronomers now have observational evidence that at least some of them spin about like whirlpools, wrapping up the fabric of space with them.

Dr. Tod Strohmayer of NASA's Goddard Space Flight Center, Greenbelt, MD, has studied one such black hole system with NASA's Rossi X-ray Timing Explorer and found unique patterns in the X-ray radiation that have previously only been seen in spinning neutron stars. With these new parameters, he could verify that a black hole, like a neutron star, can spin.

The observation also challenges theories about neutron star radiation. Strohmayer presents his findings today at the American Physical Society Spring Meeting in Washington, D.C. Computer animation illustrating the discovery will be broadcast on NASA TV at noon EDT today.

"Almost every kind of object in space spins, such as planets, stars, and galaxies," said Strohmayer. "With black holes, it's much harder to directly see that they are spinning, because they don't have a solid surface that you can watch spin around. We can, however, see the light emitted from matter plunging into the black hole. The matter whips frantically around the black hole before it is lost forever."

The black hole that Strohmayer observed is the stellar variety, which is formed from a collapsed star. When stars at least 10 times more massive than our Sun exhaust their fuel supply, they no longer have the energy to support their

tremendous bulk. These stars explode their outer shell of gas in an event called a supernova.

The remaining bulk, still several times more massive than the Sun, collapses into a single point of infinite density, called a singularity. Neutron stars form through a similar process, only from a slightly less massive star in which the inner core collapses into a dense chunk as heavy as the Sun yet only 10 miles across.

The Rossi Explorer, launched December 1995, has long recorded a certain type of X-ray flickering from neutron stars called quasiperiodic oscillations, or QPOs, caused by hot gas dancing around the neutron star in a lively orbit. Astronomers think that these oscillations are produced by motions of matter very near the innermost stable orbit -- the closest orbit a blob of gas can maintain before falling into the central object.

Strohmayer's target was GRO J1655-40, a microquasar 10,000 light years from Earth. A microquasar is a specific type of black hole with jets of high-speed particles shooting perpendicularly from the plane of matter that orbits it. Strohmayer observed two QPOs, a previously detected one at about 300 Hertz (Hz) and a newly detected one at 450 Hz. (A hertz is a unit of frequency equal to one cycle per second.)

The black hole mass has been established at seven times the mass of our Sun from earlier optical observations of GRO J1655-40. "A spinning black hole modifies the fabric of space near it," said Strohmayer. "The spinning allows matter to orbit at a closer distance than if it were

not spinning, and the closer matter can get the faster it can orbit. For GRO J1655-40 we can now say that the only way for it to produce the 450 Hz oscillations is if it is spinning."

Strohmayer's finding also marks the first detection of paired QPOs from a black hole. Neutron stars often exhibit paired QPOs, and this is thought to be a result of radiation coming from the solid neutron star surface.

Strohmayer's detection of paired QPOs from an object with no solid surface, therefore, challenges these important theories of how neutron stars produce these QPOs. The spin of a black hole would be caused by the angular momentum of the star that formed it, Strohmayer said, particularly if that progenitor is a spinning neutron star.

Additional information and artistic concepts are available on the Internet at:

http://heasarc.gsfc.nasa.gov/docs/xte/learning_center/

<http://www.gsfc.nasa.gov/GSFC/SpaceSci/structure/spinningbh/spinningbh.htm>

Swept away: Study suggests massive water erosion of Mars' highlands

Washington University in St. Louis

News Release

St. Louis, Mo., May 16, 2001 -- Massive erosion shaped the surface of Mars, according to planetary scientists at Washington University in St. Louis.

Brian M. Hynek, doctoral candidate in Earth and Planetary Sciences, and Roger J. Phillips, Ph.D., professor of earth and planetary sciences and director of Washington University's McDonnell Center for the Space Sciences, suggest that western Arabia Terra, an area the size of the European continent, experienced an extensive erosion event caused by flowing water.

"We argue that this entire region has been massively eroded," said Hynek. "The region used to look like the rest of the highlands, but a vertical kilometer of material - enough to fill the Gulf of Mexico - has been relocated downslope and spread out into the northern plains."

The researchers used high-resolution topographic data from the Mars Orbiter Laser Altimeter (MOLA) instrument on the Mars Global Surveyor mission to construct detailed maps of the planet's surface. "Before this mission, topography was known only within a kilometer at best; now we are accurate to within half a meter at any given point on the surface of Mars," said Hynek.

MOLA's accuracy, and the more than half a billion data points it has collected, reveals many previously unknown features of Mars' surface. The research was published in the May issue of the journal *Geology*.

Mars is divided into two main areas: the older Southern Highlands with lots of craters and valley networks, and the younger Northern

Lowlands with few craters and no valley networks.

When the researchers began studying maps from the new data, they noticed that one region, western Arabia Terra, is a kilometer lower than the rest of the highlands and borders the lowlands to the north. Before the Mars Global Surveyor mission, this region was lumped in with the rest of the highlands. But the new topography reveals that there is much more going on here than previously thought. Looking carefully at western Arabia, they noticed that it differs from the rest of the highlands in having very few large craters, and only a few traces of valley networks, and numerous erosional remnants. "This combination makes it very likely that the entire region was swept away," said Hynek.

But how can you remove all this material and carry it away?

"Lots of things can erode planets. Wind is very effective on long timescales; volcanoes, ice and glaciers can all erode features, but on this large of a scale these are unlikely explanations," said Hynek. He said that the massive size of the eroded area and the remnants of valley networks suggest running water was responsible.

The researchers believe the erosion event took place very early in Mars' history, during the Late Noachian, and ended by around 3.8 to 3.5 million years ago. The timing coincides with other water features found on the planet and heavy outflow of lava from volcanoes early in Mars' history, as the researchers noted in the journal *Science* earlier this year. Volcanic eruptions emit great amounts of water, carbon dioxide, sulfur and other

greenhouse gases as well as lava and ash. This could have led to the development of an atmosphere on Mars that persisted for a few hundred million years - long enough to raise surface temperature above freezing and maintain liquid water on the planet's surface.

"Mars has not always been cold and dry with little happening on the surface. At one time it had a heyday," said Hynek.

The researchers are now focusing attention on a large outcrop of hematite occurring within western Arabia Terra, the Terra Meridiani region. Hematite, an iron oxide, forms in the presence of water on Earth.

"This is very likely to be one of two Mars Rover landing sites in 2004," said Hynek. "We want to go where the water was."

NASA ESTABLISHES CONTACT WITH FAMED PIONEER 10 SPACECRAFT

NASA News

RELEASE: 01-28AR

NASA scientists have announced that they have contacted Pioneer 10, the plucky small spacecraft launched 29 years ago, ending speculation that its signal had finally fallen silent.

In a test of communication technologies for future interstellar missions, scientists operating a radio telescope antenna in Madrid, Spain established contact with the small spacecraft on Saturday, April 28, 2001 at 10:27 a.m. PDT (GMT 17:27:30). It was the first time the spacecraft had been heard since August of 2000.

"Pioneer 10 lives on," declared Pioneer 10 Project Manager Dr. Larry Lasher of NASA Ames Research Center, Moffett Field, CA. "The fact that we can still stay connected with the spacecraft is fantastic. We are overjoyed," Lasher added.

"We have been listening for the Pioneer 10 signal in a one-way downlink non-coherent transmission mode since last summer with no success," Lasher said. "We therefore concluded that in order for Pioneer 10 to talk to us, we need to talk to it." A signal was sent to the spacecraft, which locked onto it and returned a signal to the Madrid facility.

Now orbiting 7 billion miles from Earth, well outside the solar system, Pioneer 10 was launched on March 2, 1972. Pioneer 10 was the first spacecraft to pass through the asteroid belt and the first to obtain close-up images of Jupiter.

During the passage by Jupiter, Pioneer 10 also charted Jupiter's intense radiation belts, located the planet's magnetic field, and discovered that Jupiter is predominantly a liquid planet. Following its encounter with Jupiter, Pioneer 10 explored the outer regions of the solar system, studying energetic particles from the sun, and cosmic rays entering our portion of the Milky Way. In 1983, it became the first man-made object to leave the solar system when it passed the orbit of distant Pluto. The spacecraft continued to make valuable scientific investigations in the outer regions of our solar system until its mission ended on March 31, 1997. When the mission formally ended, Pioneer 10 was at a distance of 6.28 billion miles (10.10 billion km) from Earth. At that distance, it took over 9 hours 43 minutes for the radio signal (traveling at the speed of light) to reach Earth.

Pioneer 10 carries the now-famous gold plaque with an image of a man and a woman and goodwill information about Earth. Pioneer 10 is currently 7.29 billion miles from Earth, traveling at 27,830 miles per hour, relative to the sun. At that distance, the signals take 21 hours 45 minutes to make the round trip between Earth and the spacecraft. Pioneer 10's weak signal continues to be tracked by the Deep Space Network as it heads toward the constellation Taurus, where it will pass the nearest star in about 2 million years.

Further information about Pioneer 10 is available on the Pioneer 10 website located at:

http://spaceprojects.arc.nasa.gov/Space_Projects/pioneer/PNhome.html

The Sky this Month

June 2001

dd hh	dd hh
4 09 Mercury stationary	17 23 Venus 1.7 N of Moon
4 10 Pluto at opposition	18 18 Mercury 3.7 S of Jupiter
6 02 FULL MOON	19 22 Saturn 0.0 N of Moon Occn.
6 19 Mars 3.9 S of Moon	21 00 Mercury 3.1 S of Moon
8 09 Venus greatest elong. W(46)	21 03 Jupiter 0.9 N of Moon Occn.
10 08 Neptune 3.0 N of Moon	21 07 Solstice
11 16 Uranus 3.3 N of Moon	21 12 NEW MOON Eclipse
11 17 Moon at apogee	21 23 Mars nearest to Earth
13 17 Mars at opposition	23 17 Moon at perigee
14 04 LAST QUARTER	28 03 FIRST QUARTER
14 13 Jupiter in conj. with Sun	28 04 Mercury stationary
16 14 Mercury in inferior conjn.	

July 2001

dd hh	dd hh
3 11 Mars 6.0 S of Moon	17 13 Saturn 0.7 N of Moon Occn.
4 22 Earth at Aphelion	17 18 Venus 0.3 S of Moon Occn.
5 16 FULL MOON Eclipse	19 00 Jupiter 0.2 N of Moon Occn.
7 14 Neptune 2.9 N of Moon	19 13 Mercury 0.9 S of Moon Occn.
8 22 Uranus 3.3 N of Moon	19 22 Mars stationary
9 08 Moon at apogee	20 20 NEW MOON
9 19 Mercury greatest elong. W(21)	21 22 Moon at perigee
12 15 Mercury 2.1 S of Jupiter	27 02 Mercury greatest brilliancy
13 08 Saturn 3.9 N of Aldebaran	27 10 FIRST QUARTER
13 20 LAST QUARTER	27 15 Mercury 6.1 S of Pollux
15 00 Venus 3.1 N of Aldebaran	30 11 Neptune at opposition
15 05 Venus 0.8 S of Saturn	30 14 Mars 6.3 S of Moon

LOCAL TIMES of RISE and SET for the MAJOR PLANETS, 2001

Site Location:- Long. **+28.0** deg. Lat. **-26.0** deg.

Local Time:- UT **+2.0** hrs.

Date	Sun		Mercury		Venus		Mars		Jupiter		Saturn	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Jun 10	06.52	17.22	07.31	18.07	03.20	14.45	17.28	07.26	07.06	17.37	05.51	16.36
Jun 20	06.55	17.23	06.24	17.11	03.26	14.38	16.33	06.33	06.37	17.07	05.17	16.01
Jun 30	06.57	17.26	05.34	16.24	03.34	14.35	15.40	05.40	06.08	16.37	04.43	15.27
Jul 10	06.56	17.30	05.22	16.03	03.44	14.34	14.52	04.52	05.38	16.08	04.09	14.52
Jul 20	06.54	17.34	05.44	16.16	03.55	14.37	14.09	04.10	05.09	15.38	03.35	14.16
Jul 30	06.49	17.39	06.25	17.02	04.06	14.43	13.33	03.33	04.38	15.08	03.00	13.41