# CANOPUS

**The Astronomical Society of Southern Africa**

**Johannesburg Centre**

**Monthly Newsletter for December 2001**

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

## Contents:



Cover Photograph "*Sunset at Frankfort*" courtesy of **Dave Gordon**

# Editorial

The summer rains have arrived with a vengeance!!! This November has headed into the distant realms of the Guinness Book of Wetness Records. There has hardly been a clear night the whole month and our annual Star Party and Leonids watch turned out to be a bit of a "damp" squib – a very enjoyable evening all the same, but the only showers observed were those falling from the clouds and not from outer space. Not *really* true - we did manage an hour or so of observing before the clouds covered the skies once again.

**Mars Odyssey** is well and truly into the aerobraking phase of its mission, and has already observed some interesting phenomena, especially regarding a strange vortex surrounding the Martian North Pole. There is an interesting article from Space.com regarding this discovery.

**Eben van Zyl** turns to radio astronomy in his article "Another Turning Point in Astronomy" where he tells us of the discovery of and the further development of this branch of our special interest, while **Mary MacKinnon** report back on the visit last month to the research facility at Pelindaba.

**Eric Brindeau** supplies another answer to Val's question regarding the Speed of Light presenting a philosophical point of view, and **Brian Fraser** has supplied us with a general guide to the skies above for the next ***12*** months. Not all of the tables he has supplied will be printed in this issue, however, they will be uploaded to our web pages as a reference for those who need more than 2 months worth of data at a time.

Also within this issue's pages, an article from **Bill Sheehan**, covering the talk he gave while visiting us from the U.S. of A some couple of months back - thanks for the article Bill.

Those of you who receive this issue of Canopus are the ones who have paid your dues. There are still many members who have not done so for this ASSA year, and unfortunately we cannot continue to supply them with copies of our magazine without the funds used in the production and posting thereof.

As this first year of the new millennium draws to a close, we reflect back on the events of the last few months and fervently hope that the century ahead does not follow the same pattern. There is so much to be gained from research "out there" for mankind, and Bill Wheaton put it most succinctly when he quoted Carl Sagan's words on "the Pale Blue Dot" in the October issue. We really are a small number of people on a small planet circling a small star in an immense Universe . . . . . our petty squabbles and attempts at self glorification really make no mark on the immensity of space and time and we should spend more time in research for the improvement of life for *all* the peoples of this beautiful planet, our home in the universe, rather than in attempting the destruction thereof.

***The Committee** wishes you all well over the festive season - have a safe and happy holiday.*

*The Editor*

*chris@penberthy.co.za*

## Notice of Monthly Meeting

The Monthly 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 12th of December, 2001 at 20:00.

## Cheese and Wine evening

*There is no formal speaker for the evening – rather, it is an evening where we can get to know each other in a less formal atmosphere and discuss items of common Astronomical interest*

### 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 (016) 366-0955 if you are interested.

*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.*

### Public Viewing *( weather permitting )*

Public viewing nights are held *subject to suitable weather conditions* on the Friday nearest First Quarter, and are held at the Old Republic Observatory, 18a Gill Street, Observatory, Johannesburg. Starting time around 19:30. *See the ASSA event calendar for the proposed viewing dates.*

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# ASSA Jo'burg Centre - Calendar of Events

| Month | Day/ Date | Event | Details |
|---|---|---|---|
| Dec 2001 | Mon 10 | Committee Meeting 17:30 | |
| | Wed 12 | **Monthly Meeting** | Cheese and Wine/ Social |
| | Sat 22 | Vergenoeg Mine visit | |
| Jan 2002 | Mon 7 | Committee Meeting 17:30 | |
| | Wed 9 | **Monthly Meeting** | Tom Marsicano / Multiwave Astronomy |
| | Fri 18 | Public Viewing | |
| | Sat 26 | Wits Physics Solar Observatory | 10:00 / Tony Voorvelt |
| Feb | Mon 11 | Committee Meeting 17:30 | |
| | Wed 13 | **Monthly Meeting** | TBA / TAG |
| | Fri 15 | Public Viewing | |
| Mar | Sat 9 | Overnight at Tswaing Crater | Dr Dion Brandt |
| | Mon 11 | Committee Meeting 17:30 | |
| | Wed 13 | **Monthly Meeting** | Trevor / Tektites |
| | Fri 15 | Public Viewing | Meteorite Workshop |
| | Fri 29 | Easter Expedition / Kalahari Safari > 7/4 | Trevor |
| Apr | Mon 8 | Committee Meeting 17:30 | |
| | Wed 10 | **Monthly Meeting** | Basic Quantum Theory / Rob Scott |
| | Fri 12 | Public Viewing | |
| | Sat 20 | Broederstroom visit: Celebration of centenary of Franklin-Adams telescope | |
| May | Mon 6 | Committee Meeting 17:30 | |
| | Wed 8 | **Monthly Meeting** | Fermi's First Reactor/ Mike Smith |
| | Fri 17 | Public Viewing | |
| | Sat 18 | Telescope Extravaganza | Chris S |
| Jun | Mon 10 | Committee Meeting 17:30 | |
| | Wed 12 | **Monthly Meeting** | TBA |
| | Fri 14 | Public Viewing | FireWalking |

## Reminders

| | |
|---|---|
| 2002 | ASSA Symposium / hosted by Pretoria Centre/ poss. At Aloe Ridge<br>**December 4, Solar Eclipse** |
| 2003 | Centenary of Flight<br>**August: Mars opposition** |
| 2004 | Centenary Sir Herbert Baker Library Building<br>Johannesburg Centre to host 2004 ASSA Symposium<br>**June 8, Venus Transit** |

# ASSA Internet Home Page

Hi Chris,

This is the official web page of ASSA now. Can you please change the link on the JHB centre main page to point to this URL.

*http://da.saao.ac.za/assa/*

many thanks,
**Brian Fraser**

# ANOTHER TURNING POINT IN ASTRONOMY

The second turning point in astronomy during the twentieth century was the advent of radio-astronomy which came about almost by accident. During 1932 Karl Jansky of Bell Telephone Laboratories, while trying to overcome background noise in a radio receiver, discovered that a background noise repeated with a periodicity of 24 hours, thus a stellar day. The direction from which the noise came was the constellation of Sagittarius, the densest part of the Milky Way. Subsequently this point became known as Sagittarius A and it turned out to be the centre of the Milky Way galaxy.

The years passed. By 1937 radiowaves were detected coming from nebulae. These waves were emitted by the methylidene molecule CH and in 1940 cyanogen CN, was discovered in a nebula. By 1940 Grote Reber had built the first radio telescope. The antenna consisted of 45 pieces of sheet iron nailed to a parabolically shaped wooden frame. At the focus he used a crystal detector. An audio-triode intensified the signal of the incoming waves which produced an audible rumbling noise. When this rumble was traced by an oscillating needle on to a strip of moving paper a spectrum was obtained showing peaks and valleys in the tracing caused by the varying intensities of the various wavelengths. The peaks were found to correspond to emissions of various molecules.

By 1942 J S Hey discovered that the Sun emits radio waves. So too, does Jupiter. A very important discovery was that of radio waves at wavelength of 21 centimetres emitted by atomic hydrogen. That this radiation should exist was proved theoretically in 1944 by H C van de Hulst, 26 year old assistant at the Leiden Observatory in the Netherlands. And it was found experimentally in 1951 **!**

By 1948 strong radio waves were found by M Ryle and F G Smith to come from Taurus A, Virgo A and Centaurus A, corresponding to the optical sources, the Crab nebula M1 in Taurus, the "nebula" M87 in Virgo and the galaxy NGC 5128 in Centaurus. Nebulae such as M87 subsequently became resolved into galaxies. The field was wide open and an altogether new branch of Astronomy came into existence. After World War II dish-shaped antennae popped up all over the world.

Radio waves are a million times, $10^6$, longer than optical waves. Therefore the power of resolution of radio telescopes are a million times weaker than optical telescopes. The aperture must therefore be so much greater. The lobe width, i.e. the angle over which the radio signal is spread is equal to $\lambda \div D$ ra, or $60\lambda \div D$ degrees where $\lambda$ is the wavelength of the radiation and D is the diameter of the dish antenna. When a radio telescope receives waves of wavelength 1 metre by means of an antenna 100 metres in diameter its bandwidth is equal to 60 x 1 x 100 = 0,6° as compared with the resolving power of the 5 metre Mt Palomar telescope which is 1 arc second. This is 2160 times better than the resolving power of the radio telescope.

To overcome this problem two dish antennae, separated by some distance are connected to act as an interferometer. Instead of D, the diameter of the dish as divisor in the expression $60\lambda \div D$, the distance between the two dishes becomes the divisor. To obtain a resolving power of 1 arc second the two dishes must be 2160 metres apart (60 x 3600 ÷ 100). Theoretically the separation between the discs can be made equal to the diameter of the Earth or the distance between the Earth and a distant orbiting antenna.

The Very Large Array in New Mexico ( USA ) has 27 antennae, each of 25 metres width, mounted on a Y-shaped railway track. Each leg of the Y is 21 kilometres long. In their most effective positioning the array has an equivalent width of 27 kilometres. In the late 1950's Martin Ryle developed the method of aperture synthesis whereby the separated antennae are synthesised. For this advance, Ryle and his colleague Anthony Hewish were granted the Nobel Prize for Physics. On a wavelength of 21 cm, the resolving power of the Very Large Array is 2,1 arc seconds.

The largest single dish was built on the ground in a hollow between hillocks at Arecibo on Puerto Rico. This dish has a diameter of 300 metres. Being fixed to the ground, it is non-steerable and is dependent on the spinning of the Earth whereby a strip of the sky moves across the field of view of the telescope. To broaden the width of this strip, the cables by which the receptor hangs, can be slewed.

The findings of radio astronomy revealed facts that are fantastic and undreamed of. There are whole galaxies that radiate very strongly in radio wavelengths. Other sources emit very rapid pulses. These pulsars were found to be the compressed remains of supernovae. They have rapidly moving electrons which spin around magnetic beams. Each time that the beam points towards the Earth we receive a pulse of radio, light and X-ray radiation. The pulsars have diameters of no more than 30km. In the centre of the Crab nebula there is a pulsar which emits 30 pulses per second. It is the remains of the supernova of 1054 which was observed by Chinese astronomers. Its period is 1/30, or 0,033134... seconds. The shortest period of any pulsar is that of the pulsar 1937 + 21, situated at 19h37,6m and with declination +21,55°. Its period is 0,001557810049 seconds so that it spins 642 times per second. The source X1 in Cygnus has been found to radiate strongly in X-rays which emanate from rapidly moving gases being absorbed by a gravitational vortex, commonly called a black hole.

The radio telescopes discovered the quasars (quasi-stellar radio sources). They are star-like objects of low colour indices and are therefore typified as "blue". They pour out as much power as a whole galaxy, emitting strongly in the radio frequencies as well as in the ultraviolet. They are very distant, having red shifts as great as 6 and they have recession velocities of as much as 96% of the velocity of light. They are seen by the radiation which left them when the universe was very young, no more than 4% of the age of the universe and therefore reside on the edge of the observable universe.

Radio astronomy also discovered the 2,7° background radiation which is the remnant of the radiation that was emitted from the cosmo-genesis (commonly but erroneously referred to as the big bang). This all-pervading radiation is to be found everywhere and is the same in all directions (isotropic) and is similar to all observers (homogeneous).

Radio astronomy has become a new science in its own right.

Jan Eben van Zyl

# Mars Odyssey Encounters Polar Vortex

*By Leonard David*
*space.com*
*26 November 2001*

HAMPTON, VIRGINIA -- NASA's Mars Odyssey has encountered a strange, unexpected phenomenon as it slips over the red planet's north polar region. An intense polar vortex has been detected, causing Mars' atmosphere to be less dense than predicted for that area.

Likened to a jet stream on Earth, the baffling high-latitude, planet-circling vortex is being carefully eyed by scientists. Data gleaned by Odyssey shows a colder region over Mars' north pole, said Michelle Munk, flight mechanics engineer for the Langley Odyssey team.

"The polar vortex has given us some excitement in terms of seeing a different density profile [of the atmosphere] than our computer models predicted at the outset," Munk said.

"We're right were we want to be," Lockwood told SPACE.com. "We're taking small steps, closer and closer into the atmosphere. It's designed to be conservative, moving toward the corridor Odyssey needs to be in for main phase aerobraking," she said.

For those of you with Internet access, the full story may be found here:

*http://www.space.com/scienceastronomy/solarsystem/odyssey_vortex_011126.html*

# Visit to Pelindaba

On a beautiful Saturday morning 13th October 2001, already stinking hot, we waited at the entrance of Pelindaba enjoying the ambience. Trevor said he had a Bin Laden affiliation card and that that would allow us in. Mike Smith from Pelindaba, our guide, led us in convoy through the area on a scenic drive, which was obviously the original pick of the prime sites as far as views were concerned, and is surely the envy of developers.

Mike then entered a building where we were "bored" with core samples from a recently discovered impact crater, Morokweng, to the NW of Vryburg. These samples were donated to Dr Marco Andreoli. The name Pelindaba comes from the time when the dam was planned and negotiations were set up with the original tribal owners. When it was agreed that the dam would be for the benefit of all, the conclusion was PELINDABA "we are finished talking". Valindaba, where the atomic bomb was made, means "we do not talk". Like people in a 007 movie we snaked through endless corridors and up staircases until we came to a vast room, in the centre of which was the "pool". A scale model was used to demonstrate how the reactor functioned. We saw artificial crystals made in the reactor. On the balustrade bridge around the pool was a lifebelt with the word SAFARI on it - ha ha - this was no ordinary swimming pool. At the computer station we noticed workers in white coats, relaxed, and reading books on how to project a positive attitude. They watched the rods in the reactor on their screens.

After donning protective white coats which are afterwards disposed as contaminated waste, we poured over the railings looking at the glow of the pool water. The glow has resulted from decay particles in the water from radiation emitted from the fuel rods. These particles go faster than the speed of light in water. The fuel rods glowed with that same magnetising turquoise that one has seen in a telescope in the star Shaula in Scorpio. Some fuel rods used beryllium that absorbs radiation. The reactor is extremely small considering its power - about 2 metres.

Frans Van Nieuwkerk said he would "love to work here". Mike said they didn't have a problem taking him on their books, but that they did not like people working. Something would be terribly wrong if people were seen to be working there at all.

The spent fuel rods taken from the reactor are still radioactive because the uranium has daughter products. They are stored in shelves in the pool, kept under water until a batch of them is ready to be transported and disposed in dug pits on site, somewhere in the hills.

As we exited the lethal zone we had to have our soles and heels checked by a Geiger counter. If the alarm had rung would we have had to leave a shoe behind?

We crossed into the Hot Cell Containment Unit. Here Mike has constructed six viewing windows of lead glass which are extremely thick, hellishly expensive and totally impervious to radiation. These windows are unshatterable. One did shatter freakishly enough, when someone walked past and set up static. Mike said he thought they were joking when they came to tell him the news. The cells are sealed airtight. The radioactive products from the reactor to the cells are carried by an extremely cautious and expensive method.

Behind these windows radioactive filings are collected in little dishes and sorted into phials by mechanical arms These isotopes "must not be crossed, because that can make the patient very cross". These arms outside the windows were designed by Mike ingeniously, complete with all the shoulder, elbow and wrist joints. They activate similar arms inside the window, and with the index finger and thumb the work is done.

The phials are then transported to Nuclear Medicine Departments or to Industry. We saw a photo of a lesion inflicted on a worker who had skin contact with deadly isotopes. A worker who had the isotopes in a phial in a pocket for a couple of hours subsequently lost his leg. We learned that lead aprons are not impermeable to radiation.

The radioactive isotopes are returned after use and stored in six huge barrels weighing many tons, each barrel named after one of the wives, "Sarie .....etc."

Isotopes can be used in many ways. For example in industry they can detect cracks in concrete or

the thickness of metal. If a beam is sent through metal and the detector on the other side of it detects too little radiation, then the metal is too thick. A radioactive beam can be used in checking how full cans of beer are. Fruitflies that burrow into unripened mangoes are beamed at the right time and this keeps the fruit good for export.

A Technetium scan is a diagnostic scan done with isotopes and a Geiger counter. Because Technetium isotopes have a very extensive half life, they are stored in a receptacle (cow) until required for the examination. They are then "milked" to a higher shell (shorter half life), now known as Cobalt 60 where decay is rapid, i.e., a few hours. This is obviously to the patient's advantage. The patient is injected with isotopes. Tumours and infections are made up of very rapidly splitting cells, (something like half a second), and so they absorb all sorts of things like protein, amino adds and Technetium, in the flurry.

A Geiger counter is then passed over the patient and the area of tumour or infection spotted and recorded on an x-ray plate, and the information is stippled on it. Technetium cannot be used to bombard the tumour, although this technology is still in an experimental stage. They are trying to get different tumours to show up in different colours so they can bombard that area of colour with the same colour laser beam.

We learnt that the "cow" was not the Hospital Matron as was erroneously thought by some hospital staff.

The rest of the day was spent unwinding on a splendid old farmhouse lawn where we had lunch under the trees. We saw exotic birds and discussed involved science. We set off on the loveliest hike in Gauteng, namely the Philadingwe Nature Trail on a hot Saturday afternoon. Don't tell Computicket about this show. It was the best.

Thanks Trevor for arranging this day for us and Mike for taking us around.

**Mary MacKinnon**

# NASA BULLDOZER ROVERS COULD GET THE SCOOP ON MARS

*NASANews@hq.nasa.gov*
*RELEASE: 01-208*

Tiny bulldozer rovers may some day dish up the dirt and pack it in on Mars. The scoop-and-dump design of a prototype bulldozer rover being developed by NASA engineers mimics that of a bulldozer and dump truck.

Unlike a life-size bulldozer and dump truck, which can weigh several thousand pounds, these rovers are lightweight, intelligent and can work without an operator at the wheel. Yet they have the same capabilities, relative to their size, as their heavy-duty counterparts.

Robotics engineers think the basic research on these bulldozing rovers may support future missions to look for life or those to sustain a human presence.

"If water sources, such as hot springs, layers of ice or groundwater reservoirs are discovered on Mars, a network of these rovers could conduct scientific investigation and excavate the site piece-by-piece, just as humans would on an archeological dig," said Brian Wilcox, supervisor of the Robotic Vehicles Group at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "Rovers like these may also play a role in establishing a space outpost for eventual human occupancy. They may be used to create buried habitats or utility trenches and to excavate resources to support life.

"We think a greater amount of terrain can be excavated if the workload is shared among several smaller vehicles. Smaller solar powered vehicles have a higher power-to-weight ratio than bigger vehicles, yet together can perform the same tasks as a large vehicle," said Wilcox.

Weighing approximately 3.6 kilograms (8 pounds), the bulldozer rovers have arms with a tiny scoop to dig up and dump the soil into an overhead bucket. They use their arms to right themselves if they fall over. Working in groups, they will create a virtual communications network with a central control tower, equipped with stereo cameras that will provide a 360-degree view of the terrain. A reflector will unfurl from the tower and divert the sun's energy to bulldozer rovers that are down a hole or ditch.

The bulldozer rovers share the same processor and software as the nanorover originally designed to fly on a Japanese asteroid mission. Four prototypes are working at this time. Engineers are working to determine the optimum size of the rovers for excavation tasks. They expect to have several more working prototypes by the end of the year.

"When people hear about the work we do, they sometimes think we are just talking science fiction," said Wayne Schober, manager for advanced robotics surface systems at JPL. "We worked on some of the most advanced robotic vehicle designs of the mid-1980s, such as those that enabled the two-armed coordinated robots for the International Space Station, the Mars Pathfinder Rover and the rovers about to explore Mars. Weare not all fun and games. We mean business."

These researchers are working on the next generation of air, surface and subsurface vehicles for exploration of the planets, including Mars and Venus, Jupiter's moon Europa and Saturn's largest moon Titan. The vehicles include a tumbleweed ball, which can blow with the wind; blimps; and all-terrain rovers, which can traverse down steep hills and gullies.

NASA's Cross Enterprise Technology Development Program provided funding for this work

The California Institute of Technology in Pasadena manages JPL for NASA. JPL is the lead American center for robotic exploration of the solar system.

# Questions and Answers

**Why does light travel at 300 000km/s?**

*Well – are there any erudite Astronomers/Physicists/Boffins out there who can tell us why light travels at "the speed of light"?*

This question of why light travels at a certain speed is an invalid question in a philosophical context. Philosophy is the science that provides man with a comprehensive view of life, and science and astronomy form part of the natural sciences that depend on this conceptual foundation.

When we refer to light, we are referring to all its characteristics that we observe. Light is an element of nature. Like every element of nature, every galaxy, star and speck of dust, they all have specific characteristics and identities. Its speed is one of the essential elements without which light would not be light.

Everything in nature, which has not been altered or influenced by man, had to be and could not have been otherwise. They are facts of reality.

Using his conscious faculty, man gains knowledge about existence by observing and integrating the facts of reality. Through his knowledge of existence and existents, he can further his understanding and reshape reality for his own purposes, adhering to the facts of reality. This fact is important as man determines what is true or false by whether or not his judgements correspond to or contradict the facts of reality.

To question why light behaves as light does is to question the law of identity. Everything that exists acts according to its specific nature. Implicit in the question of why light travels at a certain speed is the assumption that it could have behaved otherwise or by someone's choice or whim. In this view, reality and existence are not the metaphysically given, but created by one's consciousness. According to this subjective view, reality can be whatever what one wants it to be, facts and existence is divorced from perception.

*"Nature, to be commanded, must be obeyed."*
Francis Bacon

**Eric Brindeau**

# MARS ODYSSEY'S FIRST LOOK AT MARS IS ALL TREAT, NO TRICK

From: NASANews@hq.nasa.gov
RELEASE: 01-214

NASA's 2001 Mars Odyssey gave mission managers a real treat this Halloween with its first look at the Red Planet. It's a thermal infrared image of the Martian southern hemisphere that captures the polar carbon dioxide ice cap at a temperature of about minus 120 C (minus 184 F).

The spacecraft first entered orbit around Mars last week after a six-month, 285 million-mile journey.

The image, taken as part of the calibration process for the instrument, shows the nighttime temperatures of Mars, demonstrating the "night-vision" capability of the camera system to observe Mars, even when the surface is in darkness.

"This spectacular first image of Mars from the 2001 Mars Odyssey spacecraft is just a hint of what's to come," said Dr. Ed Weiler, Associate Administrator for Space Science at NASA Headquarters in Washington." After we get Odyssey into its final orbit it will be much closer to Mars than when it took this image, and we'll be able to tell whether or not there are any hot springs on Mars, places where liquid water may be close to the surface. If there are any such locations they would be places we might like to explore on future missions."

The image covers a length of more than 6,500 kilometers (3,900 miles), spanning the planet from limb to limb, with a resolution of approximately 5.5 kilometers per pixel (3.4 miles per pixel), at the point directly beneath the spacecraft.

The spacecraft was about 22,000 kilometers (about 13,600 miles) above the planet looking down toward the south pole of Mars when the image was taken.

It is late spring in the Martian southern hemisphere. The extremely cold, circular feature shown in blue is the Martian south polar carbon dioxide ice cap , which is more than 900 kilometers (540 miles) in diameter at this time and will continue to shrink as summer progresses. Clouds of cooler air blowing off the cap can be seen in orange extending across the image.

JPL manages the 2001 Mars Odyssey mission for NASA's Office of Space Science. The thermal-emission imaging system was developed at Arizona State University, Tempe, with Raytheon Santa Barbara Remote Sensing, Santa Barbara, Calif. Lockheed Martin Astronautics, Denver, is the prime contractor for the project, and developed and built the orbiter. Mission operations are conducted jointly from Lockheed Martin and from JPL, a division of the California Institute of Technology in Pasadena.

The Mars Odyssey image is available on the Internet at:

*http://photojournal.jpl.nasa.gov/cgibin/GenCatalogPage.pl?PIA03459*

# HUBBLE MEASURES ATMOSPHERE ON WORLD AROUND ANOTHER STAR

*NASANews@hq.nasa.gov*
*An extract from* RELEASE: 01-232

Astronomers using NASA's Hubble Space Telescope have made the first direct detection and chemical analysis of the atmosphere of a planet outside our solar system. Their unique observations demonstrate it is possible with Hubble and other telescopes to measure the chemical makeup of extrasolar planets' atmospheres and potentially to search for chemical markers of life beyond Earth.

The planet orbits a yellow, Sun-like star called HD 209458, a seventh-magnitude star (visible in an amateur telescope) that lies 150 light-years away in the autumn constellation Pegasus. Its atmospheric composition was probed when the planet passed in front of its parent star, allowing astronomers for the first time ever to see light from the star filtered through the planet's atmosphere.

## LOCAL TIMES of RISE and SET for the MAJOR PLANETS, 2002

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 |
| Jan 01 | 05.20 | 19.02 | 06.27 | 20.09 | 5.05 | 18.49 | 10.25 | 22.53 | 18.57 | 05.27 | 16.36 | 03.20 |
| Jan 11 | 05.28 | 19.03 | 06.55 | 20.16 | 5.23 | 19.02 | 10.18 | 22.34 | 18.12 | 04.42 | 15.54 | 02.38 |
| Jan 21 | 05.35 | 19.03 | 06.39 | 19.43 | 5.41 | 19.12 | 10.11 | 22.15 | 17.28 | 03.57 | 15.13 | 01.57 |
| Jan 31 | 05.43 | 18.59 | 05.14 | 18.23 | 6.00 | 19.17 | 10.04 | 21.56 | 16.44 | 03.13 | 14.32 | 01.16 |
| Feb 10 | 05.50 | 18.54 | 04.10 | 17.29 | 06.19 | 19.19 | 09.57 | 21.37 | 16.01 | 02.30 | 13.53 | 00.36 |
| Feb 20 | 05.57 | 18.46 | 03.56 | 17.17 | 06.36 | 19.18 | 09.50 | 21.19 | 15.20 | 01.48 | 13.14 | 23.57 |
| Mar 02 | 6.03 | 18.37 | 04.07 | 17.22 | 06.53 | 19.15 | 09.42 | 21.01 | 14.40 | 01.08 | 12.36 | 23.19 |
| Mar 12 | 6.08 | 18.27 | 04.32 | 17.31 | 07.09 | 19.11 | 09.35 | 20.43 | 14.01 | 00.29 | 11.59 | 22.41 |
| Mar 22 | 6.13 | 18.16 | 05.06 | 17.41 | 07.25 | 19.07 | 09.28 | 20.27 | 13.24 | 23.52 | 11.23 | 22.04 |
| Apr 01 | 06.18 | 18.06 | 05.49 | 17.53 | 07.41 | 19.03 | 09.21 | 20.11 | 12.48 | 23.16 | 10.47 | 21.28 |
| Apr 11 | 06.23 | 17.56 | 06.40 | 18.09 | 07.58 | 19.02 | 09.14 | 19.55 | 12.13 | 22.41 | 10.12 | 20.52 |
| Apr 21 | 06.27 | 17.46 | 07.35 | 18.28 | 08.16 | 19.03 | 09.06 | 19.41 | 11.39 | 22.08 | 09.37 | 20.17 |
| May 01 | 06.32 | 17.38 | 08.10 | 18.41 | 08.33 | 19.07 | 08.58 | 19.28 | 11.06 | 21.35 | 09.03 | 19.42 |
| May 11 | 06.38 | 17.31 | 08.09 | 18.34 | 08.51 | 19.15 | 08.50 | 19.16 | 10.33 | 21.03 | 08.29 | 19.07 |
| May 21 | 06.43 | 17.26 | 07.25 | 18.01 | 09.06 | 19.27 | 08.40 | 19.04 | 10.01 | 20.32 | 07.55 | 18.32 |
| May 31 | 06.48 | 17.23 | 06.18 | 17.10 | 09.18 | 19.41 | 08.30 | 18.54 | 09.30 | 20.01 | 07.21 | 17.58 |
| Jun 10 | 06.52 | 17.22 | 05.26 | 16.25 | 09.27 | 19.56 | 08.19 | 18.43 | 08.59 | 19.31 | 06.48 | 17.24 |
| Jun 20 | 06.55 | 17.23 | 05.09 | 16.02 | 09.31 | 20.12 | 08.07 | 18.34 | 08.28 | 19.02 | 06.14 | 16.50 |
| Jun 30 | 06.57 | 17.26 | 05.23 | 16.03 | 09.31 | 20.27 | 07.53 | 18.24 | 07.57 | 18.32 | 05.40 | 16.16 |
| Jul 10 | 06.56 | 17.30 | 06.04 | 16.32 | 09.27 | 20.40 | 07.39 | 18.15 | 07.26 | 18.03 | 05.06 | 15.41 |
| Jul 20 | 06.54 | 17.34 | 06.54 | 17.26 | 09.20 | 20.51 | 07.23 | 18.05 | 06.55 | 17.34 | 04.32 | 15.07 |
| Jul 30 | 06.49 | 17.39 | 07.28 | 18.23 | 09.11 | 21.01 | 07.06 | 17.56 | 06.24 | 17.05 | 03.58 | 14.32 |
| Aug 09 | 06.43 | 17.44 | 07.44 | 19.06 | 08.59 | 21.09 | 06.49 | 17.46 | 05.53 | 16.36 | 03.23 | 13.57 |
| Aug 19 | 06.35 | 17.49 | 07.46 | 19.36 | 08.46 | 21.15 | 06.30 | 17.36 | 05.21 | 16.06 | 02.48 | 13.22 |
| Aug 29 | 06.25 | 17.53 | 07.38 | 19.53 | 08.31 | 21.18 | 06.11 | 17.26 | 04.49 | 15.37 | 02.12 | 12.46 |
| Sep 08 | 06.15 | 17.57 | 07.19 | 19.53 | 08.14 | 21.19 | 05.51 | 17.15 | 04.17 | 15.07 | 01.35 | 12.09 |
| Sep 18 | 06.04 | 18.01 | 06.41 | 19.21 | 07.53 | 21.14 | 05.31 | 17.04 | 03.45 | 14.36 | 00.58 | 11.32 |
| Sep 28 | 05.53 | 18.05 | 05.43 | 18.03 | 07.28 | 21.01 | 05.10 | 16.53 | 03.11 | 14.05 | 00.20 | 10.54 |
| Oct 08 | 05.42 | 18.09 | 04.57 | 16.57 | 06.54 | 20.36 | 04.49 | 16.42 | 02.38 | 13.33 | 23.41 | 10.15 |
| Oct 18 | 05.32 | 18.14 | 04.49 | 16.58 | 06.11 | 19.52 | 04.28 | 16.31 | 02.03 | 13.00 | 23.01 | 09.36 |
| Oct 28 | 05.23 | 18.20 | 04.55 | 17.30 | 05.20 | 18.50 | 04.07 | 16.20 | 01.28 | 12.27 | 22.21 | 08.55 |
| Nov 07 | 05.16 | 18.27 | 05.04 | 18.06 | 04.28 | 17.42 | 03.46 | 16.09 | 00.52 | 11.52 | 21.40 | 08.14 |
| Nov 17 | 05.12 | 18.34 | 05.16 | 18.42 | 03.46 | 16.44 | 03.25 | 15.59 | 00.15 | 11.15 | 20.58 | 07.33 |
| Nov 27 | 05.09 | 18.41 | 05.33 | 19.17 | 03.15 | 16.05 | 03.05 | 15.48 | 23.37 | 10.38 | 20.16 | 06.50 |
| Dec 07 | 05.09 | 18.49 | 05.56 | 19.50 | 02.53 | 15.42 | 02.46 | 15.38 | 22.58 | 09.59 | 19.33 | 06.08 |
| Dec 17 | 05.12 | 18.55 | 06.24 | 20.16 | 02.37 | 15.31 | 02.26 | 15.28 | 22.18 | 09.18 | 18.50 | 05.25 |
| Dec 27 | 05.17 | 19.00 | 06.45 | 20.24 | 02.26 | 15.28 | 02.08 | 15.18 | 21.37 | 08.36 | 18.07 | 04.42 |
| Jan 06 | 05.24 | 19.03 | 06.22 | 19.46 | 02.20 | 15.31 | 01.51 | 15.08 | 20.55 | 07.53 | 17.24 | 03.59 |

# Mars: the most beguiling of the planets;

*a lecture by William Sheehan*
*given to the Astronomical Society of South Africa*
*at the old Union Observatory*
*Johannesburg, South Africa*
*October 10, 2001*

It's a great pleasure for me to be in South Africa. I remember growing up and being tantalized by the great Mars images obtained in 1939 & 1954 by Earl C Slipher at Bloemfontein, above all the color images - by far the best of their era - obtained in 1954 & 1956 by W. S. Finsen with the 26½-inch refractor just down the hill from where I am speaking tonight. For a long time, the two leading observatories monitoring Mars were the Lowell Observatory at Flagstaff, Arizona and the Union Observatory at Johannesburg, South Africa**;** both had the power to pique the imagination of one who, as early as at age ten, was rapt with Mars.

A hundred years ago, H. G. Wells, in his science-fiction classic The War of the Worlds, envisaged large-brained, octopus-tentacled Martians arriving on the Earth to begin the conquest of the brave new world they had chosen for their home ( they were thwarted not by men but by the least of our microbial brethren, bacteria - germs to which the Martians had not acquired immunity ). Now an invasion is indeed fully underway - not of the Earth by Mars, rather of Mars by the Earth.

From prehistoric times, Mars appeared as a "wandering star" which perennially flared into angry brilliance**;** then, seemingly appeased, it retreated again into safe and distant obscurity. Like a mountain seen from afar, it long formed a remote backdrop to human activity. Perhaps its presence was noted by our wandering ancestors of the savannah, whose footprints crossed the Laetoli plains of East Africa. Certainly it must have been remarked by the European cave-dwellers of the Ice Age, who saw in our seven dipper stars the form of a she-bear (Ursa Major) 30,000 years ago and followed the tracks of the Moon and the brighter planets. These wanderers - a little like Leonardo da Vinci's sinistral handwriting - generally trend in a backward direction ( but see below ); i.e., they move right to left - west to east - relative to the general drift of stars. Recently, the cave paintings of Lascaux, which date back 18,000 years, to before the last Ice Age, have been found to contain depictions of star-groups, including the Pleiades, Taurus the Bull, and Corona Borealis.

From a vivid red dot among the rest of the stars, Mars has come to loom steadily larger in our field of view. In our own time, it has become a mountain all but filling it. But if there is something to the mountain analogy, then the mountain Mars begs to be climbed. "Every high mountain," writes historian Daniel Boorstin, "was idolized by people who lived in its shadow; the Hindus had their High Places, the Himalayas; the Japanese had their Fujiyama; and the Greeks their Olympus, with a purer air, a whiter clarity, where the gods could taste of happiness forever." We have - Mars.

Are we alone in the universe, or a mere detail dictated by the "cosmic imperative"? Clearly we can answer these questions only by familiarizing ourselves with worlds beyond our own. Mars is the most convenient and hopeful world where this perennial question - one of the most fundamental humanity can ask - can be tested.***

Mars has just passed ( on June 12 ) an exquisitely eventful opposition, its first of the new century, approaching within 67 million kilometers of the Earth. Oppositions are the perennial occasions on which Mars lines up on the side of its orbit opposite from the Sun to the Earth, minimising the separation between the two. At the present opposition, Mars was 26 degrees south of the celestial equator, which put it practically overhead from Johannesburg. If a Martian would have dropped a plumbline from the zenith, it would have hit us on our heads (!).

It has now retreated far from the Earth, but will be coming to an even better opposition on August 28, 2003, and once again very favorably placed in the South African sky. Reaching a distance of less than 56 million kilometers, the red planet will actually be marginally closer than at any time in all human history.

These first two oppositions of the 21st century are remarkably favorable**;** a suitable beginning to

a century that may well deserve to be remembered as the "Martian" century - a century in which a flotilla of automated spacecraft will set out to explore Mars, to be followed, in time, assuming all goes well, by manned missions. It is even likely that the first man (or woman) to set foot on Mars has already been born.

But why should we go to Mars?

Human fascination with Mars stretches across millenia. I will briefly describe the history of that fascination, also some of the themes that seem to be of current importance. No other planet beyond the Earth has so richly beguiled humanity as Mars.

To begin with, this may have had something to do with its vivid color. The reason for the red color is indeed the same as that for the reddish color of a drop of blood - when ferrous iron in Mars's soil combines with oxygen, it turns to ferric iron, more popularly known as rust - the same chemical reaction that is harnassed in the hemoglobin molecule. Mars, indeed, has always reminded men of a drop of blood. We now know that, in a real sense, it is quite literally blood-red.

To early star-watchers - less jaded perhaps than we are - the red color of Mars evoked a strong emotional response. For that matter, there can be no doubt that red is a special color - it is especially reactive on our nervous systems.

As primitive vocabularies grow to describe colors, the first color they include after black and white is red. It is the last part of color vision to disappear in cases of brain damage, also the first to come back during recovery. It is an ambiguous stimulus; red signals danger, as in the eyes and bodies of some poisonous tree frogs, but it is also a sexual attractant. From the red star Aldebaran (the eye of the Bull) we get the familiar phrase "seeing red." Flowers use it to attract insects, while cosmetic makers (and restaurateurs) know its ability to command attention and heighten sensual arousal.

Though Mars early collected around itself a raft of mythological associations - usually inspiring thoughts of warfare and bloodshed - it wasn't until much later that it began to be the subject of scientific inquiry. At first its motions were of interest. Discuss *Retrograde motions, when Mars walks "crablike" - backward - across the sky. Ptolemy's theory. Copernicus's theory. Tycho Brahe, the wizard-figure who lost his nose in a duel and who, in reverence, always sauntered out under the heavens in his robes. 1609 - publication of Kepler's laws, based on Kepler's methodical reduction of Tycho's observations of Mars, of the elliptic motions of the planets. The shape of Mars's ellipse explains, by the way, why its oppositions aren't all created equal.

Kepler was a dreamer as well as a man of exact calculation. He dreamed of a more illustrious era than his own troubled lifetime, fraught with fighting between Catholics and Protestants, when Germany and later Bohemia were ravaged by the Thirty Years War and when even the dead scholar's bones could not achieve piece - the cemetery in which he had been laid to rest was dug up for a battlefield. He dreamed of when men would learn to fly, and reach the Moon or even the other planets**:** "Ships and sails proper for the heavenly air should be fashioned. Then there will also be people, who do not shrink from the dreary vastness of space." Such sails and ships remained centuries off, but Kepler's wide-ranging imagination conceived of them.

When they finally came, those sails and ships would follow elliptical paths around the Sun, and on approaching the Moon or a planet would be swung into elliptical paths around them. The laws of spaceflight are also Kepler's laws. The open road to Mars was paved by the mind of Johannes Kepler from a dingy little room in Prague.

So even before it began to emerge as a planet - a rotund world, a place - like our own, Mars, in the work of Tyco and Kepler, had already helped us to define our place in the universe.

The same year Kepler published his first two laws, the telescope was invented. Kepler applauded the instrument: "O you much knowing tube, more precious than any sceptre. He who holds you in his right hand, is he not appointed king or master over the work of God!"

The first telescopes were too small and optically inefficient to show much of anything on Mars, a small planet, never less than 140 times the Moon's distance from the Earth. It could be dismissed by the late seventeenth century astronomical writer Bernard de Fontenelle as "not being worth the trouble" of stopping at. The result of observational astronomers was not quite a negative summation. In 1659, the Dutch astronomer Christiaan Huygens, son of a diplomat, poet, and confidante of the artist

Rembrandt, first recognized dark patches - in particular, the one long known as the Hourglass Sea and late called Syrtis Major, the Great Bog , which allowed him to work out the period of rotation, 24-plus hours. (I pause here to note how significant - for the citizens of a small country with generally lackluster skies - the contributions of the Dutch astronomers have been, beginning with Huygens. Let me say to any members of the audience who may be of Dutch descent, "Goienaand, Hoe gaan dit? Goed dankie."). Huygens and Giovanni Cassini, the leading astronomer at the Paris Observatory at the time, independently made out the bright south polar cap. Cassini's nephew, Maraldi, who also worked at the Paris Observatory, and added the discovery that the cap was not centered directly over the rotational south pole. Thus the coldest point on Mars does not coincide with the pole itself. (We now know that Maraldi was absolutely right: the point where the cap's elevation is greatest is offset from the pole by 225 kilometers).

Maraldi deserves to be considered the first explorer of the Martian Antarctic. Maraldi, curiously, hedged as to the nature of the caps; the first person to suggest that the caps were snow was William Herschel, who wrote, "the bright polar caps are owing to the vivid reflection of light from frozen regions."

The reason for the interest in the Martian Antarctic is that the south polar cap promises to be one of the richest areas in which to hunt for water on Mars. As has long been known, the cap becomes very large during the southern hemisphere winter; but it is almost entirely composed of dry-ice (frozen carbon dioxide), and is rapidly eaten away during the Martian summer to a small residual cap. (The residual north polar cap, on the other hand, consists of a mixture of water and carbon-dioxide ices.) However, as spacecraft observations have shown, the small residual cap of frozen carbon dioxide stands upon a large southern plateau, extending nearly 100 kilometers beyond its outer edge, and it is quite possible that this plateau consists mostly of buried ice.

At the present epoch, the Martian ice caps are found (in spacecraft images) to be surrounded by abrupt scarps rimming their perimeters, strong evidence that the cap margins are eroding in the current Martian climate. Also, both polar regions are surrounded by vast tracts of layered terrain. This means that there were once much larger polar expanses in the remote past. Yet if Mars once sported much larger caps of ice, where is all the water now?--That, for Mars, is the question.

Detailed studies of the polar caps were first carried out in the nineteenth century by an Italian astronomer - one of the greatest observers of Mars of all time - Giovanni Schiaparelli. He was the uncle of the fashion designer, Else Schiaparelli, and would become known as the man who created a new fashion of looking at Mars. Schiaparelli (the astronomer) was born in Savigliano, Italy, in 1835, educated at Turin, and after studying at Berlin and Pulkova, rose to the directorship of the Brera Observatory in Milan. His great work forging a link between comets and meteors was carried out there. (Among other things, he showed that the August meteors, the Perseids, were debris thrown off from Comet Swift-Tuttle of 1862. He later showed that the Leonids - which may put on a spectacular display in November of this year - were debris thrown off from Comet Tempel-Tuttle. Since this comet circles the Sun once every 33 years, when the Earth crosses the part of the comet's orbit soon after the comet itself has been there, spectacular showers of meteors have been seen, such as the great storms of 1833, 1866, and 1966. There's a good chance we may be in for another "meteor storm" this year.)

Schiaparelli's career as a planetary observer did not begin until he was over forty, and awaited the hitherto optically-challenged Brera Observatory's acquisition of a decent telescope - an 8.6-inch (22-cm) aperture Merz refractor. I had the opportunity to visit Brera in March of this year, when I was asked to give a talk on Mars at the Hoepli Planetarium. Unfortunately, I left my slides at home, so I'll have to do my best to describe it to you. The observatory had been founded in 1760 by Roger Boscovich, as part of the Jesuit college established in the old Spanish Palazzo of Brera. It is down the street from the famed opera house La Scala, and boasts its own art gallery founded by Napoleon. Today it is mainly used as a studio for training artists and designers. One enters from the Via Brera; passes into a colonnaded square, arrayed with copies of classical sculptures - nymphs and heroes, gods and goddesses - and by means of a stairway (just down a hall set off with a niche occupied by a marble Patroclus in the arms of Menelaus) progresses, in Dante-esque fashion, "to the stars."

The dome was on the rooftop, in Schiaparelli's day, looking out upon the still pellucid skies of Lombardy. In the summer the air boiled violently above the red-brick tile rooftops heated by the afternoon sun, but at other seasons the seeing was often magnificent. Clouds of industrial smoke did not yet hang heavily in an oppressive cope over Milan's rooftops, cathedral, and observatory.

In 1877, Mars came to one of its very favorable oppositions - almost as good as that of 2003 will be. In Washington, D.C., Asaph Hall discovered the two miniature moons of Mars, Phobos and Deimos. Despite the grandness of the opportunity, Schiaparelli was a methodical man, and does not, at first, seem to have been particularly interested. He was busy doing routine work - measuring double stars. Then one night in August, while watching an eclipse of the Moon, he decided to turn his telescope on Mars. One can still imagine the magic of that night; it was a scene that might have been scored by Verdi (Schiaparelli's neighbor; La Scala, the famous opera house, is just down the street from Brera). Eclipsed blood-red moon, and Mars, nearby, glowing like an ember in the sky. A dark, olive-skinned, bearded man, with sharp penetrating black eyes, turns the telescope toward Mars. What floats into his telescope is wonderfully enchanting**:** a beautiful faberge-egg of a planet, a salmon disk streaked here and there with patches of cinnabar, vermillion, and cinnamon-brown. His first vision is confused; "I must admit," Schiaparelli wrote, "on comparing the aspect of the planet with the recently published maps this first attempt did not seem very encouraging." But his interest had been stirred. He made a first sketch, then returned to the planet again a few nights later. The markings began, with practice, to gather into recognizable shapes. From the first look of a curiosity-seeker, Schiaparelli became a dedicated connoisseur of the Red Planet. He resolved to draw up a new, more accurate, map, on which he would introduce a nomenclature based on the geography and mythology of the classical world. He was a passionate classicist, immersed in the old literature. Such names as Syrtis Major, Chryse, Utopia, Elysium, and Tharsis, still in use today, were first introduced on this map. He also made out linear markings - *canali*, he called them, from the Italian word meaning grooves or channels (and, I hasten to add, not necessarily artificial). They extended between the dark patches which he regarded as water-filled seas (of which more anon!)

From the comfort of his warm Italian observational redoubt, Schiaparelli also provided full descriptions of the chill Martian polar regions, comparing them with those of the Earth. Schiaparelli returned to his tower to observe Mars again at the oppositions of 1879, 1881, 1884, 1886, 1888, and 1890 - launching expedition after expedition, unfurling his telescopic sails upon the seas of interplanetary space. Like the Portuguese Henry the Navigator, who from his rugged promontory at Sagres had sent caravel after caravel to reach farther and farther around the unknown coast of Africa, a series of expeditions that would culminate (after Prince Henry's death) in the triumphs of Bartholemieu Dias and Vasco da Gama, so Schiaparelli, from his observatory in Milan, commenced the "first organized continuous enterprise" into the unknown world of Mars. He was in his day in the forefront of Martian research - and he knew it. He wrote to his friend, the Belgian astronomer Francois Terby, in 1886 that he had begun the exploration of "a New World, this world of Mars **...** which we must conquer little by little. It will be a less difficult and bloody conquest than the exploits of Cortes and Pizarro. But there are, alas, no more than ten observers seriously occupied with it even during the most favorable periods of the oppositions."

All that was about to change. A man who always regarded Schiaparelli as his "maitre Martien" (Martian master), but who was to surpass even his master in the ability to raise public interest in the planet, appeared suddenly on the scene. This was the American, Percival Lowell, who was (as his cousin James Russell Lowell said of Edgar Allen Poe) "two-fifths of him genius, and three-fifths sheer fudge." He was an amateur; perhaps the greatest amateur of his time. Through his influence, enthusiasm about Mars attained to a greater pitch than at any time before or since. He was born in 1855, scion of one of the oldest, wealthiest, and most distinguished families in America (according to the well-known toast, "in the town of the bean and the cod,/ Lowells talk only to Cabots,/ and Cabots talk only to God.") Harvard-educated, Lowell in his twenties took on management of some of the family's business interests, including cotton mills, trusts, and electric companies. However, he became profoundly dissatisfied with this conventional

upper-class role. After six years of business and a romantic crisis in which he broke off an engagement to an unidentified socialite, he bailed out and booked passage to Japan. He spent a decade living mostly in the Far East, served as the American diplomat to Korea, and wrote four books about a part of the world then little known in the West. (In Japan, he is still regarded as one of the hundred most important men of the twentieth century - for his role as a diplomat and his books about Korea and Japan, not for his thinking about Mars.)

Despite an initial attraction to Japanese art and gardens, Lowell's romantic impulse for the Far East was soon tempered by his irritation at what he came to regard as the inefficiency and irrationality of premodern people. As his infatuation with the Far East waned, his mind increasingly returned to a dormant boyhood interest in astronomy. At Christmas 1893, he was stirred by reading a book by the French astronomer Camille Flammarion: "The present inhabitation of Mars by a race superior to ours is very probable." Flammarion quoted Schiaparelli, who in the 1880s had recorded changes in some of the dark markings on the surface of the planet and had exclaimed: "The planet is not a desert of arid rocks. It lives!" Here was a destination even more exotic and romantic than the Far East. Lowell was thirty-nine years old when he decided to give up everything else in pursuit of his Martian obsession. It might seem an advanced age for a new career - not, however, when you're a Lowell and neither money nor security are factors. He was neither as old as Columbus when he set his westward course for the Indies nor as old as Schiaparelli when he first took up the study of Mars.

Funding his interest with his personal fortune, he borrowed a telescope, an 18-inch refractor by Pennsylvania optician John A. Brashear, and went west, to Arizona Territory, to observe Mars for its forthcoming opposition in 1894. He was assisted by Harvard astronomer William H. Pickering, just back from Peru where he had observed Mars with one of the finest refractors ever made, a 13-inch Alvan Clark -- it is now at Bloemfontein! - and on indeterminate leave, also Pickering's assistant A. E. Douglass. Lowell's observing logbook records his first impressions with the 18-inch. On June 1, 1894, Mars was still four months from opposition; inconveniently placed before the dawn, it had to be sought by early-risers at 3 o'clock in the morning, to whom it appeared as a small gibbous in the field of the eyepiece. Even so far away, its disk tantalized and rewarded scrutiny: "Terminator shaded," Lowell mused, "limb sharp and mist-covered forked-bay vanishes like river in desert." Lowell's use of the term desert is remarkable, given that contemporary views of Mars - including Schiaparelli's - stressed an interpretation of the planet in which the dark areas were oceans, the lighter areas lands. But Lowell's imagination had already been captured by the starkly beautiful Arizona deserts located south of the fir-covered mesa on which he had built his observatory, and it continued to be stirred by such vistas, especially those of the Painted Desert as seen in remote perspective from the San Francisco Peaks. So-called because the marls and soft rocks of which the hills are composed are of many colors - chocolate, red, vermillion, pink, buff, and gray - the Painted Desert conjured up for Lowell the same delicate palette of colors he found in the Martian globe: The resemblance of its lambent saffron to the telescopic tints of the Martian globe is strikingly impressive. Far forest and still farther desert are transmuted by distance into mere washes of color, the one robin's-egg blue, the other roseate ochre, and so bathed, both, in the flood of sunshine from out of a cloudless burnished sky that their tints rival those of a fire-opal. None otherwise do the Martian colors stand out upon the disk at the far end of the journey down the telescope's tube. Even in its mottlings the one expanse recalls the other.

From the first, Lowell was keen to see the canali -- or canals, as they had already become universally known in the English-speaking world. But they were all but absent from the disk. Indeed, in June, he had confided to his notebook: "With the best will in the world, I can see no canals." Was it possible his expedition to the Arizona Territory had been for naught? He returned, briefly, to Boston in July, having made out only a few of the canals; but on his return to Flagstaff in August, they were a blooming presence on the disk (though seen only a few at a time in moments of exquisite seeing). They were there along with the dark spots (seen by Pickering from Peru in 1892 and called by him "lakes" his brother, Edward Pickering, the director of Harvard, had wired back skepticism, "how do you know they are lakes?") which partook in the

sweeping changes affecting the rest of the disk; changes not so much of size as of color. The lakes deepened and became richer in hue, which to Lowell's mind gave a clue to what they were. They seemed like Flagstaff itself, a verdant spot on the verge of a desert. "When we put all these facts together," he wrote, "**...** one solution instantly suggests itself of their character, to wit: that they are oases in the midst of that desert." And he continued: "Here then we have an end and reason for the existence of the canals and the most natural conceivable one - namely that the canals are constructed for the express purpose of fertilizing the oases**....** And just such inference of design is in keeping with the curiously systematic arrangement of the canals themselves**....** The whole system is trigonometric to a degree."

The straightness of the canals (their traveling along geodesic lines, the shortest distance between two points on the planet's surface) could mean only one thing: they were artificial. This was not such a howlingly unreasonable surmise. One of the first things stressed in art schools has always been that nature never draws a straight line, a principle abundantly borne out by the astronauts' views of the Earth from orbit. As Story Musgrave, veteran of six Earth-orbital flights in the Space Shuttle, once told me: "Nature never makes a straight line; every time you see a straight line that's humanity at work. Nature likes curves, humans like straight lines"). Given the existence of a network of linear markings like the canals of Mars - assuming they were true features of the planet, and had the forms depicted in Lowell's drawings - his deduction became not only logical but inescapably so: they must be the handiwork of denizens of the planet.

This, in a nutshell, was Lowell's theory: Mars, being a smaller world, had evolved more rapidly than the Earth; it had already lost much of its water-supply, and was well on its way to utter desiccation. In order to survive, its inhabitants had had to build a vast system of irrigation channels to transport precious water from the melting polar caps to the equatorial regions. These, Lowell deduced, were the system of canals that Schiaparelli had first recorded in 1877. (One must consider this in the light of the day - it was an era of railroad building and canal building. The Suez Canal had been completed in 1869, or virtually on the eve of Schiaparelli's discovery of his lines on Mars.)

All this Lowell deduced from the small and blurry images he obtained through his 18" Brashear telescope, images of a planet never closer than 56 million kilometers from the Earth. He clung to this belief - despite a withering tide of opposition from professional astronomers - right up until his death in 1916.

We now know that the Martian canals were illusions - their reality was finally disproved when Mariner 4 bypassed the planet in 1965, showing a heavily cratered surface like the Moon's but no canals. They are artifacts of the eye-brain system's tendency to link up disconnected patches and chaotic details into order and system. In larger telescopes - and in spacecraft cameras - the canals disappear like the face of the "Man in the Moon" into a mass of irregular details. But Lowell's influence was more lasting than the canals. For a long time a broadly Lowellian view of the planet - with a wave of darkening sweeping down from the melting polar cap observed seasonally, and suggesting to most astronomers the active processes of vegetable growth and decay - continued to be in vogue, while his vision of embattled Martians struggling to stave off the impending doom of planetary desertification lived on in the science fiction of H. G. Wells and Edgar Rice Burroughs, but also of Ray Bradbury, who still featured canals prominently in the landscape of **The Martian Chronicles** as late as 1948.

The first spacecraft vistas of Mars - woefully selective, and obtained over a series of postage-stamp regions of the planet representing only one percent of the surface - were obtained by Mariner 4 in 1965. The images came as a shock to generations who had been suckled on Lowellian romances. Mars appeared to be another moon; stark, cratered, forlorn. Two more fly-by Mariners, in 1969, shortly after the Apollo 11 landings, did nothing to change the dour impression.

Finally, Mariner 9, which went into orbit in 1971, showed the real Mars, or much more of it than the flyby Mariners had shown. Mars was no mere lunar wasteland of cosmic bombardments from the embryon ages of the Solar System. After emerging from a violent youth which it shared with other planets, it has continued to evolve, and bears on its surface the legible hieroglyphs of change inscribed boldly in polar caps asserting the importance of seasons and in

aeolian features attesting the action of forces of erosion and deposition. There are patent signs of great geological upheavals: shield volcanoes such as Ascraeus Mons and Olympus Mons, towering 25 kilometers above the Martian sea-level and far more imposing than the Hawaiian shield volcanoes of the Earth. Equally impressive is a vast equatorial-trending canyon rifting the crust a sixth of the way around the planet's circumference - a failed tectonic rift. This is the Grand Canyon of Mars, Valles Marineris, next to which the Grand Canyon of the Colorado or even the Great Rift Valley of East Africa pale into insignificance.

Above all there are ancient floodplains and dry river valleys, which prove that water was once abundant and flowed freely on the surface of Mars. There were deluges covering the surface to depths of hundreds of meters over hundreds of square kilometers, there may even have been in the Northern Hemisphere - though the evidence is much debated - seas. And where there was water, could life have been far behind?

Twenty-three years ago, the two Viking landers first looked out, from ground-level, upon the surface of Mars. Because they were first - and to increase their chances of safe arrival - the Viking landers were directed to flat-lands, bland and featureless rolling plains of Chryse (the Land of Gold) and Utopia. More daring was Pathfinder, which arrived at the Ares Vallis flood plain near the equator, on American Independence Day, 1997 - cushioning its plunge onto the Martian surface by coming down on a pillow of airbags. Its first pictures made those of the Viking landers look bland by comparison. Now bone-dry, the Ares Vallis landing site - located at the mouth of the ancient flood plain - bears evidence even to non-geologists of past catastrophic floods. Boulders in the so-called Rock Garden have flat tops, and are slanted and stacked in the same direction; frozen in positions where they were abandoned by torrents washing down the valley. Some are igneous; others display the layered structure suggestive of sedimentary (sediment-deposited) rocks.

The skies of Mars present an intense, ever-changing panorama. Despite the thinness of the Martian atmosphere (about the same thickness as that of the earth's stratosphere), it has been known, ever since Viking 1, that the Martian skies are remarkably bright ("like the skies over Los Angeles on a smoggy day"). Early in the Viking mission, their color had at first been rendered in evocatively earthlike blue. In the end, it was decided it was no true-blue; rather the product of our having so long drunk, to intoxication, the idea of an earthlike Mars. Later images were recalibrated with greater sophistication to Martian salmon-pink. The Martian sunrises are majestic Homeric stirrings**:** glorious bursts of color and light in a white sky tinged with the faintest hint of blue, lilac- rather than rosy-fingered affairs. As the Sun climbs higher above the horizon vanish vanished without a trace, and the skies revert to dusty brownish-orange - the strange skies of a rust-red world.

So far, Pathfinder is as close as we have gotten to Mars, though incredible results have also been obtained from the Mars Global Surveyor, which has been monitoring the planet from orbit, and more are expected when the next spacecraft, NASA's 2001 Mars Odyssey, enters orbit two weeks from now.

What is it we will find out?

I can tell you what we **want** to find out. Above all we want an answer to the question: where has all the water gone? Probably deep beneath the surface, where the water is trapped as permafrost and, at great depths, even as underground rivers. Apparently, however - and there is tantalizing data from Mars Global Surveyor to support this - under certain circumstances it can flow, and has flowed, even in the relatively recent geological past, onto the surface; breaking the mold as the chick does the shell, bringing relief to the otherwise eternal and unrelenting aridity of the Martian deserts. It is obvious that these outbreaks of water-seepage onto the surface must be triggered by local climate changed. In the past, however, the global climate on Mars was obviously much more benign than at present; the planet had a thicker atmosphere, and liquid water flowed on the surface to produce the dry riverbeds discovered by Mariner 9. We know there were organic materials likewise - carbon-based, complex molecules - mixed in with the ices that fed the planet from comets (which ultimately came from David Block's all-pervasive cosmic dust) just as on Earth.

The raw materials seem to have been present - liquid water and organic molecules - for life to have formed on Mars. Hence, in part, the excitement over the possible fossil life-forms - nano-bacteria sized - in a Martian meteorite

announced with much fanfare in 1996. The case, by the way, remains highly controversial. Since meteorite's do arrive from Mars, obviously - about a baker's dozen have been identified, including a bit alleged to have struck dead a dog at Nahkla, Egypt, in 1911 - it is even possible the seeds of life on Earth were sewn from Mars. In that case we ourselves are - Martians.

If life did develop independently on Mars, we want to know how far that life resembles life on Earth - both in general plan and in detail (e.g., are the same amino acids used; the same nucleic acids; are the DNA and RNA used like that in ourselves, etc.?).

If life did not develop on Mars, it will be equally important to know that. Is life a "cosmic imperative," to use the phrase coined by Nobelist Christian de Duve in his best-selling book **Vital Dust**, is it written into the heart of the evolution of the planets from their dodgy beginnings in meteoritic fire-storms - or even earlier, during their incubation in the gloomy, cold, but protective and harboring womblike caves of interstellar dust-clouds? Is it common, or is it a rare happening? Are the starry skies at night filled with the eagle-aeries of other beings; or are they vast uninhabited deserts, in which case we are alone, terribly and inconsolably alone, in the cosmic voids?

Are the worlds in space rife with life, or are most of them tenantless, hanging empty like rejected weaver's nests?

Mars is our best chance so far to learn the answers to these perennial questions -- questions that have burned in the human imagination ever since Mars was perceived only as a glowing coal in the dark cave of the night-time sky.

**Bill Sheehan**

# For Sale

## Meade 4500 Telescope

* 2x barlow
* MA 25mm Eyepiece
* MA 12mm Eyepiece
* MA 9mm Eyepiece
* Equatorial Mount
* Original packaging and documentation

Price: **R2000.00 cash ONLY, Not negotiable**

### Contact: Eduard Rothbauer

(011) 726 7070(w)
(011) 802 7885(a/h)

## Visit to Vergenoeg Mine

Vergenoeg, situated in the Cullinan district, some distance from Pretoria, is the world's fourth largest Fluorspar mine. Fluorspar is a calcium fluoride [CaF2], and industrial products include fluoridation of water, hydrofluoric acid [HF], and in uranium enrichment.

The geologist, Mnr Fourie, has kindly allowed us to visit there on Saturday 22 December 2001 from about 10:00. The visit will include a tour of the open cast facility, an opportunity to collect specimens, a tour of the plant, and a possible limited overnight dark sky opportunity.

If you are interested in joining in, please contact the writer:

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*trevorgo@transtel.co.za*


*Submitted by* **Chris Stewart**

# The Sky this Month

## December 2001

| dd hh | dd hh |
|---|---|
| 1 03 Saturn 0.4 S of Moon Occn. | 15 09 Mercury 1.7 S of Moon |
| 2 14 Mercury 4.0 N of Antares | 15 11 Venus 9.7 S of Pluto |
| 3 11 Jupiter 1.4 S of Moon | 17 19 Saturn 3.7 N of Aldebaran |
| 3 14 Saturn at opposition | 18 07 Neptune 3.5 N of Moon |
| 4 21 Mercury in superior conjn. | 19 12 Uranus 3.7 N of Moon |
| 6 22 Moon at perigee | 20 20 Mars 4.4 N of Moon |
| 7 01 Mercury 11.1 S of Pluto | 21 13 Moon at apogee |
| 7 03 Pluto in conj. with Sun | 21 19 ***Solstice*** |
| 7 20 **LAST QUARTER** | 22 21 **FIRST QUARTER** |
| 9 15 Venus 5.2 N of Antares | 28 08 Saturn 0.1 S of Moon Occn. |
| 14 06 Venus 0.9 S of Moon Occn. | 30 11 **FULL MOON** Eclipse |
| 14 21 **NEW MOON** Eclipse | 30 14 Jupiter 1.0 S of Moon Occn. |

## January 2002

| dd hh | dd hh |
|---|---|
| 1 06 Jupiter at opposition. | 18 09 Moon at apogee |
| 2 08 Moon at perigee | 18 10 Mercury stationary |
| 3 12 Earth at Perihelion | 18 22 Mars 5.3 N of Moon |
| 6 04 **LAST QUARTER** | 21 18 **FIRST QUARTER** |
| 9 12 Mercury 1.2 S of Neptune | 24 15 Saturn 0.1 N of Moon Occn. |
| 11 10 Mercury greatest elong. E(16) | 25 13 Venus 1.4 S of Neptune |
| 12 19 Mercury greatest brilliancy | 25 23 Mercury 4.5 N of Venus |
| 13 13 Venus 1.4 N of Moon | 26 10 Mercury 3.2 N of Neptune |
| 13 13 **NEW MOON** | 26 19 Jupiter 0.8 S of Moon Occn. |
| 14 11 Venus in superior conjn | 27 20 Mercury in inferior conjn. |
| 14 16 Neptune 3.6 N of Moon | 28 14 Neptune in conj. with Sun |
| 15 02 Mercury 4.0 N of Moon | 28 22 **FULL MOON** |
| 15 22 Uranus 3.8 N of Moon | 30 09 Moon at perigee |

### LOCAL TIMES of RISE and SET for the MAJOR PLANETS, 2000

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 |
| Dec 07 | 05.10 | 18.49 | 05.11 | 18.56 | 04.35 | 18.05 | 10.40 | 23.38 | 20.49 | 07.20 | 18.23 | 05.06 |
| Dec 17 | 05.12 | 18.55 | 05.37 | 19.30 | 04.44 | 18.24 | 10.34 | 23.20 | 20.04 | 06.35 | 17.40 | 04.23 |
| Dec 27 | 05.17 | 19.00 | 06.10 | 19.58 | 04.57 | 18.42 | 10.28 | 23.02 | 19.20 | 05.50 | 16.57 | 03.41 |
| Jan 01 | 05.20 | 19.02 | 06.27 | 20.09 | 5.05 | 18.49 | 10.25 | 22.53 | 18.57 | 05.27 | 16.36 | 03.20 |
| Jan 11 | 05.28 | 19.03 | 06.55 | 20.16 | 5.23 | 19.02 | 10.18 | 22.34 | 18.12 | 04.42 | 15.54 | 02.38 |
| Jan 21 | 05.35 | 19.03 | 06.39 | 19.43 | 5.41 | 19.12 | 10.11 | 22.15 | 17.28 | 03.57 | 15.13 | 01.57 |
| Jan 31 | 05.43 | 18.59 | 05.14 | 18.23 | 6.00 | 19.17 | 10.04 | 21.56 | 16.44 | 03.13 | 14.32 | 01.16 |