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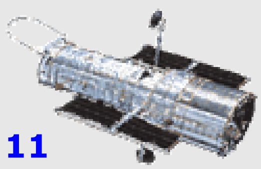
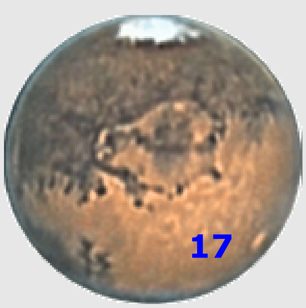
IN THIS ISSUE



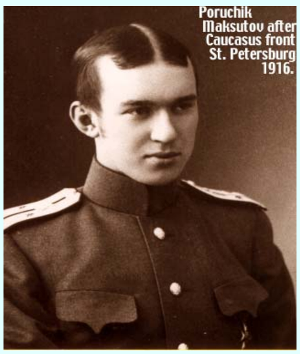


Dmitri Maksutov: The Man and His Telescopes ©

By Eduard Trigubov and Yuri Petrunin

Introduction

In the annals of telescope making there is a single name that has become synonymous with ingenuity, innovation, elegance of design, and optical quality: Maksutov. While not the first to consider melding the best attributes of refracting and reflecting telescopes into a single instrument, Dmitri Maksutov did conceive an optical system that was to spawn a class of very compact, high-definition instruments that would be relatively easy to manufacture.



Maksutov served with distinction in the First World War. This photograph of Porichik (Lieutenant) Maksutov was taken in St. Petersburg in 1916, on leave after serving at the front in the Caucasus Mountains.

The year 2001 marked the 60th anniversary of the invention of the meniscus catadioptric telescope by this remarkable Russian optician. Despite the current resurgence in popularity of his telescope designs, the story of Maksutov's tumultuous life remains largely unknown in the English-speaking world, and his family's extensive connections to America will come as a surprise to most readers.

Dmitri Dmitriyevich Maksutov was born on April 11, 1896, in the Russian city of Nikolayev, and three years later the family moved 70 miles to the port city of Odessa. His father, a naval officer serving with the Black Sea fleet, came from a family with a long and distinguished naval tradition. His great-grandfather, Peter Ivanovich Maksutov, was given the title of prince as a reward for bravery in combat, thereby raising the family to hereditary nobility. His grandfather, Dmitri Petrovich Maksutov, was the imperial governor of Alaska when the United States purchased this vast territory for two cents an acre in 1867.

Troubled Times

After graduating from cadet school in 1913, Maksutov enrolled in the Military Engineering College, located in the czarist capital of St. Petersburg. When the First World War broke out in August of the following year, classes were canceled and the students were sent to the frontlines to fight. Maksutov served with distinction in the Caucasus as a radio operator, winning promotion to the rank of lieutenant.

In 1916 he volunteered for flight school, where he cheated death during a training flight as his flimsy aircraft disintegrated around him. He miraculously survived a fall from an altitude of more than 200 feet, but the serious injuries he sustained required prolonged hospitalization. Maksutov was discharged from the hospital soon after the 1917 revolution and almost immediately attempted to emigrate to the United States via China. Yet he made it only as far as Harbin (Manchuria) before his infirmities and a lack of funds forced him to turn back.

The ravages of World War I and the Russian Revolution in 1917 led to difficult times for the Maksutov family. Political tensions had a far greater impact on the other male members of his immediate family. His mother remained in Odessa, but Maksutov's father and younger brother, Konstantin, who had fought the Communists during the Revolution, fled to France. Later they would emigrate to the United States and eventually settle in Long Island, New York. Maksutov's father subsequently served in the merchant marine and died in 1958. Konstantin took up chemical engineering and lived until 1987. Since Dmitri's grandmother was buried in the Alaskan town of Sitka, three generations of Maksutovs are buried on American soil.

A Life in Optics

In the early 1900s Dmitri's interest in astronomy was awakened by a gift from his grandfather: a small, 150 year-old, mahogany-and-brass Dollond refractor. He longed for a more powerful telescope, but commercial instruments from Germany were prohibitively expensive. So, at age 15, the budding astronomer decided to build one from scratch. He ground and polished a 7 inch mirror, fabricated a Newtonian telescope around it, and began to make regular observations. He was soon elected a member of the Russian Astronomical Association, and the first of his many articles about mirror making appeared in the organization's journal. In 1919 Maksutov traveled to the central Siberian city of Tomsk, where he enrolled in the Tomsk Technical Institute.

The ravages of Russia's civil war had resulted in a severe shortage of teachers, so despite his student status Maksutov taught classes in physics while continuing to study optics. One of his professors noticed his extraordinary talent and spoke

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highly of him to Dmitri Rozhdestvensky, the founding director of the State Optical Institute in St. Petersburg, an organization better known by its acronym, GOI. Accepting an offer to join the staff there, he worked under the supervision of well known optician Aleksander Chikin, the author of a popular book on mirror making who is remembered today as one of the "patron saints" of Russian amateur telescope makers. But Maksutov's initial tenure at GOI was short. He mistakenly believed his entire family had emigrated, but early in 1921 (the year in which he also married Tatiana Nazarova) he received a letter from his mother, who was still living in Odessa.

He soon left St. Petersburg to join her, supporting his family by making optics for the Odessa Observatory in a home workshop as well as teaching classes in mathematics and physics. In 1927 he took a job at the Odessa State Physical Institute, where he quickly organized a workshop to manufacture telescopes for schools. Within a year he turned out a hundred well made 5½ inch Newtonian telescopes, all with first class optics, ground and polished by hand.

In February 1930, Odessa was subjected to a purge and, like hundreds of other suspected enemies of the Soviet regime, Maksutov was arrested. He later described the ordeal as the worst experience of his life; there were no trials, and every other randomly chosen suspect was shot. But fate smiled on Maksutov once more, and he was released in the middle of March. Three months later he accepted an invitation to return to GOI in St. Petersburg, where he once again started making astronomical optics in a workshop that would become the Soviet Union's most important training ground for opticians.

This proved a fertile time for optical innovation. Unaware of the research of George Ritchey, Karl Schwarzschild and Andre Couder, Maksutov independently produced his own aplanatic reflecting telescope designs. This constituted one of his greatest theoretical works and was published in the GOI bulletin in 1932. He also developed a new method of testing the figure of mirror surfaces, similar to the famous Ronchi test, that used a grating with curved rather than straight lines. This approach was identical to the null test independently invented many years later by Eric Mobsby in England (S&T: November 1974, page 325), among others. He also strove to improve the traditional Foucault knife-edge test. Although Maksutov published dozens of valuable articles describing these innovative techniques, his work remained all but unknown to foreign opticians due to the effective isolation of the U.S.S.R. prior to World War II.

Maksutov's first major undertaking was the 32 inch objective lens for the large refractor at Pulkovo Observatory near St. Petersburg. This instrument had been ordered from the famous English firm of Grubb Parsons in 1913. All the components except the objective lens had been delivered by 1926, and after several unsuccessful attempts to procure a satisfactory objective lens in England and Germany, the decision was made to produce one at GOI.

But the project suffered many setbacks. Repeated failures to cast a blank for the crown-glass element were exacerbated by Maksutov's strained relations with his co-workers arising from their perception of him as a "class enemy" owing to his titled background. These difficulties ultimately resulted in his arrest in 1937. Officials accused him of sabotage, long delays in selecting the crown element of the 32 inch objective, and spying for Japan. Although these accusations were utterly baseless, Maksutov spent nine months in prison and did not complete the objective until 1946. By then the era of large refractors had long since passed, and this superb lens simply became a relic displayed in Pulkovo Observatory's museum.

During the 1930s Maksutov's opticians found time to produce a wide variety of extremely challenging optical systems, including fast apochromatic objectives, aspheric projection lenses, two 14 inch f/2 Schmidt cameras, a 16 inch aplanatic reflector for the Byurakan Observatory in Armenia, and a 20 inch horizontal solar telescope for Pulkovo. Maksutov's work was not limited to practical optics. He also applied for more than 10 patents, and published several articles and books including: "*Aberration-free reflective systems and methods of their control*" (1932); "*Shadow methods of testing optical systems*" (1934); "*Optical flats, testing and manufacturing*"(1937).

The Meniscus Optical System

Maksutov was hard at work on his astronomical instruments when the Germans invaded the Soviet Union in 1941. As Hitler's armies prepared to encircle and lay siege to Leningrad (formerly St. Petersburg), many scientific and industrial organizations, including GOI, were evacuated far to the east out of harm's way. It was during a long journey by train to remote Soviet Central Asia that Maksutov once again began to contemplate the design of a telescope suitable for schools. The result was the invention of his now famous meniscus system. Five years later in his book "*Astronomical optics*", Maksutov recounted how his thoughts unfolded on the trip:

Is everything satisfactory with the construction of the small reflector? Will it last for long? No, such telescopes contain aluminized mirrors, which need re-aluminizing after a while. How can this be avoided? One solution would be to place a plane-parallel window at the front of the telescope. This would increase the cost of the telescope, but we need to do it if we wish to produce a rugged telescope for schools. A closed tube would also be desirable because thermal convection currents inside the tube would be reduced, improving image quality. Thoughts continue... The same window could hold

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the diagonal mirror, so the telescope would be free of spider vanes, eliminating diffraction spikes in the images of stars. Thoughts continue... What if, in other optical configurations like the Gregorian or the Cassegrain, the secondary mirror were attached to the optical window? What if this window were made not in a plane-parallel form, but as a meniscus lens with an internal curvature equal to the surface radius of the secondary mirror?

In this case, the secondary mirror would become an aluminized spot in the central part of the meniscus. Such a system seems very appealing, because the central obstruction would be minimized and there would be no chance of secondary mirror becoming misaligned.

It was clear from the beginning that such a meniscus lens could be made achromatic (bringing all colors to the same focus), but a quick calculation showed that it would produce noticeable spherical aberration. At this moment, Maksutov nearly missed the discovery by turning his thoughts to calculating a meniscus free of spherical aberration. Then it dawned on him that the meniscus lens could introduce positive spherical aberration to compensate for the negative spherical aberration of a spherical primary mirror, or system of mirrors, without introducing chromatic aberrations.

This spark of genius didn't come totally out of the blue. Maksutov's notebooks reveal that in 1936, when he was contemplating Mangin mirrors (lenses with one silvered surface, primarily used in spotlights and lighthouse beacons), he had penciled in the margin a little sketch showing the reflective and refractive elements of a Mangin mirror separated to form a meniscus lens and a mirror. And in 1929 he published a paper describing a family of achromatic meniscus lenses. So it's fair to say that his meniscus concept, from first thoughts to final realization, gestated for at least a dozen years. Maksutov completed his first meniscus telescope on October 26, 1941, just three weeks after arriving at Yoshkar Ola in present-day Kazakhstan. He applied for the meniscus optical systems patent on November 8, 1941. The performance of this little instrument, a 100 mm f/8.5 Gregorian, was outstanding. The Maksutov-Gregorian design calls for the concave side of the meniscus lens to face the primary mirror. Turning the meniscus around permits its use in a Maksutov-Cassegrain telescope, precisely the configuration now employed in a multitude of commercial models.

As the Soviet Union fought for its survival in World War II, almost all production served the needs of the military. Yet the war years were among Maksutov's most productive and innovative. In a single year he performed the laborious and time-consuming calculations for more than 200 meniscus-based optical systems, ranging from small glasses to a 40-inch planetary telescope; a remarkable feat during the era of slide rules and logarithm tables. More than 500 calculations were done up until the end of 1944 and all classic mirror systems were modified to meniscus systems. Today such instruments are widely known under names like Simak and Rumak, but they have their genesis in Maksutov's wartime notebooks.

In November 1943 Maksutov began working at the prestigious Academy of Sciences in Moscow. By this time the fortunes of battle favored the Russians, but the retreating Germans were systematically plundering and burning the Soviet Union's finest observatories. Maksutov's new systems were therefore given much attention as potential replacements for the destroyed instruments.

International Recognition

In 1944 Maksutov's article "New Catadioptric Meniscus Systems" was published both in the GOI's bulletin and as a translation in the Journal of the Optical Society of America (volume 34, pages 270-284). These articles resulted in such widespread acclaim that Maksutov received the title "professor" without having to write and defend a dissertation. In 1946 he was granted a patent and awarded a government prize "for the creation of new types of optical systems." Yet despite this long-overdue international recognition, Maksutov's superiors never permitted him to travel abroad. How capricious that he received the Order of Lenin twice (in 1941 and 1946), yet he'd been imprisoned in 1937.

An Optical Legacy

After the war, Maksutov returned to GOI, where the first three astronomical meniscus telescopes were completed. One early model, designated MTM-1, was an 8 inch Maksutov-Cassegrain with a Nasmyth focus carried on an equatorial fork mounting. More than a half century later, this instrument still looks strikingly modern. Under Maksutov's supervision, a local factory began to manufacture a 70 mm f/10 Maksutov-Cassegrain telescope equipped with two eyepieces in a revolving turret. Soon examples of this instrument could be found in every secondary school and university in the Soviet Union.

Despite his workload, Maksutov somehow managed to find the time not only to lecture at Pulkovo but also to write two textbooks, "*Astronomical Optics"* (1946) and "*The Manufacture and Testing of Astronomical Optics"* (1948). These works contain a vast amount of practical information and served as a basic guide for succeeding generations of Russian opticians. Fortunately, there are plans afoot to translate them into English.

During the late 1940s and 1950s, Maksutov oversaw the fabrication of numerous large-aperture optical systems for professional use. Today his instruments can be found at observatories throughout the former Soviet Union. These include: two 20 inch f/13.5 planetary meniscus telescopes with non-moving (Coude-type) focal positions for Pulkovo and Crimea; a 20 inch f/2.4 Meniscus camera ASI2 in Alma-Ata (Kazakhstan); a 20 inch f/4.0 Meniscus camera AZT-5 in Crimea (Ukraine); a 700

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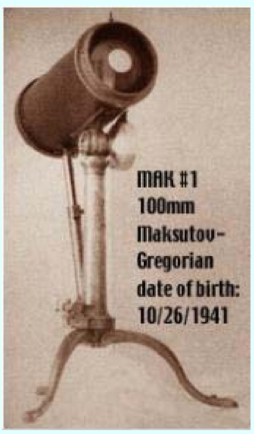
mm (27.6-inch) universal meniscus telescope with dual f/3 and f/15 foci in Abastuman, (Georgia). In 1951 he even submitted plans for a 4 meter telescope, but political forces dictated something larger than the 200 inch (5-meter) telescope atop Palomar Mountain, and eventually his team led the design effort for the 236 inch (6-meter) "Large Altazimuth Reflector" (known by its Russian acronym, BTA) now operating high in the Caucasus Mountains.

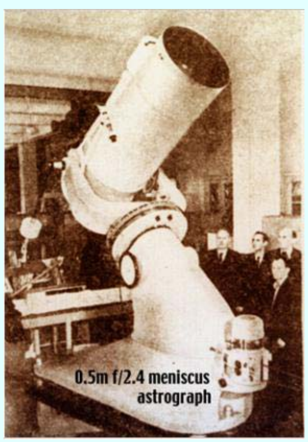
Maksutov's best and final work is generally regarded to be the 70 centimeter- (27.6 inch) aperture double-meniscus astrograph known as the AZT-16. This instrument was needed for fundamental astrometry, a demanding application that required a fast focal ratio and a large field free of lateral color and distortion. Maksutov employed a pair of meniscus correctors to satisfy these exacting parameters. Deteriorating health left him little time to finish this project.

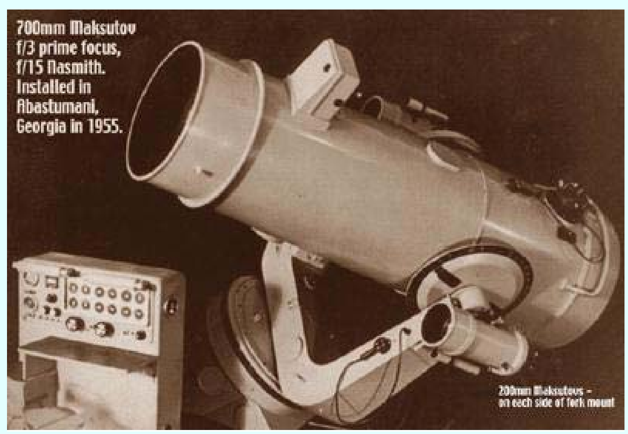
He did finish the optics, though the entire instrument was not completed until late 1964, a few months after his death on August 12th. The AZT-16 entered service four years later on Cerro Roble in the Chilean Andes.

Maksutov's interests were not devoted solely to the development of astronomical optics. He designed a gastroscope (an instrument for photographing the interior of the esophagus and stomach), for which he was granted the first of his many patents. He also invented a "microscope needle" for examining living cells inside the human body. This was a particularly challenging optical device: the "needle" is 4 mm wide and employs a six-lens objective, with the largest lens being 2.2 mm in diameter.

A rare combination of creative optical designer and master optician (he always took greater pride in the latter), Maksutov deserves to be called the father of the Russian school of astronomical optics. His books and instruments are enduring monuments that pay eloquent testimony to the range and quality of his work. His own words are perhaps the most fitting epitaph: "I always valued work more than life itself."







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Dmitri Maksutov's Telesopes

What Is A Neutrino ?

A Short and Basic Introduction
By: Triple Nickel

Wolfgang Pauli first proposed the concept of a "neutrino" in 1930, years before the first neutrino would be detected. The concept of a neutrino provided a solution to his frustrating problem with the nuclear process called beta decay. Pauli concluded that there had to be a third particle, one that didn't interact strongly enough to be detected. He was so right.

Enrico Fermi named this third particle "neutrino", meaning "little neutral one", and he was understating when he said little. In 1956, two scientists named Reines and Cowan, found and documented evidence of neutrino interactions when they were monitoring a volume of cadmium chloride near a nuclear reactor. Later, in 1995, Fred Reines was jointly awarded the Nobel Prize in physics for this work.

As we have come to learn, a neutrino's mass is near zero…very little eh? In fact, the mass of neutrinos is so small, and they travel at such fast speeds (yep, just under the speed of light), that they pass through matter without hardly being disturbed. Now sit down for this one: neutrinos are passing through you right now…thousand of them each second. I kind of like it, don't you? In fact, neutrinos pass through the entire Earth without slowing down. It would take a neutrino passing through 1,500 Earths before a slowing of its speed could be detected.

Now to finish up this short introduction to neutrinos (an there is so much more to tell), let me tell you a bit about the big picture of neutrinos and what they mean to us. As it turns out, neutrinos are produced during any nuclear reaction, both man made and natural. So, think about it, the Sun is a nuclear furnace and therefore is producing neutrinos at a fast rate. By monitoring or "observing" neutrinos coming from the Sun (and there are three "flavors" of neutrinos: electron, muon and tau), we are in a remote way, monitoring the "heartbeat" of the Sun. So, this neutrino observing is important to us not only for learning about the Sun, but also for monitoring the health of the Sun.

As a spin off to this monitoring or observing, we can detect the arrival of neutrinos created from supernovas just before we detect the visible light from the nova. Therefore, we can and have established a supernova alerting system to try to point telescopes in the direction of supernovas as they are happening.

How these neutrinos are detected is another story for another time. I just wanted you to have a basic knowledge of what a neutrino was, and how it is important, and how it applies to us astronomers! More details later. Thanks for your time. Triple Nickel

Help turn off the lights...

Join the
International Dark-Sky Association (IDA)
http://www.darksky.org

"To preserve and protect the nighttime environment and
our heritage of dark skies through quality outdoor lighting."

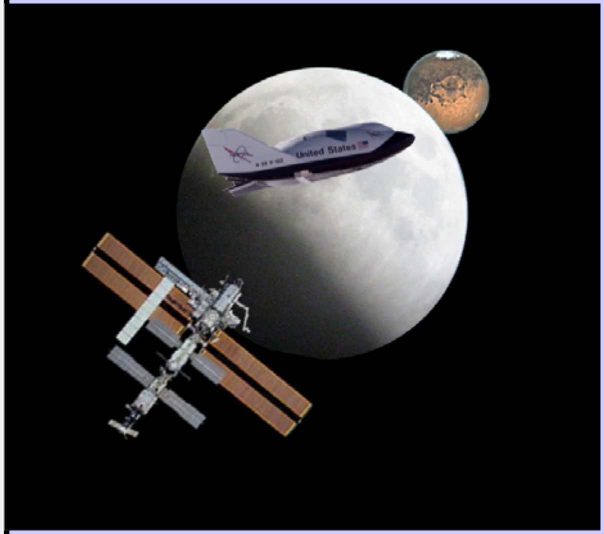
An effort is underway in Fort Bend and Brazoria counties to
reduce light pollution near the George Observatory.
For more information visit: http://people.txucom.net/tovinder/light_ord.htm

Current Events

A NEW VISION FOR NASA

"… the desire to explore and understand is part of our character..." George W. Bush

Wednesday, January 14th, 2004 In a speech at NASA's headquarters, President George W. Bush revealed a new vision for NASA. With a proposed increase of $1 billion in NASA's budget over the next 5 years, the president wants to shift the focus from the Space Shuttle and the International Space Station to the building of a new manned vehicle; returning to the



Moon within 16 years; followed by a manned expedition to Mars.

Under the new plan, the United States will complete its obligation of building the International Space Station by 2010. The current shuttle fleet would then be retired.

"With the experience and knowledge gained on the moon, we will then be ready to take the next steps of space exploration -- human missions to Mars and to worlds beyond," President Bush said.

No time frame was specified for a manned mission to Mars.

This new mission will not come without a high price. NASA has scrapped plans to service the Hubble Space Telescope, effectively "dooming" HST. According to Space.com, HST operators plan to seek assistance from Russia to keep Hubble alive and may even accept private donations. For more information visit: http://www.space.com/scienceastronomy/hubble_future_040121.html

HUGE GALAXY STRING CHALLENGES SPACE THEORY

Press Release: Research School of Astronomy & Astrophysics, Mount Stromlo Observatory, Cotter Road, Weston ACT 2611, Australia

An enormous string of galaxies 300 million light-years long has been discovered in the remote universe, challenging existing theories about how the universe evolved.

The remote area was formed very early, at a time when the universe was a fifth of its present age. The presence of the galaxy string defies existing models, which can not explain how a string this big could have formed so long ago.

This is the first time astronomers have been able to map an area in the early universe big enough to reveal such a galaxy structure.

ANU astronomer Dr Paul Francis, who coordinated the international research team, said the galaxy string lay 10,800 million light-years away. Light travels almost 9.5 trillion kilometers in one light-year, so our observation of the string is as it appeared 10.8 billion years ago. The universe was formed during the Big Bang approximately 13.7 billion years ago.

"We have detected 37 galaxies and one quasar in the string, but it probably contains many thousands of galaxies," Dr Francis said.

"The really exciting aspect of this finding is that it sheds new light on the formation of the universe. We are looking back four-fifths of the way to the beginning of the universe and the existence of this galaxy string will send astrophysicists around the world back to the drawing board, to re-examine theories of the formation of

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the universe."

The string was discovered by Dr Francis, Dr Povilas Palunas of the University of Texas, Dr Harry Teplitz of the California Institute of Technology, Dr Gerard Williger of Johns Hopkins University and Dr Bruce E. Woodgate of NASA Goddard Space Flight Center, using telescopes in Chile and at Siding Spring Observatory in New South Wales.

The team was refused time on a US telescope because many American astronomers believed the observations were technically impossible. The findings have been presented at the American Astronomical Society meeting in Atlanta.

The team compared their observations to supercomputer simulations of the early universe, which could not reproduce strings this large. "The simulations tell us that you cannot take the matter in the early universe and line it up in strings this large," Dr Francis said.

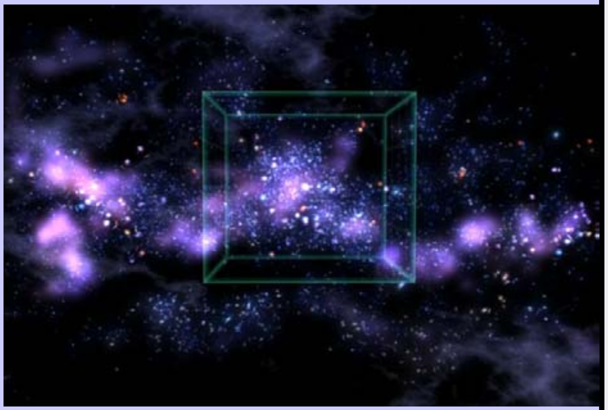
"There simply hasn't been enough time since the Big Bang for it to form structures this colossal.

"All we are seeing is the brightest few galaxies. That's probably far less than 1 per cent of what's really out there, most of which is mysterious invisible dark matter. It could be that the dark matter is not arranged in the same way as the galaxies we are seeing."

Recently, evidence has accumulated for the presence of dark matter in the universe, an invisible form of matter only detectable by the gravitational pull it exerts on ordinary matter (and light). There are many possibilities for what dark matter might be, but its true nature is currently unknown.

In recent years, it had been found that in the local universe, dark matter is distributed on large scales in very much the same way as galaxies are, rather than being more clumpy, or less. But go back 10 billion years and it could be a very different story. Galaxies probably form in the center of dark matter clouds. But in the early universe, most galaxies had not yet formed, and most dark matter clouds will not yet contain a galaxy.

"To explain our results the dark matter clouds that lie in strings must have formed galaxies, while the dark matter clouds elsewhere have not done so. We've no idea why this happened - it's not what the models predict," Dr Francis said.



The image above is from an animation of a 3D fly-through of the galaxy string. Animation available at: *http://msowww.anu.edu.au/~pfrancis/www/string/GalClustV2_big.mpg*. This is a large file (8 MB), so allow plenty of time to download.

The astronomers say the next step is to map an area of sky ten times larger, to get a better idea of the large-scale structure. Several such surveys are currently under way. The research was funded by NASA and the Australian National University.

MARS' SPIRIT BROKEN? — NOW THERE'S OPPORTUNITY

On January 3rd, at 11:35 p.m. EST, the Mars exploration rover, Spirit, successfully landed and sent a radio signal after the spacecraft had bounced and rolled for several minutes following its initial impact.

Spirit began sending back the highest resolution images ever from the surface of Mars. Everything seemed to be working well until Wednesday, January 21st, when Spirit quit sending data

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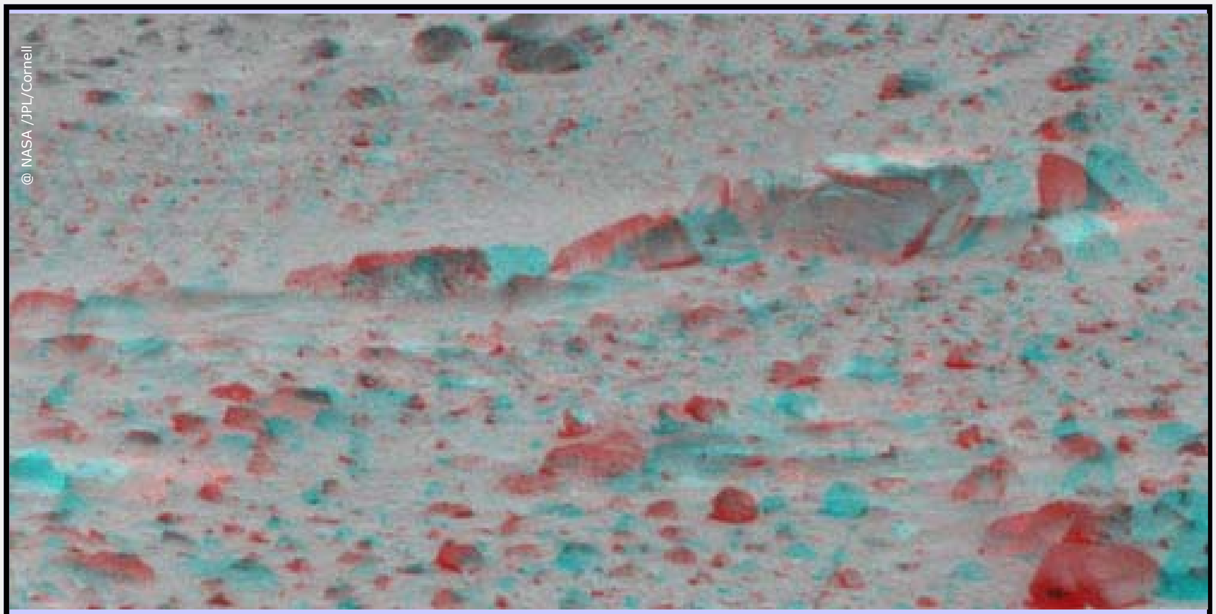

Use your red and blue glasses to view this 3-D image taken by the panoramic camera on the Mars Exploration Rover Spirit. Image credit: NASA/JPL/Cornell

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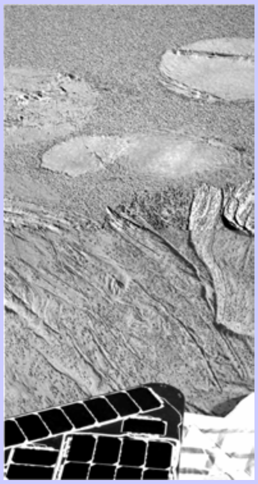
back to Earth. While NASA tried desperately to communicate with Spirit, its only responses were in the form of beeps. On January 23rd, Spirit began to send some engineering data back. On January 24th, NASA was able to isolate the problem to "flash" memory. Spirit's condition was upgraded from critical to serious. NASA continues to work to restore Spirit to a fully operational state.



NASA's second rover, Opportunity, bounced down on Mars at 9:05 PST on January 24th. "In the last 48 hours, we've been on a roller coaster," said Dr. Ed Weiler, NASA associate administrator for space science. "We resurrected one rover and saw the birth of another."

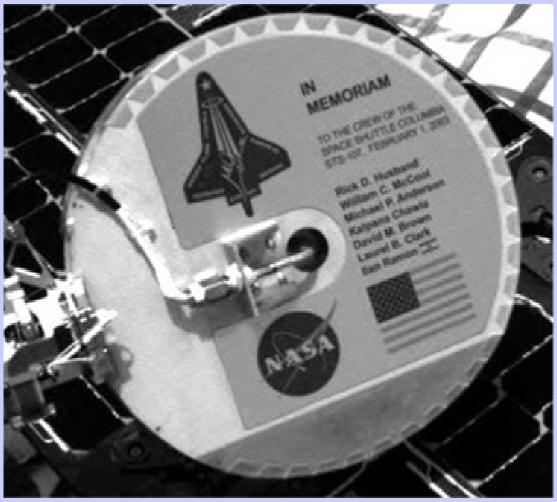
For more information: http://marsrovers.jpl.nasa.gov/home/index.html

Composite of 2 raw images from Opportunity's panoramic camera.

COLUMBIA MEMORIAL ON MARS

NASA Administrator, Sean O'Keefe, announced that the landing site of the Mars Spirit Rover would be named in honor of the astronauts who died in the tragic accident of STS-107. The area in the vast flatland of the Gusev Crater where Spirit landed this weekend will be called the Columbia Memorial Station.

A commemoration plaque was mounted on the back of the high-gain antenna of Spirit. The plaque was designed by Mars Exploration Rover engineers.



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STARDUST MEETS WILT 2

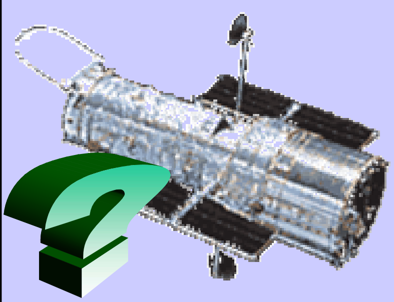
Jan 2, 2004 - Stardust, NASA's first dedicated sample return mission to a comet, passed a huge milestone today by successfully navigating through the particle and gas-laden coma around comet Wild 2 (pronounced "Vilt-2"). During the hazardous traverse, the spacecraft flew within 240 kilometers (149 miles) of the comet, catching samples of comet particles and scoring detailed pictures of Wild 2's pockmarked surface. For more information on Stardust visit: http://stardust.jpl.nasa.gov/index.html

The following sequence of images from Stardust was extracted from an animation (available at http://home.swbell.net/lesteke/JSCAS/Starscan/images/w2flyby.gif).

Stardust flyby of comet Wild 2. From top left to bottom right: approach to withdrawal

HUBBLE'S FUTURE

There will be no further space shuttle flights to the Hubble Space Telescope. On Jan. 16, NASA Administrator Sean O'Keefe announced his decision to cancel Servicing Mission 4, the final scheduled mission to maintain the Hubble Space Telescope and install new instruments. O'Keefe cited the new safety guidelines set out following the Columbia tragedy as the primary basis for his decision.



Hubble was designed to be visited periodically by astronauts who would perform repairs and install new equipment. Astronauts made several servicing visits to the telescope in the years after Hubble's launch in 1990.

Is Hubble being shut down?

No. Hubble is operating normally and will continue to function until age and natural wear take their inevitable toll on its components.

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How long will Hubble live?

Making an estimate about the life of a spacecraft like Hubble is like trying to figure out the lifespan of a new car when no previous models exist. It's difficult to predict because we have little history to base our predictions upon.

Hubble was launched in 1990. Its original mission was supposed to last 15 years. Eventually that was extended to 20 years, with a projected end date of 2010. With the cancellation of Servicing Mission 4, Hubble will probably not last that long. Scientists and engineers are looking at ways to stretch Hubble's life out as long as possible.

The telescope's gyroscopes and batteries are the two main areas of concern.

Gyroscopes:

Hubble depends on gyroscopes to point the telescope and keep it stable. If too many gyroscopes fail, Hubble becomes unusable.

Hubble has six gyroscopes. Two are broken and would have been replaced on Servicing Mission 4. Three are working and used every day. One is on standby as a backup gyroscope.

Right now it takes three gyroscopes to point the telescope, but scientists are developing software and techniques, to be tested this fall, that would allow Hubble to operate using just two gyroscopes.

Gyroscopes have been replaced repeatedly throughout Hubble's life. Based on previous history, Hubble will probably be down to two gyroscopes around 2006, and one gyroscope in 2007. We are currently unaware of a method that would allow Hubble to operate with only one gyroscope, but that possibility will be carefully studied.

Engineering improvements that were made to Hubble's current gyroscopes may extend their lives, but there's no way to tell in advance.

Batteries:

Hubble is powered by a set of rechargeable nickel-hydrogen batteries. Hubble's solar panels collect the energy that recharges the batteries 14 to 15 times a day, whenever Hubble's orbit carries it into the daylight. If the batteries die, Hubble will have no power during the nighttime, and the telescope won't stay pointed.

The batteries Hubble uses are not unlike the rechargeable batteries around your own home. As they age, their charge runs down more quickly. Once the batteries are unable to hold a charge, the telescope becomes inoperable.

Hubble has its original batteries, which means they date back to 1990. We don't know how long they will last, but their performance is starting to deteriorate.

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Engineers have been continuously monitoring the charging of Hubble's batteries and developing techniques to minimize the effects of aging. The focus was on keeping them healthy until Servicing Mission 4; now the emphasis will be on getting the most life out of them.

Other failures:

Hubble has many parts, and random failures could pose a problem. Transistors and resistors can break down, for instance. Fortunately, Hubble also has a number of redundant systems to keep the telescope working in the event of such a failure.

But since there will be no servicing mission to replace failed components, the backup systems that eventually kick in will themselves have no standby waiting in the wings to take over.

Slow degradation will also take its toll on the telescope. For instance, electronics last longer when they stay cool. The material shielding the outside of the telescope has been slowly aging, resulting in a gradual rise in the temperature of some of Hubble's components.

What will happen when Hubble stops working?

Hubble will continue to orbit the Earth until a method is devised to safely de-orbit the telescope. The current plan is to build and launch an unmanned robotic device that will rendezvous with Hubble and attach a rocket to it. The rocket will fire in a controlled manner and alter Hubble's orbit. Hubble will fall to Earth and crash into the ocean, safely away from populated areas and shipping lanes.

Plans are still underway for the James Webb Space Telescope, Hubble's successor, which would be launched in 2011. JWST will be designed to view objects in visible light and infrared, and its mirror will have six times the area of Hubble's mirror. Its goal is to study the first stars and galaxies that formed in the early universe. JWST will operate 1 million miles (1.5 million km) away from the Earth, and will not be serviceable from orbit.

Can we expect more observations from Hubble?

Absolutely. Hubble is functioning normally, and new images, press releases and science are forthcoming. Astronomers continue to submit proposals for research time on the telescope, and Hubble will continue to conduct observations until a major systems failure makes that impossible.

What plans are underway to maximize Hubble's lifespan?

Planning is only in the earliest stages, but Hubble scientists and engineers will study every option to prolong Hubble's life. Software and techniques that will allow Hubble to operate using two gyroscopes, instead of the usual three, will be tested in the fall. Adjustments to the batteries may help lengthen their life.

Teams of scientists are looking at every possibility, from servicing Hubble without the space shuttle, perhaps robotically, to examining technical methods that could conserve the usefulness of key components.

Article prepared by NASA and STScI and appears at
http://hubblesite.org/newscenter/newsdesk/future/

New Magazine for New Observers

By Triple Nickel

I can remember when I started out as a new observer how I studied both “Sky and Telescope” and “Astronomy” magazines, just to learn anything I could. I went so far as to read each and every advertisement just to see what equipment was available and to learn the “language” of astronomy

(okay, and to dream a lot). They were very helpful and the articles in those magazines were, and still are, very helpful. However, some of the articles are written at a technical level way above me or, at least, way above the observational mentality that interests me. Well, I just came across a new magazine that should fill that technical gap and be a friendly companion to all new observers.

The magazine is called “Night Sky”, and is a bi-monthly magazine that addresses the basics of astronomy. I haven’t personally read one, but the reviews and descriptions sound like just what a new observer needs - things like what the different scope types are and binocular viewing tips. The magazine takes you through an introduction to the night sky and how to find objects and use sky charts. I expect there will be the standard amount of advertisements, but again, read them and learn about the equipment out there. I am excited about this new addition to our observing tool kit and thought y’all might be too. The newsstand price is $3.99, but a one-year subscription is $17.99 (a 25% savings) and this gives you 6 issues. The first issue will be the May-June issue. First one to get a copy, bring it to a meeting for all to see! To order visit their web site: www.nightskymag.com That is all…. Triple.

Need More Astronomy?

Houston Area Astronomy Clubs

Fort Bend Astronomy Club http://www.fbac.org/
Meets the third Friday of the month, 7:00 p.m.
First Colony Conference Center
3232 Austin Pkwy
Sugar Land, Texas

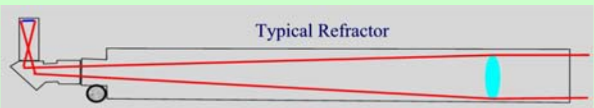
Houston Astronomical Society http://spacsun.rice.edu/~has/
Meets the first Friday of the month, 8:00 p.m.
University of Houston
Science and Research Building, room 117

North Houston Astronomy Club http://www.astronomyclub.org/
Meets the fourth Friday of the month, 7:30 p.m.
In the Teaching Theater at Kingwood College
20000 Kingwood Drive
Kingwood, Texas

Astronomy 101

Know Your Types of Telescopes

How well do you know your types of telescopes? This month I present a brief review of 8 types of telescopes. Although this article is geared for a novice, those who have been around awhile just may learn something new.



Refractors: The first telescopes were refractors. Good refractors consist of a multi-element front objective lens in a long tube. Refractors yield the best, sharpest views since there is no central obstruction (as found in reflectors). Unfortunately, refractors cost the most per inch of aperture. Good quality refractors will have at least a two element (achromatic) lens. One element will be a convex lens made of crown glass. The other element will be convex and made of flint glass. This combination reduces color aberration.

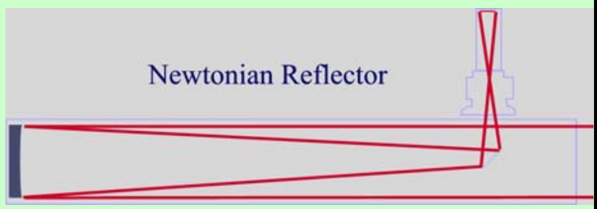
Higher quality refractors have from two to four lens elements with at least one made with fluorite or “ED” glass. Fluorite refractors reduce the chromatic aberration even more.

Maintenance wise, refractors seldom require alignment of the optics. Refractors are the best instruments for observing the Moon and planets. They can also be used to observe brighter deep sky objects and double stars. Refractors in the 2” to 4” range are fairly affordable depending upon manufacturer. Refractors above 4” are in the expensive range.

Achromatic Refractors: One problem with refractors is chromatic aberration. This is where white light is broken up into its different colors. Another problem is spherical aberration. This is where the curvature of the lens causes the point of focus for light going through the center of the lens to be different from the point of focus for light going through the edges. Different types of materials diffract (bend) light at different angles. When lenses of different materials are glued together an achromatic lens is formed. Achromatic lenses help correct the aberrations.

Apochromatic Refractors: The lensing system in an apochromatic refractor (APO) eliminates just about all aberration. They are the best telescopes you can buy for observing fine detail in the planets and the Moon. They are also the most expensive. APOs use multiple elements (up to 4) in their main lens which is made from low dispersion (ED) glass and/or fluorite.

Newtonian reflectors: These telescopes are



named after their inventor, Sir Isaac Newton. They use a large parabolic primary mirror located in the bottom of a long tube to concentrate the light. The light is then reflected back up the tube to a smaller flat secondary mirror which reflects the light out the side of the tube to an eyepiece. The secondary mirror causes an obstruction of the light entering into the telescope. This obstruction tends to make the image less sharp than a refractor.

Schmidt-Newtonian: A Schmidt-Newtonian is just like a conventional Newtonian reflector, except that it has a Schmidt corrector plate on the front. A conventional Newtonian operating at f/4 would have intolerable off-axis aberrations. The addition of the Schmidt corrector plate reduces edge of field coma and astigmatism by about 40%. Thus, an f/4 Schmidt-Newtonian will exhibit aberrations similar to a conventional Newtonian operating at f/5.6 or even f/6. On the

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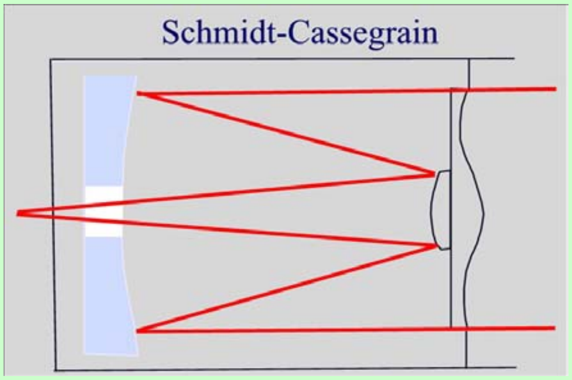
downside, a Schmidt-Newtonian requires the light to pass through an additional (non-linear)



element, and a dew-collecting one, at that.

Schmidt-Cassegrain: Schmidt-Cassegrains use a spherical primary mirror to focus incoming light onto a convex secondary mirror which sends light back through a hole in the primary mirror. Spherical mirrors introduce spherical aberration which is corrected by using a corrector plate at the front of the telescope. This "folding of the light" results in a much shorter tube length for a given aperture and focal ratio.

Maksutov-Cassegrain: The Maksutov-Cassegrain uses a main mirror and a lens (hyperbolic secondary mirror). It also has a corrector plate to eliminate spherical aberration. The secondary mirror is glued onto the back of the corrector plate instead of being held by brackets. This cuts down on the size of the obstruction in front of the main mirror, which means higher resolution and light gathering. The design of the corrector plate is different from the Schmidt. It is harder to make correctly and is therefore more expensive. Maksutovs are generally smaller aperture telescopes because of the price.

Ritchey-Chretien: This variation of the Cassegrain design uses a hyperbolic primary mirror and a hyperbolic secondary mirror. This configuration corrects for coma at the expense of astigmatism. However, since astigmatism is so small to begin with, it can be increased considerably before it becomes larger than coma. The resulting two mirror system is optimized for a specific field of view. The Ritchey-Chretien camera was developed for wide field photography. It is not suitable for high resolution imaging over a small field.

Dall-Kirkham: The Dall-Kirkham type of Cassegrain appears to have been developed in the 1930s by Horace Dall of Luton, England. It is constructed with a primary mirror that is less than a full paraboloid and a spherical secondary mirror. A properly designed Dall-Kirkham can deliver the finest images of any Cassegrain. At fast focal ratios (f/4 or faster), the Dall-Kirkham design has significant off-axis coma.

Further reading:
http://www.rfroyce.com/cassegrains.htm
http://www.rcopticalsystems.com/overview.html
http://www.weasner.com/etx/guests/mak/MAKSTO.HTM

Ken Lester

Star Party News

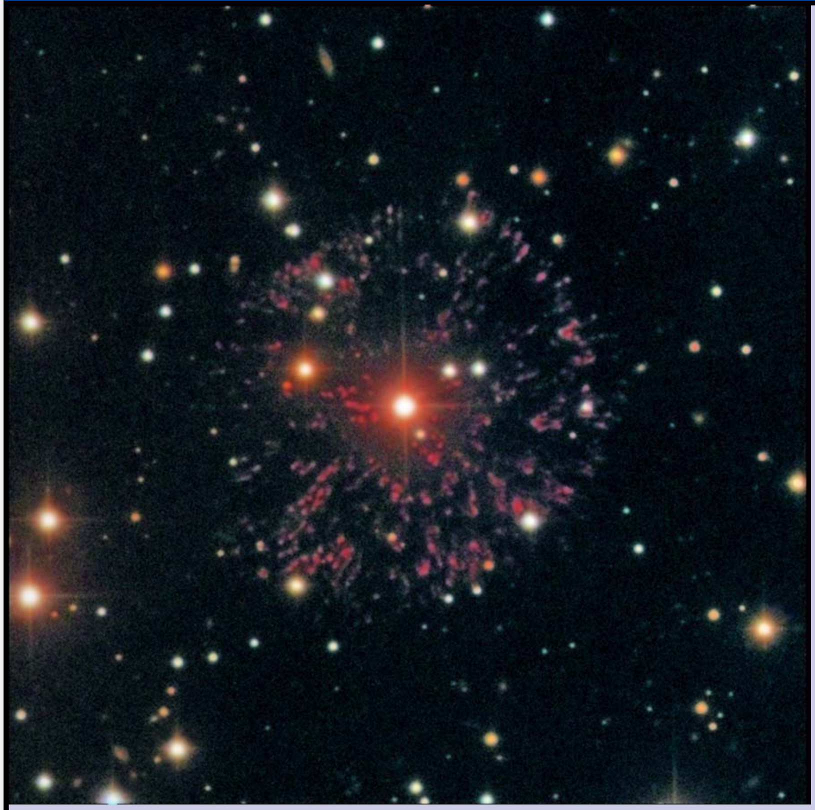
We're off to a slow start for 2004. Our first star party of the year was scheduled for January 24th at Challenger 7 Memorial Park. Unfortunately, a weather system moved in, bringing rain and complete cloud cover.

Our next star party will be on February 21st at Moody Gardens. As always, the star party starts at sundown (6:11 p.m.). Most people show up about 30 minutes early to set up their scope. The exact location at Moody Gardens has not yet been finalized. Be sure to check our star party web page to get last minute details including the star party location at Moody Gardens. Electricity will be available.

See you there!

Star party web page: http://home.swbell.net/lesteke/JSCAS/StarParties/starparty.htm

Member's Gallery

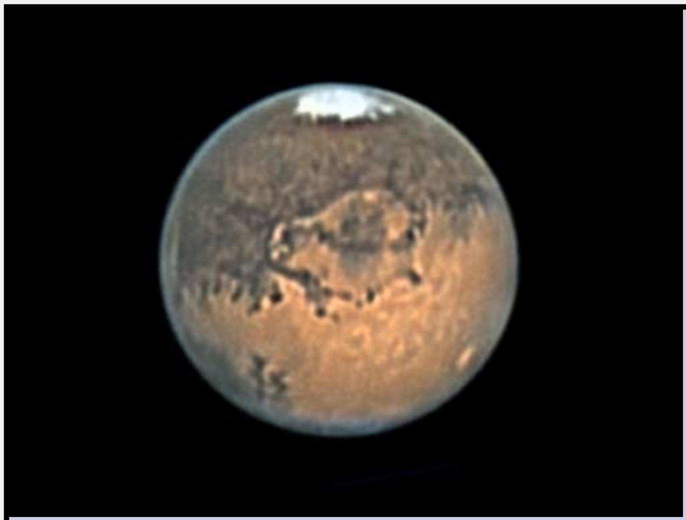


GK Persi
Image by Arne Henden
Processing by Al Kelly©

L/RGB color composite of the expanding stellar debris from GK Persei, well known for Nova Persei 1901. Processed by Al Kelly from images taken on 12/29/03 by Arne Henden of the US Naval Observatory in Flag-staff, AZ. Arne made numerous CCD images through the 1.55-meter USNO scope using BVR filters. All images were summed to create the luminance layer, while red=I, green=V, and blue=B.

NGC-891
Randy Brewer©

Shot from Randy's backyard on 11/19/03 with the Mewlon 300 @ F/12 using the AO-7. Luminance was 12 X10 minute shots.



Mars One Day Before Opposition 2003
Ed Grafton©

This image of the Solis lacus (lake of the Sun) region of Mars was taken on August 26th 2003. This region is sometimes referred to as the "Eye of Mars" since some see this region as resembling an eye. Mars was over 25 arc seconds in diameter, tiny by most standards but very large for Mars in this favorable opposition. Taken with a ST5 CCD camera on a C14 at f/39 from Houston, Texas.

The Globular Cluster Omega Centaurus
Ed Grafton©

The finest example of a globular cluster in the sky. This globular is visible to the naked eye but you will need a southerly location to view it. Located at a declination of -47 degrees, it barely peeks above the trees in South Texas, Florida and the desert southwest regions of the USA. This globular is about 150 light years across and is at a distance of about 20,000 light years. The star density is estimated to be about 25,000 times greater than the star density in the neighborhood of our star the Sun. This image is an RGB taken with a 120mm refractor at f/4 with a ST237 CCD. Taken from Danciger Texas on 4/8/00. R=G=B=100 seconds

Arp 333
(NGC 1024)
Dick Miller©

Dick's first image using his MX 716 CCD camera. 10" Newtonian with a total exposure of only 20 min, 2 x 2 binning.

Visual Observing

By Chris Randall

★ **SSO (Solar System Objects)**: Summary for February 15th, 2004

Object	Constellation	Mag	% Ill	Rise Time	Transient	Set Time
Sun	Capricornus	-26.7	100	07:00	12:34	18:08
Moon	Sagittarius	Bright	22	03:01	08:06	13:13
Mercury	Capricornus	-0.5	94	06:30	11:48	17:07
Venus	Pisces	-4.1	70	09:02	15:12	21:25
Mars	Aries	0.9	90	10:24	17:01	23:42
Jupiter	Leo	-2.5	100	19:36	01:53	08:10
Saturn	Gemini	0.5	100	14:11	21:11	04:08
Uranus	Aquarius	5.9	100	07:23	12:58	18:38
Neptune	Capricornus	8.0	100	06:21	11:43	17:06
Pluto	Serpens	13.9	99	02:39	08:07	13:35
Ceres (1)	Gemini	7.6	98	14:08	21:38	05:04
Iris (7)	Crater	9.4	98	20:31	02:18	08:04
Hebe (6)	Gemini	9.4	98	15:03	21:45	04:23
Eunomia (15)	Hydra	9.0	99	17:44	00:04	06:19
Linear C/2002 T7	Pegasus	7.1	94	08:17	14:53	21:32

Note: hi-lighted times denote daylight events.

★ **BSO (Bright Sky Objects)**:

NGC 2451 (Cr-161) – Open cluster in Puppis, magnitude 2.8, size 45’, ~40 stars.
NGC 2362 (C-64, Cr-136, Mel-65) – Open cluster in Canis Major, magnitude 4, size 6’, ~60 stars.
IC 4665 (Cr-349, Mel-179) – Open cluster in Ophiuchus, magnitude 4.2, size 40’, ~30 stars.
NGC 2168 (M-35, Mel-41) – Open cluster in Gemini, magnitude 5.1, size 28’, ~200 stars.

★ **DSO (Dark Sky Objects)**:

NGC 2403 – Galaxy in Camelopardalis, magnitude 8.9, size 22’ x 12’.
NGC 2392 (C-39, Eskimo) – Planetary Nebula in Gemini, magnitude 9.9, size 50”.
NGC 2467 (Cr-164) – Open Cluster in Puppis, magnitude ~7, size 15’, ~50 stars.
Also **SH2-311** Nebula, Magnitude --, size 17’ x 12’.
And **Haffner 18** Open cluster, magnitude 9.3, size 4’, ~15 stars.

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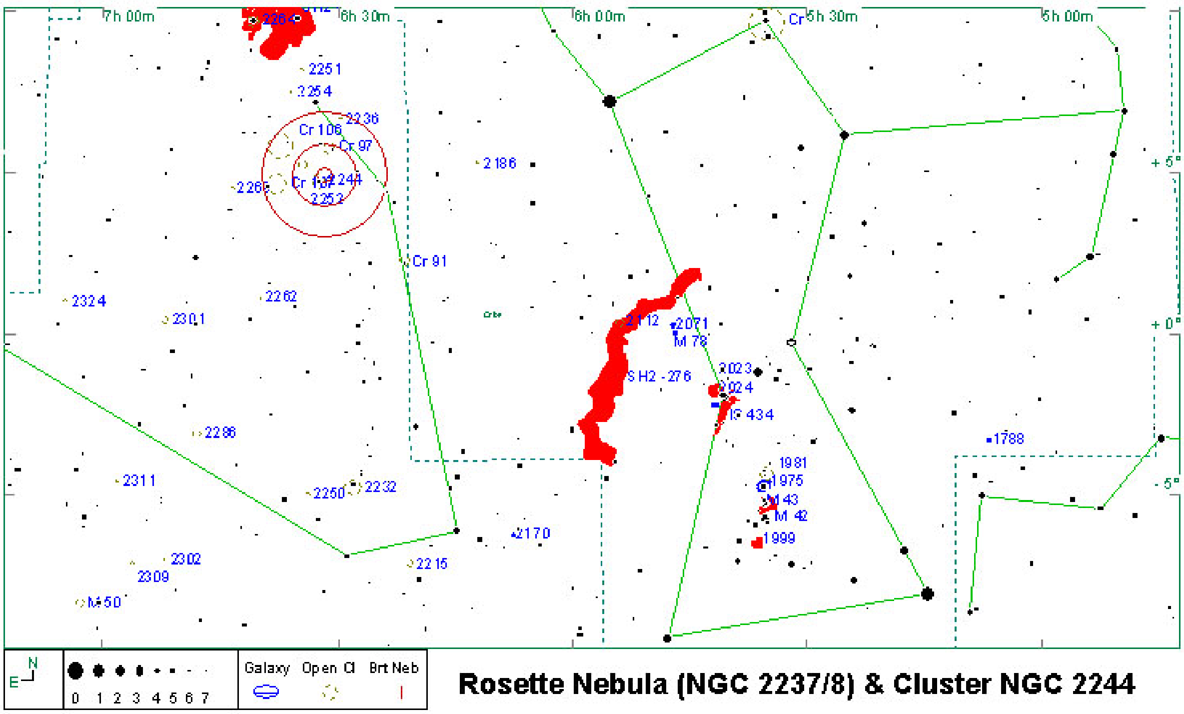
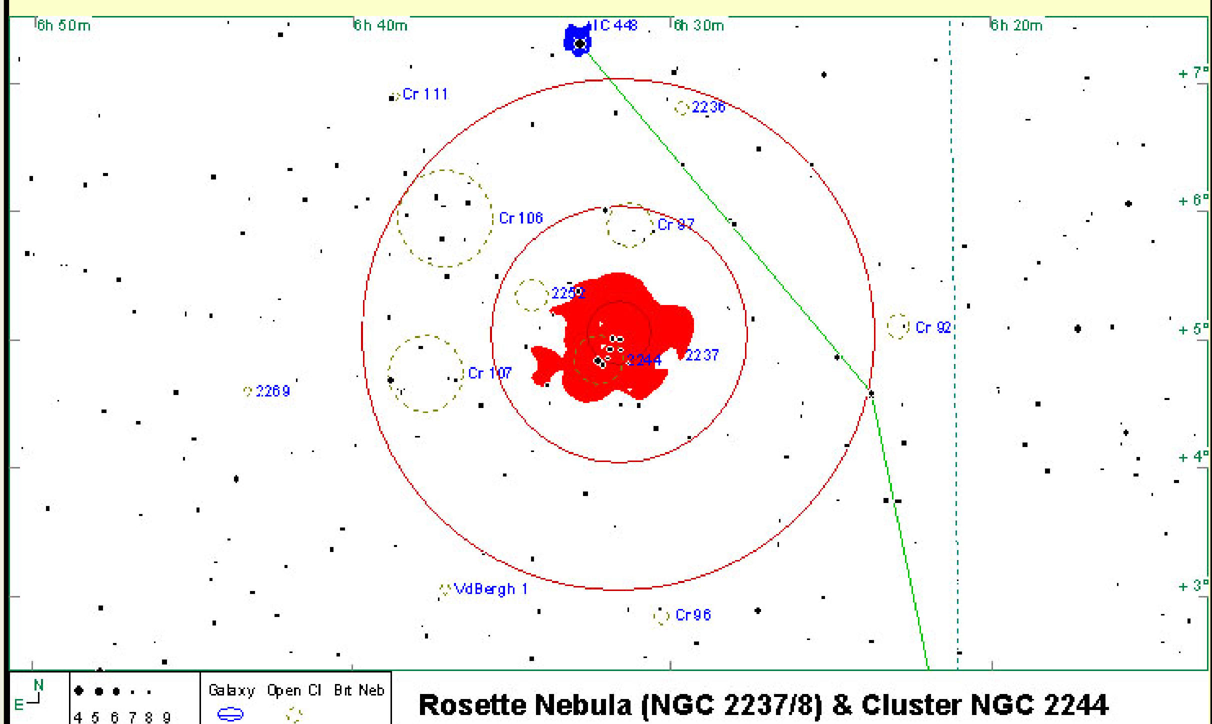


Rosette Nebula (NGC 2237/8) & Cluster NGC 2244



Rosette Nebula (NGC 2237/8) & Cluster NGC 2244

(Continued from page 19)

★ **CDMP (Chris' Don't Miss Picks):**

The Rosette region: Have a rose just in time for Valentines Day.

NGC 2237/8 (SH2-275, LBN-949,) – Nebula in Monoceros, magnitude ---, size 80' x 60'.

NGC 2244 (C-50, Cr-99, Mel-47) – Open Cluster in Monoceros, magnitude 4.8, size 23', ~100 stars.

Observing Planets During the Day

The brighter planets, Venus and Jupiter, can be seen in broad daylight — if you know where to look. The best chance of seeing them are when they are close to the Moon. Using a pair of binoculars, slowly scan around the Moon until the planet pops into view. Our former president, Becky Ramotowski, who now lives in Albuquerque, New Mexico, took the picture of Jupiter and the Moon on January 12th, 2004. "For two months in a row now I've seen Jupiter during the daytime," says Becky. "This shot was made using a Nikon digital camera hand held to one ocular of my 8 x 56 binoculars". Becky's image is going to be used by the Lodestar Planetarium in Albuquerque in their shows. It also appeared on SpaceWeather.com on the day it was taken.

The image of the crescent Moon and Venus was also taken by Becky at approximately 3:30 p.m. on January 24th in Albuquerque, New Mexico.

Johnson Space Center Astronomical Society

An association of amateur astronomers dedicated to the study and enjoyment of astronomy. Membership is open to anyone wishing to learn about astronomy.

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SIGS

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Binocular Observing
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Telescope Making
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February Meeting Agenda

February 13th Center for Advanced Space Studies/Lunar Planetary Institute, 3600 Bay Area Blvd. (at Middlebrook Drive). Meeting starts at 7:30 p.m.

Meeting start and welcome

Presentation— Dr. Paul Maley
1) Views From The Antarctica Solar Eclipse
2) Plans For The Nearest/Cheapest Solar Eclipse
3) What to Expect From the Transit of Venus

Break

SIG reports

Charlie's Challenge, Charles Hudson

Astronomical Oddities, Hernan Contreras

International JSCAS interview

Starscan Article Submissions—Ken Lester

Door Prizes

Starscan Submission Procedures

Original articles of astronomical interest will be accepted up to 6 P.M. February 25th.

The most convenient way to submit articles or a Calendar of Events is by electronic mail, however, computer diskettes or CDs will also be accepted. All articles should include author's name and phone number. Also include any picture credits. The recommended format is Microsoft Word. Text files will also be accepted.

Submitter bears all responsibility for the publishing of any e-mail addresses in the article on the World Wide Web.

Editor's electronic address is: lesteke@swbell.net. Be sure to include the word Starscan in the subject line for proper routing of your message.

Starscan Staff

Editor	Assistant Editors
Ken Lester	Sheila Steele
	Ken Steele

Cover Image by Al Kelly

L/RGB image of planetary nebula NGC 4361 in Corvus. Images were taken with a Starlight Express MX916 on a 32" f4 Newtonian on 5/30/03 from Danciger, Texas, using Schuler RGcBc filters. Four 240-second unfiltered sub-exposures, two 240-second sub-exposures in red, two 240-second sub-exposures in green, and two 240-second sub-exposures in blue were self-guided in Astroart and processed in AIP4WIN.