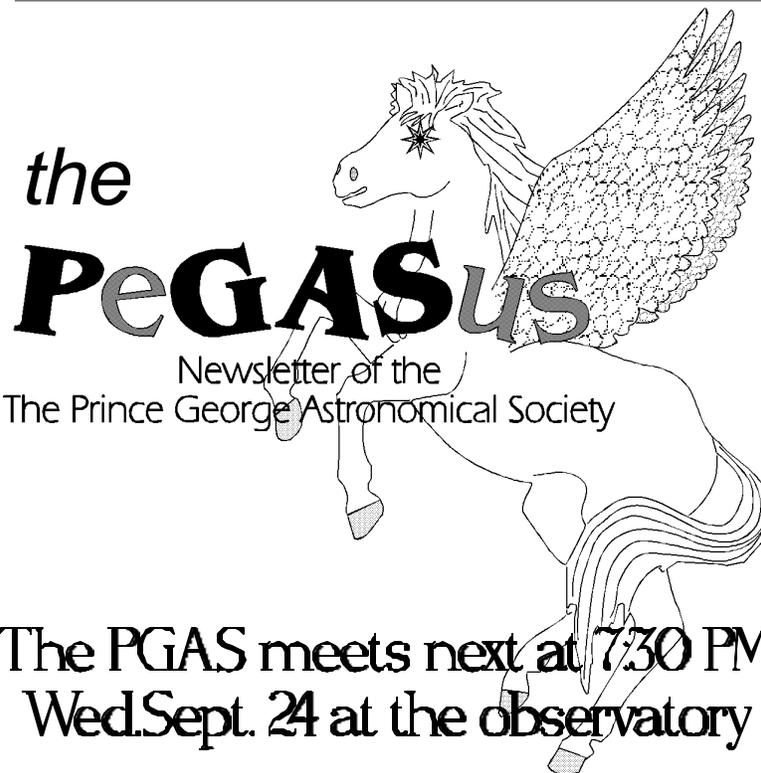


1997 SEPTEMBER ISSUE #77



The PGAS meets next at 7:30 PM
Wed. Sept. 24 at the observatory

INSIDE :

<i>PGAS Executive</i>	2
<i>Editorial</i>	3
<i>Coming Events</i>	4
<i>The Night Sky</i>	4
<i>Three Eclipses</i>	6
<i>A Plug for RASC</i>	8
<i>Contact</i>	10
<i>Voyager Update</i>	13



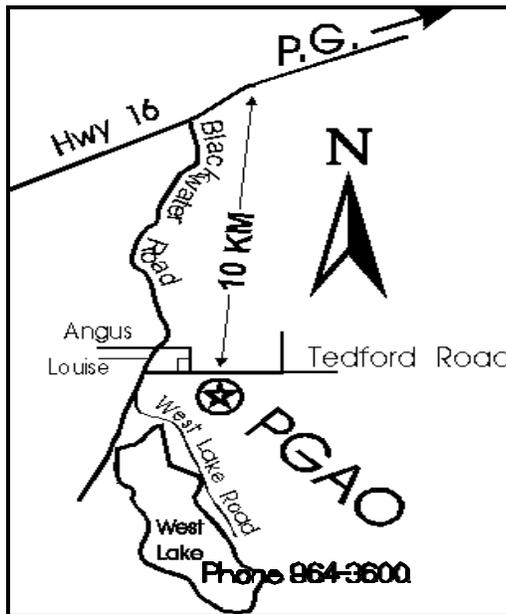
the PeGASus
is published monthly by
the *Prince George*
Astronomical Society.

Our pursuits are out of this world.
Our activities are astronomical.
Our aim is the sky.

Contributions to the newsletter are
welcome.

***Deadline for the next
issue is OCT 17
at the latest***

Send correspondence to
The PGAS
3330 - 22nd Avenue
Prince George, BC, V2N 1P8
or
Nelson@cnc.bc.ca



**Prince George
Astronomical Society
Executive, 1996/97**

President
Jon Bowen
563-9869

Vice President
Bob Nelson
562-2131/563-6928

Secretary
Brian Potts
562-8113

Treasurer
Steve Senger
964-1202

Members at Large
Gil Self 964-7279
Rob Frith 563-6084

Appointed Directors

Technical
Bob Nelson

Program
Gil Self

Observing
Brian Potts

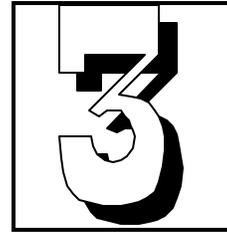
Promotional
Sanjay Nikhanj
964-9630

Building
Mike Hansen
563-3731

PeGASus Editor

Editorial

by Gil Self



If I look at this blank page long enough I may think of something to say, but maybe not . So I step outside and sit on my porch for a while seeking inspiration. It is about midnight and it's a clear warm evening (in September-go figure). A lot of small ideas are clicking around in my head trying to become a sentence and maybe a paragraph maybe an editorial.

Things like -- astronomy is a great hobby, you can enjoy it so simply all you need is a clear night. Sort of like fishing, contemplative, it doesn't really matter if you get anything. But I think I might have trouble turning that sentence into a page.

Or another thought-- some people get paid for doing this. Do you think it could be as enjoyable for those folks or does it become dull like a lot of jobs? What kind of hobby does an astronomer have --photocopier repair, retail sales, heating system maintenance --probably not.

I (collectively) can measure so much in the sky, distance, mass, color, temperature, rotation rate, I can image the surface of a distant star, I can detect distant companions. I can see the remaining effect of the big bang. But for something really special, go outside tonight and watch the Pleiades for a while. They are about 30 degs ahead of the moon tonight. Sure Jupiter is up and outstanding as ever. And the great square is right there in front of you and over a little is Andromeda. But find the Pleiades and just watch them for a while, don't measure anything , just look.

There is a connection somehow (no I am not smoking that green stuff). Watch the sky , follow the sky for a few months. Follow the movement of the constellations, take your binoculars out to a dark site, maybe even come out and host a group of school kids or just contemplate a small part of the sky---Now that's Astronomy.

G. S.



Coming Events

If you are involved with any astronomical or otherwise scientific activity on behalf of the PGAS, please list the activity here.

Don't forget Friday night open house throughout October

The Night Sky for October '97

by Bob Nelson, PhD

Hi folks. As September gives way to October, the skies get dark sooner, but the temperature falls giving rise to dampness and the danger of fog later in the evening. The weather generally deteriorates but we often get good weather now and then. As usual, here is the planetary roundup with mention of deep sky observing later.

MERCURY is at superior conjunction on the 13th; after that it sets minutes after the Sun and is therefore not visible this month. As we swing into November, Mercury will move eastward of the Sun and should be seen after sunset. However, since it will be south of the celestial equator, it will be an unfavourable apparition for northern observers.

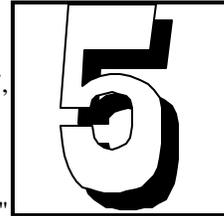
VENUS is low in the southwest at sunset and sets over an hour later. It too lies south of the celestial equator and is therefore not a great sight for northern observers. Again, as the weeks go by, Venus will move somewhat eastward from the Sun, reaching greatest eastern elongation in November.

MARS, in Ophiuchus for most of the month, is a difficult object low in the south southwest at sunset and sets around an hour and a half later.

JUPITER, in Capricornus, is low in the south at sunset and sets around midnight (PST). It is stationary on the 8th and then moves westward (retrogrades) against the background of stars. It is a fine object of magnitude -2.5 and angular size 43"; it should be possible to see the Great Red Spot when it transits the central meridian. According to the Observer's Handbook, there is a double shadow transit on Jupiter (at 13:39 UT = 5:39 PST) but is not visible to us in the western horizon at that time.

SATURN, in Pisces, rises at sunset and sets at sunrise. It is at opposition on the 10th. It's brightness is around magnitude 0 (+0.2 in the Observer's Handbook and -0.3 by Redshift) and makes a disk of diameter 20".

The rings span 45" and are tilted 10 degrees (so that we see the southern side). Several moons, as always are usually visible -- the brightest are Titan, Rhea, Tethys and Dione (of magnitudes 8.4, 9.7, 10.3 and 10.4 resp.).



URANUS, in Capricornus, is low in the south after sunset and sets around midnight (PDT). It is around magnitude 5.8 and makes a 3.6" disk. It is not difficult to find with the 24" telescope (we do, after all have the NGC Max setting circles) and, when viewed in the finder, it stands out clearly against the background stars. At 3.6", it is not much of a disk but should look different from a star.

NEPTUNE, in Sagittarius, transits around an hour after sunset and sets itself at around 10 PM (PST). At magnitude 7.9, it is not too hard to find but is only a 2.4" disk.

PLUTO, in Scorpius, is low in the southwest at sunset and sets at around 10 PM (PST). It is only at magnitude 13.87 and should be a challenge to find.

DEEP SKY observing should also be good in early October with the new Moon occurring on Oct. 1. There is a meteor shower on the 22nd -- the Orionids. The asteroids Ceres and Vesta are also visible -- given clear skies on an observing night, let's go after them. The constellations Aquarius and Capricornus are visible to the south at 10 PM. I was looking at them last month; it's good to learn stars and deep-sky objects in parts of the sky we don't often see. The Milky Way including the Cygnus Loop is pretty well overhead, so northern deep sky objects are conveniently placed.

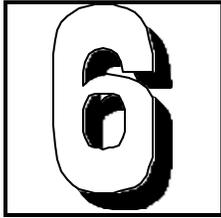
B.N.

STREAMS IN THE SUN

Observations from the Solar and Heliospheric Observatory (SOHO) have revealed that the Sun bears some similarity to Earth's atmosphere. The "rivers" of hot plasma (electrically charged gas) flow just below the surface near the Sun's poles.

Material in these oval regions move about 10 percent faster than its surroundings. The jet streams circuit the Sun at latitudes of 75 degrees and are about 27,000 kilometers across. The satellite also found that the Sun has belts that flow at varying speeds in the northern and southern hemispheres.

These zones extend as much as 19,000 km below the surface. The features seem related to the Sun's 11-year magnetic cycle, as the midlatitude belts gradually migrate toward the equator and sunspots seem to form at the edges of the zones.



THREE TOTAL SOLAR ECLIPSES (WRONG PLANET)

A great night to schedule a club observing session is on the evening of November 10th when the shadows of three of Jupiter's moons will be on the planet's disk--three total eclipses of the sun

happening simultaneously on Jupiter! Callisto's dark shadow (much of it penumbral with a tiny umbra) transits Jupiter between 6:10 PM PST and 10:52 PM; Ganymede's black shadow transits Jupiter between 6:59 PM and 10:36 PM; Io's black shadow transits Jupiter between 7:34 PM and 9:51 PM. As well, Io itself transits Jupiter as a bright but tiny orangish dot between 6:15 PM and 8:32 PM. As Io leaves Jupiter's disk, Ganymede's shadow partially eclipses Io between 8:24 PM and 8:43 PM. Maximum eclipse of 87 percent is at 8:34 PM, just as Io's transit ends so the second half of the eclipse will be the only part visible, when Io is brightening just off Jupiter's west limb. [See the Guide CD-ROM Star Chart advertisement on page 65 of the May, 1997 Sky & Telescope. Text sources: June Sky&Tel p.78 and Pat Kelly's list in THE OBSERVER'S HANDBOOK.]

This will be an exceptional evening!

TWO OTHER NICE EVENTS:

Currently Venus and Mars can be seen in mid-twilight, LOW in the southwest. On October 5th the crescent moon will form a pretty equilateral triangle with the two planets. Venus will lie 8 degrees below the moon while much fainter Mars is 8 degrees upper left of Venus or 8 degrees lower left of the moon. Antares, the rival of Mars, will lie about 6 degrees to Mars' left and somewhat lower. You may require binoculars to spot Mars and Antares in the twilight. The crescent moon again passes the two planets November 3rd and 4th.

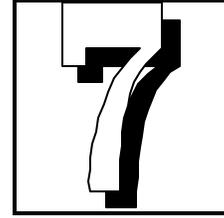
The bright gibbous moon occults the bright star Aldebaran early Sunday morning, October 19th. From Vancouver the moon's north polar area just catches the star. The disappearance on the bright limb is at 1:26 AM PDT; reappearance on the dark limb is at 1:43 AM, only 17 minutes later. The northern limit graze is fortunately on the dark limb. The OBSERVER'S HANDBOOK graze path runs from about Whistler Mountain to just north of Kamloops to about 60 miles south of Edmonton. (I'm sure that David Dunham will give us the details a few days in advance).

Four 4th and 5th magnitude stars in The Hyades are occulted a few hours before Aldebaran with dark limb reappearances at 9:26 PM PDT, 10:25 PM, 10:28 PM, and 11:06 PM on the 18th (OBSERVER'S HANDBOOK times are for Vancouver).

Alan Whitman

HUBBLE SEPARATES STARS IN THE MIRA BINARY SYSTEM

Although the giant star Mira has been known for 400 years, astronomers have had to wait for NASA's Hubble Space Telescope to provide the first ultraviolet images of the extended atmosphere of the cool red giant star and its nearby hot companion.



By giving astronomers a clear view of the individual members of this system, Hubble has provided valuable insights into other types of double star systems where the stars are so close they interact with one another.

The separation between Mira and its companion is about 70 times more than that between Earth and the Sun, (equal to an angular size of only 0.6 arcseconds -- the apparent diameter of a dime at four miles away) even smaller than the typically fuzzy ground-based telescopic image of a single star as smeared out by Earth's turbulent atmosphere.

Using the European Space Agency's Faint Object Camera aboard Hubble, Margarita Karovska and John Raymond of the Harvard-Smithsonian Center for Astrophysics, Cambridge, MA; Warren Hack of the Space Telescope Science Institute, Baltimore, MD; and Edward Guinan of Villanova University, Villanova, PA, obtained both ultraviolet and visible light images and spectra of the two separate stars in the Mira system. The results appear in the June 20 *Astrophysical Journal Letters*.

In ultraviolet light, Hubble has resolved a small hook-like appendage extending from Mira in the direction of the companion, which might be material from Mira being gravitationally drawn toward the smaller star. Alternately, it could be material in Mira's upper atmosphere being heated due to the companion's presence.

Hubble's visible-light images show that Mira has an odd, asymmetrical shape resembling a football. This may be tied to dramatic changes occurring during its expansion-contraction cycles, or to the presence of unresolved spots on its surface. Hubble allows astronomers to measure the star's size at about 60 milliarcseconds, corresponding to a diameter some 700 times larger than our Sun. If Mira were at the center of our solar system, it would extend out more than 300 million miles, well beyond Mars' orbit and nearly two-thirds of the way to Jupiter.

Mira (officially called Omicron Ceti in the constellation Cetus) is the prototype for an entire class of stars known as "Mira-type variables." Although once like our Sun, Mira is now at the end of its life, and has evolved into a cool red giant star that is highly variable in brightness. Contracting and expanding every 332 days, Mira sheds vast amounts of material through its powerful "wind" of gas and dust.

Mira's companion is a burned-out star called a white dwarf that is surrounded by material captured from Mira's wind. At a distance of about 400 light-years, Mira is the closest wind-accreting binary system to Earth.

Separating the spectra of Mira and its companion -- something astronomers previously have tried to do through indirect means -- is a crucial step for studies of physical processes associated with wind accretion in binaries.

Mira was discovered on August 13, 1596, by Dutch astronomer David Fabricius, who mistook it for a nova because it later faded from view. He called it Mira, meaning "The Wonderful." Astronomers later realized it was really the first case of a variable star.

A Plug for the RASC

by Orla Aaquist

Amateur astronomy is a popular pastime around the world. Astronomy enthusiasts usually subscribe to popular astronomical periodicals such as the **PeGASus**, SkyNews, Astronomy or Sky and Telescope. Almost every large city like has an astronomy club. Prince George has the PGAS. The PGAS is probably one of the most unique hideaway of Canadian amateur astronomy which is not affiliated with the Royal Canadian Astronomical Society (RASC). When I lived in Prince George not too long ago the PGAS satisfied my amateur needs. Prince George has a great observatory, a great telescope, but more importantly, some great amateur astronomers. Other cities, like Fort McMurray, are not so lucky. After moving here I decided to join the RASC and was surprised to rediscover a national treasure.

Moving to Fort McMurray was one motivation for rejoining the RASC. Another was the new RASC Journal. Receiving it is worth a membership in this national organization, and I hope that RASC members in the PGAS, share this journal with the rest of the members. It is an order of magnitude better than the old Journal, and if it were available on news stands (and I was not an RASC member) I would purchase it along with my copy of Sky and Telescope. Along with the RASC Journal, RASC members get a copy of SkyNews (that new, glossy, all Canadian astronomy magazine). Receiving 6 issues a year plus the annual publication of their Handbook is worth the price of a membership.

The RASC brings together people with a common interest from all walks of life. The organization is so strong that many professional astronomers participate in the society. Some feel that the participation of professionals is too extensive; however, they help give the organization credibility, guidance, and often access to professional observatories. With internet access, the Canadian astronomical community is only a mouse-click away. For the last few months I have subscribed to a listserv group moderated by the RASC in Halifax. Every day I receive about 10 to 20 messages (summarized in a single message), from amateurs from Victoria to St. John's. Our very own Alan Whitman adds a word or two on occasion.

In the RASC you will find amateur astronomers who do useful scientific work. When I taught at the University of Manitoba, Chris Brown, from the Winnipeg Centre, spent many nights at the Centre's and the University's observatory capturing the light curve of a variable star. He subsequently wrote a paper on his observations which was published in the PASP. Canadian amateurs discover comets, exploding stars, watch for earth-crossing asteroids, participate in international efforts to make occultation timings, and much more. The gateway to some of these activities are in the RASC.

Most professional astronomers would never think of going outside on a clear night to enjoy the night sky. Yet, some important observations can best be done with very little equipment. Observations of aurora displays and meteor showers, for example, require only the unaided eye. All one needs is a good clear horizon and dark skies away from city lights and pollution, and Prince George, compared with Vancouver, has a big advantage when it comes to light pollution. A good pair of binoculars, or field glasses, may be helpful but is not essential. It is also quite simple to photograph aurora displays and, with some luck, to photograph a meteor trail with high-speed film in a stationary camera on a tripod.

Ask any professional if they own a telescope, and the answer is most often no. Yet any small telescope can observe an incredible amount of detail that many professionals are not aware of. Observers with a small instrument can count the numbers and measure the sizes and locations of sunspots. Since the sun is so bright, the main lens or the telescope mirror can be quite small. To avoid severe eye damage, one must never look directly at the sun with a telescope without a proper sun filter. The moon is a fascinating object to study with a small telescope. With an instrument of less than 50 power one can see craters, mountains, and dark lunar "seas." During lunar eclipses a small telescope reveals certain craters slipping into the Earth's shadow.

If you want to do useful science in a simple way, then astronomy is the hobby of choice. But to begin, you need to contact other enthusiasts. Some of them are right here in Prince George, while others are on the other side of the country; a few are on the other side of the world. If you are ready to spread your wings beyond Prince George, begin with the RASC.

O.A.

NEW INSTRUMENT FOR HUBBLE

A \$25-million ultraviolet spectrograph has been selected by NASA for the fourth Hubble Space Telescope servicing mission, currently scheduled for 2002. The University of Colorado at Boulder and Ball Aerospace & Technologies Corp. designed the Cosmic Origins Spectrograph (COS) to obtain ultraviolet spectra of faint objects. While promising to shed light in several arenas, from stellar atmospheres to the local interstellar medium, COS's principal mission is to measure the density, composition, and ionization state of intergalactic gas clouds billions of light-years away. Doing so should provide scientists with new insights into the nuclear reactions that took place shortly after the Big Bang; they may also be able to better pin down the overall cosmic density of baryons (ordinary matter particles) -- a crucial cosmological parameter.



C O N T A C T

By Steven Senger
af115@pgfn.bc.ca

During the summer holidays, our family saw several movies including a few SCI Fi's. Most were pretty good, some not so good, but at least they were all consistently expensive. Mars Attack was one of my favorite movies, simply because I was raised in the 50's & 60's when this genre of theme was so popular. Actually, I was born the same year that Albert E=mc² Einstein died. Anyway, I developed a special fondness for these "B" Grade sci fi movies productions, so that plus and all star cast and excellent special effects makes MARS ATTACKS a B grade classic.

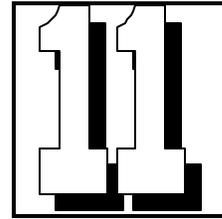
I've digressed... I want to talk about the movie " CONTACT".

It is simply the best movie of the year! I'll put it beside " The Day The Earth Stood Still " anytime. I wanted to see CONTACT in the theater for two reasons: first, it dealt with SETI; 2nd, Jodie Foster was in it. The show was better than I anticipated - good storyline, good acting, and more science fact than fiction (up to the point where they make contact). Unlike some critics I wouldn't want to tell you too much about the story, but I think it's safe to say this: Jodie Foster plays a astrophysicist who has chosen to use telescopes that are designed to detect radiation below the wavelengths of light photons (okay, infra red too). Dr. Elinor Arroway (Jodie Foster) points these radio telescopes not at Black Holes, or Quasars, but instead does a systematic search, sweeping the entire sky looking for "little green men".

SETI - Search for Extra Terrestrial Intelligence is a real science presently being done at several sites around the world. Most radio dishes are used for astrophysics, and so they should. But despite it's small budget, the SETI project is even frowned upon by some in the Astronomical community. What are my feelings? Well, I've never believed that one should put all their eggs into one basket. There are 100's of billions of stars in our Galaxy, and the Hubble Telescope images indicate 100's of billions of Galaxies. All scientist agree that planetary systems occur as part of the evolution of most single star systems (we even have direct observational evidence of this now with wobbling stars ie. Pegasus 51, Ursa Major etc.). Most scientists would agree that life could evolve on a PLANET that has been given: enough time, the right size, and the right orbital radius from it's star (I'm trying to say a planet that can support liquid H₂O). Now, it is a simple deduction that some of these planets that have life could evolve into making crystal radio sets, TV sitcoms, maybe even "Intelligence"! although we're still waiting for that to happen on Earth.

I enjoyed the movie Contact so much that I bought the book, and discovered it was written by Carl Sagan. The book is different enough that you can enjoy both the movie and the book as separate stories. The same important messages that Carl was trying to communicate in the book, were portrayed in the movie.(I admit I liked the movie better, but that could be because I experienced it first).

After reading the book, I searched the Web using my POWERFUL 286 computer and found an excellent interview of Jodie Foster explaining her role in the movie. She had interviewed Carl Sagan a few times and also so visited Carl a couple of times at the Seattle hospital just before his death.(Carl Sagan with his wife Ann Druyan co-wrote the book about three years ago, and eventually co-produced the movie.) Jodie Foster commented that she wanted to make sure that the movie reflected the same important messages that Carl was communicating in his book.



Meanwhile, back on the Web - I proceeded to look up SETI projects. The most extensive systematic research is being conducted by Project Phoenix. They have their own official web site - their address is <http://www.seti.org>. never mind - go to a search engine like yahoo, type Phoenix and SETI and you're there. On their web site, they actually have a section on the movie CONTACT. The movie reflects not only Project Phoenix but also its researchers. The head director of Project Phoenix is a woman, Ph.D. Astronomer Dr. Jill Tarter, the project manager is Ph.D. physicist Kent Culler, who is blind. In the Movie, one of the lead researchers is a Kent Clark who also happens to be blind. Interestingly, Kent Culler was originally cast to star as himself, but his character was expanded to a point where the director thought a professional actor was needed.

Too bad. Project Phoenix critiqued the movie with reality checks ie: at one point Jodie Foster contacts headquarters using a radio phone. On the real project they wouldn't dare use any radio device - they have enough trouble screening and filtering out other Earth generated radio interference. Another is the use of the Very Large Array (VLA) in New Mexico. Although it has 27 antennas, it is still 4 times less sensitive than the Arecibo dish in Puerto Rico.(obviously the VLA would have better resolving power, and as they point out - more photogenic). In addition, they show Jodie (Dr. Arroway) Foster frequently using head phones to listen to the signals. In reality, Phoenix writers point out that their computer can examine 28 million channels simultaneously, so it is not practical to buy 28 million head phones and hire 28 million students. (I would like to mention, in the movie's defense, that Jodie wasn't listening to just ANY frequency. She was listening to the universal background frequency of H₂ Times Pi (3.14). Both are universal constants, and an intelligent civilization that was trying to broadcast to other worlds may use it. All and all, Project Phoenix gave it a good thumbs up. (also it doesn't hurt their cause, and it's good PR). Towards the end of the movie Carl Sagan had to jump from science reality to Science fantasy. For this, Carl had contacted Kip Thorne - a professor of theoretical physics at CALTECH. Ironically, I had read Kip's Book about Black Holes last year... an excellent book and a must-read for any one interested in Black Holes. He also made an outrageous bet with Stephen Hawkings about Black holes. If you want to know about the bet you'll have to read Kip's book or Hawkings "A Brief History of Time".
ARE WE ALONE ? IS there life in the universe ?? YES! I actually have proof, and I am



going to let you, the reader, in on this. Come closer... I have to whisper. A few decades ago, NASA scientists discovered life on the Moon, and a few years later on Mars too ! They have indisputable proof. Wait, it gets better! It was also shown to be intelligent life.

Here for the first time, I will reveal how they know this. You will need a mirror. On the count of three, point the mirror at yourself. **WE ARE IT!** Twelve astronauts have walked on the Moon, and we have landed the Viking space craft on Mars. We are the proof that intelligent life does exist in our universe. We would have to own a pretty big ego to claim that we are the **ONLY** ones in the entire **UNIVERSE!** The movie phrases it beautifully - "If we are alone, then the universe is an awful big waste of space".

There is a great demand for time on any of the radio antennas. I realize that SETI is a very long shot. What are the odds that a nearby star system not only has life, but intelligent life transmitting at about the same time our antennas are listening? Their transmissions could have been sent millions of years ago, and they have since blown themselves up. Or they have not as yet built a radio transmitter. If they are transmitting, is it at one of our listening frequencies? Radio dishes are used for practical purposes, such as calculating rotational speeds of planets, or detecting elements in space. They have shown us the humongous jet lobes created from Black Holes. The impact of this data and how it will affect our world is infinitesimal compared to discovering that we are not alone in the universe. Can we afford not to listen? Excuse me, I have to go... I think I hear someone knocking on my door.

Steve (the unofficial movie critic)

HUBBLE REVEALS HUGE CRATER ON THE SURFACE OF THE ASTEROID VESTA

Astronomers have used NASA's Hubble Space Telescope to discover a giant impact crater on the asteroid 4 Vesta. The crater is a link in a chain of events thought responsible for forming a distinctive class of tiny asteroids as well as some meteorites that have reached the Earth.

The giant crater is 285 miles across, which is nearly equal to Vesta's 330 mile diameter. If Earth had a crater of proportional size, it would fill the Pacific Ocean basin. Astronomers had predicted the existence of one or more large craters, reasoning that if Vesta is the true "parent body" of some smaller asteroids, then it should have the wound of a major impact that was catastrophic enough to knock off big chunks. The observations are described in the Sept. 5 issue of Science Magazine.

The collision gouged out one percent of the asteroid's volume, blasting over one-half million cubic miles of rock into space. This tore out an eight-mile deep hole that may go almost all the way through the crust to expose the asteroid's mantle (Vesta is large enough to be differentiated like Earth -- with a volcanic crust, core and mantle, making it a sort of "mini-planet".)

Because of the asteroid's small diameter and low gravity, the crater resembles smaller craters on the Moon that have a distinctive central peak. Towering eight miles, this cone-shaped feature formed when molten rock "sloshed" back to the bullseye

center after the impact.

The immense crater lies near the asteroid's south pole. This is probably more than coincidental, say researchers. The excavation of so much material from one side of the asteroid would have shifted its rotation axis so that it settled with the crater near one pole.



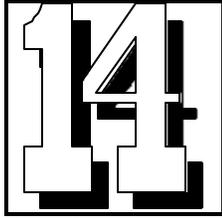
Unlike some other large asteroids that have jumbled surfaces due to the asteroids' breakup and recollapse, the rest of Vesta's surface is largely intact, despite the cataclysm. This is based on previous measurements showing it has a surface of basaltic rock -- frozen lava -- which oozed out of the asteroid's presumably hot interior shortly after its formation 4.5 billion years ago, and has remained largely intact ever since.

TWO VOYAGER SPACECRAFT STILL GOING STRONG AFTER 20 YEARS

Twenty years after their launch and long after their planetary reconnaissance flybys have been completed, both Voyager spacecraft are now gaining on another milestone -- crossing that invisible boundary that separates our solar system from interstellar space, the heliopause. Since 1989 when Voyager 2 encountered Neptune, both spacecraft have been studying the environment of space in the outer solar system. Science instruments on both spacecraft are sensing signals that scientists believe are coming from the heliopause -- the outermost edge of the Sun's magnetic field that the spacecraft must pass through before they reach interstellar space.

The Sun emits a steady flow of electrically charged particles called the solar wind. As the solar wind expands supersonically into space, it creates a magnetized bubble around the Sun, called the heliosphere. Eventually, the solar wind encounters the electrically charged particles and magnetic field in the interstellar gas. The boundary created between the solar wind and interstellar gas is the heliopause. Before the spacecraft reach the heliopause, they will pass through the termination shock -- the place where the solar wind abruptly slows down from supersonic to subsonic speed. "Based on current data from the Voyager cosmic ray subsystem, we are predicting the termination shock to be in the range of 62 to 90 astronomical units (AU) from the Sun". Most 'consensus' estimates are currently converging on about 85 AU. Voyager 1 is currently at about 67 AU and moving outwards at 3.5 AU per year, so crossing the termination shock should be sometime before the end of 2003. "Based on a radio emission event detected by the Voyager 1 and 2 plasma wave instruments in 1992, we estimate that the heliopause is located from 110 to 160 AU from the Sun," "The low-energy charged particle instruments on the two spacecraft continue to detect ions and electrons accelerated at the Sun and at huge shock waves, tens of AU in radius, that are driven outward through the solar wind. (cont on page 14)

Voyager 2 was launched first on Aug. 20, 1977, and Voyager 1 was launched a



few weeks later on a faster trajectory on Sept. 5. Initially, both spacecraft were only supposed to explore two planets -- Jupiter and Saturn. But the incredible success of those two first encounters and the good health of the spacecraft prompted NASA to extend Voyager 2's mission to Uranus and Neptune. As the spacecraft flew across the solar system, remote-control programming has given the Voyagers greater capabilities than they possessed when they left the Earth.

There are four other science instruments that are still functioning and collecting data as part of the Voyager Interstellar Mission. The plasma subsystem measures the protons in the solar wind. The magnetometer instrument onboard the Voyagers measures the magnetic fields that are carried out into interplanetary space by the solar wind. The Voyagers are currently measuring the weakest interplanetary magnetic fields ever detected and those magnetic fields being measured are responsive to charged particles that cannot be detected directly by any other instruments on the spacecraft. Other science instruments still collecting data include the planetary radio astronomy subsystem and the ultraviolet spectrometer subsystem.

Voyager 1 encountered Jupiter on March 5, 1979, and Saturn on Nov. 12, 1980, and then, because its trajectory was designed to fly close to Saturn's large moon Titan, Voyager 1's path was bent northward by Saturn's gravity sending the spacecraft out of the ecliptic plane, the plane in which all the planets but Pluto orbit the Sun. Voyager 2 arrived at Jupiter on July 9, 1979, and Saturn on Aug. 25, 1981, and was then sent on to Uranus on Jan. 25, 1986, and Neptune on Aug. 25, 1989. Neptune's gravity bent Voyager 2's path southward sending it also out of the ecliptic plane and on toward interstellar space.

Both spacecraft have enough electrical power and attitude control propellant to continue operating until about 2020 when the available electrical power will no longer support science instrument operation. Spacecraft electrical power is supplied by Radioisotope Thermoelectric Generators (RTGs) that provided approximately 470 watts of power at launch. Due to the natural radioactive decay of the plutonium fuel source, the electrical energy provided by the RTGs is continually declining. At the beginning of 1997, the power generated by Voyager 1 had dropped to 334 watts and to 336 watts for Voyager 2. Both of these power levels represent better performance than had been predicted before launch.

The Voyagers are now so far from home that it takes nine hours for a radio signal traveling at the speed of light to reach the spacecraft. Science data are returned to Earth in real-time to the 34-meter Deep Space Network antennas located in California, Australia and Spain. Voyager 1 will pass the Pioneer 10 spacecraft in January 1998 to become the most distant human-made object in our solar system.

Voyager 1 is currently 10.1 billion kilometers from Earth, having traveled 11.9 billion kilometers since its launch. The Voyager 1 spacecraft is departing the solar system at a speed of 17.4 kilometers per second (39,000 miles per hour).

Voyager 2 is currently 7.9 billion kilometers from Earth, having traveled 11.3 billion kilometers since its launch. The Voyager 2 spacecraft is departing the solar system at a speed of 15.9 kilometers per second (35,000 miles per hour). (15.9 kilometers per second).

PGAS CONTRIBUTORS

The PGAS would like to thank the following individuals, corporations and government agencies who, since 1991, have donated money, goods or services to the construction and operation of the Prince George Astronomical Observatory.

Ministry of Adv. Ed. Training and Tech.	\$25,000
BC Science Council	16,000
BC Lotteries	3,900
Helmar Kotsch (Acme Mas.)	1,932
Northwood Pulp and Timber	1,665
Electrical Services Ltd.	1,583
Royal Bank of Canada	1,500
Regional District of Fraser-Fort George	1,000
Prince George Rotary Club	1,000
The Pas Lumber Co	750
Rustad Broth & Co Ltd	750
Canfor Polar Division	744
A.V. Jay Roofing	600
Xerox Canada	500
Russelsteel	465
Lakeland Mills Ltd.	460
Canfor Clear Lake Division	270
Lutz Klaar	200
Canfor Netherlands Division	200
Art Beaumont	150

The greatest contributors to the construction and operation of the observatory are from PGAS members who have generously contributed their time to this project. The value of their contribution surpasses all external contributions.

The PGAS is a non-profit organization dedicated to the advancement of astronomy and science in general in Prince George and the neighboring northern communities. Donations of money or materials to the society are greatly appreciated and tax deductible.

**Support
Community
Science**
Join the PCAS



spee-dee printers
& office products

490 brunswick street
prince george, b.c. V2L 2B6
phone 604-562-2414
fax 604 -562-9159

**Internet services thru the courtesy of
The Borealis Group
A Communications Company**

.printed courtesy of

**Spee-Dee Printers
and
XEROX OF CANADA**

We thank you for your support.