NOVA NOTES

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THE NEWSLETTER OF THE HALIFAX CENTRE OF THE RASC
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NOVA NOTES, the newsletter of the ***Halifax Centre of the Royal Astronomical Society of Canada***, is published bi-monthly in February, April, June, August, October, and December. The opinions expressed herein are not necessarily those of the *Halifax Centre*. Material for the next issue should reach the editor by **December 31, 1992**. Articles on any aspect of astronomy will be considered for publication. "Letters to the Editor" or to our resident expert: "GAZER" are also most welcome. The editor can be reached at:

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Inside This Issue...

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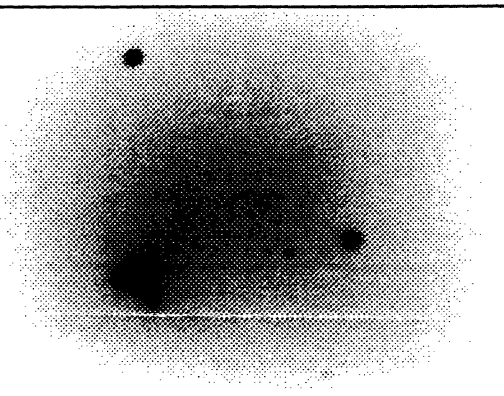
Editor's Report

Well, this issue has expanded up to the normal 10 pages and is a great way to finish off Volume 23 of *Nova Notes*! I have enjoyed my first year as editor and will be continuing on next year. I've now got it down to about 16 hours per issue, including addressing and stamp licking! But **you**, the membership, must keep sending me material to publish!

In the next issue I intend on starting a Centre gossip column, to be called "RASCal Happenings" or something like it (got any ideas?), so look out! If you know of any juicy gossip (names won't be used), please send it my way.

You should have noticed that only **my** astrophotography seems to be in the "Astrophoto of the Month" feature. Its **not** because I'm biased - its because no one sends me anything!

Come on folks, there's lots of talent out there... Ω



"Astrophoto of the Month"
Comet P/Swift-Tuttle

David Lane took this 5 minute image with an SBIG ST-6 CCD Camera using the 40cm cassegrain telescope at the Burke-Gaffney Observatory, Saint Mary's University (field size 6.4 x 5 arc-minutes). This negative image was taken on October 17 @ 23:45 UTC, when the comet was still small and not very well developed. The "line" next to the brightest star represents the movement (about 32 arc-seconds) of the comet's "stellar" nucleus. Note that the coma is not circular and is noticably offset from the nucleus.

President's Report:
by Patrick Kelly

My, but time passes quickly. Here we are already into a new R.A.S.C. year. There are several issues that I would like to address in this issue.

Astrophotographers take note!

As you will read elsewhere in this issue, the R.A.S.C. has just launched a new national calendar. The actual design and production for this project was undertaken by the *Vancouver Centre*, and is based on a similar calendar that they produced last year just for their own centre. The national office has provided the funding to produce it. The profit will be shared half and half between the *Vancouver Centre* (who are handling all of the administrative details) and the national office. The pictures that accompany

each month were all taken by society members (in the case of the 1993 calendar, the work of Rajiv Gupta of Vancouver and John Mirtle of Calgary).

If this calendar is successful, (and I see no reason why it should not be), there will be a 1994 edition.

The December **BULLETIN** will contain an announcement giving the details for a competition on how you can submit **your** favourite black and white photos for possible inclusion in the 1994 calendar.

Membership renewals

It is that time of the year again. I would like to thank those of you who have already renewed and would hope that those of you who are now receiving a second reminder with this issue will renew as soon as possible. Keep in mind that the membership fees are the same as last year's. Also, please remember to bring your renewal form with you (or to enclose it if mailing your renewal). This not only makes life easier for the treasurer and the keeper of the Centre membership list (yours truly!), but also gives us a record with which to ensure that you receive your 1993 Observer's Handbook, etc.

G.A. Help Needed

With the 1993 General Assembly (G.A.) fast approaching, the people involved in organizing it will be increasingly on the prowl looking for warm bodies to help out. Although the planning is going quite well and can be done by a limited number of people, when the G.A. is actually on, we will require additional help for several tasks. Some of these jobs are:

- helping out with the registration desk.
- transporting delegates to and from the airport.
- putting up direction signs.
- help in running the registration/information desk.
- help with running audio visual gear for the paper sessions.
- display competition judges

Most of these jobs do not require a great deal of time, especially if we have lots of volunteers, as that would minimize the time that each person would have to put in. Unfortunately(?), Halifax has reputation from the G.A.'s of 1975 and 1980 for putting on a well-organized show and we don't want to ruin our record, do we! If you can help out in any way at all, please call Mary Lou at 865-0235. She will be thrilled to hear from you!

No Banquet for 1993!

At the suggestion of one of our members, we will not be having a banquet this year for our May meeting. Since there will be a banquet as part of the General Assembly, it was felt that members would find it to be a nice change of pace to attend the awards banquet at the national level. The May meeting will still be held, but will be used as an organizational meeting for the G.A.

Until next time, *chalmey Huv*! (Klingon for "Clear skies!") Ω

Scheduled Observing

Friday, December 9th at the Beaverbank Site at dusk. This is a special observing session for the total lunar eclipse. We also hope to do some deep sky observing and view **Comet Swift-Tuttle** at its brightest during the total phase!

Observing during the winter months is often difficult at both of our observing sites due to the lack of snow clearing and the freezing temperatures. But, the keeners do attempt to get out anyways if the temperature is not too cold. If the conditions look good, give us a call and join us!

For information call Doug Pitcairn (463-7196) or Dave Lane (443-5989)

New Society Publication

A 1993 National RASC Calendar!

The R.A.S.C. has added a new publication to its list of services. The 1993 R.A.S.C. National Calendar has arrived! This wall calendar is a visual feast, not only does it contain a wealth of astronomical information, but also high quality amateur astrophotos. It really has to be seen to be believed! Have you ever wanted an easy way to remind yourself of upcoming astronomical events? With the R.A.S.C. wall calendar, you can have your own calendar totally devoted to observing. No more trying to find the date and time of that upcoming occultation from amid the clutter of dentist appointments, luncheon engagements, school concerts and children's hockey practices! These calendars also make great Christmas gifts!

It is printed on high quality glossy paper and each month is graced with a beautiful black and white astronomical photograph taken by an fellow R.A.S.C. member. There is also a lots of additional data on each month's calendar. To begin with, for **each** day the times of moonrise and moonset are given, along with a picture of the Moon's phase. The times are given for both the eastern and western parts of Canada, but a simple table lets you easily correct the times to Atlantic Standard Time for Halifax's location to an accuracy of six minutes! In addition, the size of the Moon also changes perceptibly to show whether the Moon is near apogee or perigee!

Once a week the times or sunrise and sunset are given (again for both the eastern and western halves of the country, and easily correctable for Halifax). Other information that will be found includes dates and times of meteor showers, conjunctions, oppositions, and other easily visible phenomenon. Dates are also given for the major star parties held in Canada. Lastly, the back cover contains a calendar for 1994 which highlights the dates of New Moon for that year.

Copies can be picked up at the December and January meetings, or by mail. The price, if it is picked up at a meeting, is **only $6.00**, which includes G.S.T., while the price for mail orders is **$7.00** to cover the additional cost of postage and handling. Mail orders should be sent to:

Halifax Centre, R.A.S.C.
c/o 1747 Summer Street
Halifax, Nova Scotia
B3H 3A6
Attn: 1993 Calendar

Please send a cheque or money order made payable to "Halifax Centre, RASC". Do **not** send cash through the mail.

We only received eighty calendars so be sure to get yours before they are gone! Ω

Apollo 17 Two Decades Later

by Roy L. Bishop

The following personal account of Apollo 17 is adapted from one I wrote for the National Newsletter (predecessor to the **BULLETIN***) 10 years ago. Since the original article was well-received, and since the membership of the Halifax Centre is now considerably different, I prepared this updated account for the interest of newer members.*

In addition to the 500th anniversary of Columbus' voyage to America, 1992 marks the anniversaries of two voyages beyond this planet: it is 35 years since Sputnik 1 astounded the world, and 20 years since the end of the Apollo flights to our Moon. Without the first, the second would not have occurred, and without the second, the technological momentum that spawned the Mariners, Pioneers, Vikings, Voyagers, and Space Shuttle would have been much slower to develop.

The Apollo program was born of international rivalry and presented to the world as a symbol of American vitality and technology. The program came to maturity during the turmoil of the late 1960's, a turmoil that was accompanied by changing priorities which, in turn, brought the Apollo venture to an early end. Yet despite those circumstances, Apollo captured the minds of people as no other venture had done before, nor ever can again. For the first time humans left this planet behind and travelled to another world. The magic of that unique time is now history.

As an undergraduate engineer, I recall vividly a clear October evening when Sputnik 1 was announced. Fifteen years later, I stood with my son beneath palm trees and saw night transformed into day by the departure of Apollo 17. As the years pass, I appreciate more and more how incredibly fortunate I am to have experienced those years, and to have been present at the start of the final voyage of Apollo.

Apollo 17 was unique in several respects. Nothing to equal the mass of that rocket has been launched before or since. Together with Skylab, it represented the end of the "no deposit/no return" hardware in the American manned space program. It is unlikely that ever again will such a formidable machine be hurdled from Earth's surface for but one flight. As the last manned flight to another world, and the last such flight in this century, it marked the end of an era. When manned flights to our moon and beyond are resumed, probably never again will they rise from Earth's surface as spaceships complete in themselves. As the only nighttime launch of the Saturn V rocket, Apollo 17 was awesome.

Aside from the launch itself, other aspects of that warm Florida night 20 years ago remain with me. Our viewing site was on the banks of the Indian River, directly west of the launch complex. Despite an estimated half million observers in the area, there was nothing but a wide expanse of water in front of us. During the hours of waiting, pelicans, ducks, and egrets occasionally flew by, and once the dorsal fins of a school of dolphins broke the water's surface between us and the moonship.

As day departed, the white Saturn rocket dominated the scene with blue-white beams of searchlights fanning out past it up into the moist night sky. During the evening a large, distant electrical storm slowly moved out of the north-east to take up position over the Atlantic behind the glowing rocket. Pinkish-orange flashes played through the complex clouds and occasionally a bolt of lightning connected to the water below. With distance reddening its colours and silencing its thunder, the storm resembled a scene from an old painting, and was reminiscent of the conditions that may have been responsible for the earliest beginnings of life on Earth. It made a fitting backdrop for the evolutionary step occurring that night.

All that long, warm afternoon there had been a few aircraft in sight, but as the mid-evening launch time approached, the lights of planes and helicopters became more numerous. In the final minutes there were several dozen all over the sky, some with brilliant searchlights, no doubt to be available in the event the flight had to be aborted in its early phases. Even from our remote site, the amount of hardware amassed to support the launch was impressive. Then came a hold at the 30 second point. As the minutes passed, the activity in the sky subsided together with the emotions of the multitudes in the dark below.

Toward midnight the sky was clearer. High in the east between the horns of Taurus, the planet Saturn shone down on its namesake, the floodlit Saturn V. As the new launch time of 33 minutes into December 7 approached, the activity in the sky increased once again.

The first evidence that the rocket was alive was a sudden orange glow around its base. A few seconds later, and to my great relief, a brilliant, searing, yellow-orange light appeared directly under the rocket. Apollo 17 was rising on a pillar of flame and the gamble I had taken in travelling so far had paid off.

The flame from the first stage engines seemed to have the brilliance of the surface of the Sun. But it was not a white Sun - it was the yellow of burning kerosene, the fuel of the rocket's first stage and the colour of lamps of a century ago. The glare and rays of the floodlights which had dominated the night up to that point were utterly lost in the radiance of that flame, and for miles around night turned into dawn as a strange apparition rose in the east. Even the

gigantic white rocket was lost in the dark above its own exhaust.

A Saturn V does not leap into the sky like a smaller rocket or the Space Shuttle. Several seconds passed before it rose its own length and cleared the launch tower. However, gulping 13 tonnes of kerosene and liquid oxygen every second, the rocket's mass fell away and the fire beneath drove it with an increasing acceleration up into the stars above.

Suddenly a low rumble began and quickly grew to a powerful, chest-shaking thunder. In the wonder of following that ascending flame, now high in the sky, I had totally overlooked the silence of the first minute of the launch. Approximately one percent of the 180 million horsepower of a Saturn V is converted into sound and now that thundering herd had traversed the 19 kilometres of marsh and water separating us from the launch pad. Soon the pounding roar was joined by the sound of sharp explosions, likely caused by supersonic parcels of flame breaking away from the exhaust once it was clear of the launch pad. With the entire coastal region reverberating to this staccato thunder, the loudest sustained sound ever produced by humans, it was difficult to think coherently. The fact that three men were riding that flaming machine to another world only compounded the emotional impact of those moments.

As the second minute into the flight passed, the level of both the light and sound dropped rapidly. Soon the yellow flame was but a brilliant point. Then suddenly it vanished, leaving only the twinkling stars and Saturn itself in the dark above. A few seconds later a bright, blue-white star appeared - like Venus, only brighter - as the hydrogen burning second stage ignited. Over the next few minutes this star dimmed, and dropped toward the horizon as the moonship headed eastward out across the Atlantic toward Africa. Seven minutes after launch it disappeared behind a low cloud bank just to the right of the steaming launch tower. I then turned back to Earthly matters and spent the rest of the night coping with a massive traffic jam.

Apollo carried with it the emotions of many people, emotions related to the romance and challenge of the unknown, of space, of a rocket of unprecidented power, of the classic age-old adventure of a lunar voyage, and of the first vision of Earth as a small turquoise sphere alone in the black silence. It may well be that the most valuable gift of Apollo was the latter, and the perspective it provided of us and our home.

If the human race survives its self-inflicted problems, long after today's headlines have vanished into the mists of time, our era will be remembered as the one in which humans first ventured beyond Earth. To those who would still question Apollo, the best answer I have yet heard was given by Gordon Donaldson, a CBC news commentator during those years. He put it this way:

"It's the sort of situation that if you need to ask, you'll never understand the answer." Ω

Constellation of the Month: Perseus

by Joe Yurchesyn

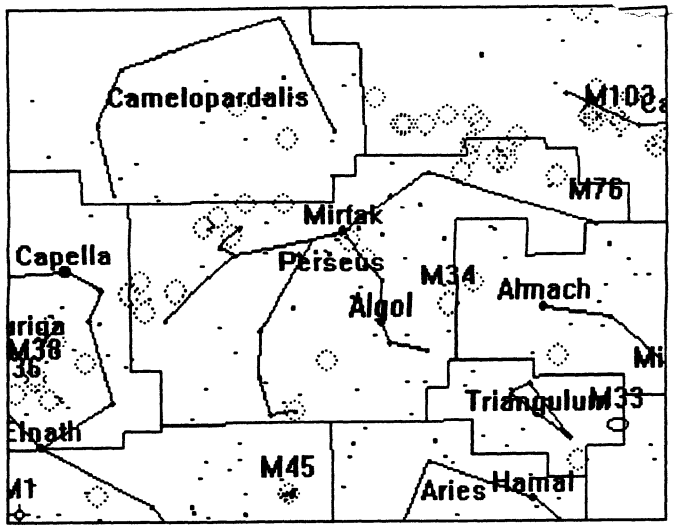
According to Greek mythology, Perseus was one of the greatest heroes, great-grandfather of Hercules, and traditionally the ancestor of the Persians. Perseus was of partly divine parentage. his mother Danae having been visited by Zeus in the form of shower of gold. Owing to a prophecy that Perseus would slay his grandfather (King Acrisius of Argos), both mother and son were imprisoned in a wooden chest and cast into the sea. The chest, however, floated safely to the island of Seriphus, where it was found by the fisherman Dictys (father or brother to King Polydectes of the island). Here, Perseus grew to manhood, and eventually fulfilled his destiny.

It was at the request of Polydectes that Perseus undertook his most famous exploit, the slaying of the most fear-some Medusa, one of the Gorgons whose glance turned men to stone. The Gorgons were three serpent haired sisters, who appear to have been guilty of the same sin as Cassiopeia, and angered the gods by their excessive vanity. Medusa was the only one of the three who could be killed; her two sisters being immortal. With the aid of Athena and Hermes, who supplied him with winged sandals, sword, and a helmet of invisibility, Perseus made his way the realm of the Gorgons on the furthest shores of Oceanus, near the isles of the Hesperides. There, he slew the Medusa while looking at her reflection in his polished shield. From the Medusa's blood sprang forth the winged horse Pegasus.

It was while Perseus was returning from this adventure (riding Pegasus) that he chanced upon the princess Andromeda, chained to a rock on the Ethiopian coast, as a sacrifice to the sea-monster Cetus. Perseus rescued Andromeda, slewed Cetus, and, it is hoped, warned the vain Cassiopeia to be more careful in the future. Returning to the Court of Polydectes, Perseus turned the scheming king and all his noblemen into stone by showing them the Gorgon's head. Dictys became the king of the island, and the head of Medusa was presented to Athena, who set it on the centre of her shield.

Many of the characters of the Perseus legend appear in the sky as constellations, including Perseus himself, Pegasus, Andromeda, Cetus, Queen Cassiopeia, and King Cepheus. In art, he is depicted standing, holding aloft the head of Medusa with one arm, and grasping his sword with the other. Ancient coin portraits of Perseus are rare. The best examples were minted by King Perseus of Macedonia - last king of the line of Alexander - who lost his throne to the Romans in 168 BC. King Perseus regarded himself as descendant of the ancient hero, and had himself so depicted on his coins.

Like Hercules and Orion, the star pattern of Perseus was identified in many ancient cultures with prominent national heroes or gods. The Egyptians regarded it as their god *Khem*, while to the Persians it represented *Mithras*. Biblically minded star-watchers saw it as *David* with the head of *Goliath*. The classical Greeks



referred to Perseus as "The Champion", "The Rescuer", or occasionally as "The Horseman". The Moorish name *Almirazgual* is from the Arabic *Hamil Ras al Ghul*, the "Bearer of the Demon's Head". Another Arabic name, *Kullab*, refers to the hero's weapon, and is probably the source of the *Celeub* of the *Almagest* and Bayer's *Uranometria*.

Perseus, a curvy K shaped asterism lying in the plane of the galaxy, is rich in galactic clusters and nebulae. The best star cluster offerings include NGC-869/884 (Double Cluster), NGC-1039 (M-34), and NGC-1528. There are also emission and reflection nebulae, including NGC-650/1 (M-76), and NGC-1499 (California Nebula). Surprisingly, two galaxies (NGC-1023 elliptical, and NGC-1275, irregular) are present, despite the proximity of the Milky Way. While NGC-1023 is a fine sight in a 4" or larger telescope, NGC-1275 is a tough amateur target, appearing as a faint tiny grainy spot.

NGC-1275 is also known as *Perseus A*, one of the brightest radio sources in the sky. It is an unusual disturbed galaxy, which is also known to be an X-ray source, but the 35' diameter of this source makes it enormous in size, and the tenuous gas surrounding the galaxy would have to be 80,000,000°K! Another theory involves high energy electrons, accelerated by the magnetic field of the galaxy, interacting with low energy 3°K background radiation photons to increase them to the X-ray level; a process known as the "inverse Crompton effect". Red light photographs reveal long, high velocity radial filaments, remarkably similar to M-82 in Ursa Major, and indicate a violent outpouring of material on a titanic scale. This may be the result of the formation of a massive central star or black hole in the heart of the galaxy. A more trivial outburst, in the form of a supernova explosion, reached magnitude 15.5 and occurred in 1968.

Alpha Persei lies at a distance of 570 ly's, and shines with a luminosity of 4,000 suns. It is surrounded by and is a member of a stellar association (as opposed to a true cluster) called *Perseus OB*. This is a large scattered group: visible even without optical aid and splendid in binoculars. It is some 300 ly's across and lies about 565 ly's distant. With the exception of Alpha itself, the stars of the cluster appear to form a well defined main sequence, and at it present rate of motion will require about 90,000 years to change its position in the sky by 1°.

Beta Persei (Algol) is the most famous of the eclipsing variables; and lying 100 ly's distant, it is also one of the closest. The name is from the Arabic *Al Ra's al Ghul*, "The Demon's Head", and in classical times represented the head of Medusa held by Perseus. Its name seems to suggest that medieval Arabs knew of the light changes. The first definite statement on the matter came from Geminiano Montanari in 1667, although the regularity of the period was not determined until 1782 by John Goodricke. He suggested that the periodic dimming may be attributed to the partial eclipse of the star by a darker companion. The theory remained an hypothesis until 1889, when H. C. Vogel proved it to be true by spectroscopic analysis. The star dims from magnitude 2.1 to 3.4 (an eclipse lasting 10 hours) every 2d 20h 48m 56s. *[See Sky & Telescope magazine for times for mid eclipse.]*

Located in the extreme western portion of the constellation, M-76 was discovered by P. Mechain in September 1780 and Charles Messier 6 weeks later. It is one of the most irregularly shaped planetary nebula known, appearing rectangular, similar to the Dumbell nebula (M-27); hence its name "The Little Dumbell". It may be a broad ring seen edgewise? As with virtually all planetary nebulae, the exact distance cannot be well determined, with estimates ranging from 1,750 to 8,200 ly's. The central star may have a surface temperature of 60,000°K, making it one the hottest known.

The star cluster M-34, located about 5° WNW from Algol, was discovered by Charles Messier in August 1764. It is about 1,500 ly's distant and 100 million years old. On occasion, M-34 becomes visible to the naked eye.

By far the dominant deep sky object in Perseus is the Double Cluster (NGC-869/884). Star atlases often depict it as "h - X" Persei, "h" being NGC-869 and "X" being NGC-884. In the mythological outline of the constellation, it marks the "Sword Handle" of Perseus. The existence of this object was known at least as far back as 150 BC: Hipparchus and Ptolemy both mention it as a nebula, one of the half dozen then known. Strangely, Charles Messier did not include it in his catalogue along with Praesepe and the Pleiades, even though it was certainly known in his day. Each is about 70 ly's across and contain stars totalling to 5,000 solar masses. Since each cluster contains only a few hundred stars, they are truly supermassive and superluminous. NGC-884 is the older and more distant, being 11.5 million years old and 8,150 ly's distant. NGC-869 is 7,010 ly's distant and 6.4 million years old, making it among the youngest star clusters known. Only NGC-2362 (1 million years) in Canis Major and NGC-2264 (1-2 million years) may be

younger. *[See "Deep Sky" Volume 4, No.3 (Fall 1986) for more details on the Double Cluster.]* While next observing the Double Cluster, also investigate NGC-957, located 1½° to the ENE. It may be physically linked to the Double Cluster?

Just a little something to ponder, when you next gaze in the direction of Perseus. Now!... If I could just figure out a way to observe Perseus OB in 90,000 years? Ω

Astronomy Talk Review: "Rock Around the Clock"

by Joe Yurchesyn

On September 21st, 1992, I had the pleasure to attend a lecture at Acadia University by Dr. Dale Frail, entitled Rock Around the Clock. Dr. Frail received an undergraduate honours degree from Acadia, and post-graduate degrees in Astronomy from the University of Toronto. Since 1989, he has been associated with the Very Large Array radio telescope complex in New Mexico.

The talk was about Dr. Frail's co-discovery of possible planets orbiting a millisecond pulsar. The pulsar in question is PSR 1257+12, at an estimated distance of 400 parsecs (1,300 ly). This is not the pulsar [PSR 1829-10, 8,600 parsecs (28,000 ly)] which made headlines during the summer of 1991, with an announced discovery of an orbiting planet. It was eventually determined that an inaccurate sky position resulted in a data reduction error, which gave rise to a phantom planet orbiting the pulsar with a period of exactly one half Earth year. This was too much of a coincidence, and gave rise to much questioning, which eventually revealed the error!

It is interesting to note, that while 1992 marks the 500th anniversary of Columbus's discovery of the New World, it may also mark the year of discovery of new extra-solar worlds.

The following is a review of this most interesting and well presented talk.

"ROCK AROUND THE CLOCK"

Presented by Dr Dale Frail at Acadia University

The planets orbiting the sun in our solar system are hypothesised to have formed according to the *Nebular Theory*. This theory was originally proposed by Kant and LaPlace, a philosopher and a mathematician in the 18th century. It basically involves the contraction of a rotating gas/dust cloud. The collapse is greatest toward the centre of the cloud, so that part becomes the hottest and most dense. A hot rotating disk eventually forms, and different materials condense out according to the radial temperature variation in the disk. As a result, the rocky materials are more common near the centre, and the gaseous materials are more common further out toward the edge of the disk. This separated material then acretes to form planetesimals (asteroids, comets, meteoroids, etc.) first, then proto-planets, and finally planets.

This theory is supported by the following observations:

- all planets orbit in the same direction;
- all planets have coplanar orbits;
- all planets have nearly circular orbits;
- almost all planets rotate in the same direction as they revolve;
- central star (sun) has 99% of the mass;
- planets have 99% of the angular momentum;
- terrestrial/jovian material separation versus distance.

Theory suggests that planetary systems should exist around other stars. However, identifying planets is extremely difficult because the central star is so bright, and the orbiting planets are so dim. It is best to do visual planetary searches in the infrared, since the brightness difference drops to only 100,000 times (!) in this wavelength range. In visual light, the brightness difference can be 1,000 to 100,000 times greater. Obviously, this is not an easy way to search for extra-solar planets. One way to circumvent this difficulty is to measure the black body light curve of the star. Any orbiting planets will be brightest in infrared, and will contribute an *infrared excess* to the black body radiation curve. (see Fig #1)

Extra-solar planets cannot be easily seen directly, but there are two indirect ways to search for them. These utilize astrometry or doppler shifts. In a simple two orbiting body system, both bodies orbit about a common centre of mass. This causes the bodies to exhibit a minute periodic movement in the sky. Astrometry can be used to

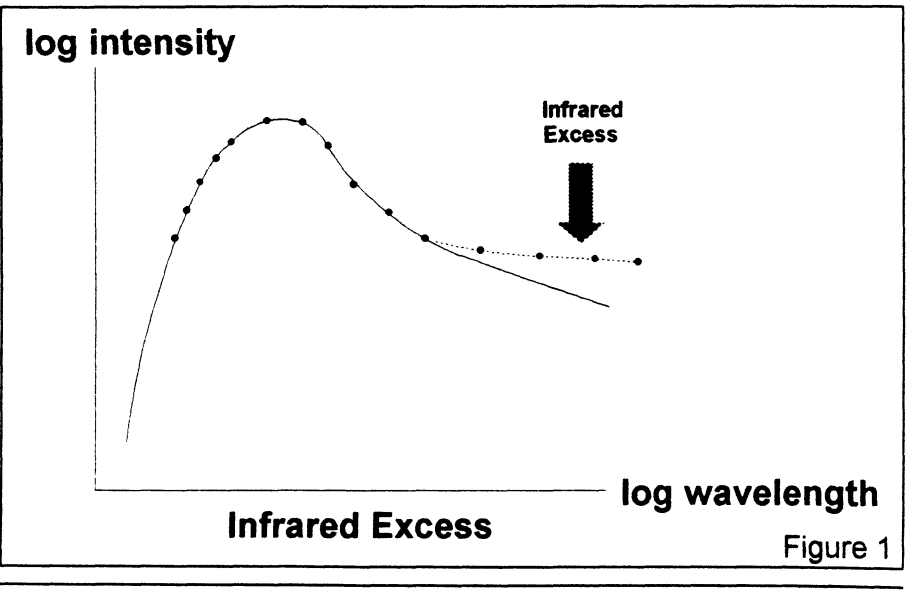


Figure 1

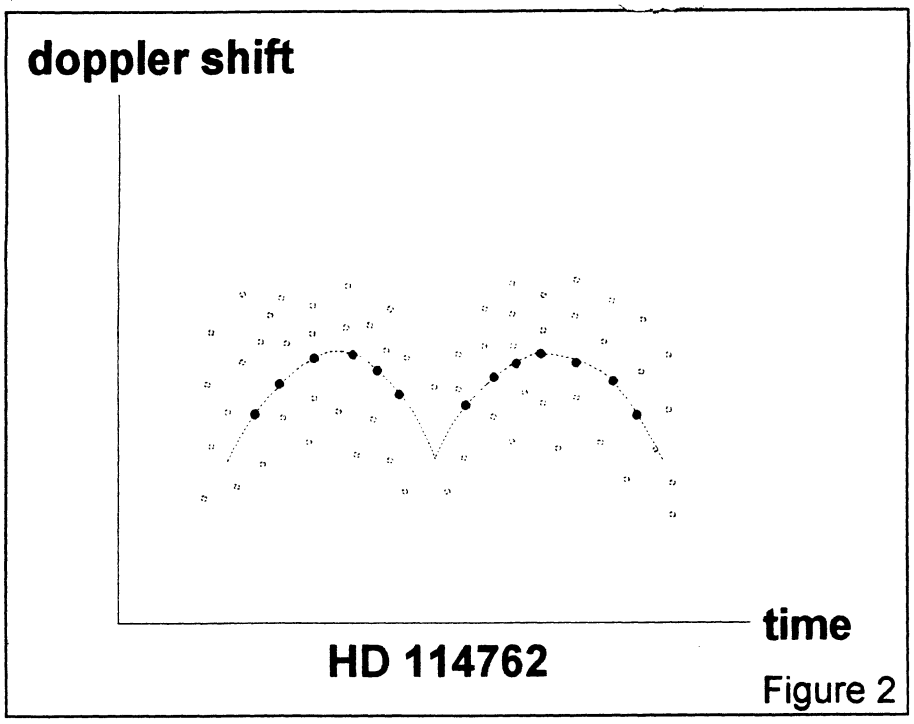


Figure 2

measure this motion versus time. This motion is maximized by a high mass planet orbiting a low mass star at a great separation, with the system being not too distant from us. This tiny movement has been searched for, but with inconclusive results. This periodic motion will also cause a cyclical doppler shift in the colour of the star light, as the star approaches and recedes from us. This shift is maximized by a high mass planet orbiting a low mass star at a small separation. The effect is not dependent on distance, since it is geometry independent.

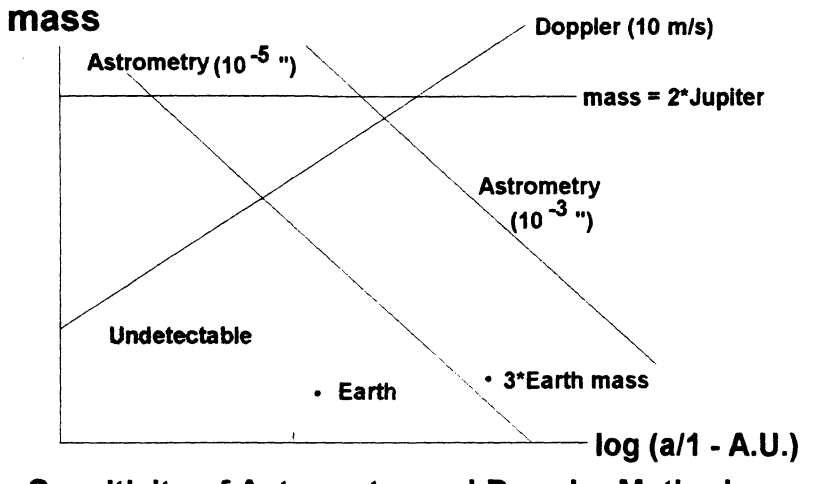
A plot of low resolution doppler shift measurements of HD-114762 is shown in Fig #2. The researchers believed they saw periodicity in this data, so high resolution data, indicated by the darker dots, was later collected. A period of 83.9 days, and a mass of 10 Jovian masses has been inferred from this data. This high resolution data represents the *State of the Art* of what is possible today.

The advantages and difficulties of astrometry and doppler combine to set minimum masses and distances for orbiting planets. (see Fig #3) Planets in the size range of the Earth are virtually undetectable.

If a planet should orbit a pulsar, the periodic motion of the pulsar about the common centre of mass will manifest itself as a gradual periodic variation in the length of time between each pulse. [This phenomena is not unlike the time variance between the actual and predicted time for eclipses of Jupiter's moons, used by Olaf Roemar to calculate the speed of light in 1676.] The advantage of this method is that the time variances will continually sum for each half of the orbital period, thereby greatly increasing detection sensitivity, especially for low mass close in planets.

Dr. Frail co-discovered these planets with Alex Wolszczan, who works at the Arecibo radio telescope in Puerto Rica. As this telescope is built into a natural ground depression and has limited pointing ability, observations are made by allowing the Earth's rotation to carry the sky past the receiver. In February 1990, a hairline fracture was discovered in one of three structural brackets which hold the instrument table at the focus of the telescope, which is suspended by cables from three support towers. Engineers shut down operation of the telescope for two months, while repairs were initiated. In the meantime, Alex recorded two months of data along the declination, which by chance, the telescope happened to be pointing, prior to being shut down.

Signals from pulsar PSR 1257+12 were received and recorded for two months. This pulsar produces 161 pulses a second [one pulse every 6.2 milliseconds], but the pulsar was found to run both fast and slow in a seemingly unpredictable manner. The Arecibo telescope is very sensitive, but has poor position finding ability. To investigate this problem further, a more accurate position of the pulsar would be required. While the VLA radio telescope is not very sensitive, it has very accurate position finding ability; so enter Dr. Frail.



Sensitivity of Astrometry and Doppler Methods

Figure 3

An observing time request on the VLA was granted, based on the Arecibo data. The new data was analyzed to determine the time variance, between when a pulse was received and when a pulse should have been received, based one pulse every 6.2 ms. The data collected looked to be periodic in nature, and it was discovered that it could be reproduced by summing two sine curves, leaving a maximum residual error of about 3%.

Based on a 1.4 solar mass pulsar (i.e central star), the two sine curves correspond to the following two planets:

Planet #1 *3.4 Earth masses*
66.6 day orbital period
0.36 A.U. distance

Planet #2 *2.8 Earth masses*
98.2 day orbital period
0.47 A.U. distance

This distance is about the same as for Mercury, except the pulsar is only about 25 km in diameter. If the planetary densities are similar to Earth's, the radii would be 1.4 Earth radii, with a surface gravity of 1.5 g. These planets are bathed in high energy X-ray and gamma ray radiation from the pulsar, so life would be unlikely.

The maximum time variance from average is on the order of 5 ms, so this is not a small effect pressing the limit of present technology. The sensitivity of this technique to discover planets is illustrated in Fig #4. As can be seen, planets much smaller than the Earth can be easily detected, and it is a dramatic improvement over the astrometry and doppler techniques. (as illustrated in Fig #3)

These planets orbit with a synodic period of 207.0 days, and a 3/2 resonance. During each close encounter, the orbital elements of the planets can be changed by an amount ranging from 0.1 to 2%. If monitoring of the pulsar is continued for the next five years, it should be possible to observe an accumulation of changes to the orbital elements of these planets. This would be highly supportive evidence which should confirm the real existence of these planets.

A natural question at this point is: "Do other pulsars have planets?". It turns out that only 20% of known pulsars have been timed accurately enough to eliminate the possibility of orbiting planets. Therefore, many other potential discoveries may be waiting to be made.

For those wondering how these planets survived the supernova explosion and retained circular orbits (for the sinusoidal time variations); they didn't! These planets are second generation planets. Prior to this discovery, theorists believed that planets could not form after a supernova explosion. Now, there are about 15 different theories (!) describing how this is possible. The one thing consistent with these theories is the presence of a companion star which survives the supernova explosion. This star eventually deposits mass onto the pulsar, and is gradually destroyed by the resulting intense solar wind from the pulsar. This has been observed in some star-pulsar binary systems, and is termed the *Black Widow Phenomena*. Eventually, the companion star is totally destroyed (i.e. completely!). However, all of the companion star's material is not swept out by the pulsar's solar wind. A tiny quantity of material (a small fraction of a percent) remains, and it may eventually accrete into one or more planets after the pulsar's solar wind subsides. Ω

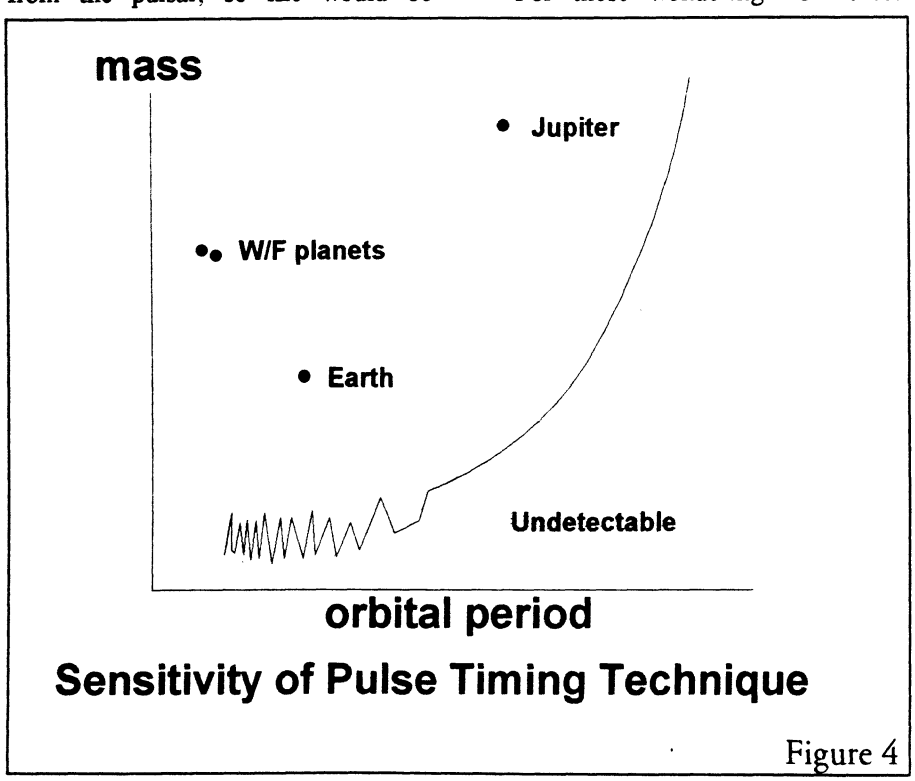


Figure 4

1992 Treasurers Report

by Joe Yurchesyn

Introduction

After a rest-bit in the Handbook Sales position, I find myself, once again, Treasurer. Unfortunately, after about 5½ years on the Executive, and numerous other interests and involvements, I am considering a change to a less demanding Executive position (or none at all) in 1993. At any rate, I have started early in my preparation of this report, so as to try to eliminate some of the small nagging errors which seem to have plagued the report in recent years. This is not to belittle the effort which Nat put into the office during his term; for I even assisted him in the preparation of the annual reports. Unfortunately, it was always started late, being completed under the gun, so to speak, to meet the Nova Notes deadline.

Accounting is a bit of a science in that an error of $0.01 is as much wrong as an error involving a substantially larger amount. However, at the same time, the records can be presented in a manner which can, in the extreme, be considered borderline fraud! To create a totally correct record up to the present, I had to examine the financial records back to 1990.

Mary Lou Whitehorne's $500 life membership payment, in October 1989, was erroneously recorded with the 1991 Fees to National Office, instead of 1990. This reduces the 1990 profit of $160.28 by $500, to a loss of ($339.72), but it also reduces the 1991 loss of ($1,424.37) by $500, to ($924.37). Another minor correction for other small errors, further increases this by $19.12, to a loss of ($943.49) for 1991. As a consequence of the life membership payment error, the 1990 cash on hand is high in the amount of $500; the corrected value being $3,918.56. The 1991 cash on hand was also in error by the above mentioned $19.12; it being corrected to $2,975.07. To add further to the complications of reporting, Nat bought a $2,500 GIC in 1991, so the $2,500 expense reported as General Expenditures & Audit is a cash asset expenditure, resulting in an real profit of ($2,500-$943.49) $1,556.51 for 1991!

1992 Summary

I am continuing to use the end of membership year (Sept 30th) as the financial "Year End" for the reasons originally outlined in my 1987 report. The bottom line of the Income Statement correctly reports a loss of ($539.99) for 1992, but we increased the amount of our GIC by $500, and loaned $1,000 to the 93GA organizing committee for seed money. After accounting for this $1,500 in two expenditures, our 1992 loss of ($539.99) is actually a profit of $960.01. This profit position is reflected in the bottom line of the Comparative Income Statement, which reports an increase in equity (What the Centre is actually worth.) of $1,214.57 over 1991. The corresponding increase in equity over the 1991 membership year was $893.84, after accounting for the $19.12 correction.

The most significant change, during 1992, was the loss of some 39 members. Excluding revenue and expenses directly associated with membership, total net revenue was about $259 higher, while total net expenses were about $141 higher. With revenue $103 higher then expenses, 1992 was essentially similar to 1991, financially speaking. However, the change in membership resulted in $715 less net membership revenue for the Centre. Therefore, overall 1992 received $597 less revenue during 1992 compared to 1991. This is approximately 50% of the 1992 change in equity!

Not reported in the Income Statement, is a flow through of $2,920 in NSPAC donations. NSPAC wishes me to thank all those members who contributed to this cause in 1992.

Due to space limitation in *Nova Notes*, the Balance Sheet and notes for the income statement and balance sheet are not published here. Any members who would like to receive a complete package, contact me. Ω

ROYAL ASTRONOMICAL SOCIETY of CANADA, Halifax Centre
COMPARATIVE INCOME STATEMENT
YEARS ENDING Sept 30, 1992 and Sept 30, 1991

ADJUSTED TO REFLECT END OF MEMBERSHIP YEAR	Years Ended September 30		Amount of Increase or (Decrease) during 1992	Breakdown of the $32 Membership Fee	Percentage of Membership Fees		Percentage of Total Revenue	
	1992	1991			1992	1991	1992	1991
REVENUE								
Membership Fees	$3,187.00	$4,432.40	($1,245.40)	$32.00	100.00%	100.00%	63.39%	63.10%
Life Members Grant	396.80	310.00	86.80	3.98	12.45	6.99	7.89	4.41
Donations	126.52	220.27	(93.75)	1.27	3.97	4.97	2.52	3.14
Educational Activities	20.00		20.00	0.20	0.63		0.40	
Interest & Dividends	427.43	292.68	134.75	4.29	13.41	6.60	8.50	4.17
Sales of Handbooks (net)	45.73	76.22	(30.49)	0.46	1.43	1.72	0.91	1.09
Advertising	20.00	20.00	0.00	0.20	0.63	0.45	0.40	0.28
General Assembly (inc. grant)	359.06	618.20	(259.14)	3.61	11.27	13.95	7.14	8.80
Other Grants	195.34		195.34	1.96	6.13		3.89	
Miscellaneous	250.05	1,054.69	(804.64)	2.51	7.85	23.80	4.97	15.01
Total Revenue	$5,027.93	$7,024.46	($1,996.53)	$50.48	157.76%	158.48%	100.00%	100.00%
EXPENDITURES								
Fees to National Office	$1,843.20	$2,287.20	($444.00)	$18.51	57.83%	51.60%	36.66%	32.56%
Library	19.80	35.00	(15.20)	0.20	0.62	0.79	0.39	0.50
Meetings & Newsletter	1,054.00	1,047.93	6.07	10.58	33.07	23.64	20.96	14.92
Annual Dinner (net)	(185.69)	(97.15)	(88.54)	(1.86)	(5.83)	(2.19)	(3.69)	(1.38)
General Assembly (inc. grant)	613.11	956.40	(343.29)	6.16	19.24	21.58	12.19	13.62
Equipment & Supplies		5.60	(5.60)			0.13		0.08
Office Administration	201.93	380.42	(178.49)	2.03	6.34	8.58	4.02	5.42
General Expenses & Audit	1,500.00	2,500.00	(1,000.00)	15.06	47.07	56.40	29.83	35.59
Educational Activities	300.00		300.00	3.01	9.41		5.97	
Insurance								
Awards & Donations	185.72	151.70	34.02	1.86	5.83	3.42	3.69	2.16
Operating Expenses Observatory								
Miscellaneous	35.85	700.85	(665.00)	0.36	1.12	15.81	0.71	9.98
Total Expenditures	$5,567.92	$7,967.95	($2,400.03)	$55.91	174.71%	179.77%	110.74%	113.43%
Surplus or (Deficit) on Operations	($539.99)	($943.49)	$403.50	($5.42)	16.94%	21.29%	10.74%	13.43%

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Notice of Meetings

Date:	**Regular Meeting - Friday, December 18th: 8:00pm;** 7:00pm for the executive meeting (all welcome).
Place:	Lower Theatre, Nova Scotia Museum, Summer Street, Halifax. Access is from the museum parking lot.
Topic:	**Nat Cohen** will be presenting a brief talk on how navigators can use measurements from the stars to determine their geographic location and **David Lane** will talk about the plans for doing CCD photometry and spectroscopy of stars at the Burke-Gaffney Observatory at SMU. And, as is tradition, we will share a Christmas cake after the meeting. See ya there!
Date:	**Regular Meeting - Friday, January 15th: 8:00pm;** 7:00pm for the executive meeting (all welcome).
Place:	Lower Theatre, Nova Scotia Museum, Summer Street, Halifax. Access is from the museum parking lot.
Topic:	**Mary Lou Whitehorne** will be presenting **"ρ Persei - A Misbehaving Binary Star".** Mary Lou recently had a paper published on this topic in the Journal of the RASC.

Halifax Planetarium Shows

The Halifax Planetarium, located in the Dunn Building at Dalhousie University, provides public shows each week on Thursday evenings at 7pm (except for the holiday season). Upcoming show dates and topics are listed below. Contact the *Nova Scotia Museum* at 424-7391 for details.

Date	Show Title
Dec 10	Stones that fall from Heaven (Doug Pitcairn)
Dec 17	The Christmas Star! (Joe Yurchesyn)
Jan 7	Stones that fall from Heaven (Mary Lou Whitehorne)
Jan 14	Oh Those Nebulae! (Doug Pitcairn)
Jan 21	Big Stars Blow Up. Small ones... (Joe Yurchesyn)
Jan 28	Stars Hangout in Gangs. (Pat Kelly)
Feb 4	The Sky is full of Colour! (Mary Lou Whitehorne)

Observing Sessions (see page 2)

1992 Halifax Centre Executive

Honorary President	Dr. Murray Cunningham	
President	Patrick Kelly	798-3329
1st Vice-President	John Connelly	679-1333
2nd Vice-President	Mary Lou Whitehorne	865-0235
Secretary	Wesley Howie	457-3052
Treasurer	Joe Yurchesyn	422-8030
Nova Notes Editor	David Lane	443-5989
National Representative	Brian Segal	783-2722
Librarian	Walter Zukauskas	423-2400
Observing Chairman	Doug Pitcairn	463-7196
Councillors	Dr. David Turner	435-2733
	Jason Adams	864-9783
	Paul Gray	864-2145