CANOPUS

The Astronomical Society of Southern Africa

Johannesburg Centre

Monthly Newsletter for October 1999

Contents:

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

Editorial

The morning skies are quite beautiful this year - Jupiter, and to a lesser degree Saturn, glowing in the West and the shimmering silver searchlight of Venus blazing in the East before the rising Sun. There is also the added bonus of our rains coming a little late this year which enables us to do some early morning observing under clear cloudless skies (without freezing fingers, toes and nose).

Jupiter of course, is at its closest to Earth in the past 12 years as we prepare to go to press.

The Leonids season is only a few weeks away and with predictions of some really great showers making their appearance in the AstroPress and the Internet, we are attempting to get the services of both an Optical-, and a Radio- Astronomer to give us the two perspectives of Leonids observing.

Brian has supplied your editor with the Astronomical Calendar for the whole of next year - but with typical editorial parsimony, I will be only publishing the next 2 months per issue. Brian has also submitted two good articles, one on the Galaxy Morphology Conference and one on Photometry

Bill Wheaton keeps us abreast of the latest from NASA and JPL in his reflections on the ill-fated Mars Climate Observer, while Evan has news of a new Astronomical site and email list which is aimed at the South African Astronomer.

Danie has supplied an interesting variable for you - V442 Centauri - and revisits an old friend in Eta Carinae who seems to be giving Astronomers much food for thought since the Chandra orbiting telescope became active and peered in it's direction.

Thanks to those of you that have paid your Annual subs - your reward (or punishment) is that you are reading this issue of Canopus.

The Editor
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Notice of Meeting

The **November** meeting of the Johannesburg Centre of the Astronomical Society will be held in the Sir Herbert Baker Library, 18a Gill Street, Observatory, on Wednesday the 10th of October, 1999 at 20:00.

Topic:

The Leonids

The Radio *and* the Optical perspective

Try not to miss this pair of talks - the Leonids arrive circa the 18th of November and you will pick up many useful observing tips from the two presenters.

Future Meetings

December 11th	Year End Star Party	At Tom's Farm
January 12th	METSOC 1999	Trevor Gould
February 9th	Computers in Astronomy	Chris^2

Dark Sky Viewing

On the Saturday nearest New Moon at Tom Budge's Farm in the Magaliesberg.

6th November
(A new list will appear in the December issue)

Year End Star Party
11th December

The Year End Star Party

Tom has once again graciously opened his home to us as a venue for our annual Year End Star Party. Those of you who attended last year's blast will remember the lethal concoction (I think it was some highly-secret rocket fuel) the Tom served up to the bold and brave amongst you. He has assured me that he has more of this medicinal anomaly ready to be consumed by any of you courageous enough to say YES! Well even if you don't try the brew - the fires will be available for you to braai your own consumables - *PLEASE REMEMBER THIS IS A BRING 'N BRAAI* - so bring along anything you wish to consume - both food and beverages. Come along from late afternoon (16:00ish) onward.

New Members

We would like to welcome the following new Members to the Jo'burg Centre and wish them many years of clear skies**:-**

Erika Ashford — Henrique Durao (Family) — Len Larson (Family)

Donations

We wish to thank the following members for their kind donations**:-**

WP Lockhart	J van Rensburg	Penberthy family	NF Peverett	H Lund
FW van Niewkerk	Chomse family	REH Overy	T Budge	E Finlay
Larson family				

Annual Library Stocktaking

To all members with books, magazines or videos currently on loan from our Library. Would you please return these at the next meeting to enable us to do our annual stocktaking exercise. We are attempting to get all the relevant information onto computer and need the items to accomplish this.

JPL and NASA News

Bill Wheaton, IPAC - 1999 November

Reflections on Mars Climate Observer

As all of you know, Mars Climate Observer (MCO) suffered a truly horrible fate, burning up in the atmosphere of Mars due to a navigation error that placed it about 90 km lower than intended during its orbit-insertion burn on September 23. It was obvious from the first that such a disaster could really only be due to some dreadful human error. This makes it all the more painful to JPL people, because nobody in their right mind goes into astrodynamics or spacecraft navigation unless they are really deeply committed to the value of what they are doing. Worldly fame and riches are certainly not likely to be in store for the JPL navigation team, no matter how well they do their job; only the satisfaction of doing something well that is important and difficult.

So my first response to the awful news was a sick feeling in my stomach, thinking of the pain of the key people involved, and the agonizing fear each had to be feeling: that a mistake or lapse on their part could have caused the loss of the mission. Second, surely with many others, I wondered whether the error would turn out to be due to a failure by one or a few responsible individuals, something (like the *Challenger* accident) traceable to a broader management breakdown, or something where one could not easily point to a clear-cut mistake at any particular point. Finally, I wondered what useful lessons we might learn that could help us in the future--and whether we would in fact learn them.

The main technical thing to understand about MCO is that, by radio tracking and ranging, it is possible to determine the distance of a spacecraft from Earth with high accuracy at any particular moment, and also the component of the velocity parallel to the line of sight. The position of Mars itself is also known with great accuracy. However, the position of the spacecraft *perpendicular to the line of sight*, and the corresponding components of its velocity, can only be determined accurately by tracking over an extended period of time. What one must do is observe the range and range-rate over a long enough time that the gravity of the Sun and planets causes substantial effects. Then, knowing the masses and positions of these Solar System bodies, it is possible to figure out where the spacecraft must have been, in three dimensions, in order to have its line-of-sight range and velocity behave in just the way observed. This seemingly unpromising procedure is actually perfectly well-defined, a high art developed over the past 300 years, thanks to the efforts of many of the greats of mathematics and physics. In the past 40 years it has been honed to a fine edge by the navigation and trajectory computation experts at JPL and their counterparts around the world.

Given a reasonably long stretch of typically accurate range and range-rate data, the method normally produces marvelously accurate results. Yet it is obviously the sort of thing that one cannot do on the back of an envelope, nor cross check in five minutes. Also, everything depends on the knowledge of the forces on the spacecraft to high accuracy as it falls along its trajectory in the grip of gravity. Here is where the infamous English-to-metric units conversion error struck. For (due to radiation pressure torques on an asymmetric solar panel) it was necessary to periodically use thrusters to maintain the spacecraft orientation. Unknown to the trajectory computation team, these thrusters produced an effect about 5 times larger than they realized, the thrust being expressed in pounds rather than Newtons. As a result, the forces they believed were shaping the trajectory were in fact not quite correct, so the whole calculation was slightly in error.

As MCO approached Mars, the planet's gravity began to bend its trajectory, yielding a check on the solution previously obtained. As the distance closed, this check became more and more accurate--but there was also less and less time to do anything about it. Ordinarily the preparation and checking of a significant trajectory correction maneuver requires many days or weeks of work, although it can be done, under some duress, in a few days; or even, in a real emergency, in hours. It also takes a little while to incorporate new data into the global trajectory computation and obtain updated answers. Finally, the light travel time back and forth to the spacecraft, around 10 min each way, was a further barrier to any quick response to the situation as it developed on

September 23. In the end it seems to have become clear that a critical situation existed only about an hour before closest approach to Mars, impossibly late for corrective action.

Yet, despite the above contributing causes, it is a fact that the trajectory and navigation methods are ordinarily extremely precise, in theory and in practice. The trajectory error really should have been apparent (one would normally expect) from an earlier failure to find *any* satisfactory trajectory that precisely reproduced the tracking data. Then careful follow-up investigation should have revealed the cause. It is inappropriate and unfair to speculate about the details beyond a certain point until the investigation is complete. Perhaps, for example, the effects of the miscalibrated thrusters were so small and so chaotic that no one could reasonably have noticed the problem and put the finger on it as a serious issue. Or perhaps any number of other things no one would ever think of beforehand combined to make the cause.

Given the thousands and thousands of critical issues involved in any sizable space mission, it has actually always astonished me that it is possible to do them as successfully as it is. I feel that I understand the broad outlines of the physics and engineering of spaceflight fairly well; the miracle I don't understand is how it is possible to make sure that nothing falls through the cracks. It is really incredible to me that *thirteen* immense Saturn V launch vehicles, every one, flew without causing a single mission failure, or that *no* JPL spacecraft failed after launch, from about 1965 until Mars observer disappeared in 1993.

However, the kind of careful, across the board, fine-toothed comb checking and rechecking that might possibly have detected the MCO trajectory error is not just morally admirable. Realistically, it is also *expensive*. It takes a great deal of time and effort by highly trained people. Those people have to eat and pay their mortgages. If one intends to pay a large team of outstanding people a reasonable wage, the total cost is inevitably going to be substantial. Long ago someone made up a budget for MCO that assumed a certain level of staffing would be sufficient for the trajectory and navigation work. That person knew that if the mission was going to go at all, it had to be done for no more than a certain amount of money.

The success of the *Apollo* program came at a high price. Similarly, JPL missions were starting to cost $1 billion each, and one reason there were no failures from 1965 to 1993 is probably that there were no *missions* launched from 1978 to 1989. If a 97% mission success-rate costs twice as much as an 80% mission success-rate, we would get more science per dollar by accepting more failures but doing more missions (by a 160/97 ratio, for these numbers I have made up) than by indulging in excessive perfection. This is the logic of NASA administrator Goldin's drive to do more missions at lower cost. But nothing comes free, and in this case the price is inevitably sometimes going to be paid in failed missions.

Whenever that happens, it will always be painful, the causes will typically be somewhat murky, we will always wonder and worry whether we have gone too far one way or the other. If we don't wonder, and worry a little, we are almost certainly way off the path we want to be on. There will often be a natural urge find the guilty and bring them to justice. We need to be sophisticated enough to realize that if there are *no* failures, we are doing something wrong. So, let us try to learn from our mistakes, so we won't fall into that hole again. If we save the cost of a Titan IV launch vehicle by doing complex astrodynamical maneuvering, maybe after all we should have two teams do the navigation calculations independently. We should probably tell the troops to get some sleep and encourage them not worry too much about spilled milk.

Oops

Speaking of mistakes, last month in my discussion of the skyhook, I mentioned that a uniform cable made of ordinary steel, of the kind used for making bridges, could only support itself in the Earth's gravity if it were shorter than about 90 km. Actually, I slipped a decimal and the correct number is more like 9 km. Because this factor appears *in the exponent*, such a cable would have to taper up in area by a factor of something like e^{540} instead of "merely" e^{54}. Embarrassing as such careless errors are, at least comparison of the two figures helps to illustrate how incredibly sensitive the practicality of such space tethers can be to the characteristics of the materials: here a factor of 10 in strength translates into a factor of e^{486}, about 10^{211}, in cable mass. Thus rather modest improvements in materials can make a great difference in practicality.

Variable of the Month:
V442 Centauri

This must surely be one of the easiest variable star fields to identify, as a fifth magnitude star shows the way, and an 8/9 mag pair reassures us that we is in the right ball park.

Doing the estimate is just as easy: Either the star is invisible or it is not. In this case an error in your estimate is not nearly as important as reporting the fact that the star is in outburst.

Enjoy looking at the field during our lovely spring dawn hours and keep following it until it is low in the West next winter.

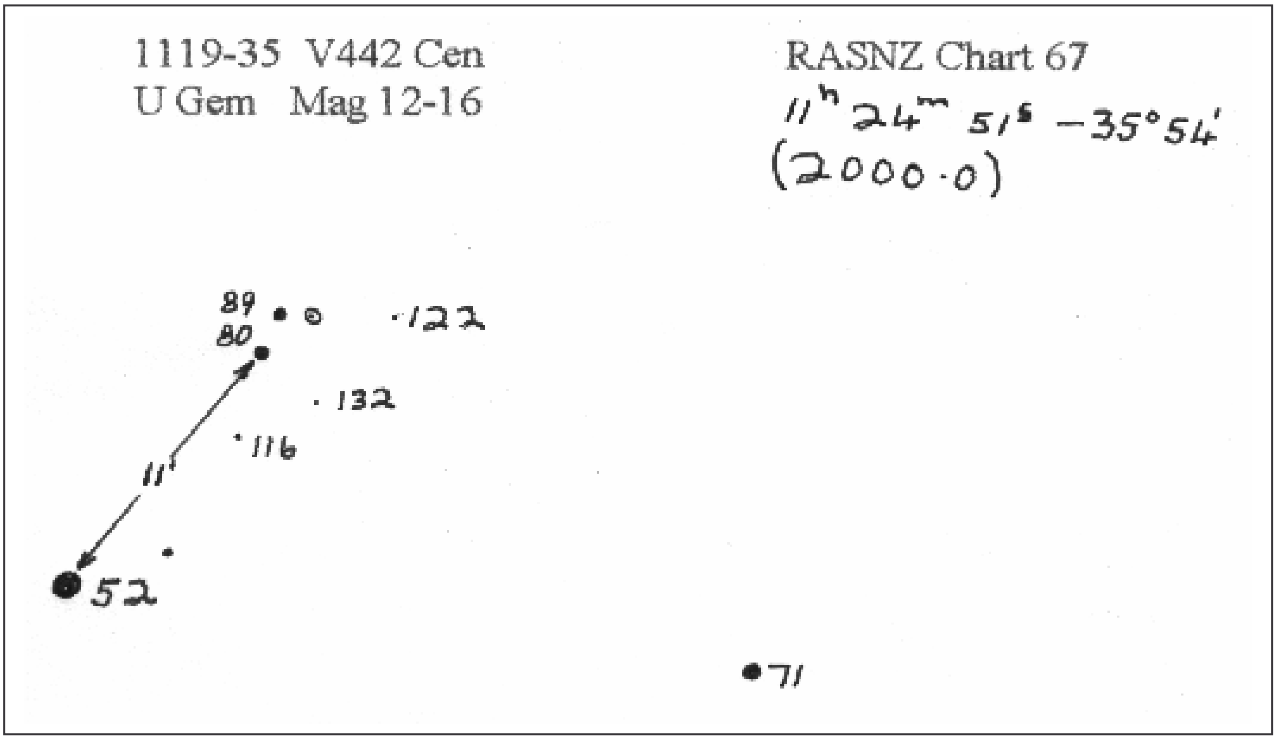
ETA CARINAE REVISITED

One of the 1999 January Variables of the Month was Eta Carinae. S&T Bulletin dated 1999 10 08 contains the paragraph below. Is it expecting too much from Canopus readers to have a daily look with their binoculars or even the naked eye, if the astronomical community finds it worth while to use a R9 000 000 000 satellite to study it?

CHANDRA SPIES ETA CARINAE

Astronomers were once again surprised by what the Chandra X-ray Observatory can see as it peered into the heart of another familiar celestial object. On September 6th, the $1.5 billion telescope was turned toward Eta Carinae, a much studied star because of its history of variable activity and because astronomers believe that it is a supermassive star on the verge of going supernova (see the January 1998 issue of Sky & Telescope, page 36). The most detailed X-ray image yet of Eta Carinae -- taken by Chandra's Advanced Charge-coupled Device Imaging Spectrometer (ACIS) -- was released today and reveals an unimaginably hot (60 million degree Kelvin) central source surrounded by a relatively cooler inner core and cooler still (3 million degrees K) horseshoe-shaped ring. "It is not what I expected," Fred Seward (Harvard-Smithsonian Center for Astrophysics) explains. "I expected to see a strong point source with a little diffuse emission cloud around it. Instead, we see just the opposite -- a bright cloud of diffuse emission, and much less radiation from the center." Why this is so is unclear at present.

Danie Overbeek

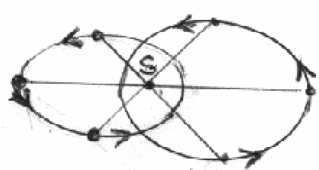


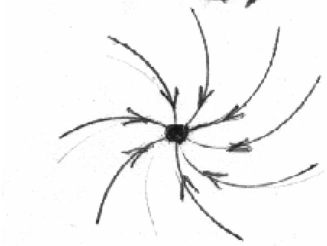
EVOLUTION OF THE GALAXIES

When we look at the fine gradations between the various classes of galaxies in the three-dimensional classification of de Vaucouleurs, eg SA(s) and SAB(s) we may think that the various classes of galaxies may, through the millennia, change from one class to the other, eg Sa to Sb, to Sc or vice versa. In SAB(s) the central bar is only slightly visible and it is hardly distinguishable from the class SA(s). But the dynamics of these stellar systems show that there are great differences in mass between the various classes which preclude the evolution of one class into another. The actual physical merging of galaxies into each other, does take place as is shown in cases such as the "Rattail" galaxies, NGC 4038/39, also known as the "Antennae" because of their widely flung spiral arms. The galaxies NGC 5426/27 seem to be in contact prior to merging. In Centaurus A, a spiral galaxy is apparently moving through a huge elliptical galaxy. There is so much empty space between the stars, that two galaxies can move through each other without collisions between the individual stars. In Centaurus A the Hubble Space Telescope has revealed "blue" stars in the obscuring dust streak. These are "new" stars as is shown by their low and negative B-V colour indices. In comparison the stars of the elliptical galaxy are "old", being "red" because they have high B-V colour indices. The new stars in Centaurus A have been formed "recently" (a few tens of millions of years ago) by the compression of the gas and dust between the older stars.

We may think that a lenticular (lens-shaped) galaxy may yet develop spiral arms or that the arms of a spiral may wind up into the lenticular form. But there is no evidence for this. It would appear that each galaxy evolves along certain lines and that the most important parameter determining the evolution, is the amount of mass available for star formation and the amount of matter in the surrounding space. These masses determine amount of bending of the space-time, the curvature of space, as set out in Einstein's Theory of Relativity. Mass exercises gravity and the motions of masses of matter are constrained by the curved "world lines" of force between the masses of matter and centred on the gravitational centre.

The first matter which was formed in the cosmo-genesis (or big bang) when the temperature had dropped to 10^9 degrees, was hydrogen, together with 20 to 28 % of helium and very little heavier nuclei of atoms. The microwave background radiation, which was present from the beginning, is very uniform, but the C O B E satellite has revealed that there are minute irregularities. It is these irregularities that caused the primeval matter to coagulate in clumps. Where these clumps moved in almost parallel lines they merged into more massive clumps. When two clumps approached each other from opposite directions, they spiraled around each other, or rather around their mutual centre of gravity, their barycentre and then revolved around each other in ellipses, thus forming a double star. The sizes of the ellipses in which they revolve, are inversely proportional to the masses of the clumps: the larger the mass, the smaller is the ellipse, but the shapes of the ellipses, their eccentricities, are identical. The line .joining two revolving bodies, always passes through their barycentre S.





For a star to form in the first instance, the matter must accrete by spiraling on to a centre of gravity. This spiral motion gives spin to the resultant star. Everything in the universe has spin. As more and more matter accretes, the pressure on the centre increases and this raises the temperature because the pressure exerted by the overlying layers, forces the separate particles closer together, thus increasing their rates of collision. Each collision liberates heat. Eventually the temperature rises so high that the accreting gas begins to glow, but it is not yet a star. Probably most of the matter in the universe was left in this form, which today we call "brown dwarfs".

The temperature has to rise to about 15 million degrees before the pressure succeeds in forcing the separate hydrogen nuclei, or protons into each other in what is called the proton-proton reaction. The proton is indicated by $^{1}_{1}H$, the upper 1 indicating its mass and the lower 1 its positive electric charge. When the two protons are forced into each other, one proton loses its positive charge and this is shot out as a positron. The resultant particle is a deuteron $^{2}_{1}H$. Besides the positron neutrinos, of no mass, but carrying away tremendous amounts of energy are shot out. Another proton is then forced into the deuteron to form a nucleus of helium of mass 3 and charge 2**:** $^{3}_{2}He$ and copious amounts of gamma rays Y, are set free. Two of the helium nuclei are then forced together to form the stable isotope $^{4}_{2}He$ (four helium two) and two protons are liberated and the process continues. The gammarays are the source of energy which keeps a star going.

Einstein's equation $E = mc^2$ showed the equivalence of matter (m in grams) and energy E (in ergs), where c is the speed of light in centimetres per second, and this vast quantity is raised to the second power! From as little as 4 grams of solar matter, which is converted into helium, the amount of energy liberated is sufficient to boil away more than 9,5 million litres of ice-cold water and turn them into steam!

The gammarays produced in the centre of a star are repeatedly absorbed by neighbouring particles and just as readily re-emitted. This is the nature of plasma, a form of matter which is in thermal equilibrium.

With each absorption and re-emission of gammarays, their frequency is decreased. Beginning at 10^{25} vibrations per second the gammarays, after about 100 million years, reach the surface of the star and by that time their frequency has been reduced to 10^{14}, which is the frequency of visible light. The eyes of humans and other animals evolved and became adapted to this frequency, giving us the faculty of sight.

The first stars that formed must have been very massive because much matter was present in a very small volume. Stars were formed in swarms, as open clusters, and in groups of hundreds of thousands, the globular clusters, and in their thousands of millions, as galaxies.

The very massive stars which formed the centres of the first galaxies, consumed their hydrogen fuel at a prodigal rate. A star of 10 times the mass of the Sun consumes its hydrogen at 1000 times that of the Sun. Such massive stars could therefore not have existed for longer than a few ten million years, before they collapsed on their centres because of the sudden decrease of radiation which had balanced the crushing gravitational force of the overlying layers. This crunch on the centre caused the helium which had accumulated there, to undergo fusion into heavier atoms - the helium flash - forming atoms such as carbon, oxygen, neon, magnesium and silicon (of mass 28). When silicon was reached, things happened very swiftly. Each two silicon atoms were fused together to form an iron nucleus (mass 56). Up to the formation of iron energy is liberated with each step up the atomic ladder. Beyond iron energy has to be supplied from outside. Iron has the most densely packed nucleus of all atoms. When iron is formed, the collapse of the centre ceases and a rebound in the form of an indescribable explosion takes place - a supernova explosion - in which the star casts off most of its substance and blows itself to smithereens.

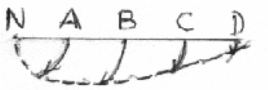
When a star goes supernova it leaves a highly compressed neutron star in its wake -- a star equal in mass to the Sun but having a diameter of 2 kilometres. A star of 10 times the Sun's mass, or more, leaves a core of less than 1 kilometre in size. This is a gravitational vortex (or black hole) where the gravity is so great that no radiation can escape because the escape velocity is greater than the velocity of light, and such a velocity cannot exist.

A galaxy having many massive stars in its nucleus, will experience intermittent and protracted supernova explosions. Seen from afar the nucleus will appear to be variable in its light intensity and variable with short periods, as short as months. These galaxies are known to us as quasars - they are 100 times brighter than a whole galaxy and variable and emit X-rays.

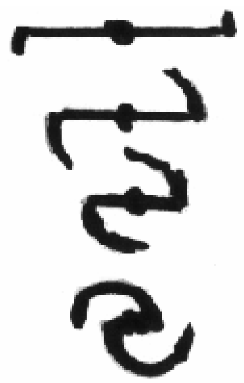
The quasars have distances of thousands of millions of light years, so that we see them by the light which left them thousands of millions of years ago when the universe was very young, not more than 10% of its present age. All galaxies will have gravitational vortices in their nuclei, some small, some very big. It is calculated that the centre of the Milky Way harbours a gravitational vortex of 300 million solar masses. The time of its variability when the supernovae lit up the nucleus is long since past. The matter which those supernovae hurled out, has gone to form the spiral arms.

The galaxy M82 in Ursa Major is a good example of a galaxy which is at present undergoing an explosion in its nucleus. This exploding phase shows that an old galaxy can also turn on the fireworks, or maybe M82 is still very young.

Thousands and millions of massive stars going supernova certainly can blow a galaxy apart, thus providing the raw material from which a second generation of stars can condense These stars find themselves caught in the gravitational field of the massive black hole in the nucleus. These stars then revolve around the nucleus, the furthest ones lagging behind as shown in the sketch. The stars at A will revolve faster than those at B, further from the nucleus N, and so on up to the stars furthest from the nucleus. The dotted curve shows the first rudiments of a spiral arm.



We also have barred spirals with varying degrees of development of spiral arms, as shown in the sketch. At the top we have a spiral in which the matter at the end of he central bar has just begun to trail behind. Secondly, the trailing matter becomes more prominent and so on until the spiral is almost completely wound up.



From this we can conclude that barred spirals eventually develop into ordinary spirals.

The Sun lies at a distance of about 30 000 light years from the centre of the Milky Way galaxy. Its rate of revolution relative to the centre is 250 km per second. To revolve once around the galaxy takes the Sun (30000 x 9,46 x 10^{12} x 2π) ÷ 250 seconds. This equals $\frac{(30000\times10^{12}\times2\times3.1416)}{(250\times3600\times24\times365.25)}$ Years, and this comes to 226 million years for one revolution around the centre. In the 4,6 x 10^9 years that the Sun has existed, it has made 20 revolutions. (Lunar samples brought back by the Apollo astronauts (1969 - 1972) have shown a maximum age of 4,7 x 10^9 years. The Sun must be at least as old as that).

D N Schramm in "The age of the Elements", determined through his study of radioactive elements that there was a peak of supernova explosions at about 9 x 10^9 years ago and a second peak at 5 x 10^9 years ago. The Sun and its planets must have condensed from the material cast out by the second burst of supernovae 5 thousand million years ago.

In order to produce a burst of supernovae 9 x 10^9 years ago, the first galaxies must have formed 4 to 5 thousand million years earlier, i.e. 13 to 14 thousand million years ago. The universe was then very young, so we are forced to conclude that galaxies formed very soon after the cosmo-genesis, or big bang. It is highly probable that the first galaxies that formed were ellipticals and that globular clusters formed at the same time as islands around the elliptical galaxies, since they both have old stars, stars poor in metals.

Barred spirals soon followed and they were followed by ordinary spirals.

Whereas elliptical galaxies and globular clusters largely contain yellowish stars, stars with high B-V colour indices, spirals also contain young stars that are called "blue" because they have small and even negative B-V colour indices. The nuclei of spiral galaxies also largely contain yellowish stars, showing that the nuclear bulges of spiral galaxies are older than the spiral arms.

All galaxies follow evolutionary paths that are determined by the amount of mass they contain. The mass of the central black hole also plays a dominant role in the course of a galaxy's evolution.

Mass also plays a dominant role in the evolution of a star. Stars of less than 2 1/2 times the Sun's mass will eventually cast off their overlying layers and end up as white dwarfs. Stars of 2 1/2 up to 8 times the Sun's mass will eventually go supernova and leave a neutron star behind. Stars of more 8 times the mass of the Sun will also go supernova and leave a gravitational vortex (black hole) behind. It seems likely that all galaxies have massive gravitational vortices in their centres.

An incontrovertible fact is that all the galaxies are moving away from each other with speeds proportional to their distances - the further they are the faster they recede. The universe is expanding because the fabric of the space-time continuum is expanding. This is called the inflationary model. The question arises whether the universe will expand forever or whether the expansion will eventually come to a stop, to be followed by contraction and an eventual big crunch, leading to a repeated big bang and expansion. If this is the case, the universe is cyclic, and consists of alternate expansion and contraction phases. The cycle from big hang through expansion, back to big bang, requires a period of 120 x10^9 years - one hundred and twenty thousand million years!

Jan Eben van Zyl

Photometers and Photometry

Photometers are devices that can measure starlight. They are used to determine the brightness of an object. Photometry is the business of measuring the brightness of stars and it is not necessary to have a photometer to do photometry - you can do it with a CCD camera or even a photographic camera.

Light consists of photons and photons are tiny bundles of energy that can generate minute electric currents and it this property that is used in photometers to measure the intensity of light.

There are basically two types of photometers - the PMT (Photo Multiplier Tube) and the photo diode.

The Photo Multiplier Tube

As its name implies, it is a tube that looks very similar to the ones you see in very old radio sets. (Remember those ones, usually glowing with a tiny red light with about 10 or 15 pins at the end that plugged into the electric circuit). The “multiplier” part of the name hints at the way the tube works. The end of the tube is coated with a special material and is fitted in the eyepiece of the telescope and pointed at the star. Light falls on this surface and causes electrons to be knocked off. These electrons are then attracted to a charged plate a short distance behind the front surface by a voltage difference of, say, 100v. The electrons impinge on this plate, knocking off more electrons because they have more energy because they have been accelerated by the voltage applied. These “more electrons” are then attracted to a second plate behind the first one causing more electrons to be knocked off. This process is repeated up to 10 times and so you get a “multiplier” effect. You then end up (hopefully) with enough electrons to produce a tiny electric current that can be accurately measured.

The brighter the star light you start out with, the greater the current you end up with and the higher your reading. You then feed this end current into a measuring device, like a volt meter or, as is the case with Dr Alan Cousins in Cape Town, one of the world’s most famous photometrists, onto a chart recorder, and you then have a permanent record that you can measure at will. If you have 10 “stages” in your tube and each requires a 100 volt differences you have to have a transformer giving you 1000 volts. And this voltage has to be very accurate - to better than 1 part in a million.

That is why PMT’s are not too popular with amateurs and what led to the development of the second type of photometer - the photo diode.

Photo Diodes.

These little devices also measure starlight through the effect of photons producing a tiny electric current on a special surface which is a diode ie it only transmits current in one direction and blocks electrical flow in the opposite direction. Much easier and cleaner to use as they usually require voltages of 6v - 12v, so power can be supplied by a couple of torch batteries.

Each type of photometer has its advantages and disadvantages. Astronomers would normally use filters of different colours with the photometer to determine the star’s brightness in the Blue (B),red (R), and Visual (essentially yellow - V) wavelengths. They also sometimes use ultraviolet (U) and near infrared (I) filters.

CCD photometry is becoming quite popular and relatively easy to do. If you have a CCD camera attached to your telescope, a computer attached to the CCD and some relatively simple software packages, you can measure a star’s brightness with comparative ease. Some amateurs reckon they can do variable star estimates quicker using a CCD than they can visually.

It’s astronomy for the new millenium.

Brian Fraser

Zastro

I would like to invite you to join the Zastro community.

The description of this community is:- "This list is intended primarily for South African amateur astronomers, but all interested parties are welcome!"

You can join this community by going to the following web page:

http://www.onelist.com/subscribe/Zastro

Or you can join by sending email to the following address:

mailto:Zastro-subscribe@onelist.com

Thanks,
Evan Dembskey
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Galaxy Morphology Conference

There is clearly something going on in the Universe. I dropped my sandwich this morning and it landed with the jam side up. It could be because of the strange RVC (Rotational Velocity Curve) in AGN's (Active Galaxy Nuclei) or perhaps dust clouds in high Z (zee) spirals. Maybe the million degree ISM (Inter-Stellar Medium) in LSB (Low Surface Brightness) galaxies has something to do with it. The cosmic FIR (Far Infra Red) reveals resonance rings never before suspected and who knows what they do? The MLR (Metallicity Luminosity Relationship) depends on the SFR (Star Formation Rate) in all galaxies with medium zee.

These are just some of the buzz words you would have picked up if you had been attending the Galaxy Morphology conference held in Midrand in September. Some of the world's top astronomers were there, including the science director of the Hubble telescope, a director of the Keck telescope, a director from the Space Telescope Science Institute, the director of the Space Infra Red Telescope (SIRTF) ......and....and....and…...(Trevor Gould was also there).

Although this conference had as its title "Towards a new millenium in Galaxy Morphology", the 80-odd talks covered all aspects of modern astronomy. There was a slant to the study of galaxies in many different wavelengths, from UV tofar IR and then radio frequencies, but topics such as the origin of life on Earth were touched on, as well as talks on new telescope facilities. David Buckley, from SAAO talked on SALT (South African Large Telescope) and Barbara Cunow from Unisa talked on her studies of Sb galaxies, done with the 1-meter telescope at Sutherland.

Many speakers referred to the HDF (Hubble Deep Field) - that fantastic picture taken by Hubble of 3000+ distant galaxies that looked so impressive and, it seems, contained enough data to keep 50 astronomers busy for a number of years. There was also excitement about the NGST (the next generation space telescope) that will take the place of Hubble one day. Most of these astronomers want to see deeper and deeper into space, and they want bigger and better telescopes. They talk of redshifts of zee=10, which brings you back about 90% of the age of the universe, and there are some strange objects at that age. One puzzle is why supernovae in the very early galaxies look similar to supernovae we see in local galaxies today.

But the one topic that came up repeatedly was Dust. Dust in near and far galaxies is one thing they don't really have a handle on. What is the dust? How big are the particles? And how much of the visible universe does it mask? 95% of the bolometric radiation is hidden from us. Galaxies seem to have lots more dust than visible stars. The problem of unmasking galaxies has been tackled by David Block, who subtracts the dust radiation from visible pictures of galaxies and has revealed that the galaxies are many times bigger than they appear to be.

One paper showed proof of a massive black hole in a galaxy core, and evidence that their are probably black holes in the cores of most spiral galaxies. Very interesting Another paper showed that star formation in spiral galaxies occurs in well-defined rings and not at random throughout the galaxy. And then it was shown that there are galaxies consisting of gas and dark matter but no stars. Surprise! The galaxy names cited look like telephone numbers.

The conventional Hubble sequence of galaxy morphology was shown to be erroneous and much debate arose as to how to replace it, and with what classification system.

Supernovae occur in our galaxy about every 30 years. Wouldn't it be exciting to see one.

If you thought that astronomers have all they answers you are way off. They don't. There are huge questions to be answered - enough work to keep many astronomers busy for the next millenium.

One thing I learned - one should be careful about making predictions, especially about the future.

Brian Fraser

In the Sky this Month

November 1999

dd hh		dd hh	
1 09	Mercury greatest brilliancy	16 09	FIRST QUARTER
4 00	Venus 3.2 S of Moon	20 23	Jupiter 3.7 N of Moon
5 06	Mercury stationary	22 02	Saturn 2.5 N of Moon
6 14	Saturn at opposition	23 08	FULL MOON
8 04	NEW MOON	24 00	Moon at perigee
9 07	Mercury 6.6 S of Moon	25 01	Mercury stationary
11 08	Moon at apogee	28 14	Mars 1.8 S of Neptune
13 17	Mars 3.1 S of Moon	29 03	Venus 4.5 N of Spica
14 15	Neptune 0.3 S of Moon Occn.	29 23	LAST QUARTER
15 13	Uranus 0.2 S of Moon Occn.	30 05	Mercury greatest brilliancy
16 00	Mercury in inferior conjn.		

December 1999

dd hh		dd hh	
2 22	Pluto in conj. with Sun	17 08	Mercury 5.5 N of Antares
3 05	Mercury greatest elong. W(20)	18 06	Jupiter 4.1 N of Moon
3 21	Venus 3.1 S of Moon	19 09	Saturn 2.9 N of Moon
6 02	Mercury 2.9 S of Moon	19 14	Mercury 10.6 S of Pluto
7 23	NEW MOON	21 05	Jupiter stationary
8 14	Moon at apogee	21 09	Aldebaran 1.3 S of Moon Occn
11 22	Neptune 0.1 N of Moon Occn.	22 08	Solstice
12 19	Mars 0.6 S of Moon Occn.	22 11	Moon at perigee
12 21	Uranus 0.2 N of Moon Occn.	22 18	FULL MOON
14 05	Mars 0.7 S of Uranus	29 14	LAST QUARTER
16 01	FIRST QUARTER		

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