The PRETORIA CENTRE
of the
Astronomical Society of Southern Africa
www.pretoria-astronomy.co.za

# NEWSLETTER MAY 2024

## NEXT MEETING

**Venue:** Christian Brothers College (CBC), Mount Edmund, Pretoria Road, Silverton, Pretoria.
**Date and time:** Wednesday 22 May at 19h15.
**Programme:**

- "What's up in June?" by Johan Smit.
- Main talk: **"Impacts since 1900 part 2"** by Michael Poll. Summary on page 9.
- Socializing over tea/coffee and biscuits.

The chairperson at the meeting will be Johan Smit.

## NEXT OBSERVING EVENING

Friday 17 May from sunset onwards at the Pretoria Centre Observatory, which is also situated at CBC. Turn left immediately after entering the main gate. Carry straight on through the car park and proceed down the tarred road that drifts to the left out of the car park and then swerves to the right. About 50 to 100 metres after the last row of studs there is a cricket sight-screen on the right. Observing will be on the cricket pitch just past the sight-screen.
**Please note that we have been instructed that no one is to drive on to the sports fields because of possible damage to the irrigation systems there.**

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## Astronomy related articles on the Internet

**1.** SF has inched a little wee bit closer to reality.
Scientists Get Serious in the Search for a Working Warp Drive (popularmechanics.com)

**2.** Key to finding alien life? Purple bacteria could be key to finding alien life (msn.com)

**3.** Gaia BH3. Meet Gaia BH3, our galaxy's most massive stellar black hole (earthsky.org)

**4. NEA's:**

- Asteroid 2013 NK4 with estimated diameter of 610 meters passed by Earth on April 15, 2024. Fortunately, at its closest approach, it was at a safe distance – more than 8 times the Moon-Earth distance. But will the next one this size also pass at its closest approach at a safe distance?
  Large asteroid safely passed Earth: See pic here! (earthsky.org)
- A near Earth asteroid (NEA) is defined as an asteroid with an orbit that brings it to within 195 million km of the Sun, allowing it to pass through Earth's neighbourhood in the solar system. See a graph of the cumulative number of NEAs discovered versus time. Discovery Statistics (nasa.gov)
- This is disquieting, but has to be taken note of. Note the many that passed with no warning. List of asteroid close approaches to Earth – Wikipedia

**5. Extreme objects in the Universe:**

For what follows, this information:
1 million = 1 x $10^6$ = 1 thousand thousand.
1 billion = 1 x $10^9$ = 1 thousand million.
1 trillion = 1 x $10^{12}$ = 1 million million.
1 quadrillion = 1 x $10^{15}$ = 1 thousand million million.
$R_\odot$ , $V_\odot$ , $M_\odot$ and $L_\odot$ stand for the radius, volume, mass and luminosity of the Sun.

- Largest known structure in the observable Universe. Its length is 10 billion light-years.
  Hercules–Corona Borealis Great Wall – Wikipedia
- Largest known galaxy. Its diameter is 6 million light-years (= 60 times the diameter of our galaxy.) It contains 100 trillion stars (about 400 times as many as our galaxy.)
  Largest Known Galaxy IC 1101 - Size, Distance, Facts (planetseducation.com)
- Stephenson 2-18, a red hypergiant star, is the largest known star in the Universe. It has an estimated radius of 2143 $R_\odot$, and a volume of about 124 billion $V_\odot$.
  Bing Videos
- This quasar has a luminosity of 500 trillion $L_\odot$.
  Astronomers discover what could be universe's brightest object (msn.com)
- A black hole labelled TON 618 has a mass of 40 billion $M_\odot$. It shines with a luminosity of 140 trillion $L_\odot$. TON 618 – Wikipedia
- The Einasto supercluster of galaxies contains a mass of about 26 quadrillion $M_\odot$. Its diameter is 360 million light-years (= 3 600 times the diameter of the Milky Way).
  Scientists find galaxy supercluster as massive as 26 quadrillion suns | Space

## Observing: NGC 4439 and NGC 7063 – by Magda Streicher

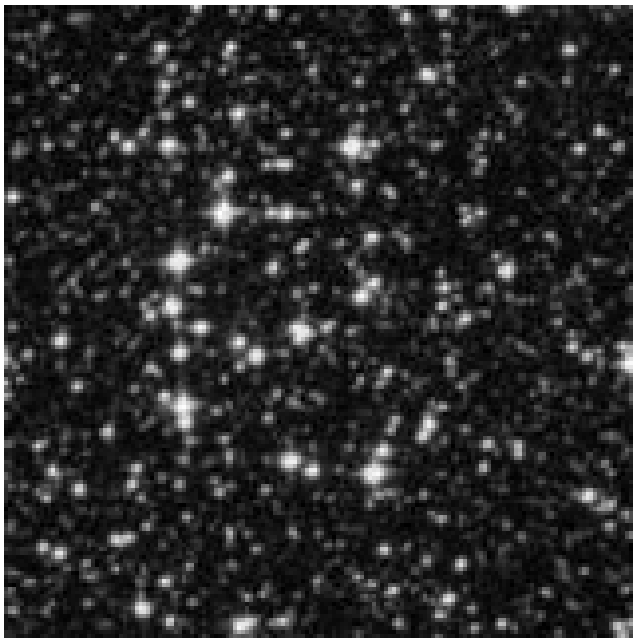
Open star clusters are incredibly varied in respect to shape, size and impressions that are reflected by the stars' relative positions. But amazingly is the fact that some of the clusters are in some ways quite similar. There is never a dull moment when observing such star clusters in their multiplicity. However, when two or more such objects correspond greatly in terms of the character they portray, something has to be written about the phenomenon.

The open cluster NGC 4439 in the constellation Crux displays approximately eleven stars resembling a dome shape pointing towards the east that stand out clearly against the background star field. A double star nestles inside this halfmoon-shaped dome of stars, with a few others pointing south. The cluster reminds me in a way of the sickle emblem on the Russian flag.

At the opposite end of the starry band marking the milky way, the constellation Cygnus, also called the Northern Cross, houses what could be thought of as a cousin cluster, so close is the resemblance. Open cluster NGC 7063 can be found 2 degrees north-east of upsilon Cygni, and a mere 20' south-west of the brilliant white 69 Cygni. The cluster is a tad fainter, slightly larger and not quite as compact as NGC 4439, but appearing very similar in shape and character.

**Compare the two clusters, notice the similarities, and wave a flag for the satisfaction and enjoyment you experience from these many-faceted star clusters. Ω**

| OBJECT | TYPE | RA | DEC | MAG | SIZE |
|---|---|---|---|---|---|
| NGC 4439 | Open Cluster | 12 h 28.4 m | - 60° 06.2' | 8.4 | 4' |
| NGC 7063 | Open Cluster | 21 h 24.5 m | + 36° 29.3' | 7 | 7' |



NGC 4439

NGC 7063

## Report for the observing evening of April 19th 2024 by Michael Poll and Johan Smit

**Michael Poll:**

There were about a dozen of us, and 3 or 4 telescopes and **No Clouds**. There was however an eleven day old moon, which blotted out the stars, but lent itself to a crater identification session, mostly in the lunar south west. (The **Lxx** numbers here are the number labels from the Lunar 100 by Charles A Wood in Sky & Telescope for April 2004).

**Craters and other features noted were:**

Sinus Iridium **(L14)** and Plato – the latter a distinct oval towards the lunar north pole. Sinus Iridium is a "bay" to the west of Plato. Copernicus **(L5)** is a large, isolated crater nearly in the middle of the Moon. It is 91 km in diameter and 4 km deep. Reinhold and Lansberg are just south of Copernicus, and the three are in a line, equally spaced.

Gassendi **(L13)** is a lovely crater also with a central peak. It was nicely placed on the terminator. Bullialdus is another crater with a good central peak, Lubiniezky is nearby and looks like an almost drowned crater. Hainzel and Mee are in the southern uplands - Hainzel overlaps Mee. Wilhelm is level with Mee but slightly to the east. Tycho is a smaller distance east of Mee.

Longomontanus is just a bit south of Wilhelm. These two are about as far apart as the diameter of Wilhelm. Clavius **(L9)** is southeast of Longomontanus. Schiller **(L30)** was almost on the limb, but its elongated shape was easily noted – it measures 179 km x 71 km.

**On the map on page 6, the crater names are:**

156 Gassendi (top left)
157 Lubiniezky
158 Bullialdus
217 Hainzel
232 Mee
233 Wilhelm
234 Tycho
243 Schiller
244 Longomontanus
261 Clavius

**The problem of round craters:**

Grove Carl Gilbert (1843 – 1918) in the 1890s and Alfred Wegener (1880 – 1930) in 1918 both postulated that the craters on the Moon were created by impacts. They did not know about each other's work because Wegener was in Europe and Gilbert was in the USA. In 1893 Gilbert showed an impactor will most frequently strike at about 45 degrees and that a graze of less than 5º occurs only 7 times out of 1000. Impacts within 5º of vertical equally are equally rare. (See figure 1 on page 7.)

Because most meteorites would therefore strike at oblique angles, it was thought that craters should have a variety of elliptical shapes and would only be circular if the impact was at a high angle. Both Wegener and Gilbert had the same problem – they could see that ***all*** the lunar craters were basically circular.

Ernst Őpik (1893 – 1985) showed in 1916 that impact craters must be formed by explosions due to the high energies of striking meteorites, and that impacts, even at low

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angles, would result in circular craters. His paper was also only rediscovered in the 1940s.

**Schiller crater (see images on page 6)**

*Moonzooblog.wordpress.com* states that *"Schiller crater is one of the most unusually shaped craters on the Moon and its formation is still a bit of a mystery. It is elongated as if it had been stretched lengthwise at some point but was probably created by a grazing (oblique) impact or is a secondary impact crater. At least one article claims that it was created by a multiple impact, i.e. the impacting object broke up just before hitting the Moon*"

As well as telescopic views of the Moon, we noted Mare Crisium with the naked eye – the feature is 570 km across. We saw Jupiter and Aldebaran disappearing into the sunset, and Antares low in the southeast about to climb into the evening sky. We looked at Crux and the Diamond and False Crosses, barely discernible to the naked eye. In the telescope we looked at IC 2602 and Alpha Centauri – this pair are now easily split after close approach around 2015.

**Johan Smit:**

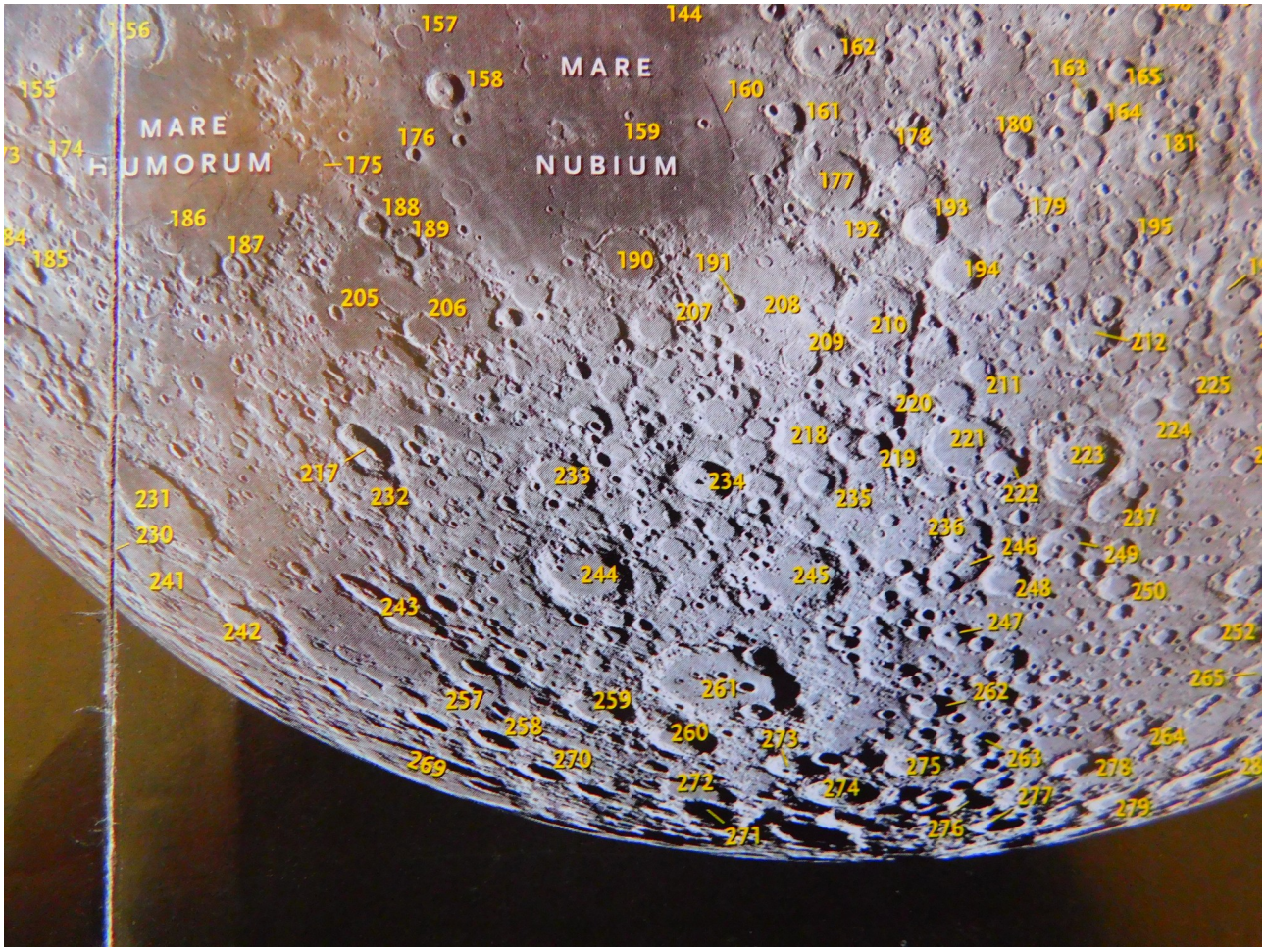
At last: a surprisingly clear evening with as good sky conditions as can be wished for in the city. Views through the telescopes was considerably better than those we have had so far this year.

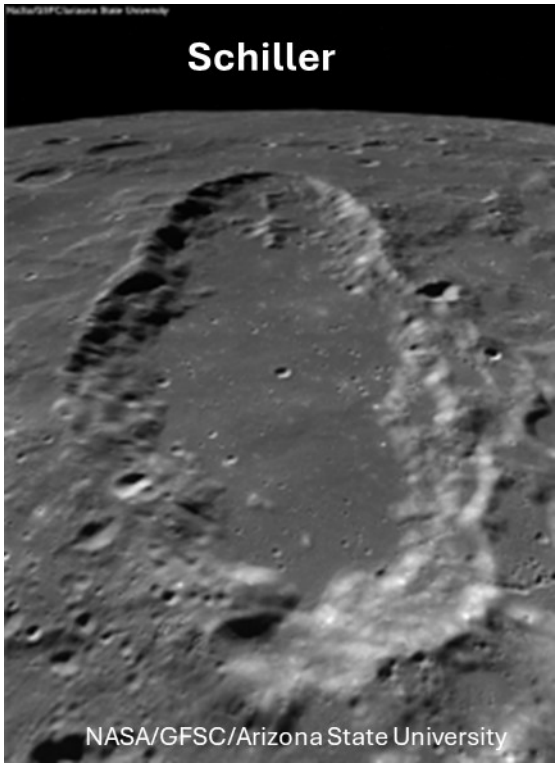
The promised demonstration of the use of a manual equatorial mount was done. A visitor who had owned such a mount for many years did not know any of the tips mentioned and was surprised at how well such a mount can work if set up correctly. All were shown how to use the manual slow motion controls to keep a target in view, and even complete novices adapted to using that seamlessly, and could even find targets in the sky.

When we had some difficulty locating targets close to the celestial pole and on the meridian, it prompted a discussion about blind (difficult to reach) spots using different types of mounts. In short, all mounts have such a blind area close to its main rotation axis. On an equatorial mount that would be around the celestial pole and when an object is close to the meridian (the line overhead from pole to pole). On an Alt-Az mount like a Dobsonian that spot is at the zenith. This prompted interesting discussions about possible solutions to these problems.

In between all the talking and demonstrations we viewed the Jewel Box and also saw the carbon star Ruby Crucis near Mimosa (Beta Crucis), and we did have a look at NGC2547 (Heart Cluster) and even Omega Centauri, which was surprisingly well resolved in a 6-inch telescope. Finally we had a good view of M42, the Orion nebula, which will not be an accessible target next month. The fact that this was easily seen proved that the sky conditions were very good on the evening.

Thanks to Vicus, one of our newer members and fellow telescope maker, we were able to enjoy coffee and rusks too. All in all, one of the better observing evenings we have had for a while. **Ω**

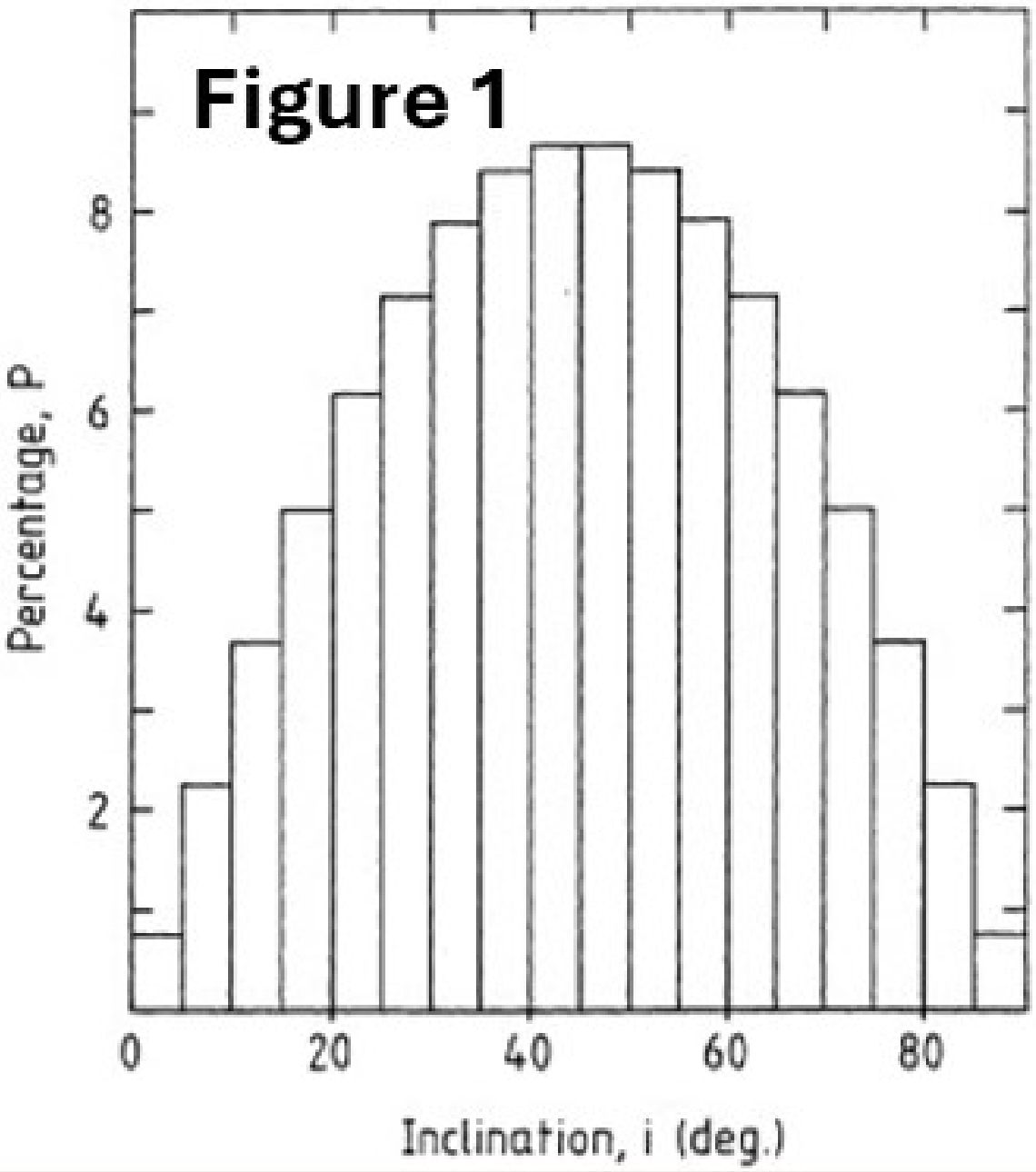




**Topmost:** Map of a part of the Moon.

**Left and top:** Schiller crater on the Moon.




NASA Astrophysics Data System

## What's up in June 2024 - by Johan Smit

**Star party time:**

First one on the agenda is the Free State star party.
Near Brandfort from 6 to 9 June 2024.
Contact the Bloemfontein Centre of the ASSA for information.

**Lunar Phases:**

New Moon 6 June.
First Quarter 14 June.
Full Moon 22 June.
Moon at Apogee, so technically a micro Moon.
Last quarter 29 June.
Best times to enjoy dark skies is the first 12 days of June, and again from 29 June until about 10 days into July.

June 2024 is a poor month for planets early evening, getting better after midnight.
Saturn rises just after midnight at the beginning of June.
Mars rises about 03:00 and Jupiter makes its way upwards just before sunrise.
By end June Jupiter will be the bright "morning star", taking Venus's job, because Venus will be too close to the Sun to see for all of June.
However, there is one special treat to look forward to:
Early in the morning of June 1 (between 02:50 and 04:00) an occultation of Neptune and the Moon will be visible from our location. It is a Saturday morning so there should be no reason not to try and see this.
Considering that it is the only one of 15 such events that will be visible this year you should really try and see this. It will also be good practice to stay up late for the upcoming star parties.

**Star party planning.**

It is advised that you attend the meeting where I will present a planning method in preparation for star parties.
The method of choosing targets is based on the RA and DEC of possible targets and how to use that to select a viewing list.
There are just too many possibilities to list in this summary (upwards of 200 possible targets).
Dust off those optics and dress warm and enjoy the winter southern sky! **Ω**

# NOTICE BOARD

**UAPs: some organizations are taking steps to make the field legitimate.** There are utterly baffling, unexplained cases of UAP sightings. Let's see what happens. Ufology: How Scientists Are Turning UFO Sightings Into Real Research (popularmechanics.com)

**Times of moonrise & moonset, sunrise & sunset, and much more.**
Go to: https://www.timeanddate.com/. Let your mouse pointer hover over the menu heading "Sun, Moon & Space" and left click on "Moon Calculator" for the Moon, or left click on "Sun Calculator" for the Sun, etc., etc.

**Old newsletters.** All old newsletters from January 2004 onward are on our website. They contain a record of our Centre's activities as well as astronomical information.

## Summary of Main Topic to be presented on May 22nd 2024 – by Michael Poll

The title of the talk is: **"Impacts since 1900 part 2"**. This is the second part of this talk – part 1 was presented on April 24th 2024. This time the following will be described: Sylacuaga, Alabama, USA in 1954; the Grand Teton Meteor in 1972 (USA); Peekskill, New York, USA in 1992; and the Other Big One (after Tunguska) - Chelyabinsk (Russia) in 2013.

Also included will be a re-iteration about the problem of round craters as discussed in the Observing Evening report which is to be found elsewhere in this edition of the newsletter. **Ω**

## Feature of the month: Our place in the Milky Way

Which Milky Way spiral arm is ours? (earthsky.org)

## Astronomy related images, video clips and documentaries on the Internet

- Images of Uranus by the JWST.
New images of Uranus are changing what we thought we knew about the planet (msn.com)

- See how an eclipse of the Sun by Phobos looked like from Mars.
Video reveals what solar eclipse looks like from Mars | Watch (msn.com)

- Video clip of the eclipse of the Sun on 8 April 2024.
APOD: 2024 May 6 – A Total Solar Eclipse from Sliver to Ring (nasa.gov)

## Report of the monthly meeting on April 24th 2024 – by Michael Poll

**Report on "What's Up" :**
Some events that are still outstanding!
**Evening Sky**
May 22nd : Moon occults globular cluster NGC 5897 in Libra. Start 19h00, end 21h00.
**Morning Sky**
May 24th : Occultation of Sigma (σ) Scorpii. Disappearance: 01h45 Reappearance 03h06.
Sigma (σ) Scorpii is a double star. Components of magnitude 2.9 and 7.8. Separation : 20".
June 4th : Venus in superior conjunction with the Sun.
**The main topic was entitled "Impacts since 1900"** and was presented by Michael Poll.

The introduction concerned the locating, tracking and cataloguing of **N**ear **E**arth **A**steroids, (NEAs) of which more than 34 000 have been identified. A scale called the Torino Scale rates the chance of an identified NEA impacting the Earth and the likely effects.

Two documented impacts of interest were described: the Tunguska event in Siberia, Russia in 1908 which is the biggest since 1900, and the Sikhote-Alin event in 1947 in the far east of Russia (near Vladivostok). Its shows how things moved slowly in the last century - although the Tunguska event occurred in 1908, it was not until 1927, that the first scientist, Leonid Kulik, was able to reach the site. Because the event was an airburst of a stony asteroid, no fragments were found and there was no crater. In contrast the Sikhote-Alin event was the disintegration of an iron meteorite weighing about 100 tons, of which about 28 tons of fragments were recovered, the largest of which weighed 1 745 kg. **Ω**

## The Pretoria Centre library – by Neville Young

Our centre used to have a library compromising hundreds of books and journals and Sky & Telescope magazines. In those days we had a place to house them in four steel cabinets in a room at the back of the CBC auditorium where we held our meetings from the late 1980s until Covid in 2020. When we were eventually allowed access to the premises again and discovered that the school was upgrading the auditorium and was going to use that room, we had to clear out the books. Hospice was the major beneficiary of some good books for them to sell as well as many books and journals to be recycled.

Michelle Ferreira and Neville Young spent a full day in August 2022 sorting through the library and making difficult decisions about which books should be kept. About thirty books found space on a shelf at Neville's house. The book list was posted on the club website but no book has been borrowed – a sign of the digital age where any information can be googled in an instant.

Neville needed his shelf space and so the committee decided that the remaining books could be distributed amongst club members and kept for as long as they wanted to keep them, on the proviso that if anyone wanted to borrow one of the books, that the book's adopted parent would be obliged to lend the book out. An updated list of the books and their adoptive homes will be available on the club website at this link - www.pretoria-astronomy.co.za/pdf/library_books_2022.pdf.

Nine books have already been adopted. Neville continues to take care of the remaining 23 while they wait for a new home. Contact him if you wish to put any of these books on your bookshelf. Many of the books are really good looking. Most are interesting in one way or another. But like all books, the pages can be felt and turned. The book can be browsed and cuddled under the glow of a gentle bedside lamp.

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| TITLE | AUTHOR | PUBLISHER | PARENT |
|---|---|---|---|
| | | | Neville Young |
| 1001 Wonders of the Universe | Bizony, P. | Quercus Publishing Plc | Neville Young |
| Amateur Telescope Making Book three | Ingalls, A.G. | Scientific American Books, Inc. | Johan Jordaan |
| Amateur Telescope Making Book two | Ingalls, A.G. | Scientific American Books, Inc. | Johan Jordaan |
| Amateur Telescope Making: Book 0ne | Ingalls, A.G. | Scientific American Books, Inc. | Johan Jordaan |
| Armchair Astronomy | Patrick Moore | | Neville Young |
| Astronomical objects for southern telescopes: a handbook for amateur observers | Hartung, E.J. | Cambridge University Press | Neville Young |
| Astronomy Delights | Magda Streicher | | Johan Jordaan |
| Astronomy in colour | Lancaster Brown, P. | Blandford Press Ltd | Neville Young |
| Astronomy within reach | Young, N | Lapa Puiblishers | Neville Young |
| Astronomy: the cosmic journey | Hartmann, W.K. | Wadsworth Publishing Company | Neville Young |
| Atlas of the skies: Journeying between the stars and planets in the discovery of the Universe | Mazzucconi, F. | TAJ Books | Neville Young |
| Collins guide to stars and planets | Ridpath, I., Tirion, W. | Collins | Neville Young |
| Deep Sky Companions: The Caldwell Objects | O'Meara, S.J. | | Johan Jordaan |
| Einstein's Legacy | Schwinger, J | Scientific American Books, Inc. | Neville Young |
| Everything Einstein Book | Priver, Phillips | | Neville Young |
| Exploring the Moon through binoculars and small telescopes | Cherrington, E.H. (Jr) | Dover Publications, Inc, New York | Neville Young |
| Galaxies | Ferris, T | Harrison House | Johan Jordaan |

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| | | | |
|---|---|---|---|
| Galaxies in the Universe | Hartmann | | Neville Young |
| Glorious eclipses: their pasr, present and future | Brunier, S., Luminet, J.P., | Cambridge University Press | Neville Young |
| Green Mars | Robinson, K.S. | HarperCollinsPublishers | Neville Young |
| Guide to the Night Sky | David Levy | | Neville Young |
| Living amongst the stars at the Johannesburg Observatory | Vermeulen, D.J. | Chris van Rensburg Publications | Neville Young |
| Moons and planets | Hartmann, W.K. | Wadsworth Publishing Company | Neville Young |
| Ontsluier die heelal: inleiding tot sterrekunde | Van Zyl, J.E. | Protea Boekhuis | Neville Young |
| Prism and lens making | Twyman, F. | Hilger & Watts Ltd, Hilger Division | Johan Smit |
| Royal Observatory, Cape of Good Hope, 1820 - 1831: the founding of a Colonial observatory | Warner, B. | Kluwer Academic Publishers | Neville Young |
| Spherical Astronomy | Robin Green | | Johan Smit |
| Star clusters | Norton, A.P., Scovil, C.E. | Willmann Bell Inc | Neville Young |
| The astronomy of Southern Africa | Collins, P., Moore, P. | Howard Timmins | Neville Young |
| The atlas of the Solar System | Cattermole, P., Hunt, G., Moore, P., Nicolson, I. | Michell Beazley Publishers | Neville Young |
| The Cambridge encyclopedia of space: Missions, applications and exploration | Ghirardi, R.,Verger, F., Sourbes-Verger, I. | Cambridge University Press | Neville Young |
| The real Mars | Hanlon, M. | Constable & Robinson Ltd | Neville Young |
| University astronomy | Kutner, M.L. | W.B. Saunders Company | Johan Jordaan |

## Have fun doing calculations for black holes on your pocket calculator - by Pierre Lourens

Do not be intimidated by the formulas in this article. They are all really simple. You need not work through the maths. You can immediately start using the two framed formulas and do calculations on your pocket calculator, after having ascertained what the symbols stand for. In the table on the next page are some values I calculated with these two formulas on my own pocket calculator.

The surface of a black hole is named the event horizon. From the inside of a black hole, nothing can escape through this surface, not even light. The radius of the event horizon is called the Schwarzschild radius $r_S$, given by the simple formula

$$r_S = 2GM / c^2$$

where **G** is the gravitational constant, **M** is the black hole mass, and **c** is the speed of light in vacuum. It can be rewritten as

$$r_S = [\, 2GM_\odot / c^2 \,] (M / M_\odot) \qquad (1)$$

where $M_\odot$ is the mass of the Sun. In this form, $M / M_\odot$ is the mass of the black hole expressed in solar masses. E.g. $M / M_\odot = 2$ means $M = 2M_\odot$. Substituting the values of the constants in the red bracket, the following very simple formula is obtained:

$$r_S = [\, 1.9742 \times 10^{-8} \,] (M / M_\odot) \qquad \text{(Units: AU)}$$

When you substitute a value for $M / M_\odot$ in this formula and calculate $r_S$ on your pocket calculator, its value is the Schwarzschild radius of the black hole in astronomical units*, abbreviated **AU**.

A curious property of black holes is that the average density of a black hole decreases as the mass increases. The average density **ρ** (pronounced "rho") is given by the simple formula

$$\rho = M / [\, (4\pi/3) r_S^3 \,]$$

which is simply the mass of the black hole divided by the volume contained within the event horizon. Substituting $r_S$ from **(1)** and doing a little bit of algebra, the following formula is obtained:

$$\rho = [\, 3c^6 / (\, 32\pi G^3 M_\odot^2 \,) \,] \; / (M / M_\odot)^2$$

Substituting the values of the constants in the red bracket, the following very simple formula is obtained:

$$\rho = [\, 1.8427 \times 10^{16} \,] / (M / M_\odot)^2 \qquad \text{(Units: grams/cc)}$$

When you substitute a value for $M / M_\odot$ in this formula and calculate **ρ** on your pocket calculator, its value is the average density of the black hole in grams/cubic centimetre.

* 1 AU = the average distance of the Earth from the Sun.

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| **M / $M_\odot$ (no units)** | **$r_S$ (AU)** | **ρ (grams/cc)** |
|---|---|---|
| 1 (Mass of Sun) | $1.9742 \times 10^{-8}$ | $1.8427 \times 10^{16}$ |
| $4.297 \times 10^{6}$ (Mass of Sagittarius A*) | $8.483 \times 10^{-2}$ | $9.9798 \times 10^{2}$ |
| $1.3575 \times 10^{8}$ (Mass of a black hole with **ρ** = 1) | 2.6800 | 1 (density of $H_2O$) |
| $6.5 \times 10^{9}$ (Mass of black hole in centre of M87) | $1.2832 \times 10^{2}$ | $4.3614 \times 10^{-4}$ |

Let's consider some of these values. The value $1.9742 \times 10^{-8}$ AU for a black hole with mass = 1 solar mass, can be converted to meters:

1 AU = $1.4960 \times 10^{11}$ m

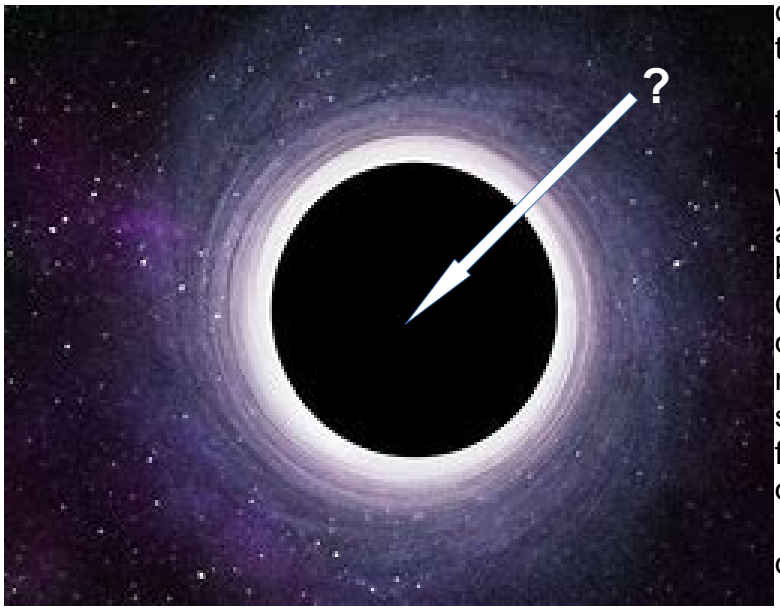
Then $1.9742 \times 10^{-8}$ AU = 2953 meters.

This means that a black hole with mass = 1 solar mass, has a Schwarzschild radius of only 2953 meters, or 2.953 kilometers! (The equatorial radius of the Sun is 696 000 kilometers.) It also has the incredible average density of $1.8427 \times 10^{16}$ times that of water!

Similarly, the value $8.483 \times 10^{-2}$ AU for the Schwarzschild radius of Sagittarius A* (which is the black hole at the centre of our galaxy) can be expressed as 0.0843 AU. This means that the Schwarzschild radius of Sagittarius A*, with mass = 4.297 million solar masses, is just 0.0843 times the average distance from the Sun to the Earth.

Also, the value $1.2832 \times 10^{2}$ AU = 128.32 AU. This means that the black hole in the centre of M87, with mass = 6.5 billion solar masses, has a Schwarzschild radius more than 3 times the average distance of Pluto from the Sun, which is 40 AU. And its average density is just 0.000436 times that of water.

The symbol **ρ** in the formulas above represent the **average density** of a black hole. You may wonder how the mass of a black hole is distributed inside the event horizon. Astoundingly, it's all concentrated near the centre. For a non-rotating black hole, its all concentrated in something like a tiny sphere (??). For a rotating black hole, its all concentrated in something like a tiny, thin ring in the plane of rotation (??). This sounds vague, but the general theory of relativity – the modern theory of gravity – is not complete and cannot explain what the hell is going on at the centre.

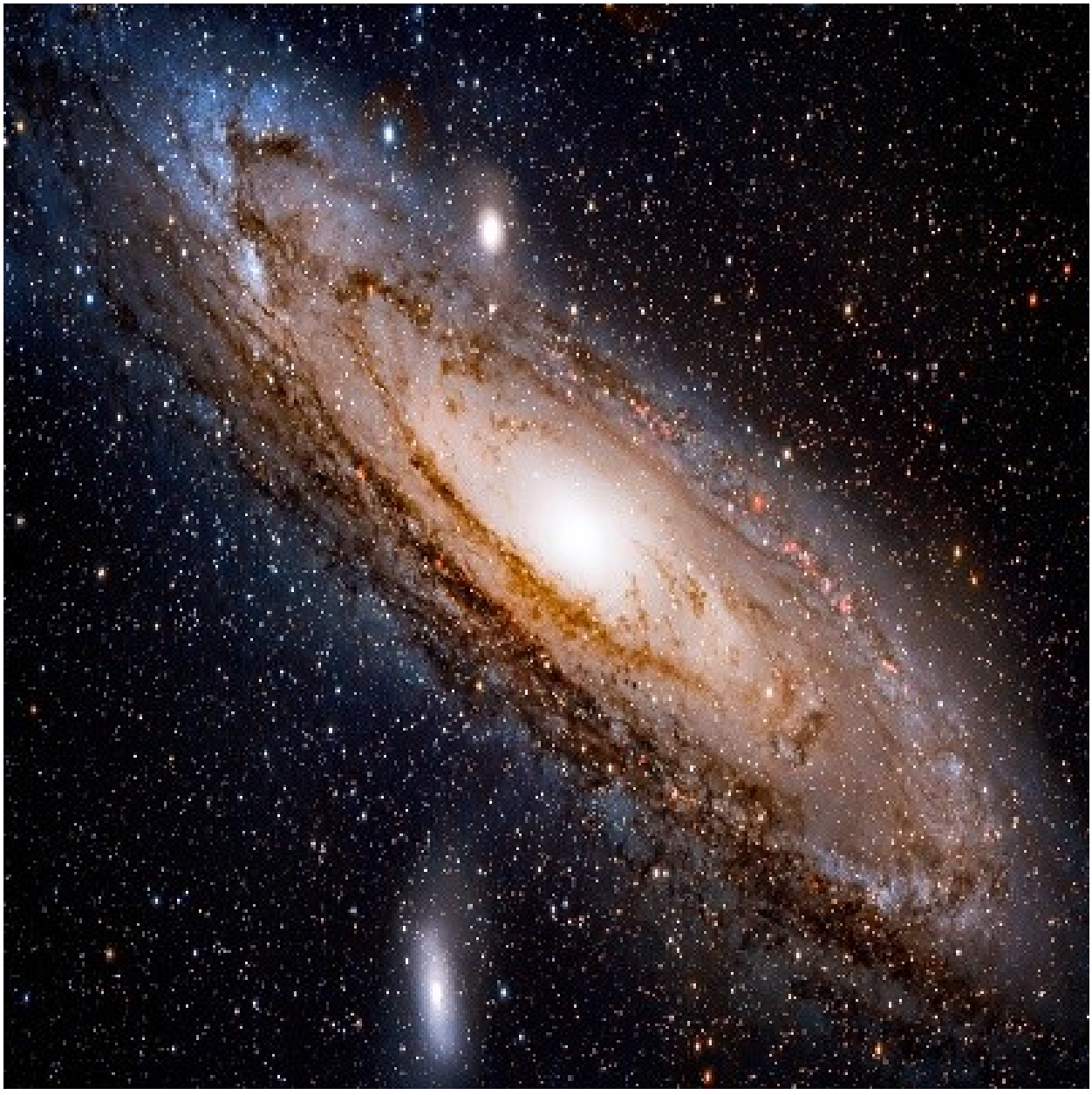



Theoretical physicists expect that a new theory that combines the general theory of relativity with quantum mechanics, will be able to explain it. This theory-to-be is called "quantum gravity". Quantum gravity is an actively developing field at the forefront of modern physics. We may live to see its completion, and then finally understand what is going on at the centre of a black hole.

The image shows an artist's depiction of a black hole. **Ω**

## Astronomy basics: The Great Galaxy in constellation Andromeda

Andromeda galaxy: All you need to know (earthsky.org)



## Web links for the astronomy enthusiast

- **The website for all information about the ASSA and the ASSA Centres:**
  https://assa.saao.ac.za/
- **ASSA Specialist Sections:**
  ASSA has various areas of interest. Join and participate!
  https://assa.saao.ac.za/sections/
- **ASSA Publications to download and enjoy:**
  MNASSA: https://www.mnassa.org.za/
  Nightfall: http://assa.saao.ac.za/sections/deep-sky/nightfall/
  To receive as part of ASSA membership benefits - *Sky Guide Southern Africa,* the astronomical handbook for Southern Africa:
  http://assa.saao.ac.za/about/publications/sky-guide/
- **Mail Groups to join:**
  For general ASSA related information: https://groups.io/g/ASSA-announce
  For posting general items and discussion: https://groups.io/g/ASSA-discussion
- **Social Media to join and share:**
  Facebook: https://www.facebook.com/Astrosocsa/?_rdc=1&_rdr
  Youtube: https://www.youtube.com/channel/UCJ4b1fhmPvYTOsy15YP-_JA
  Twitter: https://twitter.com/AstroSocSA
- **Planetaria:**
  WITS Planetarium (Johannesburg): Welcome to Wits Planetarium
  Naval Hill Planetarium (Bloemfontein): Planetarium Home (ufs.ac.za)
  Iziko Planetarium (Cape Town): Planetarium and Digital Dome - Iziko Museums
  Sutherland Planetarium (Sutherland): Sutherland Planetarium
- **More web links can be found on page 118 of "2023 SKY GUIDE Southern Africa". Ω**

## Pretoria Centre committee

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