The PRETORIA CENTRE

of the

Astronomical Society of Southern Africa

www.pretoria-astronomy.co.za

NEWSLETTER APRIL 2020

Dear member

In the light of the current situation and based upon advice from a virologist at one of the leading pathology laboratories, we regret to have to cancel the March and April viewing evenings and meetings of the Pretoria Centre of ASSA.

The situation will be reviewed in time for the May activities and members will be informed of any changes.

This decision was not taken lightly, but we believe the health of our members is important and we would not like to be the reason one of our members should fall victim to the virus.

We apologize for the inconvenience and trust the skies will be clear wherever you wish to spend time under the stars.

Bosman Olivier
Chairman

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Astronomy-related articles on the Internet

Is bright Comet ATLAS disintegrating? https://earthsky.org/space/how-to-see-bright-comet-c-2019-y4-atlas?utm_source=EarthSky+News&utm_campaign=11f7198ca6-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c64394 5d79-11f7198ca6-394671529

Meet the giant exoplanet where it rains iron. The temperatures on the day side of giant exoplanet WASP-76b are scorching, high enough for metals to be vapourized. But the night side is cooler, and winds carry an iron "rain" from the day side to the night side. https://earthsky.org/space/wasp-76b-exoplanet-iron-rain-espresso?utm_source=EarthSky+News&utm_campaign=1401e8fa1f-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c64394 5d79-1401e8fa1f-394671529

Astronomers announce 100 new minor planets beyond Neptune. https://earthsky.org/space/100-new-minor-planets-beyond-neptune?utm_source=EarthSky+News&utm_campaign=2e5e648a6b-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c64394 5d79-2e5e648a6b-394671529

Top 5 Mercury mysteries that BepiColombo will solve. This is a joint mission of Europe and Japan. The spacecraft is now on its way to Mercury. https://earthsky.org/space/top-5-mercury-mysteries-that-bepicolombo-will-solve?utm_source=EarthSky+News&utm_campaign=8366eaa6c2-EMAIL_CAMPAIGN_2018_02_02_COPY_02&utm_medium=email&utm_term=0_c64394 5d79-8366eaa6c2-394671529

Could K2-18b be habitable after all? A new study suggests that the giant exoplanet K2-18b may be more potentially habitable than previously thought. https://earthsky.org/space/k2-18b-mini-neptune-exoplanets-habitability?utm_source=EarthSky+News&utm_campaign=5b126a88d2-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c64394 5d79-5b126a88d2-394671529

What is dark energy? Dark energy is one of the great unsolved mysteries of cosmology. It's now thought to make up 68% of everything in the Universe. https://earthsky.org/space/definition-what-is-dark-energy?utm_source=EarthSky+News&utm_campaign=68e823cca7-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c64394 5d79-68e823cca7-394671529

What is dark matter? Dark matter doesn't emit light. It can't be directly observed with any of the existing tools of astronomers. Yet astrophysicists believe that it and dark energy make up most of the mass of the cosmos. What dark matter is, and what it isn't. https://earthsky.org/astronomy-essentials/definition-what-is-dark-matter?utm_source=EarthSky+News&utm_campaign=68e823cca7-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c64394 5d79-68e823cca7-394671529

Astronomy basics: Galaxies

The Milky Way is our neighborhood in the Universe. It's a galaxy and there are many others out there. Galaxies contain gas, dust, and billions of stars or more. They come in four main shapes: elliptical, spiral, peculiar, and irregular. Galaxies can collide, and grow in size by eating each other.

https://www.youtube.com/watch?v=I82ADyJC7wE

Feature of the month: Biggest explosion seen since the Big Bang

Scientists studying a distant galaxy cluster have discovered the biggest explosion seen in the Universe since the Big Bang. Researchers estimate that the blast released five times more energy than the previous record holder. The gargantuan explosion occurred in the Ophiuchus galaxy cluster about 390 million light-years from Earth. **Ω**

https://earthsky.org/space/astronomers-detect-biggest-explosion-history-universe?utm_source=EarthSky+News&utm_campaign=981bb11858-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c643945d79-981bb11858-394671529

Astronomy-related images and video clips on the Internet

The JWST. See a 38-minute documentary on the JWST (**J**ames **W**ebb **S**pace **T**elescope). https://documentaryheaven.com/into-the-unknown/

Venus phases: Late 2019 and early 2020. This video tracks a telescopic view of Venus from when it came into easy view in our evening sky – around October 2019 – to May 2020. It shows how Venus wanes in phase as the planet's disk size increases, and explains why. https://earthsky.org/astronomy-essentials/tracking-venus-in-late-2019-and-early-20?utm_source=EarthSky+News&utm_campaign=5b126a88d2-EMAIL_CAMPAIGN_2018_02_02_COPY_01&utm_medium=email&utm_term=0_c643945d79-5b126a88d2-394671529

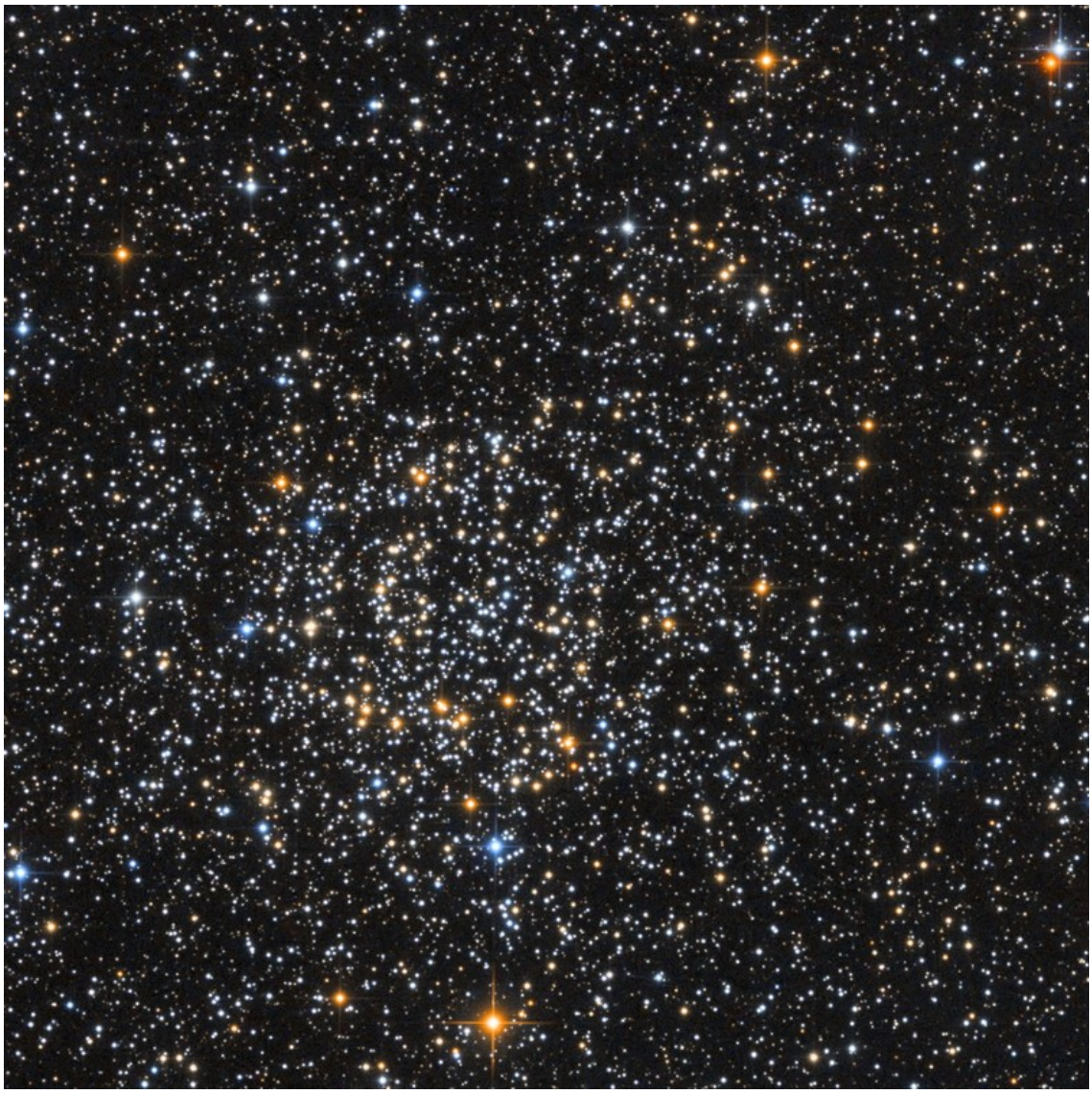
Observing: A different star cluster - by Magda Streicher

It's perhaps not so easy to spot the constellation Cassiopeia from our point of observation down south, but it has a hidden secret in its midst. Cassiopeia houses many open clusters, and some of them are truly spectacular in size, brightness and overall character.

The object to discuss is NGC 7789, in the depths of the northern hemisphere at +56 degrees, and so discussing it may bring the beauty closer to the beholder's eye. The cluster, which is relatively large, is situated between Sigma and Rho Cassiopeiae in the western part of the constellation. The grouping shows up as a field of faint stars slowly getting brighter and more condensed toward the middle area with brighter stars scattered on faint star dust. The swarm of various magnitude stars in a wide field of view shows an area of at least 20' filled with stars arranged in an unordered manner. However, and here comes the secret that NGC 7789 holds in its pocket: towards this middle area stars display colours of yellow to deep orange. It is a get-together of old members, distant from the cluster itself. Well, it is an old cluster with evolved members and it is more or less 10 000 light years from Earth.

Make a point when you are observing clusters in the future, to search out the hidden secrets this grouping so loves to hold in its midst.

OBJECT	TYPE	RA	DEC	MAG	SIZE
NGC 7789	Open cluster	23 h 57.2 m	+56° 44.1'	6.7	9'



NOTICE BOARD

- **Reminder of a 7-day astronomical get-together in the Cape – an event to diarise.** The SAAO plans to implement Africa's largest ever Astronomy Festival from 19-25 October 2020. This will be to commemorate the founding of the South African Astronomical Observatory (now a National Heritage Site) in October 1820. See the Pretoria Centre newsletter for June 2019, page 4.
- **Help explore the surface and weather of Mars' south polar region on your computer screen.** This is another Zooniverse citizen science project. https://www.zooniverse.org/projects/mschwamb/planet-four
- **Percy Jacobs' new solar telescope and first observations with it.** http://pretoria-astronomy.co.za/pdf/percy_solar_prominence.pdf
- **Record your astronomical observations on our website.** Between Percy Jacobs and Danie Barnardo, changes were made to the "Observing Section" page of the website, to provide a space where observations by members can be recorded. See http://www.pretoria-astronomy.co.za/observationguidelines.htm
- **Beanies:** Beanies will be offered for sale @ R40.00 each at every monthly meeting, until they are sold out.
- **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.
- **Data base:** Members are reminded that a data base of the books in our library is to be found on our website.

Pretoria Centre committee

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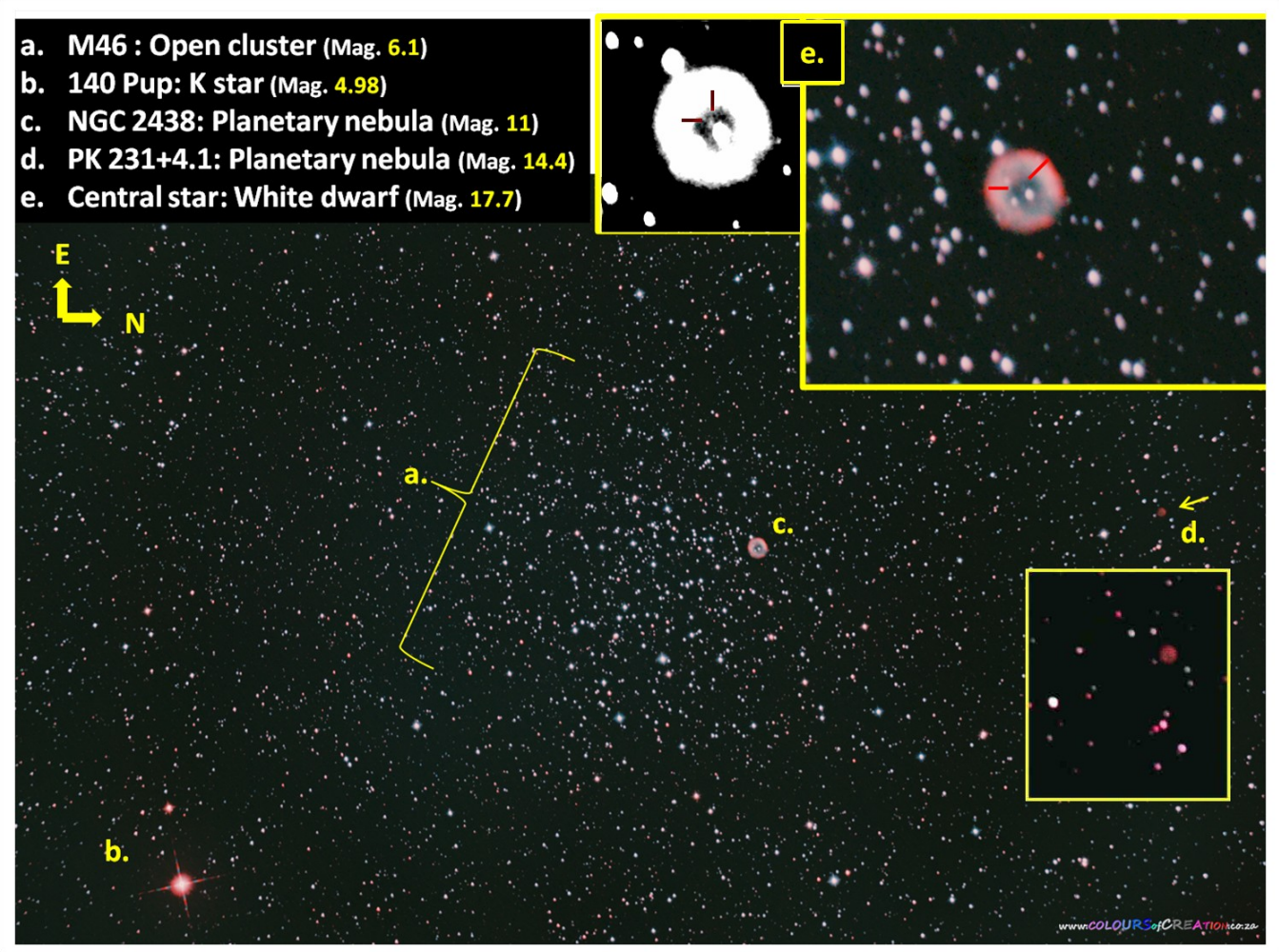
Open Star Clusters with Superimposed Planetary Nebulae: M46/NGC 2438 and NGC 2818/2818A – by Johan Moolman

Often find myself drawn to these parts of the Puppis and Pyxis constellations – containing open clusters M46 and its more flamboyant and brighter (Mag 4.2) neighbour, M47, which lies about a degree west of M46 – as well the interesting pair NGC 2818/ 2818A. Never tire of imaging these deep-sky objects through the years – and here are the 2020 attempts.

The accompanying text is a "copy and paste" effort, taken from several public Internet sites – see references supplied.



[Technical stuff: All photos (M46, NGC 2818 – clusters and planetary nebulae) were taken from my balcony, Pretoria, during March and April 2020. OTA: 10 inch Optimized Dall-Kirkham telescope; Canon 6D DSLR (modified); IDAS V4 nebular filter; Gemini 2/ Losmandy mount; Auto-guiding: Canon 400mm f5.4 lens + Orion Starshoot cam – in PHD. Mount control: Cartes du Ciel; Camera control: BackYard EOS. Stacking and processing in DSS and PixInsight, pp in Paint.Net and PICASA].

Messier 46 or **M46,** also known as **NGC 2437** (**ASSA 24**), is an ***open cluster*** of stars in the constellation of **Puppis** the Stern. An ***open cluster*** is a group up to a few thousand stars that were formed from the same giant molecular cloud and have roughly the same age. They are loosely bound by mutual gravitational attraction and become disrupted by close encounters with other clusters and clouds of gas as they orbit the

galactic centre. They are generally young objects, up to a few tens of millions of years old, with a few rare exceptions as old as a few billion years, such as Messier 67 in Cancer (the closest and most observed old open cluster) for example.

Open clusters like M46, including associations, moving groups and embedded clusters, belong to the disk population of the Galaxy - the so called Population I stars. Stars are divided by their chemical composition or metallicity. By definition, each population group shows the trend where decreasing metal content indicates increasing age of stars. Hence, the first stars in the universe (very low metal content) were deemed Population III, old stars (low metallicity) as Population II, and recent stars (high metallicity) as Population I.

The vast majority of open clusters are located close to the Galactic plane. Consequently, most known open clusters are within a couple of kpc of the Sun. One parsec is approximately equal to 31 trillion kilometres (3.1×10^{13} km) or 19 trillion miles (1.9×10^{13} mi), and equates to about 3.26 light-years. 1kpc = 1000 parsecs.

Some 1200 open clusters have been catalogued, but as many as 250 of these appear to be simply slight enhancements in the stellar density along a line of sight or small asterisms of unrelated stars. Most of the open clusters in the Galaxy have probably not yet been found, since, as mentioned earlier, open clusters are found near the Galactic plane where the interstellar dust is the most opaque. There may be as many as 10^5 open clusters in our Galaxy (Star Clusters: Encyclopedia of Astronomy and Astrophysics).

M46 was discovered by Charles Messier in 1771. Charles Messier (1730—1817) was a French astronomer who was the first to compile a systematic catalogue of nebulae and star clusters. At the time of its discovery, Messier had not published his findings quite as immediately as we do today, so another astronomer also independently discovered this cluster. Caroline Herschel wrote the following: “March 4th, [17]83. 1 deg S following the nebula near the 2nd Navis… a Nebula the figure is done by memory. My Brother (William Herschel) observed it with 227 and found it to be an astonishing number of stars. It is not in Mess catalogue.” (“227” : William Herschel used his own 7-foot telescope, a Newtonian reflector, with a 6.2 inch aperture, magnifying images 227 times (depending on the eyepiece used), to make his ‘second review of the heavens' in 1781 from his house in New Kings Street, Bath).

Dreyer described it as "very bright, very rich, very large." **John Louis Emil Dreyer** (852 – 1926) compiled the ***New General Catalogue*** *of Nebulae and Clusters of Stars*, basing it on William Herschel's Catalogue of Nebulae, as well as two supplementary ***Index Catalogues.*** The ***NGC*** and ***IC*** catalogue designations are still widely used.

M46 is approximately 4,920 light-years away. Very few clusters have their distances known to 10%... (Star Clusters: Encyclopedia of Astronomy and Astrophysics). Visual Brightness: 6.0 (mag). The cluster is very rich, with 150 stars of mag 10-13 and probably a total population of over 500, with a combined mass of 453 $\underline{M_\odot}$ (Solar masses). The brightest of these stars are of spectral type A0, and each about 100 times more luminous than the Sun (the brightest is of apparent magnitude 8.7). It occupies an area of 27 arc minutes of apparent sky, almost the size of the full Moon, corresponding to a linear extension of 30 light years at the cluster's distance of 5,400 light years. M46 isn’t standing still - it is pulling away from us at a speed of 41.4 kilometres per second. Age is given at about 300 million years. Some sources are more specific and document its age as 251.2 million years.

Open clusters are often classified according to a scheme developed by Robert Trumpler in 1930. Robert Julius Trumpler, until 1915 Robert Trümpler, was a Swiss-American astronomer (1886 – 1956). He is *most noted* for observing that the brightness of the more distant open clusters was lower than expected, and the stars appeared more

red. This was explained by the interstellar dust scattered through the galaxy, resulting in the absorption (extinction) of light or interstellar extinction of light. The Trumpler scheme gives a cluster a three part designation, with:
(1) a Roman numeral from I-IV indicating its concentration and detachment from the surrounding star field (from strongly to weakly concentrated),
(2) an Arabic numeral from 1 to 3 indicating the range in brightness of members (from small to large range), and
(3) *p*, *m* or *r* to indication whether the cluster is poor, medium or rich in stars.
[(4) 'n' is appended if the cluster lies within nebulosity].
M46 is classified as a Trumpler type II,2,r open cluster - which means that it is detached from the surrounding field, but its stars are not very concentrated toward the centre (II), the stars have a moderate range of brightness (2), and the cluster is richly populated (r), with more than 100 confirmed members. Note: Cartes du Ciel class M46 as "Class III 2m".

Few if any open clusters have enough members to be characterized in terms of dynamically meaningful quantities, such as the core radius or tidal radius (*As is applied to Globular clusters*). Instead, open cluster sizes are based on the 'angular diameter' measurement where the diameter is the apparent size of the cluster as measured on the appropriate sky survey photographs. Even when the distance to the cluster is well known, the angular diameter does not yield a well-defined linear dimension to the cluster. Nevertheless, there is a rather small spread in measured cluster diameters, the typical open cluster being between 4 and 5 pc in diameter. A few clusters are more than twice this size, and some are only one or two parsecs in diameter, but the majority fall rather close to this value. The core radius of open clusters is probably roughly 1 pc, that is to say, about the same as the typical core radii of globular clusters. There is no strong correlation of cluster size with age, although several of the oldest clusters are somewhat larger and some of the very youngest clusters are also larger. (The oldest of the open clusters is no older than the youngest of the globular clusters). Nor is there any correlation of cluster size with Galactic location or with the number of members.

That said – some authors (*Astronomy and Astrophysics, 468 (1)*) DO ascribe the following characteristics to M46: A tidal radius of 37.8 ± 4.6 ly (11.6 ± 1.4 pc) and a core radius of 8.5 ± 1.3 ly (2.6 ± 0.4 pc). The tidal radius is the distance from the centre of the cluster at which the external gravitation of the galaxy has more influence over the stars in the cluster than does the cluster itself. This is the distance at which the individual stars belonging to a cluster can be separated away by the galaxy. The core radius is the distance at which the apparent surface luminosity has dropped by half. M46 has a greater spatial extend in the infrared than in visible light, suggesting that the cluster is undergoing some mass segregation with the fainter (redder) stars migrating to a coma region. The fainter stars that extend out to the south and west may form a tidal tail due to a past interaction. Note: although not visible in *the photo*, this would be towards the SW: "Left-lower corner".

NGC 2438: ("**C**" **in photo**) is a **planetary nebula** (Pn) about 3,000 light years from Earth. A **planetary nebula** can be loosely defined as an expanding shell of thin ionized gas that is ejected from and surrounds a hot, dying star of about the same mass as the sun; the gas absorbs ultraviolet radiation from the central star and reemits it as visible light by the process of fluorescence. The **central star** of **NGC 2438** is a **white dwarf**, magnitude 17.7. It is visible in the photo - **"e"** – as a VERY faint dot (put on your reading glasses and use your imagination...!) just SE of a bright back ground cluster star positioned behind and near the "centre" of the Pn.

It was discovered by William Herschel on March 19, 1786 - 15 years after Messier found M46. At the time Messier must have failed to see "the nebula for the stars"... Long

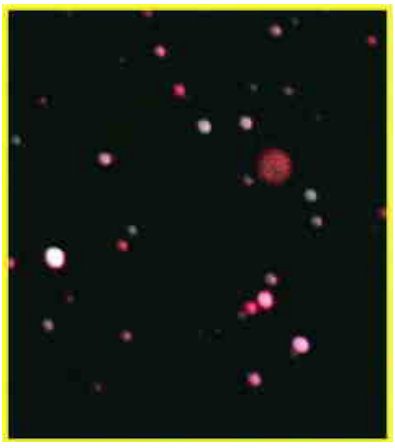
exposure photographs have shown that this planetary nebula has an extended double halo, while the more easily visible portion probably dates back to the death of the red giant in its centre.

NGC 2438 *appears* to lie within the cluster near its northern edge - (a faint smudge - it has been observed by ASSA Pretoria members on a few occasions) - but it is most likely unrelated and is most probably not a true member but is superimposed, or perhaps a passing "guest". This is deduced as:

(1) The radial velocity of NGC 2438/ central star is about 77 km/sec recession, which is different from the cluster's value and would not allow the cluster to hold it, even if it were at the same distance. Woldemar Götz, however, gives derived distances of 4,600 light years for the cluster and only about 2,900 light years for the nebula, which would mean that the planetary is a foreground object. Note: "Motion toward or away from the Sun is called radial velocity. Motion perpendicular to the direction to the Sun is called tangential velocity. The combination of the two motions is the star's space velocity. Radial velocity is measured in terms of the change in the distance from the sun to the star."(https://cseligman.com)

(2) Planetary nebulae are late states in stellar evolution, which occur only for comparatively low mass stars of less than 3 solar masses. These stars, however, need more than a billion years for their evolution until they eject their envelope to form the planetary, which is much longer than the age of M46 (more massive stars "go supernova"). However, this last argument is questionable, because some young clusters like the Pleiades (M45) contain a significant number of white dwarfs, which must have evolved from more massive stars; these stars must have lost most of their mass during their evolution, probably in the form of strong stellar winds in their Red Giant phase, and must have gone through a planetary nebula phase. (http://www.messier.seds.org/.). M46 and NGC 2438 are thus an example of a superimposed pair, possibly similar to NGC2818A in Pyxis, a planetary nebula superimposed on the open cluster NGC 2818. (ASSA 33). See below.

Pk 231 +4.1 ("d" in photo): Auke Slotegraaf drew my attention to this planetary nebula a few years ago - I failed to recognise it in an image I took at the time. It is located 22 arcminutes NNE of NGC 2438. "The "Pk" designation comes from the names of the *then* Czechoslovakian astronomers Luboš Perek and Luboš Kohoutek, who in 1967 created an extensive catalogue of all of the planetary nebulae known in the Milky Way as of 1964. The numbers indicate the position of the object on the sky".

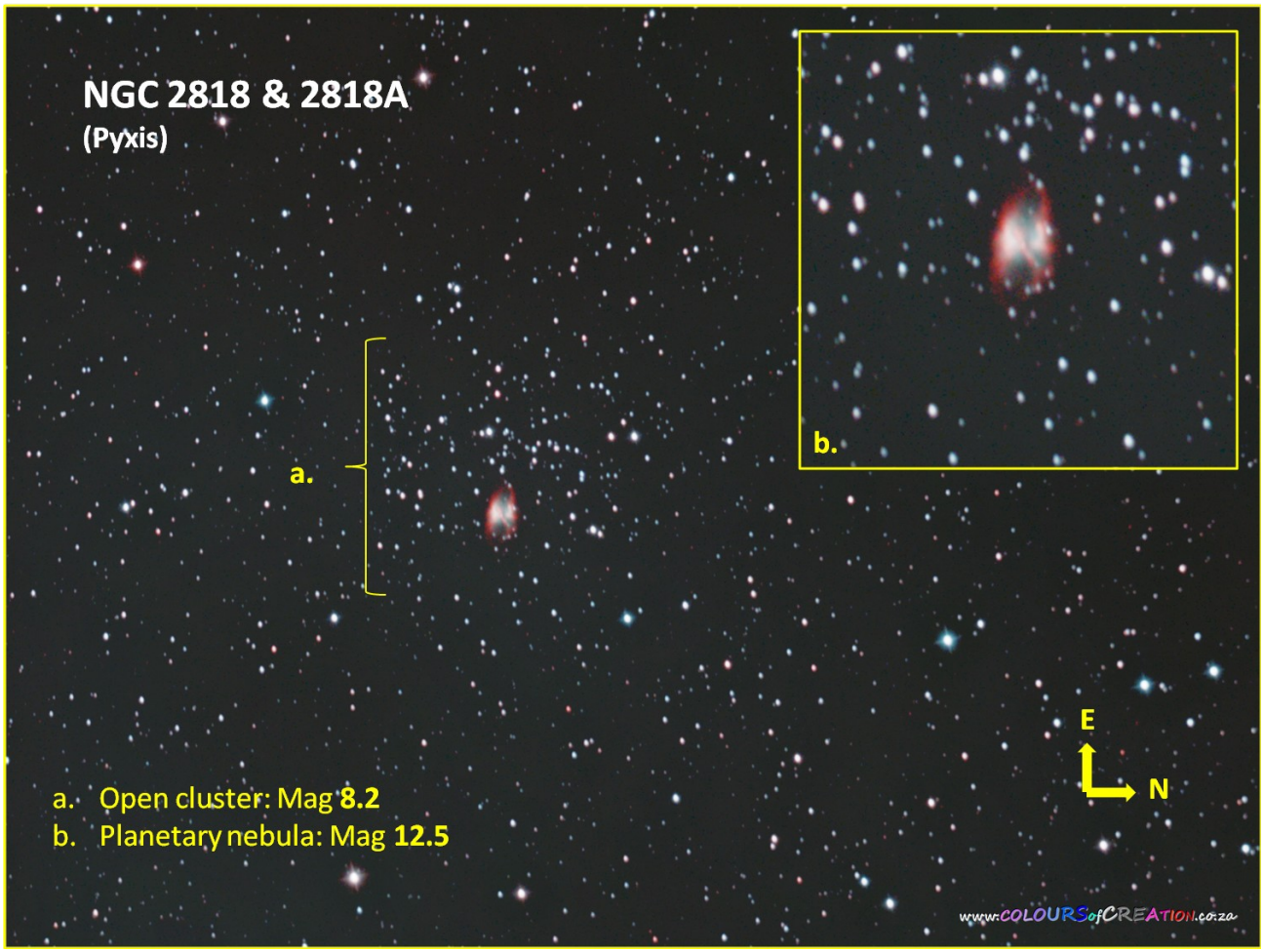


. A visual observer, Steve Gottlieb, shared the following on this faint planetary – aka Minkowski 1-8 (M 1-18) - from his 1987 observation: "- 17.5" (1/31/87): at 130x + OIII filter; fairly small and round, can hold steadily with averted vision, estimate V = 14.5-15.0. Situated 3.5' NNE of a mag 9 star (SAO 153263) within a small arc of four mag 13-14 stars oriented NW-SE and 22' NNE of NGC 2438 (off the NE edge of M46)". Its apparent diameter is given as 30", at a distance of 8400 ly. (http://www.deepskyforum.com) German-American astronomer, Rudolph Minkowski was best known for his spectroscopic work on supernovae, but he was also interested in "gaseous nebulae." In the 1940s he created a catalogue of planetary nebulae that he had identified with the 60- and 100-inch telescopes at Mount Wilson. In three papers written up for the *Publications of the Astronomical Society of the Pacific* entitled "New Emission Nebulae" in 1946, 1947 and 1948, he listed nearly 200 real (or suspected)

planetary nebulae. (https://skyandtelescope.org/sky-and-telescope-magazine/minkowski-planetary-nebulae/)

NGC 2818, 2818A

(Aka. Dunlop 564, Cl Collinder 206, Cl Melotte 96, Cl Raab 82, Cl VDBH 59, ESO 372-13, C 0914-364, h 3154, GC 1801).



There appears to be some confusion in the literature as to the specific naming of this jewel in **Pyxis:** the cluster vs. the planetary nebula. This is supported by an observation by **Magda Streicher** (her visual observation notes on this object can be found on the **Deep Sky Observer's Companion** website): "The initial references indicate the planetary as NGC 2818 and the cluster as NGC 2818A, SIMBAD does agree; but in the NGC-IC catalogue they're are both listed as NGC 2818 without commentary." **Cartes du Ciel** identifies NGC 2818 as an "open cluster" and designates the PN as PK 261+8.1. **APOD** (July 13, 2014) also mentions that "the planetary nebula NGC 2818 seems to lie within an open cluster NGC 2818A."

Auke Slotegraaf's Deep Sky Observer's Companion website relates, amongst others, the following two historical observations: "James Dunlop discovered this object from Paramatta, New South Wales, and included it as No. 564 in his catalogue of 1827. Using a 9-inch f/12 telescope, he described it as "a pretty large faint nebula of a round figure, 6' or 8' diameter; the nebulosity is faintly diffused to a considerable extent. There is a small nebula in the north preceding side, which is probably a condensation of the faint diffused nebulous matter; the large nebula is resolvable into stars with nebula remaining."
John Herschel (1847) Cape Observations: Discovered by Sir John Herschel at the Cape of Good Hope with an 18-inch f/13 speculum telescope. He recorded it as "A very curious

object which reminds me strongly of Messier's 46 [NGC 2437] and IV.39 [NGC 2438].... - " On a second occasion... It is a fellow object to Messier's 46, with its enclosed planetary nebula IV.39."

The cluster is quite faint – mag.8.2 – with stars contained in an area about 7 arcminutes across. It is described as a “lovely stringy cluster” by Magda Streicher – this is apparent in the photo. The Pn, mag 12.5, is 30-40 arc seconds in diameter, and is situated about 2’ west of the geometrical centre of the cluster. Cluster and Pn are believed to be some 10 000 light-years away – at THAT distance the Pn would be about 4 light-years across. Cartes du Ciel (Information from catalogue SAC: Saguaro Astronomy Club Database) gives dimension of 8’ x 8’ for the open cluster; and classifies it as a Type II, 2, m, n. (See explanation and discussion on the Trumpler classification above).

Superimposition. Initially, the following were the prevailing views on this pair: “The well known spatial coincidence of the planetary nebula NGC 2818 with its surrounding cluster is an example of a case that visually supports an association.” Pedreros (1989) determined a distance of d = 2300 pc for the cluster, consistent with the parameters derived for the planetary nebula: d = 2660 ± 830 pc (Zhang 1995). Equally encouraging *at the time* were radial velocities (Tifft et al. 1972) for two A-type stars in the cluster that yielded 3 ± 20 km s−1, compared with VR = 8 ± 13 km s−1 obtained for the planetary nebula. Such evidence, in conjunction with the general agreement in distance and reddening, has been the basis for the conclusion that the two are associated. *However* – later results suggest otherwise. A comprehensive radial velocity study of stars in the cluster field by Mermilliod et al. (2001) yields a cluster radial velocity from 15 red giant members of VR = 20.7 ± 0.3 km s−1, while the radial velocity of the planetary nebula is established to be VR = −0.9±2.9 km s−1 (Durand et al. 1998) and VR = −1±3 km s−1 (Meatheringham et al. 1988), *consistently smaller than the velocity of the cluster*. The greater precision of recent estimates results in a velocity discrepancy of ΔVR = 22 km s−1, implying a spatial coincidence rather than a physical association, as concluded by Mermilliod et al. (2001).
(Article in “Publications of the Astronomical Society of the Pacific” · October 2007 Daniel J. Majaess and David G. Turner.)

M46/ NGC 2438 and NGC 2818/ 2818A are thus proven examples of superimposed pairs of open clusters and planetary nebulae – interesting celestial gems that have been intriguing astronomers for over 200 years. Both these deep-sky objects are currently gracing our night skies – yours to explore and enjoy!

PS. For detailed information and observation notes on these and other celestial targets, be sure to visit the **Deep Sky Observer’s Companion** website: http://www.docdb.net .