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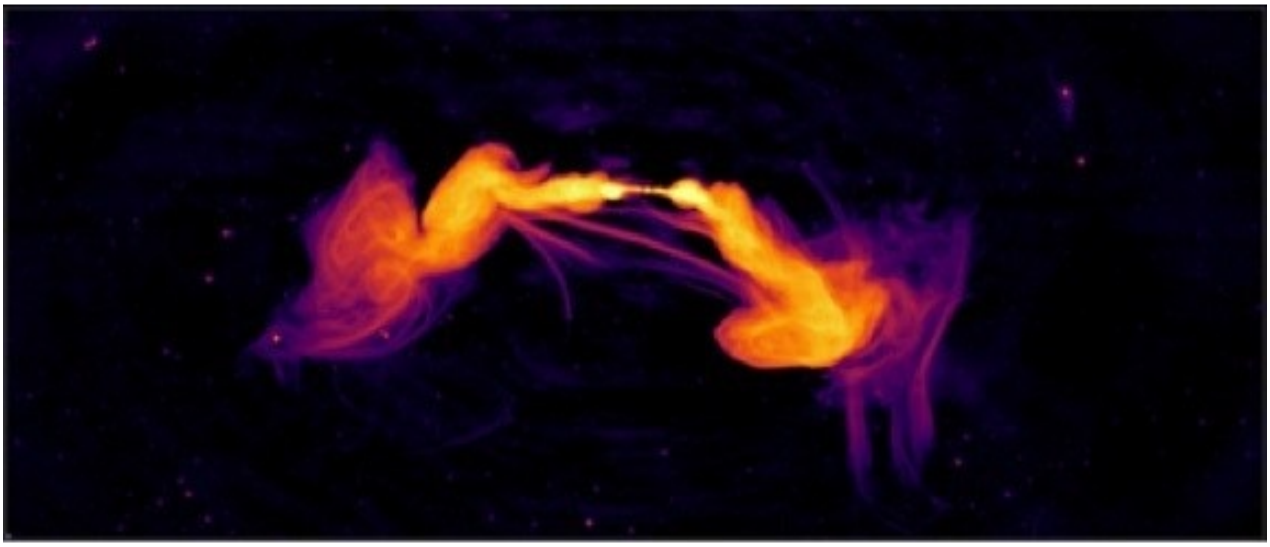

In this issue:

Cover Caption: Image reconstructed using radio emission data from MeerKAT at 1000 MHz, showing unusual collimated synchrotron threads connecting radio emission lobes of ESO 137-006 (M. Ramatsoku et al., 2020, A&A). Image credits: Rhodes University/INAF/SARAO (See p 10)

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News Note: EPFL (Switzerland) Joins SKA Organisation

The Swiss science and technology university École Polytechnique Fédérale de Lausanne (EPFL) has become the 14th member of the SKA Organisation (SKAO) following a unanimous decision by the SKA Board of Directors.

EPFL will be the lead institution coordinating involvement in the SKA on behalf of the Swiss academic community*.

Chair of the SKA Board of Directors Dr Catherine Cesarsky was delighted to welcome EPFL to the SKA Organisation as our newest member. This renowned research institution and its partners have brought valuable expertise to the SKA, and we look forward to working ever more closely with our Swiss colleagues as we enter this exciting phase of the project, completing the very last steps before construction.

At a national level, Switzerland has held observer status within the Organisation since 2016, with many Swiss research institutions and many industry partners contributing to various aspects of the SKA. The country has a history of world-class research and development in science and astronomy, including leading the recent CHEOPS mission to study exoplanets, developing world-leading instrumentation for the ESO telescopes in Chile, and being one of the hosts of the major international particle physics infrastructure CERN.

Scientists at Swiss institutions are active in eight of the SKA's science working groups, including those focusing on galaxy evolution, cosmology and cosmic magnetism.

Prof Jean-Paul Kneib of EPFL, who is leading the consortium of Swiss scientists interested in the SKA, said this new high-performance radio telescope will open a new view of the whole universe. SKA will allow us to address some key questions on our universe, such as the nature of the dark matter and the dark energy, or explore the Cosmic Dawn, the period of time when the first stars and first galaxies formed.

The white paper Swiss Interests and Contribution to the SKA, published in February 2020, outlines the extensive Swiss involvement in SKA-related science and technology, and highlights national interest in contributing research and development in the fields of distributed radio frequency systems, high performance computing, machine learning and artificial intelligence. It also notes Swiss industry expertise in data processing, system control and supervision, antennas and radio receivers and precise time management through the use of maser atomic clocks.

Annual Swiss SKA Days are now in their fifth year, bringing together national and international representatives of academia, industry and government, showcasing the breadth of opportunities for Swiss institutions and companies to be involved in the SKA. The location rotates each year to reflect the various contributions of different Swiss institutions. The next Swiss SKA day is due to be held at the University of Zurich later this year.

EPFL is now a member of the SKAO, which has been responsible for overseeing the telescope design phase, until the process of transitioning into the SKA Observatory is completed. The Observatory is due to come into being in 2020. Switzerland's Federal Council recently triggered the first political debate in parliament regarding the possible participation of Switzerland as a member state in the future.

As the dream of building SKA is about to become a reality, the State Secretariat for Education, Research and Innovation (SERI), welcomes and supports the EPFL decision to join the SKA Organisation as a special member. The accession of the EPFL will benefit to the Swiss scientific community as a whole and will open business perspectives to Swiss companies, according to Xavier Reymond, Deputy Director General for International Research Organisations at SERI, who is in charge of the relationship between Switzerland and SKAO.

Switzerland is the proud Seat of CERN and a dedicated member of the European Southern Observatory and of the European Space Agency. Therefore, we all look forward to assessing the opportunity to complement these intergovernmental endeavours with the upcoming SKA Observatory, which shares the same dedication to better understanding the universe.

SKA Director-General Prof Philip Diamond also welcomed EPFL to the SKAO, noting the importance of the country's involvement so far. Swiss institutions have been a vital part of the SKA's design phase and bring with them a well-deserved reputation for excellence in science and astronomy, as well as being involved with some of today's most exciting projects. As we move ever closer to SKA construction, EPFL's membership serves to highlight the broad range of expertise that the SKA can count upon in this next phase.

The Square Kilometre Array (SKA) project is an international effort to build the world's largest radio telescope. The SKA is not a single telescope, but a collection of telescopes, called an array, to be spread over long distances. It will be constructed in Australia and South Africa with a later expansion in both countries and into other African countries.

The design has been led by the SKA Organisation based near Manchester, UK and supported by more than 1 000 engineers and scientists in 20 countries. The SKA Organisation is transitioning to the SKA Observatory, an intergovernmental organisation established by treaty, to undertake the construction and operation of the telescope.

The SKA will conduct transformational science and help to address fundamental gaps in our understanding of the universe including the formation and evolution of galaxies, fundamental physics in extreme environments and the origins of life in the universe.

*The Swiss Academic Community includes the Universities of Geneva, Zurich, Bern, ETH, CSCS, FHNW, HES-SO, and Verkehrshaus Lucern.

[William Garnier, Director of Communications, Outreach and Education, SKA]

News Note: Germany investing R400 million to expand MeerKAT

New additions to the MeerKAT telescope will push its computing requirements up 10-fold, requiring an overhaul of its computing hardware. The 64-dish telescope will grow by 20 dishes – expanding the maximum distance between dishes from 8km to 17km, which pushes up both its sensitivity and ability to create radio images. But this comes at a computing cost.

The storage capacity required to store all the data that the larger MeerKAT will collect is in the region of 100 PetaBytes, which is about 22 million DVDs. The timing of (the) MeerKAT Extension coincides with a planned refresh of the existing MeerKAT computer hardware in order to capitalise on technology advances, according Rob Adam, managing director of the South African Radio Astronomy Observatory (SARAO).

The extension of MeerKAT is a joint venture between South Africa and Germany, with both countries contributing about R400 million. The Max Planck Institute for Radio Astronomy will provide the actual dishes, through funding from the Max Planck Society.

The South African funding will come out of the SARAO's existing budget. When inaugurated in 2018, MeerKAT had a price tag of R4.4 billion. It is the most sensitive telescope of its kind in the world and has already made scientific discoveries, such as the giant bubbles of radiation at the centre of our galaxy.

MeerKAT will eventually become part of the Square Kilometre Array (SKA) which, when complete, will be the world's largest radio telescope (and the largest scientific apparatus on Earth) with dishes and antennas in South Africa and Australia.

The SKA will be built in stages, with the $1-billion first phase expected to start in late 2021. The first phase will see the number of dishes in South Africa growing to 194, and more than 130 000 smaller antennas in Australia

SARAO's Adam anticipates that the new MeerKAT dishes will be operational by the end of 2022.

The MeerKAT extension will be included in the first phase of the SKA, says SKA spokesperson William Garnier. The dishes are SKA compliant, and the global SKA project had been involved throughout the development of the planning.

The value of the extension will be part of South Africa's contribution to the SKA, says Adam. "It also fits in with existing SARAO plans to develop prototype compute infrastructure of SKA1 as part of our contribution to developing the SKA1 system."

[See also *MNASSA* **78**, 97, 2019, August 2019]

News Note: New List of South African–based astronomers

Dr Fernando Camilo, Chief Scientist at SARAO (SA Radio Astronomy Observatory) has compiled a new list of SA-based astronomers.

It now includes 201 unique names, including 66 post-docs, from 14 institutions, namely AIMS, NWU, Rhodes, SAAO, SARAO, UCT, UCT-IDIA, UFS, UJ, UKZN, UNISA, UP, UWC, Wits. N.B. several astronomers have part appointments at more than one institution. The new list includes for each person the institution(s), name, position held, department/faculty and interests.

The whole list can be seen at https://tinyuri.com/Astronomers-in-SA

An earlier census with less detail was published by IS Glass in *MNASSA* **74**, 256, 2015. In 2017 he also published a list of 49 astronomers with "NRF ratings", comparing their NRF class with their more objective (though not necessarily more realistic) H indexes

(The H-index is the number H of publications of an individual that have been cited H or more times (See *MNASSSA* **76,** 16, 2017). This list included most of the actively publishing astronomers of that time.

Many institutions and universities in SA now include departments either of astronomy or of cognate subjects. They are as follows, with numbers of astronomers: AIMS (African Institute of Mathematical Sciences) 4, NWU Mafikeng 9, NWU Potchefstroom 20, Rhodes 14, SAAO 31, SARAO 25, UCT 28, UCT IDIA (Institute for Data-Intensive Astronomy) 4, UFS 8, UJ 6, UKZN 25, UNISA 7, UP 6, UWC 23, Wits 6. Though "optical" astronomy still dominates, radio observations are steadily becoming more important.

News Note: Brian Warner at 80

On 13 and 14 January 2020 the Department of Astronomy at the University of Cape Town held a Symposium to honour the 80th birthday of Prof Brian Warner and to celebrate 50 years of astronomy at UCT. The reputation of the department of course owes much to his leadership.

History of the Department

There were for many years connections between the Royal Observatory (later the SAAO) and UCT, though there was no formal astronomy department until Richard H Stoy (Director of the Royal Observatory 1950-1968) was appointed Honorary Professor of Astronomy, which position he held 1957-1968. However, other UCT Physics staff were involved in the subject, especially JD Fernie and PAT Wild. AP Fairall was a lecturer from 1970 until 2008 (until he was killed in a diving accident) and PAT Wild was a Senior Lecturer until 1982.

A noteworthy early astronomical PhD was that awarded to AWJ Cousins of the Royal Observatory in 1953.

Following some Science Faculty meetings in 1967-68, the formation of a Department of Astronomy was approved by the Minister of National Education in September 1969. This was during the difficult period of transition from the Royal Observatory to the South African Astronomical Observatory.

Brian Warner was appointed Professor and Head of Department in 1972, in which position he continued until he became emeritus in 2004. He had previously worked at the University of Texas. He brought with him to South Africa Edward Nather who set up an innovative high-speed photometer incorporating offset guiding and digital control through a minicomputer. This instrument was central to the success of the department. Within a few years it had earned a well-deserved reputation in time-domain photometry. A good example was high-speed photometry of accreting compact binaries which became an area of particular strength of South African astronomy thanks to Brian's leadership in this field.

Other early staff members of the UCT department were AD Thackeray who was visiting Professor 1974-1978, following the closure of the Radcliffe Observatory in Pretoria. Don Kurtz was a Research Associate 1977-2001 and MW Feast was an Honorary Professor 1983-2019.

In recent years there have been several important additions to the teaching and professorial staff, reflecting the high regard in which the department is held by government funders and the increasing investment in visible- and radio-region astronomy in South Africa.

R Kraan-Korteweg became Head of Department in 2005 and was succeeded by P Woudt in 2015.

The department has graduated 54 PhDs, many of whom have continued to have active and successful careers in astronomical research.

The UCT Astronomy Department has of course continued to enjoy close cooperation with SAAO and make use of its telescopes. There are several joint appointments and some staff have moved between the two institutions.

The programme of the Symposium included the following:

Patrick Woudt "50 Years of Astronomy at UCT" (on which the previous section is largely based).
Ian Glass "History of Astronomy at the Cape Observatory".
Christian Knigge "Cataclysmic variables" (by remote connection to Southampton).
Paul Groot "Gravitational Wave Astophysics" (UCT/Radboud)
Deanne Coppejans "Radio Observations of Cataclysmic Variables" (by remote connection to Northwestern, USA).
Dante Hewitt "MeekKAT census of nearby nova-like variables", (UCT).
Brian Warner "Mrs Isaac Newton" – as Newton was not married, this title excited some curiosity. The Mrs Newton referred to was the famous Isaac's mother!
Phil Charles "Hot dense HeII outflows from the BH dipping transient Swift J1457.2-0933" (Southampton).
David Buckley "SALT observations of accretion-driven transients" (SAAO).
Steve Potter "Polarimetry and cataclysic Variables" (SAAO).

Kerry Paterson “Searching for optical transients” (Chicago).
Khine Motsoaledi “Cataclysmic variables in optical transient surveys” (UCT).
Miriam Nyamai “Radio observations as a tool to study non-spherical outflows from the classical nova V339 Del” (UCT).

A celebratory dinner was held afterwards at Groot Constantia and was attended by particpants and people associated with Brian Warner at various stages of his career. [ISG]

News Note: River Club development

The present owners of the River Club, a 14.7-hectare property lying between the Cape Town campus of the South African Astronomical Observatory (the former Royal Observatory) and Liesbeek Parkway, have for several years been trying to get permission to develop the site. Their project is a huge one – to cost R4 billion, involving office, retail and residential buildings up to 10 storeys high.

In April 2018 Heritage Western Cape granted a two-year provisional protection of the site following representations by local interests. The area involved is part of TRUP – the Two Rivers Urban Park – that also includes Valkenburg, SAAO, Maitland Garden Village and Ndabeni. TRUP was set up in 2003 to open up the area for recreational, cultural and heritage activities.

The protection order was strangely opposed by the provincial department of Transport and Public Works and the City of Cape Town who chose to support the developer rather than a fellow state institution.

A tribunal under the auspices of the provincial Department of Culture, Sport and Recreation has now upheld the protection order of 2018. The chairperson of the tribunal, Ashraf Mahomed, stated inter alia "Notable and alarming at the same time, is the concern that government officials who are meant to serve the people of this country and should be loyal and respectful towards each other, are perceived to form alliances with other tiers of government and developers, instead of aligning the scarce resources with experience skills to solve complicated heritage issues cooperatively, internally, and in good faith".

However, the developers have not given up and are planning to appeal further.

The property is subject to occasional inundation, being part of the flood plain of the Liesbeek River. Previously it was the Railways Sports Ground and latterly it has been rented out to the River Club as a pub/restaurant, conference venue and golf driving range. Considering that the would-be developers bought the property from Transnet for R12 million, there is clearly a lot of potential profit involved and it will be interesting to see it the pressure can be resisted. [ISG]

News Note: SALT contributes to a new understanding of novae

An international team of researchers, led by Dr Elias Aydi, a former SAAO and University of Cape Town PhD Student, now at Michigan State University (MSU), have discovered a new cause for the incredible brightness observed when a star explodes. The discovery used high-resolution optical spectroscopy from different telescopes including SALT to better understand the stellar explosion or nova.

A nova is an explosion on the surface of a star that can produce enough energy to increase the star's brightness by millions of times. Sometimes a nova, which occurs in stars called white dwarfs, is so bright it appears as a new star to the naked eye. A white dwarf star strips material from its companion star that piles up on the dwarf's surface, eventually triggering a thermonuclear explosion.

While for many years astronomers have thought that nuclear burning of material on the surface of the white dwarf directly powered all the light from the explosion, more recently astronomers started debating that "shocks" from the explosion might power most of the brightness.

The research is detailed in a paper published in the journal *Nature Astronomy* titled "Direct evidence for shock-powered optical emission in a nova."

"This is a new way of understanding the origin of the brightness of novae and other stellar explosions," said Elias Aydi, a research associate in MSU's Department of Physics and Astronomy, who led an international team of astronomers from 40 institutes, across 17 countries. "Our findings present the first direct observational evidence, from unprecedented space observations, that shocks play a major role in powering these events."

The SALT observations were taken under the transient follow-up programme, with Dr David Buckley at SAAO being the Principal Investigator. Nova became an important class targeted by the programme since 2016, led by Dr Aydi, who was a graduate student at the time. It now involves a number of different co-investigators from 3 of the SALT partners (South Africa, USA and Poland) plus many other international collaborators.

Astrophysical shocks form in a similar fashion to those formed by a supersonic jet aeroplane. When the jet exceeds the speed of sound, it produces a shock which leads to a loud sonic boom. In a nova explosion, the shocks produce light rather than sound.

When material blasts out from the white dwarf, said Aydi, it is ejected in multiple phases and at different speeds. These ejections collide with one another and create shocks, which heat the ejected material producing much of the light.

Another side effect of astronomical shocks are gamma-rays, the highest-energy kind of electromagnetic radiation. The astronomers detected bright gamma-rays from the star, known as nova V906 Carinae, whose explosion in the constellation Carina was first detected in March 2018. Using NASA's Fermi Gamma-ray Space Telescope, they showed that V906 Car had the brightest gamma-rays ever observed for a nova, proving that it hosts energetic shocks.

But the real surprise came because an optical satellite – one of the six nanosatellites that make up a collection of satellites operated by an international consortium called the BRITE constellation of cube-sats – just happened to be looking at the part of the sky where the nova occurred. Comparing the gamma-ray and optical data, the astronomers noted that every time there was a fluctuation in gamma-rays, the light from the nova fluctuated as well.
"We observed simultaneous fluctuations in both the visual and gamma-ray brightness, meaning that both emissions are originating from shocks," said Kirill Sokolovsky, a research associate at MSU and a co-author on the paper. "This led us to the conclusion that shocks are indeed responsible for most of the brightness of the event."
"We were lucky that members of our team were observing that part of the sky with these special satellites and were able to collect this unprecedented set of data," Aydi said. "This allowed for continuous monitoring of the nova for 65 days, producing an unprecedented dataset."

The team estimates that V906 Car is about 13,000 light-years from Earth. This means that when the nova was first detected in 2018, it had actually happened 13,000 years ago. This new information may also help explain how large amounts of light are generated in other stellar events, including supernovae and stellar mergers, when two stars collide with one another.

Adapted from https://msutoday.msu.edu/news/2020/seeing-the-light-msu-research-finds-new-way-novae-light-up-the-sky/

News Note: Unexpected features found in distant galaxy using MeerKAT

An international team has uncovered unusual features in the radio galaxy ESO 137-006 using MeerKAT data

ESO 137-006 is a fascinating galaxy residing in the Norma cluster of galaxies, and one of the brightest objects in the southern sky at radio wavelengths. The classical picture of a radio galaxy consists of an active galactic nucleus (AGN, hosting a growing supermassive black hole) shooting out two jets of plasma filled with particles that move at speeds close to the speed of light. The material within the jets eventually slows down and billows out, forming large radio lobes. ESO 137-006 is characterised by two such lobes of very bright radio emission.

“New features have been uncovered in this galaxy in the form of multiple, extremely collimated threads of radio emission connecting the lobes of the galaxy. The radio emission from the threads is likely synchrotron radiation caused by the high-energy electrons spiralling in a magnetic field,” explained Mpati Ramatsoku, a Research Fellow at Rhodes University and lead author of the study (see cover picture).

The nature of these unusual features is unclear. It is possible that these features may be unique to ESO 137-006, because of its harsh environment, but it is equally possible that these features are common in radio galaxies but, so far, we have been unable to detect them due to sensitivity and resolution limits. According to the team that made this discovery, which is composed of collaborators from South Africa and Italy and is partly funded by the European Research Council, further observations and theoretical efforts are required to clarify the nature of these newly discovered features.

Ramatsoku points out that understanding the nature and the physics of these collimated synchrotron threads (CST) could open a new science case for sensitive radio interferometers like MeerKAT and, in the future, the SKA.

“This is exciting because we did not expect it at all,” says Professor Oleg Smirnov, Head of the Radio Astronomy Research Group at SARAO. “Such serendipitous discoveries are very important for MeerKAT because it highlights its incredible capacity for finding the ‘unknown unknowns’ in our Universe”.

Reference: Ramatsoku, M, et al *A & Ap* **636**, L1, 2020.

News Note: MeerKAT and SALT observe mysterious stellar event

The MeerKAT radio telescope and the Southern African Large Telescope have combined forces for the first time to discover and identify a unique and previously unseen flare of radio emission from a binary star in our Galaxy. Its radio name is MKT J170456.2-482100 and it has been identified with a K-type sub-giant star TYC 8332-2529-1 that is about twice as massive as the Sun. It is also seen in UV and X-rays.

The MeerKAT radio telescope in the Northern Cape of South Africa discovered the object which rapidly brightened by more than a factor of three over a period of three weeks. This is the first new transient source discovered with MeerKAT and scientists hope it is just the tip of an iceberg of transient events to be discovered with the telescope in future.

Astronomers call an astronomical event "transient" when it lasts only for a short time, it may appear or disappear, or become fainter or brighter over seconds, days, or even years. These events are important as they provide a glimpse of how stars live, evolve, and die.

Using an assortment of telescopes around the globe, the astronomers determined that the source of the flare is a binary system; where two objects orbit each other approximately every 22 days. While the cause of the flaring and the exact nature of the stars that make up the system is still uncertain, it is thought to be associated with an active corona – the hot outermost part of the brighter star.

The star's orbital motion was discovered and measured using optical observations with the Southern African Large Telescope (SALT). Fortuitously, it is sufficiently bright to have also been monitored by optical telescopes for the last 18 years and is seen to vary in brightness every three weeks, matching the orbital period.

"This source was discovered just a couple of weeks after I joined the team, it was amazing that the first MeerKAT images I worked on had such an interesting source in them. Once we found out that the radio flares coincided with a star, we discovered that the star emits across almost the entire electromagnetic spectrum from X-ray to UV to radio wavelengths," said Laura Driessen, a PhD student at The University of Manchester who led this work.

Patrick Woudt, Professor and Head of the Astronomy Department at The University of Cape Town said: "Since the inauguration in July 2018 of the South African MeerKAT radio telescope, the ThunderKAT project on MeerKAT has been monitoring parts of the southern skies to study the variable radio emission from known compact binary stars, such as accreting black holes.

“The excellent sensitivity and the wide field of view of the MeerKAT telescope, combined with the repeat ThunderKAT observations of various parts of the southern skies, allows us to search the skies for new celestial phenomena that exhibit variable or short-lived radio emission.”

Dr David Buckley from the South African Astronomical Observatory, who leads the SALT (Southern African Large Telescope) transient follow-up programme, which followed up on the discovery, commented: “This is a perfect example of where co-ordinated observations across different wavelengths were combined to give a holistic view of a newly discovered object. “This study was one of the first to involve co-ordination between two of South Africa’s major astronomy facilities and shows the way for future such work.” Professor Ben Stappers from The University of Manchester said: “The properties of this system don’t easily fit into our current knowledge of binary or flaring stars and so may represent an entirely new source class.”

The MeerKAT telescope is sweeping the sky for sources that vary on timescales from milliseconds to years and will significantly improve human understanding of the variable radio sky. The discovery of this new transient with MeerKAT demonstrates how powerful this telescope will be in the search for further new transient events.

Rob Adam, Managing Director of the South African Radio Astronomy Observatory (SARAO) said: “Once again we see the potential of the MeerKAT telescope in finding interesting and possibly new astrophysical phenomena, as well as the power of the multi-wavelength approach to the analysis of observations.”

The discovery has been reported by Driessen, L.N., et al in *MNRAS* **491**, 560, 2020.

Recent Southern African Fireball Observations Events # 326-334

Tim Cooper, Comet, Asteroid and Meteor Specialist, Shallow Sky Section

Abstract: This article continues the sequential numbering of reported fireball sightings from southern Africa. By definition, a fireball is any meteor event with brightness equal to or greater than visual magnitude (m_v) –4. The following events were reported to the author and details are reproduced as given by the observer [any comments by the author are given in brackets]. All times were converted to UT unless stated, and all coordinates are for epoch J2000.0.

Event 326 – 2019 June 9 – Port Elizabeth, Eastern Cape

Observed by Shaun Porter at 17h22, bright white with orange trail, fast moving, duration 1-1.5 seconds but start obscured by apex of the roof of his home. Shaun provided an image of the view from where he was standing, with a number of stars visible and with the path of the fireball indicated. From this I determine the start and end points as approximately az/alt 110°, 24° to 145°, 10°, that is from RA/Dec 17h33, –30° to 20h10, –50°, Shaun said it appeared much brighter than Jupiter, visible just above the path, magnitude –2.1, and possibly brighter than the moon, visible in the north-west, magnitude –11. No sounds heard.

Event 327 – 2019 June 11 – Pretoria and between Potchefstroom and Johannesburg

Observed by Pieter Stronkhorst driving west heading 266° on Church Street, Pretoria. He provided a sketch showing the fireball descending from an altitude of about 30° in azimuth 275°, towards the horizon in azimuth 255°.

Observed by Regart Venter at 04h25, driving west on the N12 freeway towards Potchefstroom, heading 263°. Seen on his righthand side descending at a shallow angle towards his left and did not reach the horizon before burning out. Green colour, and although morning twilight was well advanced it lit up the sky.

Event 328 – 2019 July 25 – near Muldersdrift, Gauteng

Observed by Rubin Kruger, just after 18h00, driving in direction 23° on the N14 from Krugersdorp, just before the intersection with R114, the fireball moved from upper right hand side of his windscreen descending to his left towards azimuth 330°, fast moving, duration about 5 seconds, orange colour. Rubin thought it 'high above me but seemed to be lower than a shooting star'.

Event 329 – 2019 July 30 – Hazyview, Mpumalanga

Observed by Dave Gear at 15h25 while walking his dogs during bright evening twilight, duration 3 seconds, colour blue/white, started at az/alt 90°, 60°, and ended at 10°, 10°, that is from RA/Dec 16h11, –22° to 15h12, +53° and which gives a path from just below δ Scorpii, descending to the left and finishing just above the horizon below Boötes. The fireball left a persistent train visible for 3 seconds and broke into several pieces before burning out.

Event 330 – 2019 September 24 – near Baltimore, Limpopo

Observed by Tim Cooper at 22h39 during a watch for meteor activity from asteroid Bennu, m_v = –5 at termination, long path from 00h41m, –47.8° to 19h26m, –49.8°. Path length 49.1°, duration 3 seconds, giving apparent speed 16.4°/sec. First third of passage white, then yellow as the meteor became brighter, last quarter of passage orange core surrounded by white with sparkling appearance, not dissimilar to the typical Geminid meteor in appearance. Left very persistent white train, lasting for more than 15 secs.

Event 331 – 2019 September 26 – Leisure Island, Knysna, Western Cape

Observed by Elton Harding at around 20h00, facing direction 195° when he saw 'a fireball - never seen anything like it in my life'. m_v = –7, duration 3 seconds, leaving a broad trail, and broke into three fragments before disappearing. From a description given I determine the path from az/alt 230°, 80° to 266°, 55°, that is from RA/Dec 21h20, –39.7° to 19h20, –29.4°, from below the tail of Grus to just above the handle of the teapot of Sagittarius where it disintegrated. Jupiter (m_v = –1.9) was lower down below the point of termination.

Event 332 – 2019 September 28 – Orkney, North West

Observed by Rudi van den Heever at 21h55, very bright meteor, duration 8 seconds, colours seen white and red, left a 2 second persistent train. No disintegration and no sounds heard. Path was approximately from az/alt 200°, 60° near Grus and descending towards the right at an angle of 45°, towards the Scorpius/Sagittarius region.

Event 333 – 2019 November 2 – Emalahleni, Mpumalanga

Observed in evening twilight by Christiaan Bronkhorst at 16h44, duration 4 seconds, bright white or blue-white fireball seen while travelling north on Montagu Street, Emalahleni. The fireball was seen in azimuth about 340°, perhaps halfway up from the horizon and descending steeply down and slightly to the left. From this description the path was approximately from the constellation Delphinus towards Lyra. A five days-old crescent moon was situated upper left of the path, altitude 62° and magnitude –10.3. No persistent train or disintegration noted.

Event 334 – 2019 December 20 – Midrand, Gauteng

Observed by Paul Pritchard at around 22h50, fast moving streak seen through thin clouds, duration perhaps one second, yellow and orange colours mentioned, path from around centre of Orion descending straight down through Auriga and burning out on the horizon. Much brighter than any stars or planets, no sound.

Acknowledgements

Thanks to Kos Coronaios (ASSA Observing Director) for forwarding various reports from the public.

New stamps glow with the stars of the southern skies

Johan Kruger, SA Post Office

Since time immemorial, humankind has been gazing up at the skies in wonder. The beliefs of SA's peoples are celebrated on a limited edition of stamps and envelopes featuring the stars and constellations of the southern hemisphere.

Stamps

The stamps depict ancient beliefs, but they will appeal even to the youngest people in the 21st century. Printed with glow-in-the dark ink, the stamps shine like proper stars. The set consists of ten stamps and two first-day covers designed by artist Anande Nöthling.

Fig 1. The first stamp features Canopus, called the Horn star (*Naka*) in the South African languages Sotho, Tswana, Venda, Lobedu, Ndebele and Pedi. The |xam people invoked this star when in search of ant eggs.

Fig 2. A stamp featuring three delightful little warthogs celebrates the three stars known as Orions' Belt among English speakers. These stars are known as the Bush Pigs – *Dikolobe* – among Sotho and Tswana speakers.

Fig 3. Sirius is called 'Pulls the Night Across' – *Kgogamasigo* – in Tswana, with similar names in Sotho, Venda and Zulu. The Xhosa people call it The Champion – *iQhawe*. This constellation is featured on the third stamp.

Fig 4. A beautiful stamp featuring a heraldic lion celebrates the Scorpius stars; the Khoikhoi people called them The Lion's Eyes – Xami di mura. The !Xu people, a tribe belonging to the earliest hunter-gatherers in southern Africa, called it the Fire-Finishing Star.

Fig 5. The Southern Cross is called the Male Giraffe – *Thutlwa* – by Sotho, Tswana and Venda speakers. The legendary SA philosopher Credo Mutwa called this constellation the Tree of Life. Naturally this constellation also features on a stamp.

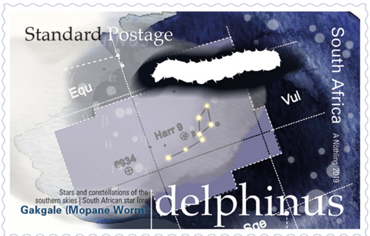

Fig 6. In dried form the Mopane Worm is a delicacy among indigenous South Africans. *Gakgala*, meaning mopane worm, is the name for the constellation Delphinius among the Tswana people and the star as well as the larvae of the Mopani moth feature on this stamp.

Fig 7. The stamp featuring Centaurus, contains the Two Pointers. For the |xam, the two pointers to the Southern Cross are the Lion Stars - two lions transformed into stars by a young woman.

Fig 8. The |xam people saw the star Alde-baran as the Male Hartebeest, one of the most highly evolved ungulates capable of reaching speeds of up to 70 km/h. These qualities gave rise to their name, which means "tough ox."

Fig 9. A French astronomer, Nicolas-Louis de Lacaille, while visiting Cape Town to chart the southern skies, grouped some very faint stars together to create "*Mons Mensa*", Latin for "Table Mountain", next to the Large Magellanic Cloud. This is the only constellation that represents a geological feature on earth.

Fig 10. Look up at the southern skies in an area where there is no light pollution, and you will be stunned by the sight of the Milky Way. The |xam believed the Milky Way originated when a girl of the Early People scooped up a handful of

ashes and roots from the fire and flung it into the sky. The colours of the roots made the colour of the stars. To other peoples in SA, the Milky Way represents a supernatural foot path across the sky along which the ancestral spirits walked. The tenth stamp features this most dramatic feature of the southern night skies.

First Day Covers

Fig 11. One first day cover features the Large and Small Magellanic Clouds. Several San groups named these stellar clouds after the male and female steenbok, a charming little antelope that pairs for life and fiercely defend their territory. The |xam people, who once lived across the Northern Cape of SA, called the Magellanic clouds ostrich eggs.

Fig 1, 2. The Pleiades star cluster, known in the west as the Seven Sisters, features on the second first day cover.

The Xhosa would watch for the first appearance of *isiLimela*, as it is called in their language, in June. The coming-out ceremony of the abakwetha initiation school, a rite of passage where boys would become men, was determined by the appearance of this stellar grouping. It is customary for Xhosa men to count their years of manhood from this date.

The Khoikhoi used the Pleiades to forecast the start of the rainy season.

Acknowledgements:

In alphabetical order

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Chris de Coning.ASSA Archivist
Magda Steicher. ASSA Deep Sky Observer

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How to Make a Cassegrain Secondary Mirror

Etsuo Takayanagi, ASSA JHB Centre & ATM member
Chris Stewart ASSA President

Summary

Amateur telescope makers hesitate to build Cassegrain telescopes due to the difficulty of testing the convex hyperboloidal secondary mirrors. The Foucault test is, however, applicable to inspecting secondly mirrors from the rear side of the convex surface. This way of testing the convex surface makes the production of a Cassegrain secondary much easier than other methods. For this to be feasible, the mirror blank should be of optical glass. The method of retouching a convex surface is different from that of parabolizing a concave surface.

Introduction

When the primary mirror of a telescope becomes 25cm or larger in diameter, the Cassegrain telescope has an advantage over a Newtonian in that the tube is much shorter for the equivalent focal length. However, only a few amateur telescope makers have taken up the challenge of making a Cassegrain type telescope, largely because of the difficulty of making a convex hyperboloidal secondary mirror.

This difficulty is mostly due to the lack of a simple inspection method. Convenient and simple methods for testing and retouching Cassegrain secondary mirrors are introduced in this note.

Conventional Method of Inspecting Cassegrain Secondary Mirrors

Traditionally, testing the secondary mirror of the Cassegrain telescope has been done using the following techniques, all of which are indirect methods. They cannot not inspect the surface directly, in isolation from other factors in the system. Since it is therefore difficult to know the actual aspect of the mirror precisely, one cannot correct it accurately by these methods. It is like scratching your itchy feet from the top of your shoes!

Newton Fringe test

The convex mirror under test is placed in contact with a concave "test plate", and the Newton's rings interference "fringe" pattern produced is interpreted to assess the deviation in contact. **Disadvantages:**

- It is necessary to make a test plate with an accurate concave hyperboloid of the desired characteristics
- It is difficult to figure the convex mirror to match the curvature of the concave test plate
- It is difficult to read and interpret the Newton's rings well.

Autocollimation test

The entire Cassegrain telescope is assembled and collimated, then aimed at an optically flat test which has the same or larger diameter as the telescope's primary mirror. The system is inspected by the Foucault test at the focus of the telescope. (This is described, inter alia, in "How to Make a Cassegrain", Edited by Albert G. Ingalls, Amateur Telescope Making Book one, 1955, Scientific American).

Disadvantages

- It is difficult/expensive to make/obtain a suitably large, high-quality aluminized optical flat;
- Set up of each test session is laborious.
- The difficulty of interpreting the results and translating that into figuring actions

Star Image Test

Evaluating the surface of the secondly mirror by means of the star image through the fully assembled Cassegrain telescope. Disadvantages

- It can't be used in the daytime
- Atmospheric effects
- The necessity for an absolutely stable tracking mount
- The difficulty of interpretation
- Set up of each test session is laborious.

Proposed method: Direct Inspection of the Secondary Mirror

The best way to inspect the secondary mirror is to use the very sensitive Foucault test, which is popular among amateur telescope makers the world over. However, in this case, we shall view the surface under test from the *rear* side of the *convex* secondary mirror - which then presents the necessary *concave* surface to the tester. This is illustrated in Fig, 1**.**

Since the surface is inspected by the light passing *through* the glass, it is vital to use glass without striae (inhomogeneities or strains). Optical glass is therefore the best material to us if this test method is to be employed. The lead author has successfully used an optical glass called BK7 (a variety of crown glass). Since this is typically employed for mass-production of achromat lenses, it is commonly available and relatively inexpensive.

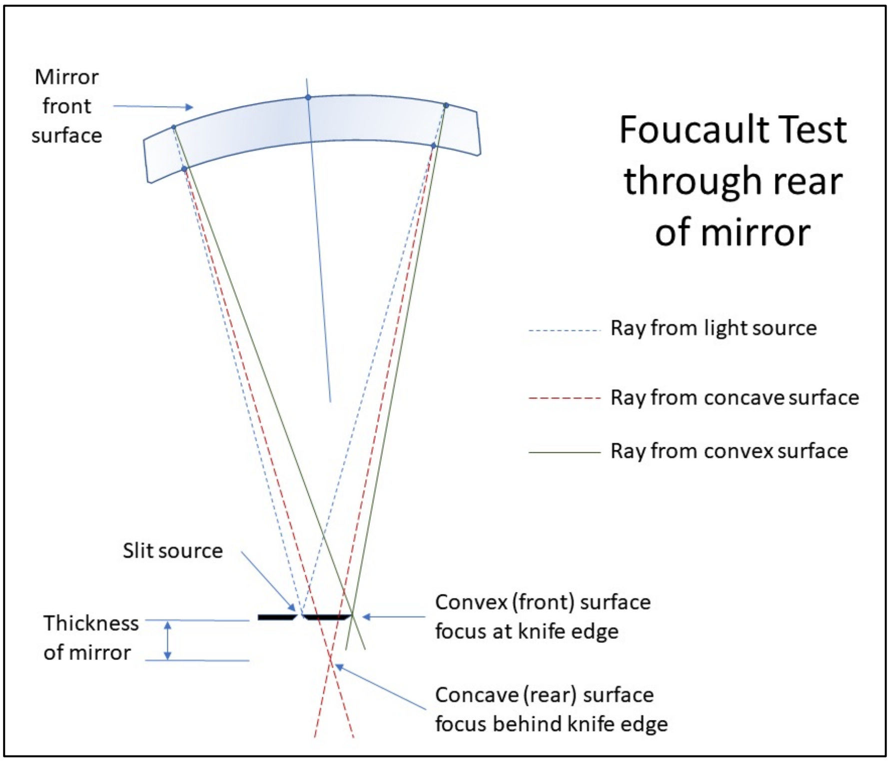


Fig 1. Foucault test through rear of mirror.

Amateur telescope makers with the experience of making good parabolic mirrors can easily perform Cassegrain secondary mirror inspection done this way. It allows them to draw on their experience with the Foucault test to interpret the results and produce an accurate secondary mirror. Variants of the Foucault test, e.g. the wire test, to measure zonal radii of curvature are equally applicable.

Symbol	Meaning
A	Amplification Factor The effect of the secondary mirror on the system's effective focal length
$\mathbf{D_1}$	Primary mirror optical diameter (i.e. excluding bevel)
$\mathbf{D_2}$	Secondary mirror optical diameter
$\mathbf{f_E}$	Effective focal length of the system, as experienced at the Cassegrain focus
f	Natural focal length of the primary mirror
$\mathbf{f_1}$	Primary mirror focal point (Prime Focus)
$\mathbf{f_2}$	Position of the final focal point of the system (Cassegrain Focus)
b	The "back focus", being the distance from the primary mirror optical surface to the secondary focus $\mathbf{f_2}$
$\mathbf{m_1}$	Distance between main mirror focal point and convex mirror surface
$\mathbf{m_2}$	Distance between convex mirror surface and the final Cassegrain secondary focus
R	Radius of curvature of the secondary mirror convex surface, at the zone under consideration
$\mathbf{R_0}$	Radius of curvature of the central (axial) zone of the secondary mirror convex surface
y	Radial distance from the centre (axis) of the secondary mirror to the convex zone under consideration
$\mathbf{y_0}$	An axial radius of 0 where the secondary mirror's central zone is, i.e. where the optical axis of the system intersects the secondary mirror optical surface.
$\mathbf{y_{max}}$	The radial distance from the centre to the outer optical edge of the secondary mirror i.e. half of D_2 (the optical diameter of the secondary)
k	Longitudinal aberration Difference in radii of curvature between the central zone and the zone under test.
x	Adjustment factor for translating longitudinal aberration k from traditional paraboloid to hyperboloid

Designing a Cassegrain secondary mirror

In the design formulae below, the symbols are as follows and illustrated in Fig. 2

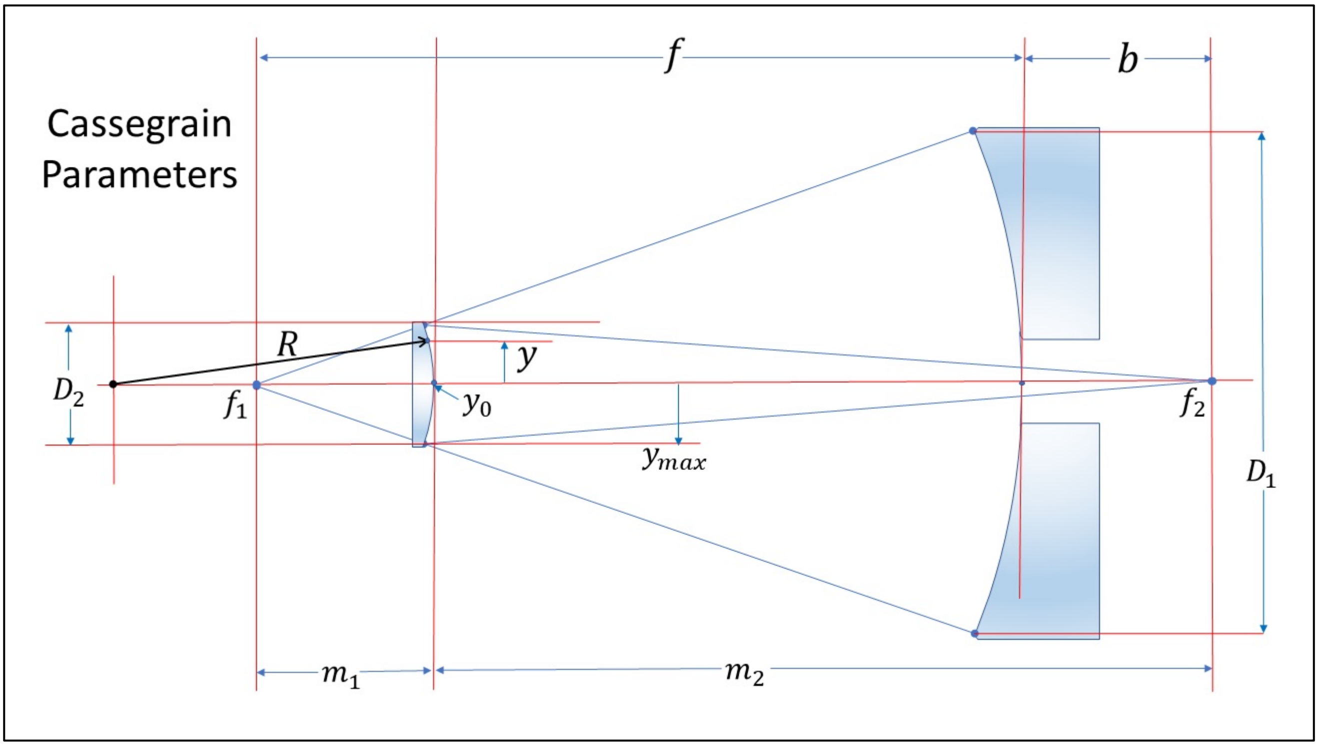


Fig 2. Cassegrain parameters

Initial considerations

There are several fundamental issues to consider when designing the instrument, which are inextricably entwined and thus require some thoughtful compromises to be made. The tradeoffs involved are decisions the designer must make, according to the purpose to which the instrument is to be put. The main tradeoffs are between

- Size of the central obstruction presented by the secondary (**D_2**)
- Desired location of the secondary Cassegrain focus (**f_2**)
- Amplification factor (**A**)

These are discussed later, along with the calculations.

Desired location of the Cassegrain focus (f_2)

For visual purposes with an equatorially mounted instrument, the Cassegrain focus can become impossibly awkward to reach, necessitating painful contortions on the part of the observer. The most common solution is to introduce a diagonal to bring the final focus out to the side at $90^{o}$to the optical axis. If the prism can be rotated about the telescope's optical axis to achieve a comfortable eyepiece position, so much the better. For use with a camera, more or less "back focus" may be required to accommodate the camera's mechanical properties and any filters which may need to be interposed, in order to ensure the focal plane can be brought congruent with the sensor.

Deciding the Secondary mirror optical diameter

The *minimum* diameter of the Cassegrain secondary is determined by the simple formula

$$D_2 = D_1 (m_1 / f)$$

(Source: "How to make a reflective telescope", Jirou Hoshino, 1974, Kouseishakouseikaku)

This minimum value assumes a point source. Off-axis rays from extended objects (anything more than a few arcseconds in diameter) will miss the secondary and thus not contribute to the final image. This results in *vignetting*, where the brightness of the field of view in the eyepiece progressively fades from the centre towards the edge. For individual stars, close doubles and small planets this may be acceptable, but for nebulae and star clusters it is suboptimal - and on a large bright object such as the Moon it becomes objectionable, obviously requiring a larger secondary.

However, due mostly to diffraction effects, one would prefer the central obstruction (the size of the secondary mirror and its supporting structure) to be kept to a practical minimum. This is absolutely vital to preserve good image quality, with crisp pinpoint stars and high-contrast fine detail in extended objects. Also, the larger the secondary diameter the heavier it is, and thus the more robust the supporting "spider" assembly must be to avoid vibration and to preserve collimation. The spider vanes add to the diffraction effects.

Obstruction diameters below about 15% *of the primary diameter* have negligible effect in this regard. As this increases, the effects become rapidly worse. As a rule, 25% is still quite reasonable. Nonetheless, some commercial instruments go as far as 45% in order to make a compact, easily baffled instrument, or to fully-illuminate the edges of a large sensor.

As a practical rule-of-thumb, the *actual* physical diameter of the secondary mirror is therefore normally chosen to be about 10% to 15% *larger* than the calculated minimum value, specifically to avoid vignetting off-axis rays.

Those not satisfied with rule-of-thumb, or who have a specific imaging sensor size to consider, may calculate the *additional* secondary mirror size necessary to avoid vignetting over a given field of view using this formula:

$$additional\ secondary\ diameter = 2\tan\alpha\ (f - m_1)$$

where αis the *radius* in degrees of the object field of view that should be fully illuminated. The value α = 0.5 degrees (the apparent diameter of the Moon) will show an area 4 times that of the Moon, which should be sufficient unless catering for larger target objects such as open star clusters is really necessary. The full calculation for a practical secondary mirror diameter is thus:

$$\boldsymbol{D_2} = D_1(m_1/f) + 2\tan\alpha\ (f - m_1)$$

Note: bear in mind that these formulae calculate the size of the **optical** surface of the mirror: the amount necessary for edge bevel should be added to this in choosing the glass diameter, and the surrounding mounting hardware, should be also be kept in mind when considering the obstruction diameter.

The Amplification Factor and Effective Focal Length

The Amplification factor is the ratio of the distance from the secondary to the final focus, versus the distance within the primary focus at which the secondary is placed to intersect the cone of light from the primary mirror. Applying this factor to the primary focal length determines the effective focal length of the system as a whole, and thus also its effective focal ratio.

Again, the calculation is easy, being the ratio of the distance from the secondary to the final focus, vs. the intercepted portion of the primary focal length:

$$A = m_2 / m_1$$

The effective focal length of the entire system is then:

$$F_E = A\ f$$

If the amplification factor has been decided in advance, then the position of the secondary can be calculated as follows:

$$m_1 = (f + b) / (A + 1)$$

Within limits, the focal length can be amplified to almost any extent, but the higher the amplification the poorer the final image quality and the greater the level of precision required in manufacture. For this reason, typical values are in the range of 3 to 4.

Testing the mirror

Testing proceeds almost exactly as for that of a paraboloidal mirror. As a first pass, the general shape and smoothness is qualitatively assessed, bearing in mind that the shape is more pronounced than for a paraboloid. But it remains vital to perform quantitative measurements in order to obtain the required level of precision.

As usual, a representative series of zones is chosen on the mirror, and the position of the knife edge / wire / etc. to null each zone is recorded. For each zone, the calculated theoretically perfect radius of curvature is compared to the measured value. Naturally, the Amplification factor affects the eccentricity of the hyperbolic surface, and thus also the zonal radii of curvature by comparison to the paraboloid. The formula for determining the desired radius of curvature for any given zone thus differs from that of the paraboloid.

Calculating Radius of Curvature for each zone of the convex mirror

The formula for the required radius of curvature of any given zone is as follows:

$$R = \sqrt{\{[4(m_1 m_2)^2 + y^2(m_1+m_2)^2] / (m_2 - m_1)^2\}}$$

As with making the paraboloidal primary mirror, when grinding and polishing the hyperboloidal secondary of a Cassegrain, the desired nominal radius of curvature of the entire mirror is characterised by that of the central zone. For the special case of the central zone, y = 0 and the formula devolves to the simple formula given below, which can be used for testing progress with a spherometer.

$$R_0 = 2\ m_1\ m_2 / (m_2 - m_1)$$

The required *Longitudinal Aberration* k (the difference in the radii of curvature between a given zone and the centre) is thus

$$k = R - R_0 \qquad \textit{... moving source}$$

Note: For a Foucault tester where the knife edge and light source move together, this formula applies directly. However, for a tester with a *fixed light source* where only the knife edge moves, the knife edge travel will be increased by a factor of two:

$$k = 2(R - R_0) \quad ... \textit{fixed source}$$

Quick calculation for k

In these days of spreadsheets and programmable calculators, using the preceding formulae should be no problem. However, for those used to the paraboloid who want to quickly estimate the knife edge readings for the hyperboloid, one can use the following table to obtain an adjustment factor that can be applied to the paraboloid formula. The factor is dependent upon the amplification factor of the system, **A**. Simply look up the adjustment factor x for the designed amplification factor in the table, calculate the value for a zone as if it were a paraboloidal, and multiply the two to obtain k, i.e.

$$k = x\left(\frac{y^2}{2R_0}\right) ... \textit{moving source, or } k = x\left(\frac{y^2}{R_0}\right) ... \textit{fixed source}$$

Amplification factor (A)	Adjustment factor (x)
3.00	4.00
3.10	3.82
3.20	3.65
3.30	3.50
3.40	3.36
3.50	3.24
3.60	3.13
3.70	3.03
3.80	2.94
3.90	2.85
4.00	2.77
4.10	2.70
4.20	2.64

(Source: "How to make a reflection telescope", Shigemaro Kibe, 1967 Seibundoushinkousha)

Making the secondary mirror

Grinding and polishing

Prepare three glass disks of the required secondary diameter. One disk of good quality optical glass (to become the secondary mirror) and two disks of ordinary glasses (to be used as tools) should be selected.

Using conventional grinding and polishing techniques, one side of the optical glass will be the convex surface of the secondary mirror, whereas the opposite (back) surface is ground and polished concave. The curvature of both faces of optical glass should be exactly same. If the radii of curvature have even a slight difference, chromatic aberration occurs as the light passes through the glass. This will degrade the view in the Foucault test so that testing of the convex surface will be problematic.

During the grinding process, generating the curvature of the two sides of the secondary should be performed concurrently. Alternate work on the two mirror sides and then additionally grind the tools against one another, for equal durations each wet, in order to ensure the curves stay matched.

However, in the polishing and figuring stages, *the concave surface must be done first*. This is necessary for the test process, but also avoids scratching a perfectly good convex surface.
Producing the hyperbolic surface of the *concave* rear side follows the same process as for making the parabolic surface of the main mirror. It is not difficult work for anyone who has experience of making parabolic mirrors. However, the shadow patterns of an hyperboloid are more stark and higher in contrast compared to those of the paraboloid, due to the more aggressive curvature.

Next, polish the convex surface. Polishing must be done very carefully until *all* the pits from grinding are completely gone.

Normal polishing must be done carefully to produce a spherical shape, ensuring all pits are polished out

An irregular star-shaped piece of thick paper is placed on the pitch surface, pressed strongly, then removed to leave an indented pattern

The central portion of the lap is depressed, taking on the star shape and not making contact

Fig 3. Polishiing and figuring the secondary mirror's convex surface

Figuring the secondary

Once polishing is finished, figuring of the convex side to an hyperboloid can commence. This is the same process as making a strong oblate sphere surface in a concave surface - but being convex the strokes are a bit counterintuitive compared to “normal” polishing. Therefore, the surface of the pitch lap is deformed by *pressing an irregular star into the central portion*. This concentrates the contact of the lap towards the edge of the mirror, thereby increasing the radius of curvature at the edge versus that of the centre, promoting generation of a convex hyperboloid. (Fig. 3)

Testing

The Foucault test is done from the back side of the secondary. In this case, there are two focal points to be found – one by light reflected directly off the concave back of the mirror, and the other from light having passed through glass and internally reflecting off the convex surface. The distance between these two focal points are commensurate with the thickness of the glass. At the same time, there is a slight lateral displacement between the two points.

When performing a Foucault test, tilt the secondary mirror so that the focus of the light reflected from the concave *rear* surface is hidden by the knife edge. As a result, only the light internally reflected from the convex surface remains to be analysed at the knife edge, and it is possible to see the state of the convex mirror surface. (Fig.1)

Because the diameter of secondary mirror is so small compared with the primary mirror, it is a little bit more difficult to make a Couder Screen than for the Primary - but it is possible. A simple paper bar or pin stick are also effective. Fig.4

Fig 4. A simple paper bar is effective to denote the zones under test.

All usual methods (Foucault zone test, wire test etc.) are applicable for measuring the zonal radii, for comparison to the ideal values calculated as previously described. Note that for the wire test, it is still necessary to block the image from the concave surface of the secondary to avoid confusion. Putting the wire next to (rather than replacing) the knife edge solves this problem. A monochromatic light source is to be preferred. An Auto Foucault tester was used by the lead author in the case illustrated in Figs 5, 6.

Fig 5. Foucault test setup, with Auto-Foucault tester.

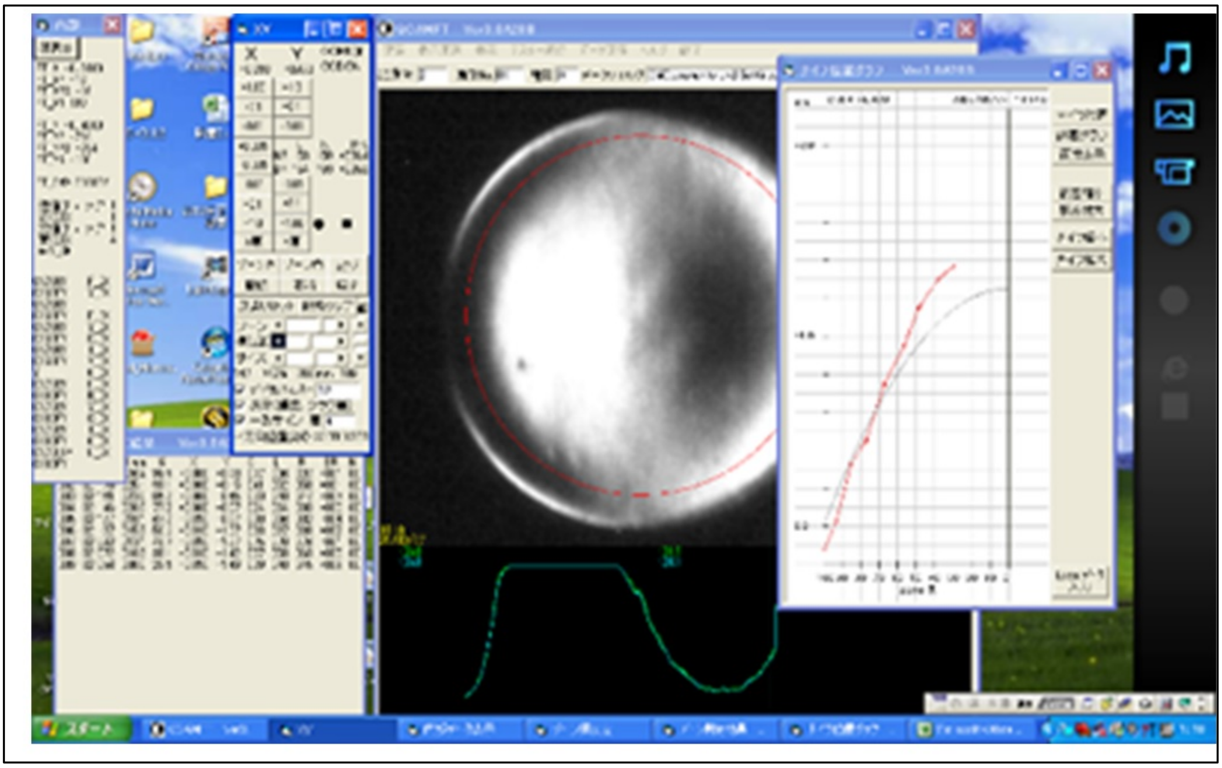


Fig 6. Test measurements and calculations by Auto-Foucaut tester.
Retouching of Convex surface

The method of retouching the surface of a convex mirror is essentially the reverse of that used to figure a concave surface. For example, the same W movement of the mirror which is used to erase the hill of a concave surface in the process of retouching a parabolic surface, will make the hill higher in the convex mirror. Thus, to produce the desired hyperbolic curve in the convex surface, a very strong hyperbolic surface (very deep valley as viewed from the tester) must be made first. After that, the depth of valley must be reduced by the W strokes of the mirror. The difference of the processes of retouching convex versus concave surfaces is shown in Fig 7.

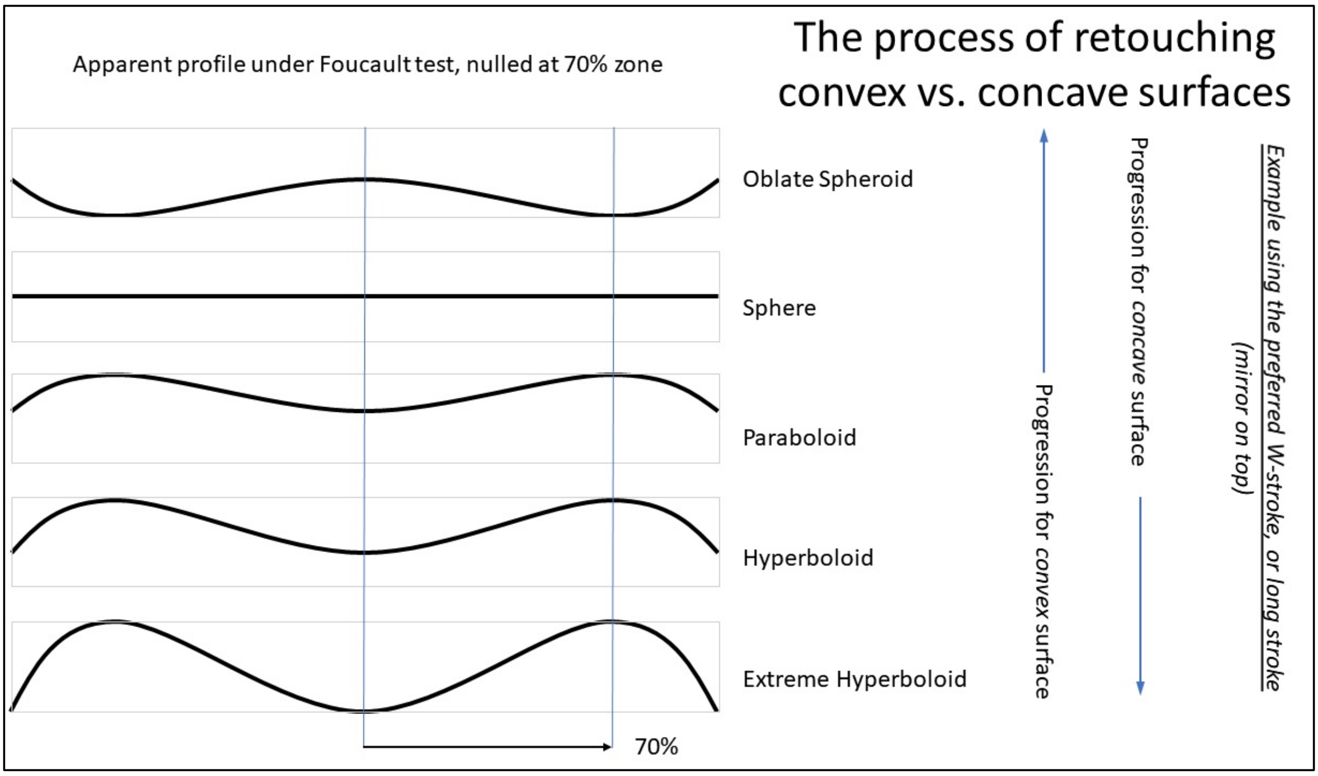


Fig 7. Foucault tests of convex and concave surfaces

Acknowledgments

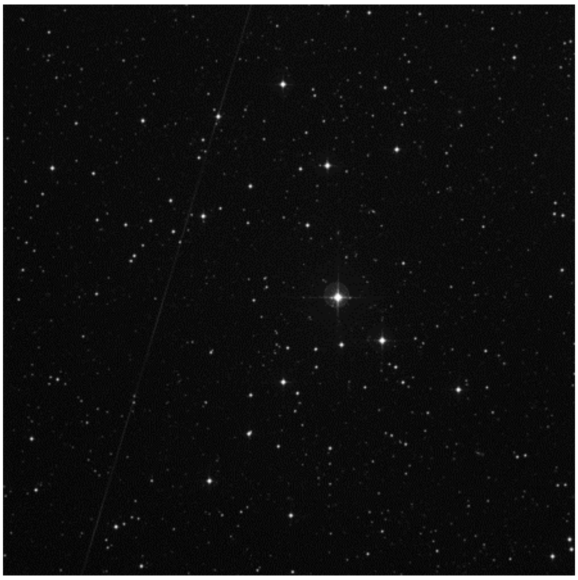
The authors wish to express their thanks to the cooperative members of the ATM class in Johannesburg, in particular Mr. Johan Smit (former chairman of the ASSA Pretoria Centre), for their ongoing camaraderie, stimulation and inspiration.

April 2020

Streicher Asterisms 23-25

Magda Streicher

Streicher 23 – Corvus

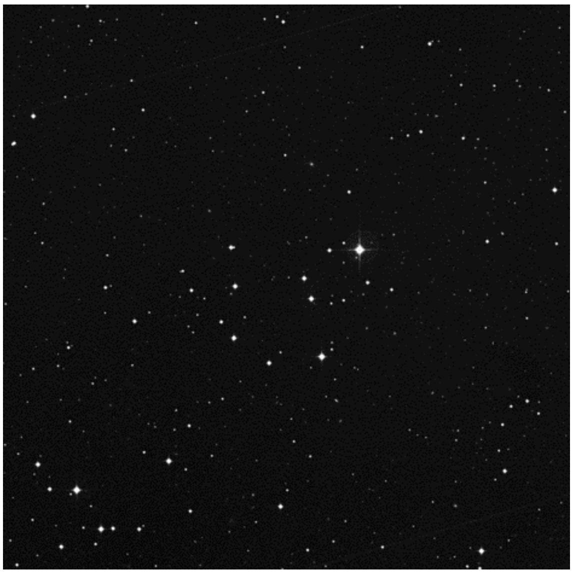


This asterism represents almost a cowboy in shape. It is situated about 5 degrees south-east of delta Corvi. Two prominent stars of similar brightness gazing back at one like two eyes form the north-eastern end of the grouping. A faint string of stars running north to south resembles the long slender arms. The brightest star HD 111156 is magnitude 7.2, and resembles the large, typical belt buckle, with the rest forming the sculptured legs, positioned well apart. Searching for star asterisms is great fun with some vivid imagination and pondering of possible images.

OBJECT	TYPE	RA	DEC	MAG	SIZE
Streicher 23 DSH J1247.3-1903	Asterism	12h47m.19	-19°03'.42"	9.5	22'

Picture Credit: DSS

Streicher 24 – Crater

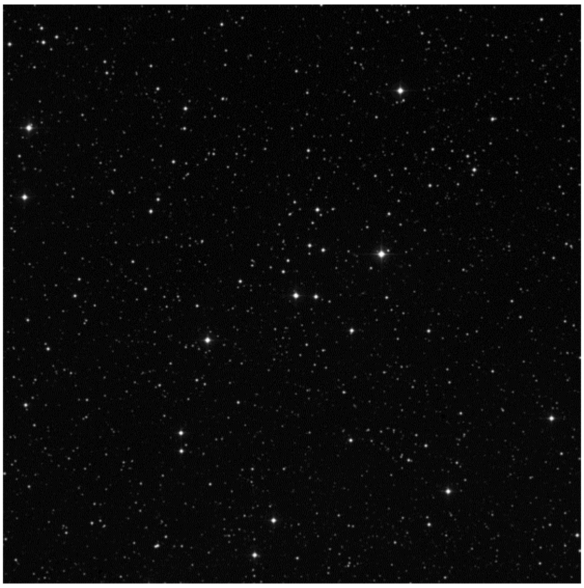


The brightest star in the constellation Crater is delta Crateris with a spectral Type-K and obvious in a light-yellow colour. Further north is the magnitude 4.8 epsilon Crateris, and as luck would have it, I stumbled on a star group a further 4 degrees north. Take a sip out of the heavenly cup constellation and taste this asterism that resembles a more modern tin cup in formation. The stars opening towards the west with a magnitude 8.9 star towards the south resembles the end of the handle. Asterisms are scattered all over the starry skies and virtually every constellation should have a few outstanding ones.

OBJECT	TYPE	RA	DEC	MAG	SIZE
Streicher 24 DSH J1111.6-0835	Asterism	11h11m.35	-08°35’.40”	8.5	9’

Picture credit: DSS

Streicher 25 – Gemini



This grouping is not clearly visible against the background but is very unique. A full three-quarter circle can be seen that opens towards the west with a lovely yellow coloured 8.9 star rounds off this grouping. They resemble the tassels of an antique bonnet. Fainter stars sprinkle in the north-eastern part of the star field.

OBJECT	TYPE	RA	DEC	MAG	SIZE
Streicher 25 DSH J0654.8+2854	Asteris m	06h54m.48	+28°54’.10”	10	6.5’

Picture Credit: DSS

Colloquia and Seminar

These form an important part of a research facility, often as a sort of pre-publication discussion or a discussion of an individual’s current research, and as such it is virtually impossible to “publish” this material. However, by recording the topics discussed in the form below does indicate to those, who are unable to attend, what current trends are and who has visited to do research: it keeps everyone ‘in the loop’ so to speak

Also included in this section are the colloquia/seminars at the SAAO, UWC, the Astrophysics, Cosmology and Gravity Centre at UCT, ACGC and the NASSP lectures, aimed the at the students and interested astronomers. In addition there are the SAAO Astro-coffees which are 15-20min informal discussions on just about any topic including but not limited to: recent astro-physics papers, seminal/classic publications, education/outreach ideas and initiatives, preliminary results, student progress reports, conference/workshop feedback and skills-transfer.

UWC

Title : Modelling Lyman alpha emitters in the epoch of reionization
Speaker: Sid Gurung Lopez (Missouri University of Science & Technology, USA)
Date: 31 January
Time: 11h30 – 12h30
Venue: Rm 1.35 New Physics Building, UWC

Abstract: The detection of star forming galaxies galaxies through their lyman alpha emission have proven to be one of the most reliable method to find galaxies in the early Universe. This galaxy population is also known as Lyman-alpha emitters (LAEs). The understanding of LAEs is linked to the understanding of the radiative transfer processes that lyman alpha photons go through in neutral hydrogen. These are very important since they affect to the flux that manage to escape from galaxies and from the nearby intergalactic medium. In this talk we present our model for LAEs in the epoch of reionization. Our model is based on the N-body simulation P-Millenium and the semi-analytical model of galaxy formation and evolution GALFORM. Additionally, our model includes the radiative transfer processes that take place inside the interstellar and intergalactic medium. During th talk we will address how the clustering of LAEs can help in the constrains in the epoch of reionization.

Title: Building stars, planets and the ingredients for life in space
Speaker: Prof. Ewine F. van Dishoeck from Leiden Observatory, Leiden University
Date: 29 January
Time: 11h00 – 12h00
Venue: Rm 1.35 New Physics Building, UWC

Abstract: One of the most exciting developments in astronomy is the discovery of thousands of planets around stars other than our Sun. But how do these exo-planets form, and why are they so different from those in our own solar system? Which ingredients are available to build them? Thanks to powerful new telescopes, astronomers are starting to address these age-old questions scientifically. Stars and planets are born in the cold and tenuous clouds between the stars in the Milky Way, and the new ALMA array now allows us to zoom in on planetary construction zones for the first time. Water and a surprisingly rich variety of organic materials are found, including simple sugars. Can these pre-biotic molecules end up in comets and ultimately new planets and thus form the basis for life elsewhere in the universe? What did the Rosetta mission find when it landed on comet 67P?

Title: Tensions in cosmological data: impact of non-standard models and systematic effects

Speaker: Matteo Martinelli (Instituto de Fisica Teorica UAM/CSIC)

Date: 14 February

Time: 11h30 – 12h30

Venue: Rm 1.35 New Physics Building, UWC

Abstract: In recent years, measurements of cosmological parameters coming from different observables have shown tensions between each other, the most striking the approximately 4.5 sigma tension on the Hubble constant between CMB and local measurements. In this talk I will briefly review the status of these tensions and some attempts to solve them modifying the late time evolution of the Universe. I will focus on a specific model, where Vacuum energy and Dark Matter interact with each other, and I will investigate the possibility that unaccounted systematic effects in Supernovae observations might help to reduce these tensions.

Title: Importance of WN stars on the ionisation and chemical evolution of galaxies

Speaker: Arpita Roy (Australian National University)

Date: 18 March

Time: 11h30 – 12h30

Venue: Rm 1.35 New Physics Building, UWC

Abstract: Massive stars are primary sources of chemical yields and mechanical and ionization luminosity budgets. Therefore, understanding massive stars' evolution is crucial to have a complete understanding of the chemical and ionization evolution of galaxies. Moreover, with the advent of instruments like MUSE, JWST (upcoming), HST, etc., we have (/are going to have) a comprehensive picture of the impact of dust-masked massive stars in the evolution of galaxies for the wide range of wavebands starting from IR to optical to UV. The evolutionary paths taken by very massive stars, M > 60MSun, remain substantially uncertain: they begin their lives as main sequence O stars, but, depending on their masses, rotation rates, and metallicities, can then pass through a wide range of evolutionary states, yielding an equally broad set of possible surface compositions and spectral classifications. The surface enrichment of He and N is quite common in rotating WNL stars, but the WNL-like surface elemental abundances in slow rotators, as observed by Herrero et al. 2000, Vink et al. 2017, etc., puzzled astronomers for almost two decades. Meynet & Maeder (2000) hypothesised that an exotic scenario of stellar spin-down needs to be invoked in order to explain the origin of these unusually high surface enriched slow rotators. Contrary to this hypothesis, I discovered that these nonrotating metal-rich stars reveal the products of nucleosynthesis on their surfaces because even modest amounts of mass loss expose their "fossil"-convective cores: regions that are no longer convective, but which were part of the convective core at an early stage in the star's evolution. This mechanism provides a natural explanation for the origin of metal-rich ([Fe/H] ≥ -1.0) slowly-rotating WNL stars without any need for exotic spin-downs. These stars have a huge impact on determining the chemical evolution of galaxies at high redshift. I will also discuss the impact of these stars on determining the ionisation budgets in different wavebands.

Title : Receiving Credit for Research Software
Speaker**:** Alice Allen (Astrophysics Source Code Library)
Date**:** 20 March
Time**:** 11h30 – 12h30
Venue: Rm 1.35 New Physics Building, UWC

Abstract: Journal articles detail the general logic behind new results and ideas, but often the source codes that enable these results remain hidden from public view and those who author these computational methods have not always received credit for their work. This presentation will cover recent changes in astronomy, and indeed, in many other disciplines, that include new journals, policy changes for existing journals, community resources such as the Astrophysics Source Code Library, changes to infrastructure, and availability of new workflows that make recognizing the contributions of software authors easier. This talk will include steps coders can take to increase the probability of having their software cited correctly and steps researchers can take to improve their articles by including citations for the computational methods that enabled their research.

The **Astronomical Society of Southern Africa** (ASSA) was formed in 1922 by the amalgamation of the Cape Astronomical Association (founded 1912) and the Johannesburg Astronomical Association (founded 1918). It is a body consisting of both amateur and professional astronomers.

Publications: The Society publishes its electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* bi-monthly as well as the annual *Sky Guide Africa South.*

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