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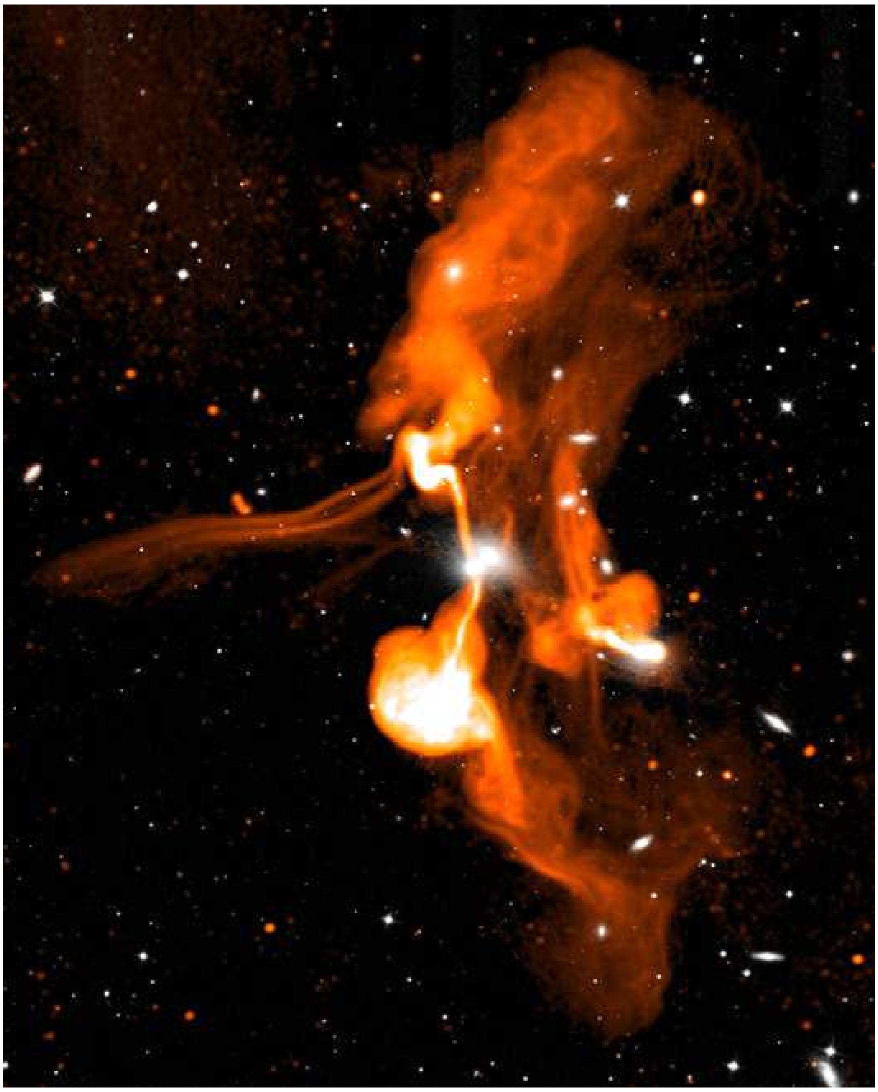

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mnassa

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Editorial Note

In the last edition of *MNASSA*, Volume 80 Nos 9 and 10, October 2021 an article on the Fireball in the Western Cape, Event 403, was unfortunately truncated during the process of publication. The author, Mr Tim Cooper has kindly included it in his current article, on page 195 and full details of Event 403 are updated and complete.

News Note: MeerKAT Data Release Reveals Beautiful New Cosmic Puzzles

An international team led by a young South African researcher has just announced a comprehensive overview paper for the MeerKAT Galaxy Cluster Legacy Survey (MGCLS). The paper to be published in the Astronomy & Astrophysics journal presents some exciting, novel results, and is accompanied by the public release of a huge trove of curated data now available for astronomers worldwide to address a variety of challenging questions, such as those relating to the formation and evolution of galaxies throughout the universe.

Using the South African Radio Astronomy Observatory's MeerKAT telescope, located in the Karoo region of the Northern Cape province, this first observatory-led survey demonstrates MeerKAT's exceptional strengths by producing highly detailed and sensitive images of the radio emission from 115 clusters of galaxies. The observations, amounting to approximately 1000 hours of telescope time, were done in the year following the inauguration of MeerKAT in 2018.

Dr Sharmila Goedhart, SARAO head of commissioning and science operations, explained that in those days they were still characterizing the new telescope, while developing further capabilities required by numerous scientists, but they already knew that MeerKAT was already very capable for studies of this sort, and observed galaxy clusters as needed to fill gaps in the observing schedule.

This was only the start. More than two years of work followed to convert the raw data into radio images, using powerful computers, and to perform scientific analysis addressing a variety of topics. This was done by a large team of South African and international experts led by Dr Kenda Knowles of Rhodes University and SARAO.

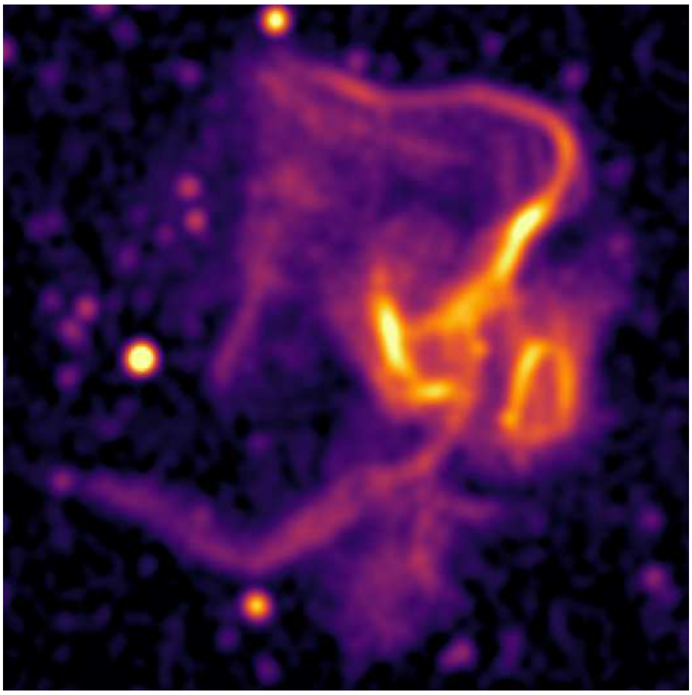

Fig 1. MeerKAT view of a complex network of radio filaments and diffuse structure, spanning more than half a million light-years, related to a galaxy affected by dynamical activity in the nearby galaxy cluster Abell 85. Adapted from K. Knowles et al., "The MeerKAT Galaxy Cluster Legacy Survey. I. Survey Overview and Highlights" (Astronomy & Astrophysics, in press). Image credit: SARAO.

The force of gravity has filled the expanding universe with objects extending over an astounding range of sizes, from comets that are 10 km (one thirty-thousandth of a light-second) across, to clusters of galaxies that can span 10 million light-years. These galaxy clusters are complex environments, host to thousands of galaxies, magnetic fields, and large regions – millions of light-years across – of extremely hot (millions of degrees) gas, electrons and protons moving close to the speed of light, and dark matter. Those 'relativistic' electrons, spiralling around the magnetic fields, produce the radio emission that MeerKAT can 'see' with unprecedented sensitivity, opening new horizons for the deeper understanding of these structures. Thus MeerKAT, particularly when adding information from optical and infrared and X-ray telescopes, is exceptionally well-suited to studying the interplay between the components that determine the evolution of galaxy clusters, the largest structures in the universe held together by gravity.

We live in an ocean of air, but we can't see it directly. However, if it's filled with smoke or dust or water droplets, then suddenly we can see the gusts and swirls, whether they're a gentle breeze or an approaching tornado. Similarly, the motions of the X-ray-glowing plasma in galaxy clusters are usually hidden from us. Radio emission from the sprinkling of relativistic electrons in this plasma can uncover the dramatic storms in clusters, stirred up when clusters collide with each other, or when jets of material spew out of supermassive black holes in the centres of galaxies.

The MGCLS paper just accepted for publication presents more than 50 newly discovered such patches of emission. Some of them we can understand and others remain a mystery, awaiting advances in our understanding of the physical behaviour of cluster plasmas. A few examples are shown here, some associated with the bright emission from so-called 'radio galaxies,' powered by the jets of supermassive black holes. Others are isolated features, illuminating winds and intergalactic shock waves in the surrounding plasma. Other types of science enriched by the MGCLS include the regulation of star formation in galaxies, the physical processes of jet interactions, the study of faint cooler hydrogen gas – the fuel of stars – in a variety of environments, and yet unknown investigations to be facilitated by serendipitous discoveries.

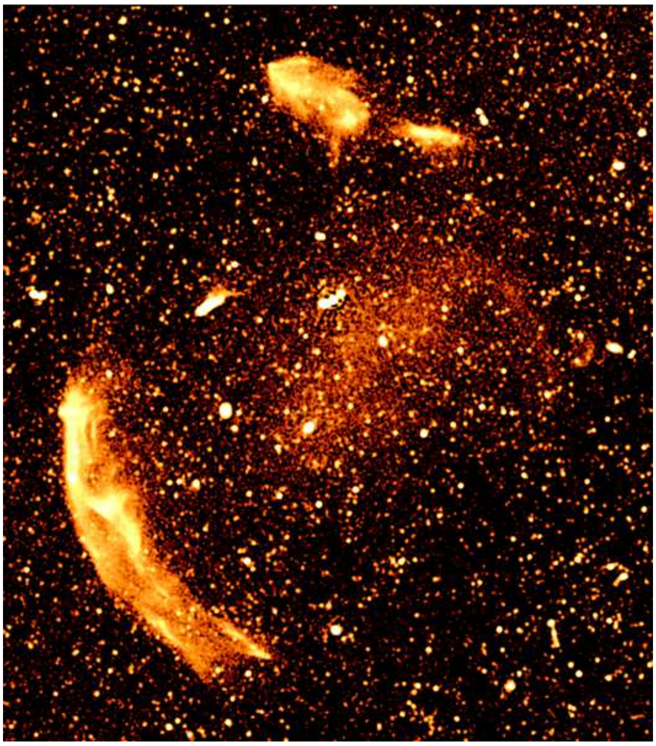

Fig 2. The MGCLS has revealed several new systems hosting faint sources on large scales. Here we see radio evidence of a powerful merger taking place between two or more massive groups of gas and galaxies. These structures (a so-called 'halo' near the centre and two 'relics' surrounding it are seen in the galaxy cluster MCXC J0352.4-7401) trace the positions and strengths of cosmic magnetic fields and electron populations travelling near the speed of light. This MeerKAT image spans approximately 10 million light-years at the distance of the cluster, and is sprinkled with point-like radio emission from even more distant Milky Way-like galaxies. Adapted from K. Knowles et al., "The MeerKAT Galaxy Cluster Legacy Survey. I. Survey Overview and Highlights" (Astronomy & Astrophysics, in press). Image credit: SARAO.

As explained by Dr Knowles, the MGCLS has produced detailed images of the extremely faint radio sky, while surveying a very large volume of space. This enabled them to serendipitously discover rare kinds of galaxies, interactions, and diffuse features of radio emission, many of them quite beautiful; but this was only the beginning.

A number of additional studies delving more deeply into some of the initial discoveries are already underway by members of the MGCLS team. Beyond that, the richness of the science resulting from the MGCLS is expected to grow over the coming years, as astronomers from around the world download the data from the SARAO MeerKAT archive, and probe it to answer their own questions.

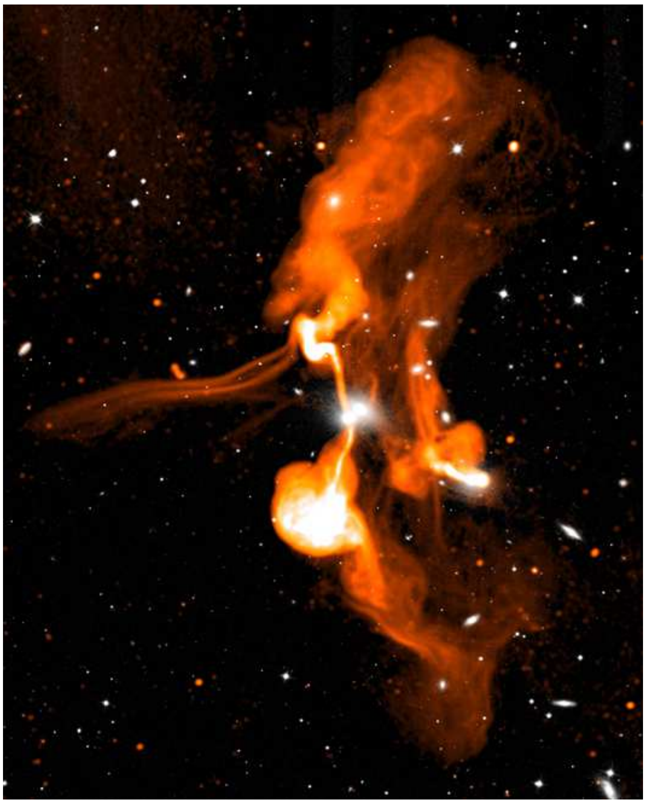

Fig 3. Two giant radio galaxies (more than one million light-years from end to end) at the center of a large group of galaxies in the cluster Abell 194, revealing the presence of relatively narrow magnetic filaments in the region, as well as complex interactions between the radio emission from the two galaxies. The MeerKAT radio image is shown in orange, with an optical image dominated by normal galaxies shown in white. Adapted from K. Knowles et al., "The MeerKAT Galaxy Cluster Legacy Survey. I. Survey Overview and Highlights" (Astronomy & Astrophysics, in press). Image credit: SARAO, SDSS.

-Press Release - 11 November 2021

News Note: MeerKAT discovers mystery clouds

An international team led by astronomers Profs Gyula Józsa, Michelle Cluver, and Thomas Jarrett has utilized the South African MeerKAT radio telescope to discover a mysterious chain of hydrogen gas clouds the size of a massive galaxy.

The accumulation of so much elemental hydrogen without associated stellar components is the largest yet discovered. Appearing at the edge of a relatively massive group of galaxies, there is the possibility that the cloud chain is gas stripped from group-member galaxies, but it may also be primordial and gravitationally drawn into the group through a cosmic filament pathway. Whatever the case, MeerKAT is proving to be a ground-breaking telescope, and this "dark" cloud discovery should soon be followed by many such discoveries in the exciting days ahead.

The discovery of the mystery clouds will be published in the renowned Astrophysical Journal under the title: "The detection of a massive chain of dark HI clouds in the GAMA G23 Field".

Fig 1. Overlay of MeerKAT 21-cm neutral hydrogen gas on deep optical image (g, r, i).

Prof Cluver from Swinburne University explained that cosmic filaments are the highways along which mass concentrations come together under the action of gravity. They expect gas-rich galaxies to be associated with these structures, using their neutral hydrogen as fuel for star formation and growth. They therefore designed their blind shallow survey to search for this type of gas along such a filament. And indeed they found gas in many galaxies, but they did not expect anything like these clouds. They form a huge complex of tenuous atomic hydrogen gas that stretches over a distance of 1.3 million light years. Seven spots of concentrated gas can be discerned from the complex.

The puzzling thing: despite its extraordinarily large gas mass (equivalent to 10 billion of our Sun's mass), there are close to no stars in the vicinity of the complex. Normally, any cool gas like atomic hydrogen is associated with their 'home' galaxy, where the gas reservoir continues to feed and grow the galaxy over eons of time. Such a large cloud simply cannot survive on its own: floating freely, the local environment is far too harsh as it gets heated up and ionised by the radiation from surrounding galaxies. Only the gravitational pull of a galaxy can, in principle, compact a cloud to a degree where it gets dense enough to create a natural shield against the cosmic background radiation.

Professor Jarrett from the University of Cape Town said that they were very surprised that they did not find any indication of a significant amount of stars, despite their thorough search using very deep ultraviolet, optical and infrared imaging. There have to be stars, it's inconceivable for a cloud the size of a galaxy to simply be floating in space!

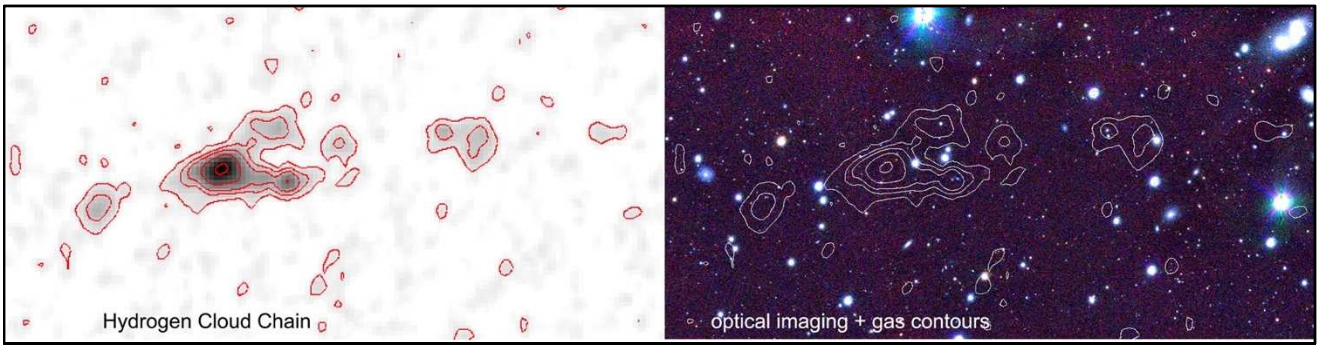

Fig 2. Dark Cloud Chain as seen in the neutral hydrogen (left) and deep optical imaging (right). No evidence of a "host" galaxy is seen at the central position of the massive cloud.

There is one possible exception to this, where a small dwarf galaxy is seen close to one corner quadrant of the cloud complex, leaving at least six dark clouds. Yet it is far too small to possibly be the origin of all this gas. Prof Józsa from the Max-Planck-Institute for Radio Astronomy and Rhodes University explained that only a handful of cloud complexes with similarities to this one are known and our new discovery seems to differ in quite some key aspects. The simplest explanation would be that of a tidal interaction between galaxies, the gas being ripped out of the host galaxies in a close encounter. But how the six of seven supermassive concentrations without any stars can be formed in such an event still needs to be explained.

No obvious connection to any donor galaxy is evident from the data. The existence of these "dark clouds" is hence a mystery yet to be solved. Maybe the complex enters the group for the first time, consisting of primordial gas gravitationally pulled into the galaxy group along a cosmic filament. Now that the clouds have been discovered, the researchers hope that it will be possible to learn about their origin using dedicated, much deeper, observations with several telescopes in the southern hemisphere. Solving this puzzle could have interesting implications for our understanding of the role that atomic hydrogen plays in how galaxies evolve in large scale structures.

-SARAO Press release

News Note: Namibia to host first millimeter-wave radio telescope in Africa

The Swedish-ESO Submillimetre Telescope (SEST) reflects starlight from the sky above La Silla, ESO's original observatory. Though now decommissioned, SEST was the only large sub-millimetre telescope in the southern hemisphere at the time of its first light, and helped pave the way for APEX and ALMA. During its operations, the instrument SIMBA was installed on it, measuring radio waves and allowing astronomers to study celestial objects including planet-forming discs around nearby stars, and distant galaxies of the early Universe. La Silla, which hosts several national telescopes, was inaugurated in 1969, and celebrates its 50th anniversary this year. It is situated at an altitude of 2400 metres in the outskirts of the Chilean Atacama Desert, where it enjoys more than 300 clear nights per year. It remains scientifically relevant among newer observatories; over 300 refereed publications per year are attributable to La Silla's work, making it one of the most productive observatories in the world.

Thanks to Radboud University's commitment of ten years of funding and support to the Africa Millimetre Telescope in partnership with UNAM, Namibia is poised to remain a significant location for space research.

This development has set in motion the start of the Africa Millimetre Telescope (AMT) project in Namibia – which aims to realise a radio telescope in the country. In addition, Radboud University guarantees a scientific and technical contribution to the Event Horizon Telescope consortium for the next ten years.

The first ever image of a black hole released in 2019 could only be taken using a global network of telescopes known as the Event Horizon Telescope (EHT). However, the addition of a telescope in Africa is necessary in order to improve future measurements and even create videos of black holes.

The AMT will be the first radio telescope in Africa that is sensitive to millimetre wavelength radiation. It is part of a large collaborative project between Radboud University, the University of Namibia (UNAM) and various international partners. The main goal of the project is to expand the telescope network of the Event Horizon Telescope with a radio telescope in Namibia.

The addition of the AMT to the EHT network, will increase the number of connections between the telescopes, thus allowing for better images and videos to be taken of the black hole at the centre of our galaxy. This will enable further tests on theories of black holes and understand how they generate gigantic amounts of energy says Heino Falcke, Principal Investigator (PI) of the project, who initiated it together with UNAM's Prof. Michael Backes.

The AMT will also work as a stand-alone telescope – the only one of its kind in all of Africa. The telescope can monitor variations in brightness of small and large black holes, which it will also do in collaboration with optical telescopes and gamma-ray telescopes such as H.E.S.S. in Namibia and the planned CTA in Chile. Astrophysical objects such as black holes can best be understood be when observed at the same time with different types of telescopes. Hence, the proximity of H.E.S.S. and the AMT is ideally suited to study the Universe, even more so, considering also the close-by telescopes in South Africa: SALT in the optical and MeerKAT in the radio regime, according to Backes, Co-PI of the AMT and Namibia's group leader for H.E.S.S.

The telescope, which will have a diameter of 15 m, will be built according to a tried-out design and will be equipped with latest generation instruments. Similar telescopes have already been realised at the European Southern Observatory (ESO) in Chile and at the Institut de Radioastronomie Millimétrique (IRAM) on the Plateau de Bure in the French Alps. The AMT shall be powered in a sustainable manner, by using solar power, wind energy and possibly hydrogen.

Fig 1. Proposed Africa Sub-millimetre Telescope.

Radboud University will guarantee €1m pa to be used for the management and utilisation of the telescope, and participation in the EHT. The guarantee is granted for the coming ten years. The money will be disbursed in phases, based on the project's progress as well as to raising external funds and means. In addition, Radboud University guarantees an investment of 1.9m for the realisation of the telescope itself.

The guarantee of Radboud University sets a good foundation for the applications for further grants and investments.

According to Han van Krieken, Rector Magnificus of Radboud University, this concerns appealing fundamental research that can only be carried out with large investments and long-term international collaboration. Radboud University researchers can keep contributing to this project over the following years and remain in a leading role.

The University of Namibia, together with local partners, are equally responsible for the realisation and the management of the telescope. This opens unique opportunities for astronomy in Namibia to conduct its own research and strengthen its position in science

In order to prepare the next generation of Namibians for the AMT, the project has its own education and outreach programme, co-lead by UNAM's Dr Eli Kasai, which has an active collaboration with partners from the local industry. For example, the first Namibian PhD candidate in the AMT Fellowship Programme will start in January 2022, and it is envisioned that from the summer of 2022 on, they will travel around Namibia visiting primary schools with a mobile planetarium.

UNAM Vice-Chancellor, Prof. Kenneth Matengu, mentioned that in many African communities, space is of symbolic significance. The AMT will function as a lighthouse project for the next generation of Namibian engineers and scientists in general. In particular, it provides UNAM with the unique opportunity to participate in progressive and international projects that can help science reach new heights. I look forward to exciting times.

The Radboud Radio Lab will carry out the technical side of the project, supported by UNAM's School of Engineering. With this unique support from Radboud University, the realisation of the AMT telescope five years from now is becoming a reality. The AMT is excellent science *in* Namibia and *with* Namibia, and the country is truly grateful for the great collaboration.

The AMT project is a paragon of international collaboration: partners like Rössing Foundation, Walvis Bay Corridor Group, and KLM already signed support statements in 2019. The research programme for AMT is being prepared by scientists from the University of Amsterdam, MIT, ESO, Oxford University, University of Turku, the Joint Institute for VLBI-ERIC (JIVE), UNAM, and others. There are also ongoing negotiations with additional parties regarding their participation in the project.

Within the EHT, Radboud University already collaborates with the European stakeholders such as the Max Planck Gesellschaft, Goethe Universität Frankfurt, and the Institut de Radioastronomie Millimétrique.

Huib Jan van Langevelde, the director of the EHT (JIVE Dwingeloo/Leiden University), is enthusiastic about the Radboud University's guarantee. He endorses the importance of the support for the AMT project. He sees the AMT is an essential expansion from Europe to the global network and an important step towards improving the future of science by way of the Event Horizon Telescope.

News Note: OAD Director Summarizes the First Decade

Kevin Govender, Director, IAU Office of Astronomy for Development

In 2008, when George Miley asked me to participate in a brainstorm around an IAU strategy, I was deeply honoured. I never imagined that, 13 years later, we would be looking back at a decade of the Office of Astronomy for Development (OAD) – a structure that was set up to implement the very plan that was born out of that 2008 meeting. Since that meeting, there have been many celebrated occasions: in 2009 the IAU Strategic plan 2010-2020 was ratified by the General Assembly in Brazil; in 2010 South Africa won the bid to host the OAD, which would be key to implementing that plan; in 2011 the OAD was launched in Cape Town, South Africa; at the 2012 IAU General Assembly in China, the OAD made its first impressions on the IAU membership, establishing strongly the importance of astronomy for development (as compared to developing astronomy) and kicking off its first two regional offices. By the 2015 IAU General Assembly in the US, the OAD had established 9 regional offices and a resolution for its continuation was adopted. In 2016, the OAD achieved significant recognition through the award of the Edinburgh Medal and at the 2018 General Assembly, a new IAU strategic plan was adopted for the 2020–2030 decade, with the OAD featuring significantly with a clear mandate distinct from its sister offices.

When the global pandemic struck in 2020, the OAD had 11 regional offices in place and was experienced and agile enough to quickly react to the situation with an extraordinary call for COVID-related projects. Now, in 2021, as the OAD celebrates its 10th anniversary as well as a very positive external review, we do so in a world very different from the one in 2008. It is a world that has changed and continues to change rapidly, as disease, climate and other challenges threaten life as we know it.

The OAD and its global network are well placed to act constructively in such a landscape – in fact, it has always been built into our DNA that we should continue to find ways in which we can help make the world a better place, addressing the challenges we face as humanity. The foundations of the OAD have been built on humility, openness and inclusion – the projects supported by the OAD come from communities around the world who themselves identify needs and design activities to address them. We have recognised, however, the essential need for interdisciplinary conversations in order to maximise the potential impact that astronomy, in all its aspects, can have on furthering sustainable development. The three flagships identified from OAD activities over the years (in short, astronomy for economic development; astronomy for humanity; and astronomy skills for development) all require partners from fields outside of astronomy in order to realise the global impact. They also require funding and we are fortunate to now have the IAU fundraiser to support such activities.

The OAD’s location on the African continent was not entirely coincidental. In the original discussions, and during the initial years of the OAD, there was a specific intention to focus on Africa due to the levels of developmental need as well as the potential of astronomy to make a significant impact on the continent’s trajectory. This potential has been recognised by a number of African leaders who have driven efforts to leverage the field of astronomy for Africa’s growth and development. In 2024, the IAU General Assembly will take place in Africa for the first time, and the OAD will be intimately involved in making this a significant event both for the continent and for the OAD’s work globally.

On the occasion of this 10th anniversary of the OAD, it is paramount to recognise all the individuals and organisations who make the OAD what it is.

Without mentioning individual names, I would like to state, without reservation, that the OAD would not be what it is, nor achieved what it has without the ongoing support of the core OAD team in Cape Town; the remote teams of reviewers, fellows and volunteers around the world; the 11 regional offices and their respective teams; the many project leaders and communities supported through the call for proposals; and of course our dedicated Steering Committee and principal organisations, the International Astronomical Union (IAU), and the National Research Foundation (NRF) and the Department of Science and Innovation (DSI) of South Africa. It is this global team of stakeholders who have contributed to the ongoing endeavour of using astronomy to make the world a better place!

Recent Southern African Fireball Observations Events # 396-405

Tim Cooper, Comet, Asteroid and Meteor Specialist, ASSA

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]. Where the report originated from the American Meteor Society Fireball page, the corresponding AMS event number is given. AMS reports are courtesy of Robert Lunsford. All times were converted to UT unless stated, and all coordinates are for epoch J2000.0. Descent angles, if given, are in degrees, with directly upwards = 0°, horizontally left to right = 90°, directly downwards = 180° and horizontally right to left = 270°.

Event 396 – 2021 April 20 – Rustenburg, North West

Observed by Edwin Radiokana at 04h09, travelling in direction 222° on Dr Moroka St, Rustenburg, twilight was already well advanced, when he saw a large yellow ball with blue green tail, said 'like the colour of the aurora', duration 1-2 seconds, ending in a terminal flash to m_v = –9 and suddenly disappeared. Path from az/alt 242°, 41° to 239°, 39°, that is RA/Dec. 16h06, –37° to 15h54, –39°. There is a good agreement with the source of the Anthelion meteors. AMS Fireball Report 2398-2021.

Event 397 – 2021 May 2 – Langebaan, Western Cape

Observed by Katherine Thomson at about 18h15, sitting outside with a friend when she saw a 'bright orange ball which looked like a big star' with orange tail, duration less than three seconds, no fragmentation, and path from approximately az/alt 76°, 12° to 95°, 15°, or RA/Dec. 15h00, +05° to 15h30, –12°. The event does not coincide with any known radiants and was a sporadic fireball.

Event 398 – 2021 May 18 – Steytlerville, Eastern Cape

Observed by Frans Koekemoer at about 07h25, bright fireball seen in daylight, looked up and saw a bright ball with tail with fragments breaking off, very fast moving and duration less than one second, and lost sight of it when it passed below the Baviaanskloof Mountains due south. Frans said it appeared to be very close. The altitude of the mountain ridge as seen from the location is 14°. Descent angle 120°, path from az/alt approximately 120°, 48° to 180°, 14°, that is RA/Dec. 04h25, –44° to 12h48, –70°. The path is consistent with the radiant of the Helion meteors.

Event 399 – 2021 June 21 – Roodepoort, Gauteng

Observed by Micah Potgieter and Gerhard Nagel at 18h25, duration 3-4 seconds, bright blue-green colour about as bright as the moon which was then 87%

illuminated, magnitude –12.0, altitude 74° in azimuth 49°. Micah saw the fireball through a west-facing window, 'fuzzy appearance, looked like it had flames' and lost sight of it when it descended below a neighbouring rooftop. Gerhard was cycling nearby and confirmed the short path downwards toward his right. Left persistent train for 2 seconds. From Micah's description, path very approximately from az/alt 260°, 30° to 265°, 15°, that is RA/Dec. 09h54, –20° to 09h00, –11°. Descent angle 150°. The fireball probably emanated from one of the many radiants active around Scorpius and Sagittarius during June. AMS Fireball Report 3493-2021.

Event 400 – 2021 July 14 – Durban West, KwaZulu-Natal

Observed by Ewan McPhail at 02h12, duration 7-8 seconds, orange, yellow and white colours were seen, m_v estimated about –9. Path from az/alt 180°, 26° to 125°, 29°, that is RA/Dec. 12h06, –86° to 04h52, –43°, path length 48° and the fireball left a persistent train of about 10° visible as a 'short whitish smoke trail, which disappeared quickly into the dark'. The path does not coincide with any known radiants and the event was sporadic. AMS Fireball Report 3814-2021

Event 401 – 2021 August 8, 23h00 UT (August 9, 01h00 SAST) – various locations from Riversdale to George, Western Cape

Several persons reported hearing sounds at around 1am local time on the morning of August 9. Locations included Riversdale, Mossel Bay, Oudtshoorn, Boggoms Bay, George, Hartenbos, Klein Brak River, Wilderness and De Rust, spanning a horizontal distance of around 115 km. The most westerly location where sounds were reported was Riversdale, where it was described as a rumble, like distant thunder. The most easterly was from several observers in the environs of George, where the sounds were mostly described as rumbling like thunder. From Oudtshoorn the sound was also likened to distant thunder. Others said it sounded like an explosion, houses shook and windows rattled.

Only three visual sightings were received of the bolide. The best description was received from Ted Nutting, who was outdoors at the time and saw the passage of a bright green fireball in a clear sky, duration about 4 seconds moving west to east, and disintegrated into four or five fragments with a bright flash before disappearing. Sounds were heard about two minutes later, as up to four distinct 'bangs' and tailing off afterwards like the sound of a jet flying over. Triangulation of the start and end points gives a tentative path from west to east, seen towards the north from George, but to the south from near De Rust, where the start and end azimuths were 230° and 180° respectively, travelling parallel to a rooftop, at altitude 60-70°. Frankie Dos Santos saw the bolide through a window facing azimuth 330° from Hoekwil, near Wilderness. He described the fireball as 'very bright, much bigger than a normal shooting star', moving left to right (towards north east) at an altitude of about 45°, and very fast with a duration of about a second. The sky was overcast with thin patchy clouds and the appearance was like seeing car headlights through fog. Johan Venter observed from Vleesbaai looking north over the bay and saw the fireball as 'a ray of light moving very fast, slanting towards the ground, from left to right, [i.e. towards east], from az/alt 10°, 30° to 25°, 20°, where it exploded. It looked like a shooting star that was very close and then a big explosion'. He estimated the size as about a quarter to a third the size of the moon. From these descriptions the bolide possibly began ablation near overhead and just south of Oudtshoorn, and disrupted in the vicinity above Kammanassie Nature Reserve. Fragments may have fallen as meteorites near to the Kammanassie Mountain range.

In order to determine the fall location of possible meteorites, sufficient video footage is required which shows either the passage and disruption of the bolide, or shadows cast by the flash, which are in the anti-direction of the disruption. Unfortunately, despite requests on various forums to check security cameras, only one clip was received, from Godwin Pangel in George. The clip shows a brief very bright flash, with duration less than 1 second, and was followed 2m56s later by a booming sound. The sky is seen to be mainly overcast at the time of the bright flash. The video footage was calibrated against internet time to give the time of the flash as August 9, 01:00:30 SAST.

The event was not detected by NASA fireball detectors, neither were there any reports to the ASSA, AMS nor IMO reporting forums. I conclude that a bright bolide passed roughly west to east over the Western Cape, disrupting with a bright flash, and with accompanying sounds. Insufficient video evidence could be obtained that could have enabled determination of a strewn field site for meteorites. A separate report on the bolide along with a tentative path appeared in MNASSA, Vol. 80, pp137-141.

Event 402 – 2021 September 11 – Emalahleni, Mpumalanga
Observed by Henry Hartman at 00h43, duration 1-2 seconds, light blue-green fireball given as m_v = –10, descent angle 180°, dropping vertically in azimuth 129° from altitude 65° to 19°, that is from RA/Dec. 03h43, –40° to 07h51, –43°, path length 46°. The fireball was last seen when it passed below the level of a roof. The brightness estimate is about that of a 30% crescent moon, which was not visible at the time. The path is consistent with the location of the Anthelion radiants during September. AMS Fireball Report 5607-2021

Event 403 – 2021 September 24 – various locations Western and Northern Cape
A bright fireball was widely observed at 17h24, crossing the coast around Mossel Bay and heading northwards. There was good agreement in the observations from

southern locations which allowed determination of the heading, but a lack of reports from further north did not permit the endpoint with any certainty.

Francois le Roux saw the fireball from Hartenbos, descending vertically in azimuth 345° from altitude 33°, undergoing two bursts towards the end before terminating at altitude 15° with a bright flash. Colour was bright white. Brightness 4-5 times that of Venus, which was then in azimuth 268°, altitude 31°, magnitude –4.2, so $m_v \sim -6$. Duration 3-5 seconds. No sounds heard.

Several reports were received from De Rust. Diane McLean saw it descending vertically in azimuth 334°, duration 2-3 seconds before it descended below the Swartberg mountains which extend to altitude 8° in that direction from her location. A greenish glow followed after the fireball disappeared behind the ridge. Lanie-Marie Roets turned to see the fireball after hearing friends exclaim, just in time to see it before it dropped beneath the mountain ridge in direction NNW (azimuth ~330°). She estimated she saw it for perhaps 2-3 seconds and gave the colour as green. There was no disintegration during the time it was in view. Johan de Villiers observed the fireball with a long bright tail and colours seen were yellow, orange and bright white. Facing north, the fireball came from south, moving slightly left of overhead, and dipped below the mountain ridge, following which the whole scene lit up in that direction. Hermann Niebuhr saw the fireball as a long streak, very bright with a long tail moving south to north over the Swartberg. It was orange with a green glow, and Hermann said it was 'magical'.

Pieter Fourie was camping at Groot Brakrivier, when he saw the very bright fireball as a disk surrounded by a greenish glow, falling vertically very close to north (azimuth 0°) and disappearing behind a nearby hill at altitude 7°. He specifically commented that the path was straight down and appeared to show no lateral movement.

Eddy Nijeboer was adjusting the 8-inch Meade SCT on the lawn at his Leeuwenboschfontein Observatory, while facing north his attention turned to a bright light to his right. He saw the fireball at altitude 70° in direction ENE (azimuth 60°) falling rapidly towards north, duration 3-4 seconds, and lost sight of it as it passed below the Swartberg mountains about 20° altitude in azimuth 30°. He was not sure how long after the start of ablation he saw the fireball. Colour was blue/green and brightness about 1.5 times that of Venus, so $m_v \sim -5$. Before disappearing behind mountains the fireball broke into four pieces, with one larger main body and three small fragments. There was no sign of explosion, no persistent glow and no sounds heard.

Further north, Alta Groenewald observed from Bloukop near Tankwa in the Karoo, seeing a yellow/green light moving in a northerly direction. She gave the time as 17h20 and said it looked very big and close and thought it was going to hit the ground directly to the north of her. Sunel van Rensburg was driving in direction 300° west of Britstown when she saw the fireball to the left of the vehicle, appeared to be low towards the west and heading in the same direction. Large green ball, heading downwards, she thought the height was just above the vehicle, duration 2-3 seconds before burning out. She specifically commented on the size, which was similar to that of a 'soccer ball', and definite green colour. Friends with whom she had been visiting also saw the fireball, and agreed it burned out low towards the west.

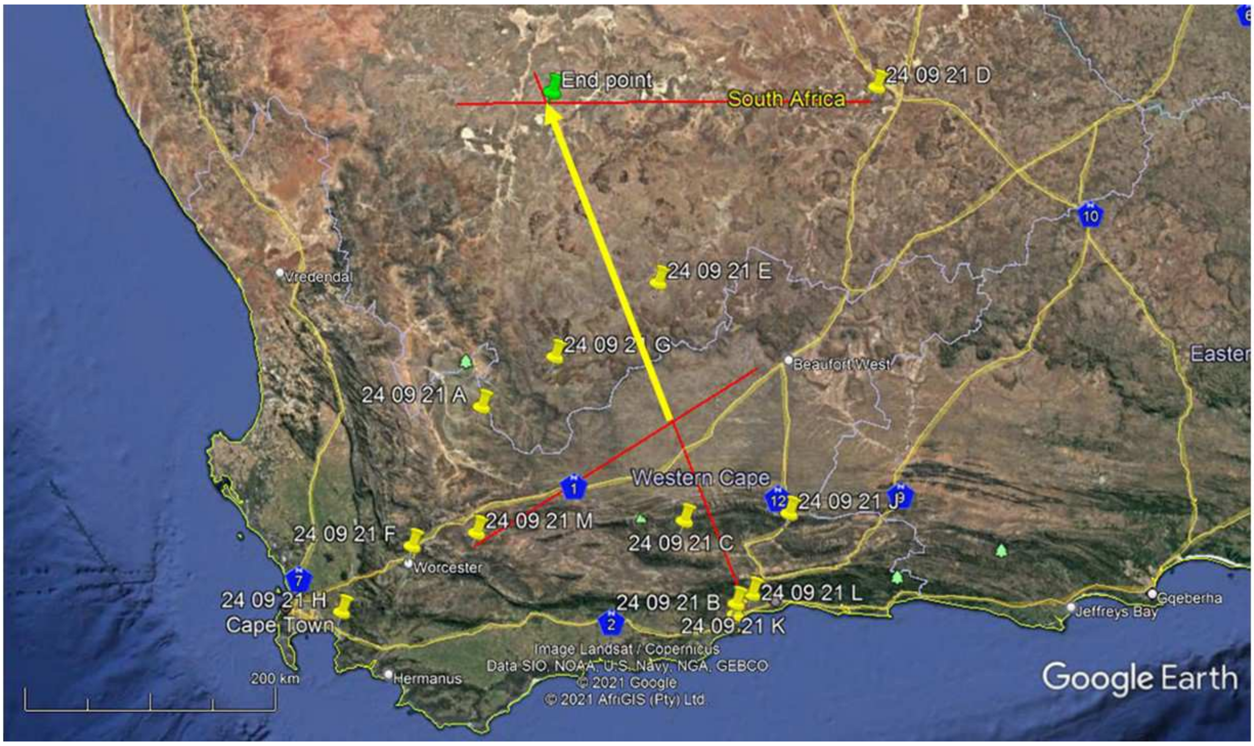

Fig 1. Possible path of event 403

Based on the reports received, a tentative path is shown in Figure 1. While the direction is fairly certain, the actual start and end of ablation are less well defined. The southern limit is taken from the observations of Eddy Nijeboer and Francois le Roux, though both may not have seen the actual start of the visible passage, while Sunel van Rensburg's observation that it burnt out to her west is taken as the northern limit. On that basis ablation began about 30 km west of Leeu Gamka, and terminated with a bright flash about 25km south east of Brandvlei in the Northern Cape. Length of path is about 250km, with an entry angle about 10-15°. While there were reports of a terminal flash, there were no reports of explosions.

The diversity of colours seen is common for bright and energetic fireballs. The colour of meteors depends on the composition of the impacting body, its speed, entry angle and free path through the atmosphere, and the density of atmospheric gases in the layers of atmosphere it traverses. Light is emitted from excitation and subsequent decay due to mainly elemental calcium, magnesium, silicon, and occasionally sodium in the meteor, as well as that of atmospheric gases, principally oxygen and nitrogen. The ultimate colour is determined by which processes predominate, and taking into account that perception of colour varies from person to person. Most agreed on white and green as the predominant colours, with a lesser number of yellow, orange and reds, as well as blue. However most commented on the green colour of the fireball, often due to magnesium emission, but more probably due to the auroral line of atmospheric oxygen at 557.7 nm. Also, unlike the case with Event 401 seen over a similar area, there were no reports of explosions or sounds associated with this event. Therefore Event 403 is not classified as a bolide, but was a bright fireball. Plotting the path as seen from the southern locations on gnomonic charts, there is no alignment with any known meteor radiants, and the event was a bright sporadic fireball.

Event 404 – 2021 November 9 – Khuma, North West and Fochville, Gauteng

Observed by Barend Swanepoel at 19h05, brighter than the full moon [not visible at the time, see below], yellow/orange fireball with duration 3-4 seconds and leaving a persistent long glowing train visible for 3 seconds. Path from az/alt 35°, 65° to 357°, 20°, which is RA/Dec. 01h06, –06° to 23h52, 43°.

The fireball was captured on video by Mark Watts at 19h07, using a ZWO ASI120MM camera with wide angle lens. A screen grab of the fireball is shown in Figure 2. Path was right to left below the moon, which was then 31% illuminated and magnitude –10, descent angle 273°. Start and end points measured from screen grabs were RA/Dec. 22h11.8', –17°58' to 21h37.2', 08°40'. The fireball left a persistent train visible for about 8 minutes, and drifted over several minutes as shown in Figure 3.

Fig 2. Image of event 404 from Mark Watts. The 31% illuminated crescent moon is just outside top left of frame. Bright object to the right is Jupiter, and top right corner is Saturn.

Plotting Barend's visual path and Mark's video paths give a coincidence in the region of the constellation of Volans, and the event was sporadic. AMS Fireball Report 7487-2021.

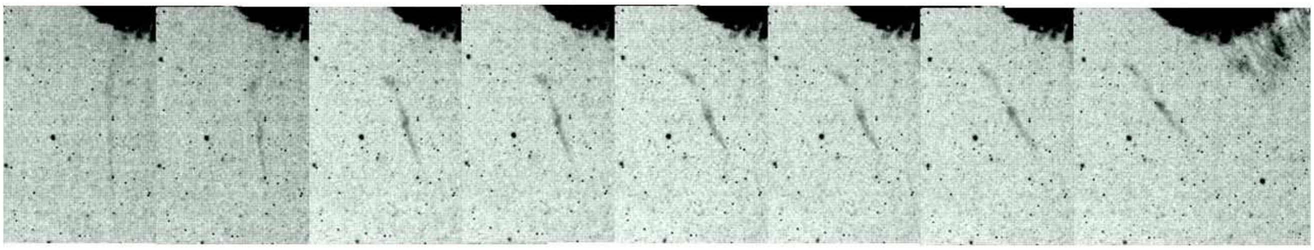

Fig 3. Persistent train from event 404, showing drift over several minutes. The screen grabs have been oriented 90° to the right in order to fit side by side.

Event 405 – 2021 November 9 – Aranos, Solitaire and Fish River Canyon, Namibia
Bright disintegrating fireball captured on video. Jens Viëtor captured the fireball from Namib Desert Lodge, Solitaire, Khomas Region, at 19h40. Camera time stamp was verified as correct and calibrated to internet time. Screen grabs from the footage were enhanced to reveal several stars which enabled accurate calibration. Path was from az/alt 159.8°, 11.4° to 151.8°, 3.3°, descent angle 223°, and duration in the video is 6.3 seconds. George van der Merwe captured the fireball from Knoppiesduin, Aranos, Hardap Region (see screen grab Figure 4), also giving the time as 19h40. Screen grabs were calibrated to give path from 235.8°, 10.4° to 226.7°, 4.4°, descent angle 231° and duration 7.0 seconds. Both reports gave the magnitude as –13 and the colour as white. Note however, the video cameras are set up for game viewing and operate in infra-red mode during the night which may have influenced the perception of brightness and colour.

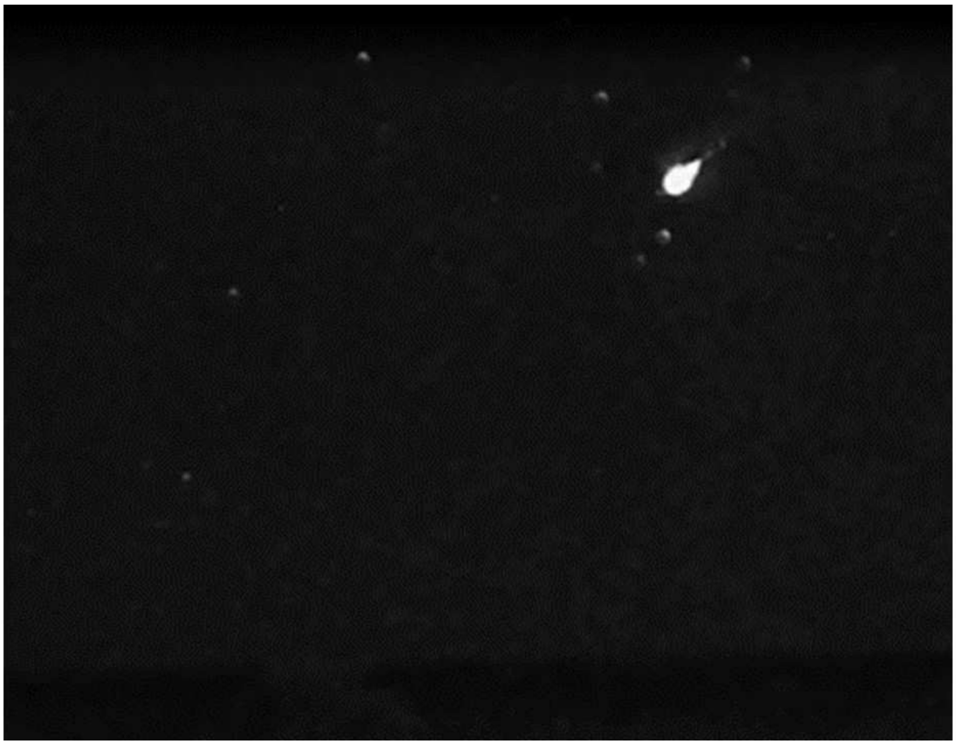

Fig 4. Screen grab of Event 405 from Knoppiesduin video, courtesy George van der Merwe. Stars in the tail of Scorpius are visible low above the horizon; immediately below the fireball is λ Scorpii (Shaula).

The fireball was also observed visually by several people, including Morné du Toit, Leez Hoevelmann, Katja Viëtor, Werner Haita and Mattanja van der Vis who were at Fish River Canyon Lodge. They saw the fireball moving to the north in direction of Keetmanshoop and described it 'as orange like fire'. An image provided from Google Earth shows the fireball moved descending left to right and low above the horizon from azimuth 240° to 290°. The direction is consistent with the calibrated videos and the fireball terminated about 70km west of Keetmanshoop. AMS Fireball Report 7488-2021.

Photographic plate measuring machines at the SAAO

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Abstract

For almost 100 years the photographic plate was the detector of choice for astronomical measurements, beginning *ca* 1880 when the technique became sensitive enough to record star images. This era however came to an end in the 21st century when electronic detectors supplanted plates thanks to their higher quantum efficiency and precision.

In this paper I describe briefly some of the photographic era instruments used at the Cape Observatory. Some of them are still extant but others, especially the big ones, have been scrapped in the interest of saving space. Very often these instruments were interesting precision devices and state-of-the-art at the time.

Introduction

Compared to eye measurements, photography achieved great success since it made observations impersonal and more reliable. Photographic imaging enabled many stars to be recorded at once. It yielded a permanent record that could be re-examined, for example to discover and investigate the history of variable and moving objects.

Nearly all astronomical photography was done with glass plates which offered greater stability than typical film materials. Many observatories built up large collections of plates and in some cases they have been digitized, though the longevity of digital media often does not match that of the original photographic materials, requiring re-recording every few years!

Photography was applied in two main areas:

- “Direct” imaging and cataloguing of the sky, yielding positions and magnitudes of the stars.
- The recording of the spectra of stars using spectrographs.

Photography brought with it many changes in technology at the Royal Observatory. This paper concentrates on one of them, namely the devices used to measure the images for extracting numerical data, whether to obtain star positions and magnitudes or to record the wavelengths and strengths of spectral lines.

To make the measurements, many special machines were devised. At first, plates were examined by eye with the aid of travelling microscopes and the results were written down in ledgers. As time went on the equipment became more sophisticated. Scales could be read electronically using optical encoders, photographic densities could be determined using photocells and image sizes could be measured impersonally. Later still, whole plates could be digitized with high resolution and the data recorded on computer-compatible media for extraction of the desired information using digital computers.

Position measurement

The Kapteyn “parallactic” plate measuring apparatus.

This instrument is not in fact one that was used at the Cape but is included because of its indirect connection and historical importance to us!

The need for a large-scale plate measurement programme came with *the Cape Photographic Durchmusterung* initiated by David Gill. The total number of stars in the CPD catalogue was 454875! They were measured under the care of his co-investigator Jacobus Kapteyn of Groningen, who designed an unusual, indeed unique, device to save a lot of the mathematical labour at the data reduction stage.

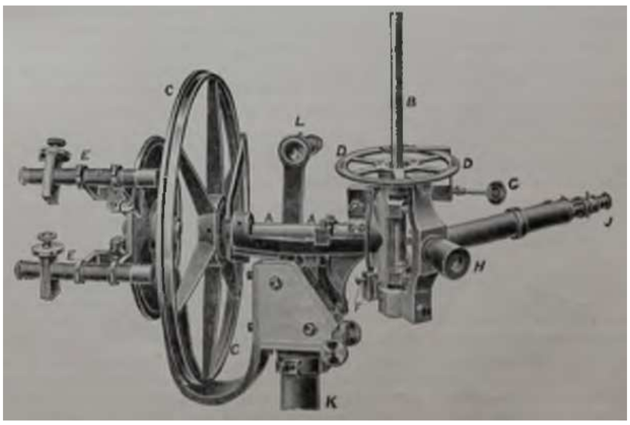


Fig 1. The Kapteyn parallactic measuring apparatus as illustrated in Gill (1913).

In his method, a plate was placed on a stand at a distance from the axis a of the machine, exactly equal to the focal length of the lens of the original telescope (137 cm). It then appeared to be on the same scale as the sky itself. A star image on the plate could be viewed through the telescope consisting of the eyepiece J and objective H (the telescope having a 90 elbow) – see Fig 1. The rest of the apparatus was used for measuring the declination with the circle D and the RA with the circle C. A secondary piece of apparatus held the plates themselves at the required distance. In spite of the simplicity, the precision achieved was better than that of the Northern equivalent, the *Bonner Durchmusterung*, where the stars were measured individually by eye using traditional instruments.

The measurements were made at Groningen and Kapteyn's instrument is still in existence there, in the University Museum. It was proposed to adopt it as the method for measuring the massive quantities of plates produced in the later international survey known as the *Carte du Ciel* (Astrographic Survey) but this idea was rejected in favour of manual measurement using x-y travelling microscopes which were thought to be more accurate.

Repsold/Gill Measuring Machine

Fig 2. The Gill measuring machine, built by Repsold of Hamburg. Two were constructed (SAAO Museum Cat. # M178, # M179).

See "On a New Instrument for Measuring Astrographic Plates" by Gill (1898).

Two of these instruments are in the SAAO Museum. They were Gill's answer to the *Carte du Ciel* question, at least so far as the Cape Zone between declinations −40° and −52° was concerned. They were delivered in 1897 and 1899. For some time, precise grids were imposed on the photographs so that only short offsets had to be measured. Grids were later abandoned.

Repsold plate measuring machine

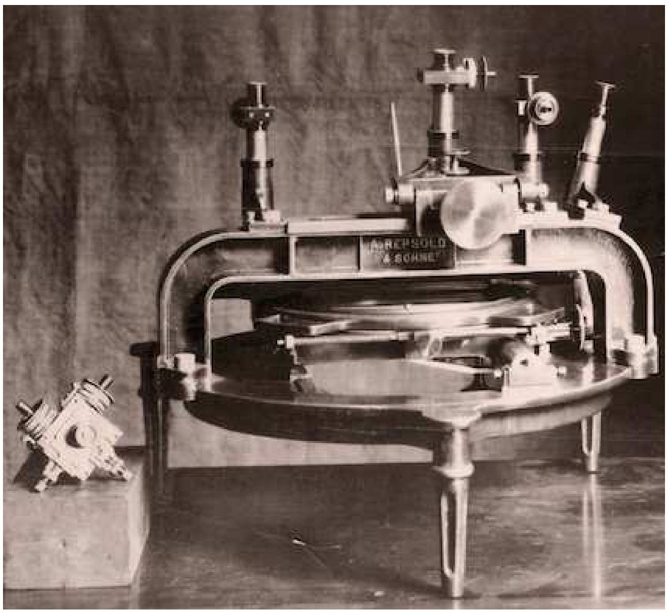


Fig 3. An x-y measuring machine by Repsold of Hamburg (SAAO photo P8793). From its resemblance to Fig 659 in Ambronn (1899) and its evident antiquity this photo may have been taken in Repsold's works.

SAAO possesses or possessed one of these machines. The first one of its kind was made for the measurement of eclipse plates by Repsold for van de Sande Bakhuyzen of Leiden in 1876 (van de Sande Bakhuyzen, MHG, 1892). It is described fully by this author and Ambronn (1899).

Our machine was altered in the 1970s to make it into a ruling engine. It was used to generate masks for the radial velocity spectrometer of the 1.9m telescope by LA Balona and to engrave graticules. Late 19th Century.

Current whereabouts unknown.

Toepfer measuring microscope.

Fig 4. Toepfer measuring microscope in SAAO Museum (Cat. # M149).

There is also an example in "Ingenium: Canadian Museum of Science and Innovation" and dated ca 1904.
Otto Toepfer & Sohn existed in Potsdam 1873-1919.
Housed in a glass and wood case.

Zeiss blink comparator

Fig 5. Zeiss blink comparator. Probably adapted from a viewer for stereoscopic plate pairs (SAAO Museum Cat. # M155).

Zeiss blink comparator, invented by Carl Pulfrich *ca* 1904. Used for comparing plates of the same area taken at different times to locate objects that had moved or changed brightness.

The nearest star, Proxima Cen, was found on a similar but larger version of this instrument by RTA Innes at the Union Observatory, Johannesburg. Unfortunately, Innes's instrument no longer exists.

Fig 6. RTA Innes with the Union Observatory's blink comparator with which he discovered Proxima Cen

in 1915 as a high proper-motion star (SAAO photo P1601).

Fig 7. Stereoscopic attachment for Zeiss Blink. This replaces the blink part (SAAO Museum Cat. # M064). In own wooden box.

Fig 8. X-Y measuring eyepiece believed to be an accessory for Zeiss blink. It appears to be an alternative eyepiece for the blink part (SAAO Museum Cat. # M132). Has own wooden box.

Hilger 2-coordinate plate measuring machine

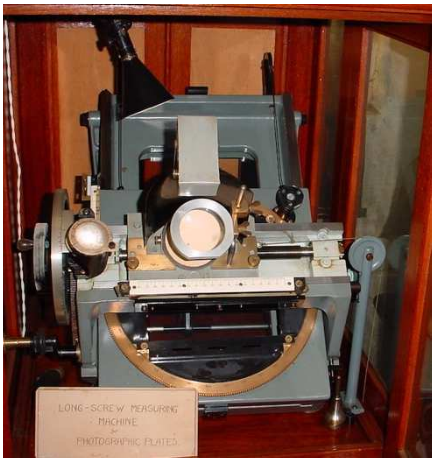


Fig 9. Hilger 2-coordinate measuring machine (SAAO Museum Cat. # M182).

Fig 10. The machine in use, probably in the 1960s (SAAO photo P4281).

Mann 2-dimensional measuring machine.

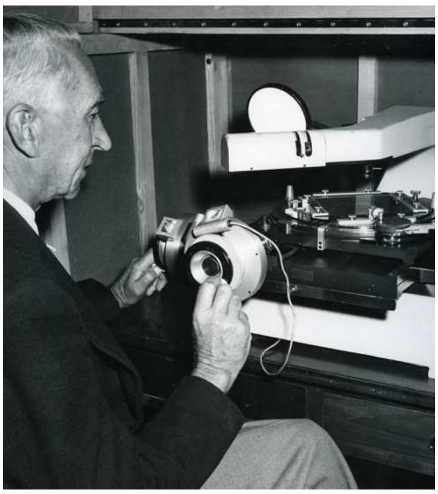


Fig 11. The Mann machine in use, probably in the 1960s. (SAAO photo P4280).

Acquired 1960 or before. Theo Russo at the controls. Parts of the instrument still exist in the Electronics Dept store. According to G. Roberts this machine suffered from backlash in the precision screws.

Zeiss 2-coordinate measuring machine.

Fig 12. Greg Roberts shown operating the Zeiss in March 1986. Photographer unknown (Photo courtesy of G Roberts).

Used mainly for parallax plates and astrometry. Machine no longer in existence.

Grubb Parsons blink comparator.

Fig 13. Remains of the Grubb Parsons Blink Comparator.

Used for finding variable stars. The remains of this instrument were photographed on a rubbish heap, November 2021. Originally purchased by Radcliffe Observatory, Pretoria, ca 1960, and moved to the Cape in 1974. Found in SAAO rubbish dump, Nov. 2021.

Spectroscopic Measurements

The McClean telescope had a multi-prism spectrograph and there was also a large laboratory spectrograph made by the Hilger company. Plates from the telescope normally had calibration spectra from a local gas discharge tube on each side of the star spectra.

The objective prism on the McClean telescope produced spectra of many stars in the field.

The 40-in (1.0m) telescope at Sutherland had the “Yapp” Cassegrain grating spectrograph attached during the early years of Sutherland (1970s) and produced plates with two different scales.

The 74-inch (1.9m) telescope while still in Pretoria had three different Newtonian spectrographs that produced tiny low-dispersion images. Later it was equipped with a large Cassegrain 2-prism spectrograph. The later Cassegrain "Unit Spectrograph" on the 74-inch (1.9m) telescope was used with various image tubes, including a McGee "Spectracon". Other plates were produced with its coudé spectrograph which has or had several cameras of different focal lengths. Several instruments were specifically for measuring these photographic spectra.

Zeiss double comparison microscope

Fig 14. Zeiss comparison microscope (SAAO Museum Cat. # M037).

For measuring spectra. A precise scale engraved on glass was placed under one microscope and a spectroscopic plate under the other. With own box. It appears in a German lithograph dated 1895.

Hartmann (Pulfrich) spectro-comparator

Fig 15. Hartmann spectro-comparator (SAAO Museum Cat. # M162).

Made by Carl Zeiss Jena. early 20th C. See Hartmann, J., (1906). There are two of these (See also M180). It is in a wood and glass case. The second one has been re-painted. With boxes containing accessories.

Hilger long-screw measuring machine.

Fig 16. Hilger Long-screw measuring microscope (SAAO Museum Cat. # M203, # M204).

Basically a travelling microscope with a precision screw and dial, capable of measuring to about 1 micron accuracy (Several of these, including some from Radcliffe Observatory). These machines were commonly used for measuring spectra at Radcliffe Observatory and the Cape. A 1978 list mentions 4 of them.

Hilger short-screw measuring machine

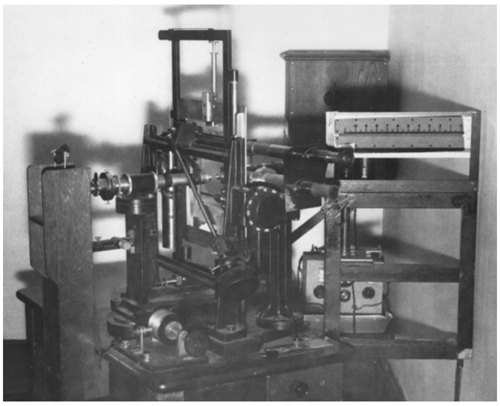
Fig 17. Hilger Short-screw measuring microscope.

Two examples are shown.
These were probably used before the more modern long-screw instruments became available (SAAO Museum Cat. # M148, # M157).

Photographic Photometry

Fig 18. Lady computer working the Schild photometer (SAAO photo P4284).

Fig 19. Schild photometer with scale of mirror galvanometer visible on right (SAAO photo P6576).



Purchased in 1932. This machine played an important part in the photographic photometry programmes of the Cape Observatory in the 1920s to the 1960s. It was modified around 1940 to make it more reliable (see Annual Reports of Director). It no longer exists. Designed in 1922 by J. Schilt (1894-1982).

Askania Iris diaphragm photometer.

Fig 20. Askania (Becker-type) Iris photometer.

This is a double-beam instrument that can be used for measuring transmission through a fixed diaphragm or for measuring the diameter of images using a variable diaphragm. It was in service for photographic photometry at the Cape.
It occupied one of several measuring rooms beneath the MRM telescope and was discarded when these were converted into the Computer Department. Found in the Electronics Department basement store in November 2021.

The principle is described in Stock, J & Williams, AD (1962). Made by Askania-werke, Berlin

Sartorius Iris diaphragm photometer

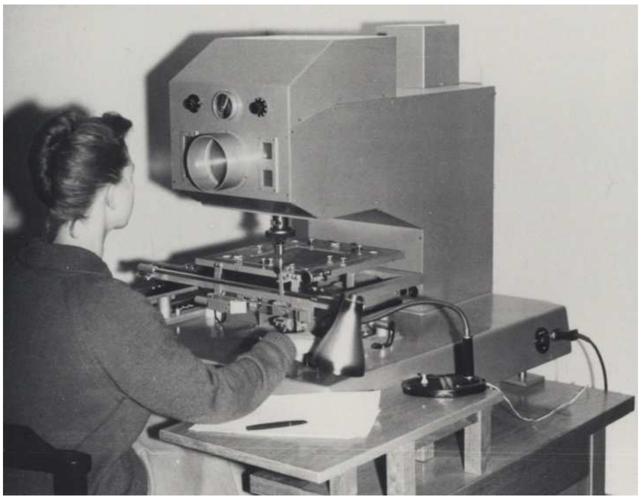


Fig 21. Sartorius Iris photometer (photo: SAAO P4282)

This machine was also used for photographic photometry and occupied one of the measuring rooms below the MRM telescope. It is not known what advantages or disadvantages it had relative to the Askania.

It was probably the instrument purchased by Radcliffe Observatory, Pretoria in 1959 and moved to the Cape when Radcliffe closed in 1974.

It no longer exists.

Plate Digitization

These machines were used to produce digital output from photographic plates such as those from spectrographs and the McMullan electronographic camera.

Joyce-Loebl Autodensidator Mk II #1 Model IIIC Serial No 962.

Fig 22. Left: photo from Joyce-Loebl Mark III CS brochure.

Fig 23. Right: Remains of instrument as found in Electronics basement.

This instrument was originally bought for the Radcliffe Observatory in Pretoria in 1968 and was for digitising spectroscopic plates. The front stage carrying the plate was moved along by a stepping motor. A beam of light transmitted through the plate was compared to a second beam passing through a servo-driven grey filter wedge whose density increased along its length, connected to a pen writing on a second moving stage at the back, mechanically linked to the front one. This produced a scan of the spectrum.

The position of the wedge was also digitized and punched out on a paper tape.
It produced 3 points per second. Supplied with 4 wedges of different densities.
(See SAAO Archives A0376, Joyce-Loebl, Radcliffe sub-file).

Casella Projection Microdensitometer

Fig 24. Casella "Projection Micrometer Machine" (SAAO Museum Cat. # M205).

Used at Radcliffe and moved to Cape Town when Radcliffe closed in 1974.

"This machine was made by Messrs. C.F. Casella and designed by them jointly with members of the staff of the Radcliffe Observatory, Pretoria". See Redman (1939) for a full description.

Joyce-Loebl Autodensidator #2

A Joyce-Loebl Autodensidator Type M Mk IIICS modified to have an x-y stage and a magnetic tape recorder was purchased by SAAO in 1971. I believe that it was interfaced to a Nova 1220 computer and ½-in magnetic tape recorder. It was used for digitizing films generated on the McMullan electronographic camera. The process was very slow due to the semi-mechanical method of density measurement. (See SAAO Archives A0376, Joyce-Loebl, Cape file)

DEMAC Measuring machine

This machine consists of a projector, high up on the wall, for 16 x 16 cm plates and a coordinate measuring table. Its purpose was to identify approximate coordinates of stars of interest for later scanning with the COSMOS machine in Edinburgh. It is still (2021) in place in the store room of the Astronomical Museum in the McClean building.
Ca 1970 (?).

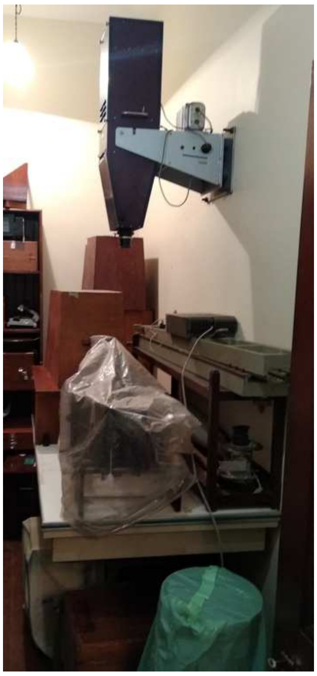


Fig 25. The Demac machine. It consisted of a projector mounted on the wall and a digitizing table (seen here cluttered with other items). It is in a small room now used as the Museum Store in the McClean dome (SAAO Museum Cat. # M181).

Acknowledgments

I thank Mr Greg Roberts, Mr Willie Koorts and Dr Robin Catchpole for comments and contributions.

The photographs in this article are by ISG unless otherwise credited.

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Streicher Asterisms

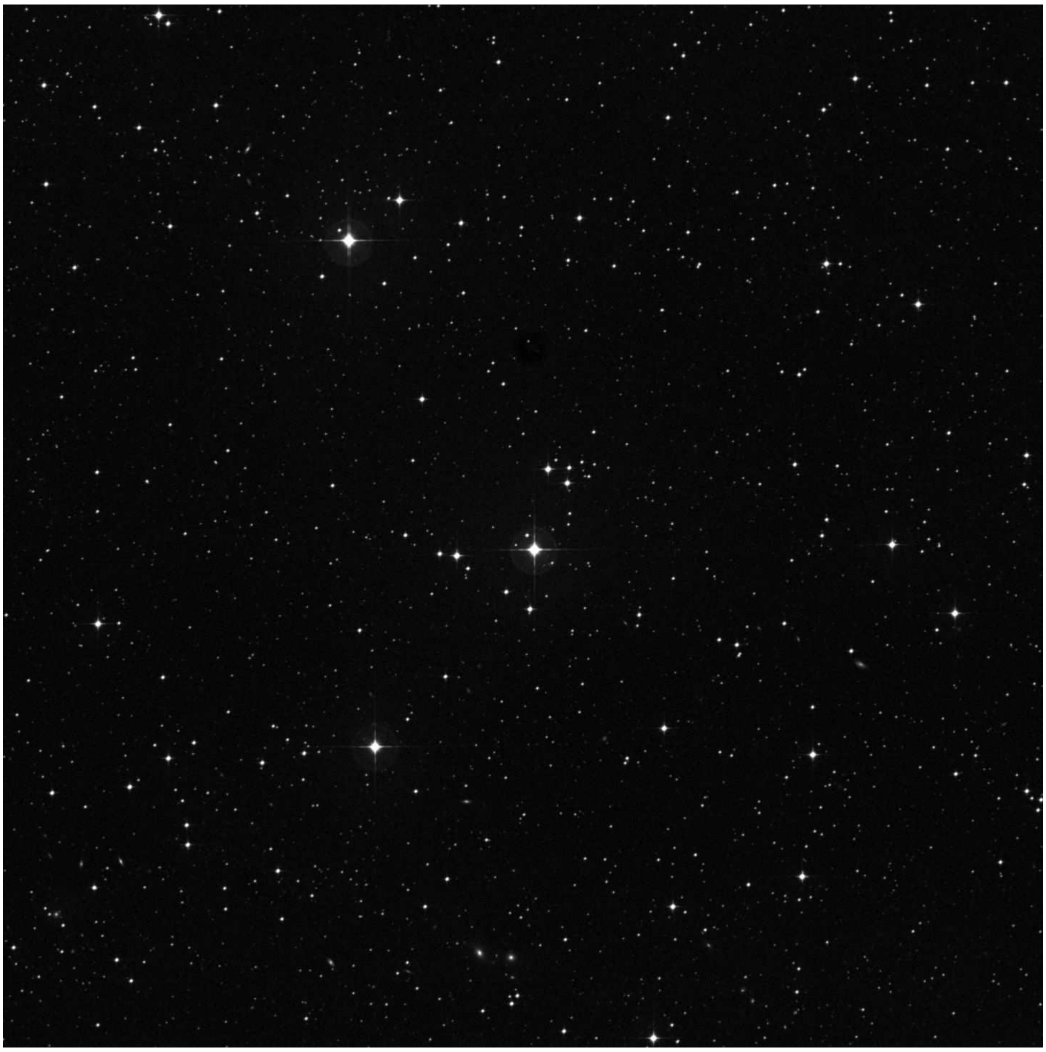
Magda Streicher

STREICHER 66 – DSH J2056.5-5915
Indus

The relatively bright magnitude 8 star, that could also be a double, listed as HD 198943, is the focus of this unusual grouping with a lovely clump of fainter stars to the north. To complete this group are a few stars in an uneven line towards the southern field.

Object	Type	RA	Dec	Mag	Size
STREICHER 66 DSH J2056.5-5915	Asterism	20h56m.30	-59°15'.30	8.5	7'

Picture Credit: http://archive.stsci.edu/cgi-bin/dss

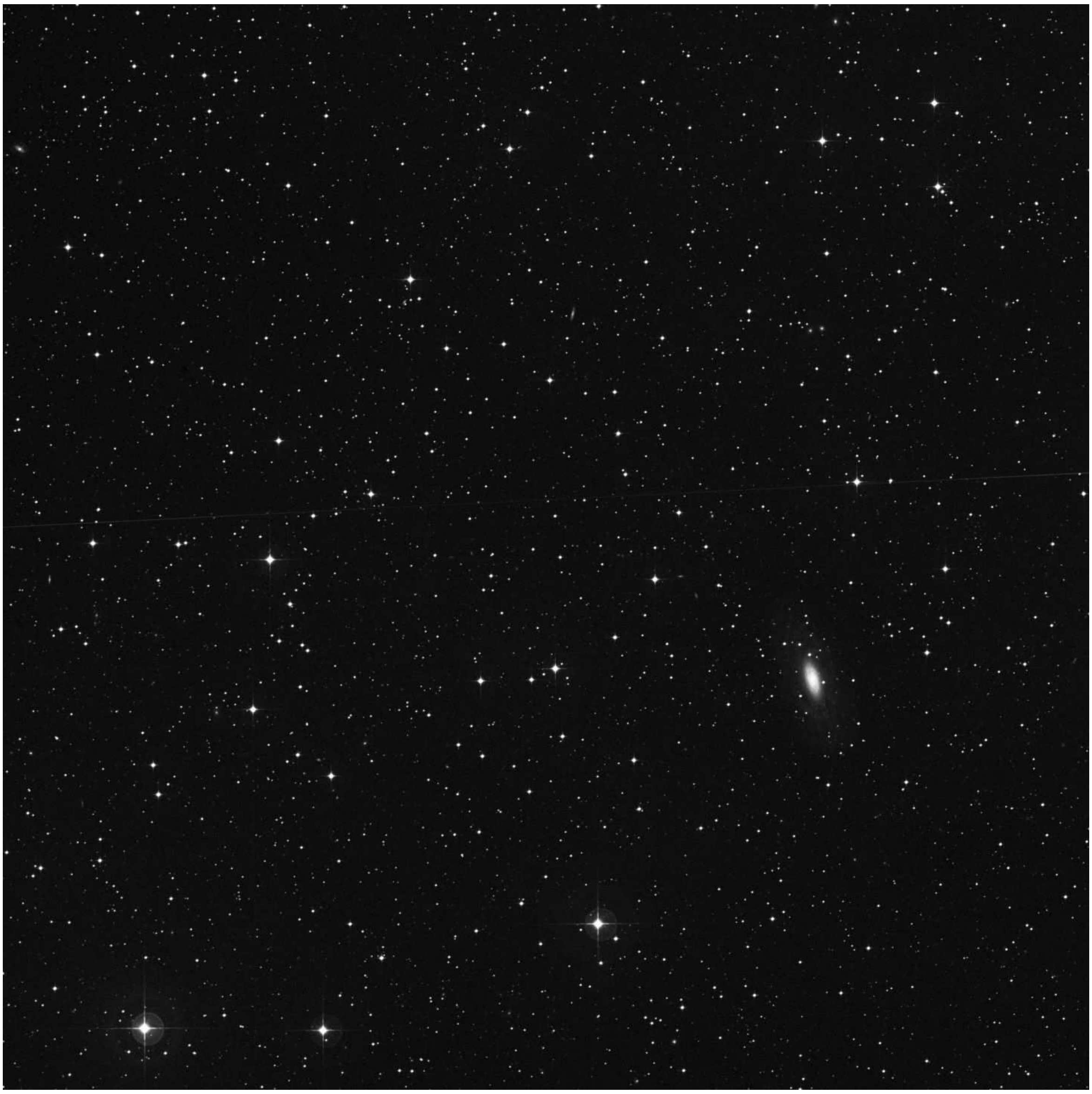


STREICHER 67 – DSH J0548.2-3407
Columba

It was exciting to discover these two fairly large, intertwined half-moon star circles that take up this special spot as a very close neighbour of the galaxy NGC 2090 just 14’ towards the east. The stars vary mainly from between 10 to 11 magnitude. To see groups of stars in all kinds of shapes stretches and enriches the imagination and mind.

OBJECT	TYPE		RA	DEC	MAG	SIZE
STREICHER 67 DSH J0548.2-3407	Asterism		05h48m.12	-34°07’.20	9.6	38’

Picture Credit: http://archive.stsci.edu/cgi-bin/dss



STREICHER 68 – DSH J1535.2-5205
Norma

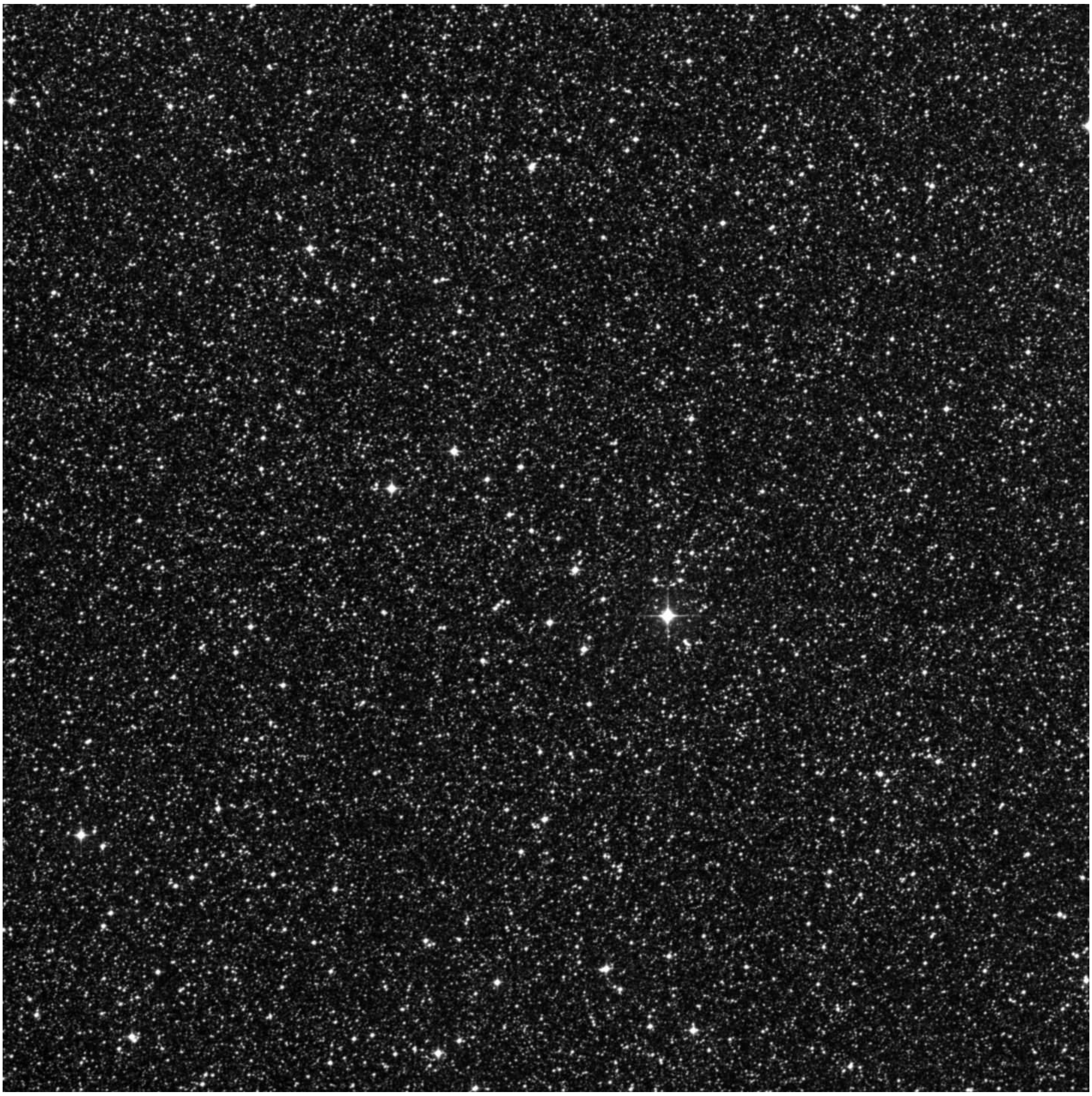
A faint gathering can be spotted in this very busy star field, barely outstanding but still noteworthy. This modest assortment, an uneven roundish shape with the brighter magnitude 10 star towards the middle area, has been catalogued as HD 138532.

Object	Type	RA	Dec	Mag	Size
STREICHER 68 DSH J1535.2-5205	Asterism	15h35m.12	-52°05’.18	10	7’

STREICHER 69 – DSH J1757.1-3953
Scorpius

A stellar grouping all but hides itself against this very faint speckled field of view, which is a fragment of the Milky Way. However, slightly brighter stars follow an uneven string in a north-east direction. A broken-off piece contains the brightest HD 163195 star with a magnitude of 7.6 situated towards the south-west tip of the group, with a knot of faint stars directly north.

Object	Type	RA	Dec	Mag	Size
STREICHER 69 DSH J1757.1-3953	Asterism	17h57m.11	-39°53'.42	10	12

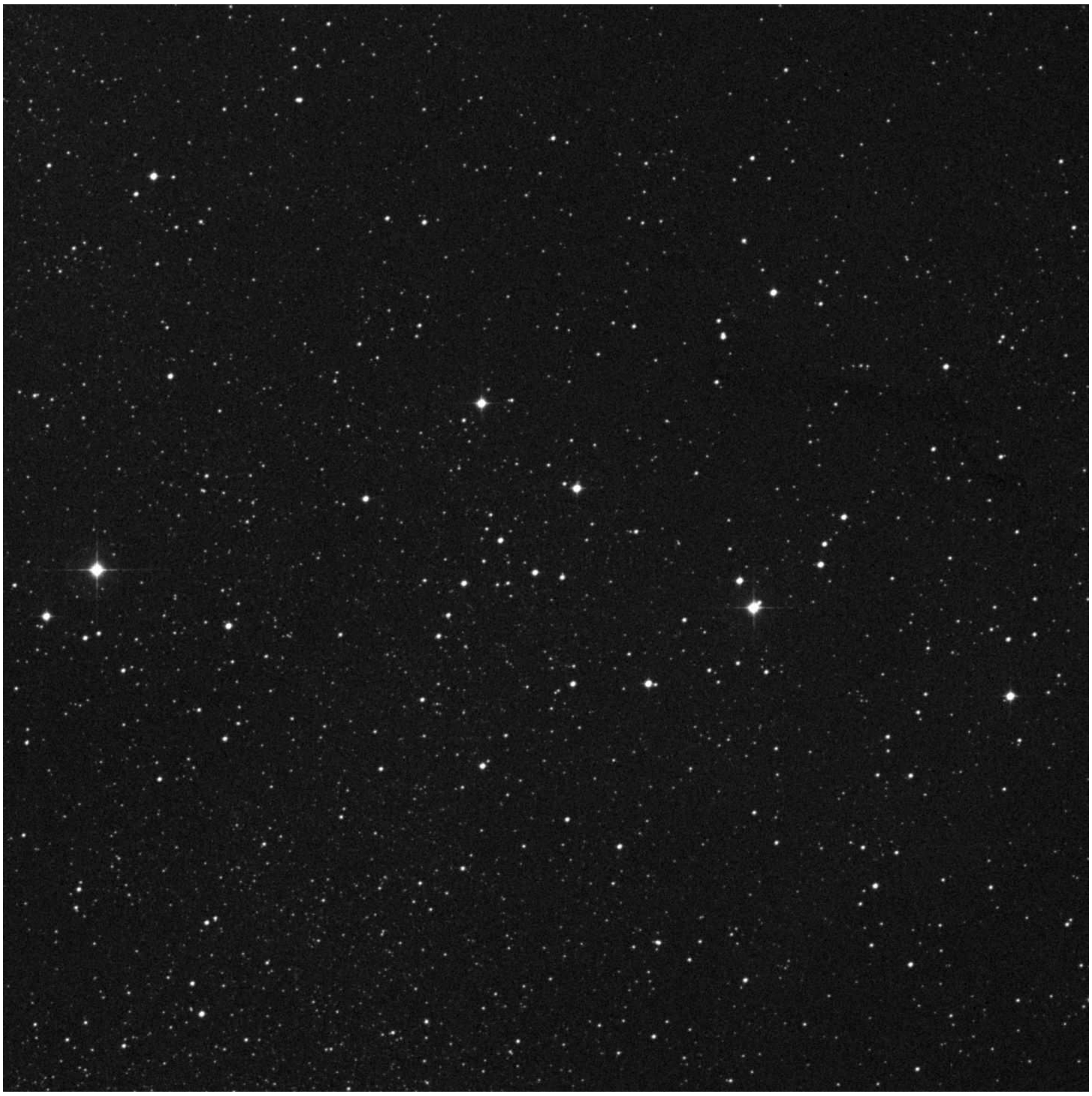


STREICHER 70 – DSH J1730.4-3341
Scorpius

Picture Credit: http://archive.stsci.edu/cgi-bin/dss

A much less concentrated group, but it still makes a statement. The focus however is the fainter handful of strung stars towards the southern part, guarded by the brighter stars towards north-west. The open cluster Collinder 333 is situated only half a degree south-east. This tail-end of the constellation Scorpius offers a rich variety of open clusters to search out.

Object	Type	RA	Dec	Mag	Size
STREICHER 70 DSH J1730.4-3341	Asterism	17h30m.29	-33°41'.12	9	11'



Webinars

Colloquia and Seminars use 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.

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With the advent of CV19, these Colloquia and Seminars are being presented to wider audiences via Zoom and other virtual systems. The editor has started by identifying what would originally been "local" Colloquia and Seminars; not easy as there are now Webinars on interesting topics from around the globe! In time we will either return to the traditional Colloquia and Seminars or many will become Hybrid session.

Title: Design, Development and Performance Modelling of WALOP Polarimeters for PASIPHAE Survey
Speaker: Mr. Siddharth Maharana, Senior Research Fellow Inter University Centre for Astronomy & Astrophysics (IUCAA), Pune
Date: 11 November
Venue: SAAO Auditorium
Time: 11h00 – 12h00

Abstract: PASIPHAE survey aims to create the first large sky magnetic field and dust cloud tomographic map of the Galactic polar regions using stellar polarimetry and GAIA stellar distances. Two WALOP (Wide-Area Linear Optical Polarimeter) instruments, to be mounted on 1 m class telescopes in South Africa and Greece are currently under development to work as survey instruments for the PASIPHAE program for creating the stellar polarization catalogue. Scheduled for commissioning in 2022, the WALOPs are being designed to operate with the combined capabilities of one-shot four camera linear polarimetry, low polarization systematic (polarimetric accuracy of 0.1%) and a large field of view of 30×30 arcminutes, which in combination will make these unique astronomical instruments. Operating in the SDSS-r broadband and narrowband filters between 500-700 nm, for each exposure, four images of the full field corresponding to polarization angles of 0, 45, 90 and 135 deg will be generated and carrying out differential photometry on these images will yield the linear Stokes parameters. We have developed a complete design and calibration strategy for WALOPs to achieve its technical goals. In this talk, I will present an overview of the instrument design, development, performance modelling and calibration routine for the instruments and their current status.

Title: Detection of Cosmological 21cm Emission with CHIME
Speaker: Dr Simon Foreman from the Perimeter Institute for Theoretical Physics/ NRC.
Date: 12 November
Platform: Zoom

Time: 16h00

Abstract: Intensity mapping of redshifted 21cm emission from neutral hydrogen holds great promise for learning about cosmology, as it provides an efficient way to map large volumes of the universe without the need to characterize individual luminous sources. The Canadian Hydrogen Intensity Mapping Experiment (CHIME) is a cylinder telescope located in Western Canada that was custom-built for this purpose, and that has collected several hundred days' worth of data since it reached full observational capacity in late 2018. I will provide an overview of the design and operational status of CHIME, and then present a preliminary version of its first 21cm science results: detection of a cross-correlation between CHIME sky maps and galaxy/quasar catalogs from the extended Baryon Oscillation Spectroscopic Survey (eBOSS). In particular, I will discuss our data processing pipeline and how we model the measured signal, as well as the implications and prospects for more precise future measurements.

Title: Investigating the radio galaxy population in the SIMBA simulations.
Speaker: Dr Nicole Thomas from Durham University.
Date: 19 November
Platform: Zoom
Time: 16h00

Abstract: There is a supermassive black hole (SMBH) at the centre of essentially all massive galaxies. There is a tight connection between the growth of these SMBHs and their host galaxies indicating that the central SMBH plays a significant role in the evolution of its host. In particular, the jets emitted from actively accreting SMBHs or radio loud active galactic nuclei (RLAGN) are thought to be a key role-player in the quenching of massive galaxies. The processes describing the accretion and feedback mechanisms of these objects, however, are still poorly defined.

The era of the Square Kilometer Array (SKA) will provide new insights into the nature of these mysterious and powerful objects. Currently the MeerKAT International GHz Tiered Extragalactic Exploration survey (MIGHTEE) aims to probe the accretion and feedback processes of AGN and star formation out to cosmic noon.

In anticipation of results from MIGHTEE, in this talk I will present predictions of the radio galaxy population from the SIMBA suite of cosmological hydrodynamic simulations. SIMBA is unique in that it includes a two-mode sub-resolution prescription for black hole accretion and includes thermal and kinetic AGN feedback With this, we can define a population of radio galaxies in SIMBA and estimate the radio emission coming from both star formation and accretion processes. We can then study the global and environmental properties of these objects.

These predictions will form basis for comparison with upcoming MIGHTEE observations, and will play a role in constraining the physical processes driving black hole accretion and feedback.

Title: NIR microlensing exoplanet search by PRIME and Roman
Speaker: Prof Takahiro Sumi
Date: 19 November
Platform: Zoom
Time: 11h00

We report the status of the NIR microlensing exoplanet search project, the Prime-focus Infrared Microlensing Experiment (PRIME). We are building a new 1.8m wide field infrared telescope at the Sutherland in South Africa.

One of the largest NIR camera will be built by using four H4RG-10 detectors loaned from the Roman project.

Abstract: Thanks to 1.3 deg^{-2} FOV, we can conduct the first high cadence microlensing survey in H-band towards the central region of the galactic bulge, where high dust extinction prevents optical observations. Because the stellar density is higher at the lower galactic latitude, we expect higher event rate. We can compare the planet abundances in high and low stellar density for the first time, which is important for the study of the planetary formation scenarios. The event rate map produced by PRIME can be used to optimize the Roman observing fields. If the PRIME telescope and Roman observe the same fields simultaneously, different light curves will be observed due to the different line of sights, so-called the space-based microlensing parallax. This enables us to measure the mass and the distance of the lens system and enhance the Roman's yields. The telescope will also be used for the ToO observations for various transients including GW, GRB and so on."

Title: Stratification of Galaxy Disks
Speaker: Prof Matthew Bershady
Date: 02 December
Venue: SAAO Auditorium
Time: 11h00

Abstract: We explore the phase-space stratification of stellar populations in galaxy disks. Stratification may arise from cooling of turbulent gas in which stars form, or from dynamical heating of collision less stellar systems. Rates of stratification should distinguish between these two processes. In the Milky Way this rate is manifest in the

age--velocity relation. We show that vertical age gradients in NGC 891's disk are qualitatively similar to the Milky Way. We also show that the age--velocity relation can be measured in external galaxies via asymmetric drift of unresolved stellar populations. Such measurements are now available for large samples of nearby galaxies from MaNGA in SDSS-IV. We interpret these measurements in the context of a simple 'disk heating' model, and compare to Local Group galaxies. We find a clear mass-dependence to the heating rate that is anti-correlated with the birth-epoch velocity dispersion. We offer a simple interpretation of this result and prospects for testing our conclusion.

Title: Dissecting Distant Galaxies: How Sub-structures Shed Light on Galaxy Formation and Evolution
Speaker: Dr Yicheng Guo from the University of Missouri (USA)
Date: 03 December
Platform: Zoom
Time: 15h00

Abstract: Galaxies have different morphology and structure, which have correlations with their physical properties. Understanding the physics that drive the formation of the Hubble Sequence remains one of the outstanding problem of astronomy and astrophysics. To answer this question requires observations of galaxies in early universe. Current advanced telescopes enable studies of not only the overall structure of galaxies but also their sub-structures (e.g., bulges, bars, spiral arms, etc.). One prominent sub-structure of distant galaxies is giant star-forming clumps. These clumps are frequently found in galaxies several billions ago, but are very rare in our local universe. Although their nature, formation mechanism, and evolution history are all in debate, these clumps contain important clues of galaxy formation and evolution, especially on the regulation of star formation. In this talk, I will introduce our work on observing and analyzing the giant star forming clumps in one of the largest surveys of the Hubble Space Telescope: Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDELS). I will also discuss how to use the physical properties of clumps to constrain and improve our current models of star formation and feedback.

Title: Gas depletion in young galaxy cluster environment
Speaker: Dr Bi-Qing For International Centre for Radio Astronomy Research (Perth, Australia)
Date: 09 December
Platform: Zoom
Time: 0930h00

Abstract: Environment plays an important role in the evolution of gas contents and star formation in galaxies. Observations have shown that satellite galaxies are HI deficient as a function of decreasing distance to their host galaxy and star formation are suppressed in dense environment. Most studies have focused on dense cluster environment in part due to sensitivity/time factor vs galaxy sample size. WALLABY, an ASKAP HI blind survey of the southern sky, will allow us to explore some of the physical mechanisms unbiasedly in different environments. In this talk, I will present the results on a study of the Eridanus supergroup using WALLABY pre-pilot survey data in conjunction with multi-wavelength data. Eridanus supergroup is dynamically young as compared to Virgo and Fornax clusters. In addition, I will give an update on the progress of WALLABY and new science to be studied

Title: The Athena observatory and its science objectives
Speaker: Dr Matteo, Guainazzi European Space Agency
Date: 09 December
Venue: SAAO Auditorium
Time: 11h00

Abstract: I will present the scientific objectives of Athena - the Advanced Telescope for High-ENergy Astrophysics. Athena was selected in June 2014 as the second L-class mission in the ESA's Cosmic Vision Programme, with a launch foreseen in 2034. It is an X-ray observatory designed to address the following two questions of 'The Hot and Energetic Universe' science theme: a) How does ordinary matter assemble into the large-scale structures we see today? and; b) How do black holes grow and shape the Universe? It will achieve these goals by studying a wide range of astrophysical phenomena: the formation and evolution of groups and clusters of galaxies; the chemical evolution of hot baryons; feedback by active galactic nuclei; missing baryons thought to populate the intergalactic medium; the formation and early growth of black holes; and the accretion by super-massive black holes through cosmic time, among others. The Athena payload an X-ray telescope with a focal length of 12 m, a 5" angular resolution (Half Energy Width) and an effective area of ~1.4 square meters at 1 keV, and two instruments: an X-ray Integral Field Unit (X-IFU) for spatially-resolved, high spectral resolution (~2.5 eV) imaging spectroscopy over a ~5" effective diameter field-of-view, and a Wide Field Imager (WFI) for high count rate, moderate resolution spectroscopy over a large field of view (~40'x40'). Such a payload performance, coupled with a rapid response of the spacecraft to serendipitous events (<4 hours over a 50% field-of-regards) poses Athena as a community-driven observatory capable of achieving breakthrough results in almost every field in astrophysics.

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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, the annual *Sky Guide Africa South* and *Nightfall*.

Membership: Membership of the Society is open to all. Potential members should consult the Society's web page : http://assa.saao.ac.za for details. Joining is possible via one of the local Centres or as a Country Member.

Local Centres: Local Centres of the Society exist at Bloemfontein, Cape Town, Durban, Hermanus, Johannesburg, Pretoria and the Garden Route Centre; membership of any of these Centres automatically confers membership of the Society.

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