SOUTHERN AFRICAN LARGE TELESCOPE

ANNUAL REPORT 2024

SALT

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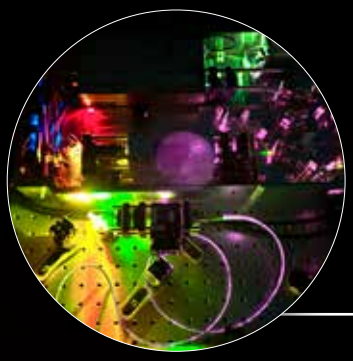


SALT celebrates two times "First Light"

The year 2024 has been a productive year for SALT in terms of new capabilities. On 28 February, the new slitmask IFU for the RSS saw First Light and is already available to the users on a shared-risk base, and on 8 May it was the turn of the Laser Frequency Comb for the HRS. Although work is ongoing to finalise the comb, both are major achievements after years of hard work and various setbacks.

Slitmask SMI-200: A story of perseverance and triumph

The capabilities of the RSS have been expanded into the second spatial dimension through the addition of a novel optical fibre integral field unit (IFU), which sits in its own slitmask cassette and is referred to as a slitmask IFU (SMI). Developed by Sabyasachi Chattopadhyay (SAAO) and Matt Bershady (UW) and made in the SAAO machine shop, SMI-200 was designed to fit within a compact volume of 130 × 140 × 8 mm. Managing the routing of many fibres within such a constrained space was a ground-breaking engineering feat, requiring novel solutions to ensure light transmission efficiency.

Science driver and specifications
The elongated hexagonal shape of the SMIs is ideal for observing galaxies over a range of inclination angles, and can be used to map more extended objects from Galactic HI regions, to merging and interacting galaxies, to galaxy cluster cores and strongly lensed galaxies. Additionally, the SMIs can be effective as photon buckets for low surface brightness observations.

The slitmasks are inserted in the same fashion as the existing long-slit cassettes at the SALT focal plane. Prismatic fold mirrors direct the focal plane into the fibre IFU and then back into the RSS collimator after the fibres are routed 180° within the cassette and formatted into a pseudo-slit. Fold-prisms ensure that the spectrograph collimator continues to see the same focal plane. SMI-200 (detailed in the table below) will be the smallest of the IFUs, using fibres with 200-micron diameter cores, larger diameter fibres will be used for future SMI developments. These devices can be used with any grating and camera angle currently available on RSS. While the IFUs have a fill-factor of roughly 60%, with a 3-point dither pattern the spatial coverage can be made truly integral.

Wavelength coverage	320 – 900 nm
On-sky field of view	18 × 22 arcsec
On-sky fibre diameter	0.9 arcsec
Number of fibres	309
Equivalent resolution	0.9 arcsec slit
Number of fibres in sky bundle	2 × 13
Sky bundle distances from IFU	~50 arcsec on both sides
IFU fill-factor	~ 60%
Median throughput relative to ideal 1 arcsec long-slit	19%

28 February
— An account by Sabyasachi Chattopadhyay

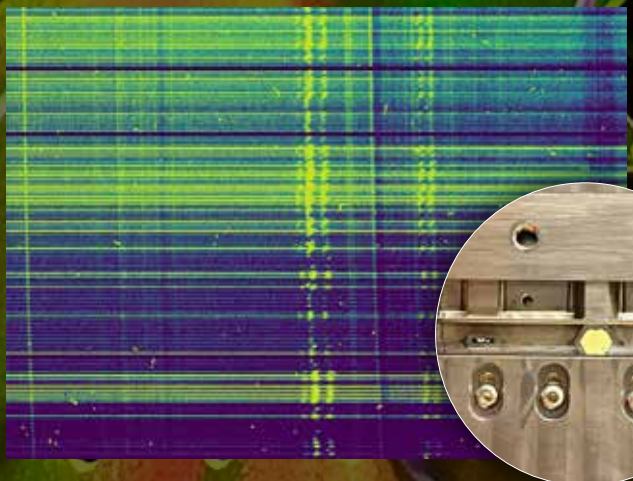
After three years of relentless effort, countless setbacks, and moments of self-doubt, SMI-200 was finally ready for commissioning. It had been a long road, beginning in 2020 with 400-micron fibres, only to realise by the end of 2022 that they were too challenging to work with. The fibres were too large to be efficiently routed within the compact housing, leading to persistent integration issues. By early 2023, the design pivoted to 200-micron fibres, leading to multiple internal reviews and refinements. The transition wasn't smooth, requiring re-evaluation of optical alignment and fibre routing strategies. There had been other hurdles, like the discovery that the instrument was inverted due to an oversight in the SALT elevator design, leading to major modifications. During the lab calibration in December 2023, it was noticed that the fibre angles had been flipped — with questionable consequences. After overcoming all these problems, on sky commissioning was finally scheduled for 28 February 2024.

With trepidation, my wife Sujata and I traveled to SALT. Immediately after arriving at the telescope, the installation itself proved to be difficult. The magnet orientation, crucial for securing the instrument in place, was unknown. Our tensions rose as precious time slipped away. Fortunately, with the expertise of Eben and Nico from the SALT Tech Ops team the issue was quickly resolved. Observatory Scientist Lisa and SALT Astronomer Rudi joined the effort, offering their expertise and support. As we prepared the first flat exposures though, no light appeared, even after increasing the exposure time. I felt panic setting in. Was it over before it had even begun? Was all the work of the last three years in vain?

Then, happily, we realised that the light from the telescope was being directed to the wrong instrument port, so the fold mirror was moved out of the beam and the exposure was repeated. And indeed, the first spectra appeared — clear, stable, flawless! A moment of pure exhilaration washed over me. It was as if the weight of the entire project had suddenly lifted. Subsequent calibration exposures confirmed that everything was working fine. Then came the final test: a bright star, followed by a galaxy. When the emission lines of the galaxy appeared unmistakably on the screen, I couldn't contain my smile, and years of stress evaporated in an instant.

In the early morning hours, I returned to the hostel, celebrating with Sujata over a quiet, heartfelt moment. It was a moment of peace, reflection and joy, knowing that the sleepless nights and countless revisions had paid off. The next day, SAAO Director Petri Väisänen made the announcement that SMI-200 had officially become the first optical IFU delivered on the African continent.

SMI-200 spectra of a bright, star forming galaxy. Individual horizontal lines represent fibre-generated spectra, while the vertical lines are from Hα, along with [N II] and [S II] lines.



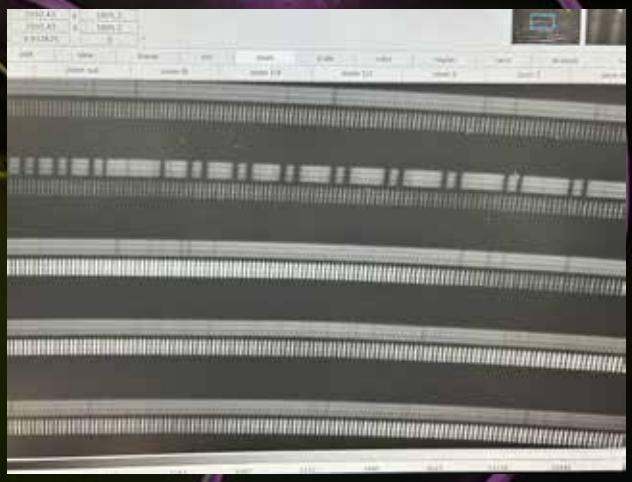
A laser frequency comb for the HRS

SALT users will soon be able to hunt for and study planets orbiting distant stars. These demanding measurements require a highly stabilised spectrograph and superb wavelength calibration. SALT's HRS was designed with this application in mind, but additional hardware and a custom data reduction pipeline were needed to realise these ambitions. Both have been under development over the past two years, and the project team celebrated a significant milestone on 8 May 2024, when the comb achieved first-light on sky. This astrocomb is the culmination of years of partnership between the two groups of scientists from SALT and Heriot-Watt University (HWU), beautifully demonstrating the power of multi-disciplinary collaboration. Working together since 2015 has afforded SALT staff and students privileged access to this highly specialised technological domain, and given HWU staff the opportunity to test their lab device(s) in an operational environment on one of the world's largest optical telescopes.

8 May — A report by Lisa Crause

After an extremely intense ten day comb integration campaign at the telescope, the HWU team was due to return to Scotland on 9 May. By the night of the 8th, the astrocomb was set up and the sky was clear, so the LFC team commandeered the telescope for about half an hour at the start of the night. A bright radial velocity standard star was observed, but this time with astrocomb light injected into the spectrograph during the observation for improved wavelength calibration precision. This was particularly exciting for HWU postdoc Shan Cheng, who had yet to see laser comb light alongside starlight on an actual astronomical spectrum. Pipeline developer Daniel Holdsworth joined in the action from the UK via WhatsApp and provided us with gorgeous spectra extracted on-the-fly. Determined not to push our luck too far, we powered down the comb and turned the telescope back over to the observers on duty that week (Encarni and Fred) straight after snapping those precious first-light frames.

Such was our lack of preparation for this milestone that we did not have any suitable beverages on hand to celebrate with! Instead, we retreated to the hostel lounge and began writing up our respective HWU and SAAO/SALT press releases. These ended up being delayed by our various travel commitments, and only went out in early July. As a result, the HWU one ended up competing with the results of the UK election, but good exposure was achieved nonetheless — including a promising new collaborative opportunity with another UK-based instrumentation group.



The First Light spectra.

Soundbites from the first-light press release:

SALT Observatory Scientist and principal investigator for the HRS upgrade project, **Dr Lisa Crause**

The astrocomb is an incredibly exciting addition to our instrument suite, with huge implications for the HRS and SALT's precision radial velocity capabilities. But even more significant is the fact that SALT is participating in the incubation of critical technologies needed to help advance this challenging field.

Having HWU developing their own astrocombs opens up opportunities to test and refine new approaches and will likely lower the threshold for other telescopes to adopt these systems for ultra-precise wavelength calibration. All of which bodes well for hunting for low mass exoplanets, the Earth-like ones that we humans find the most interesting!

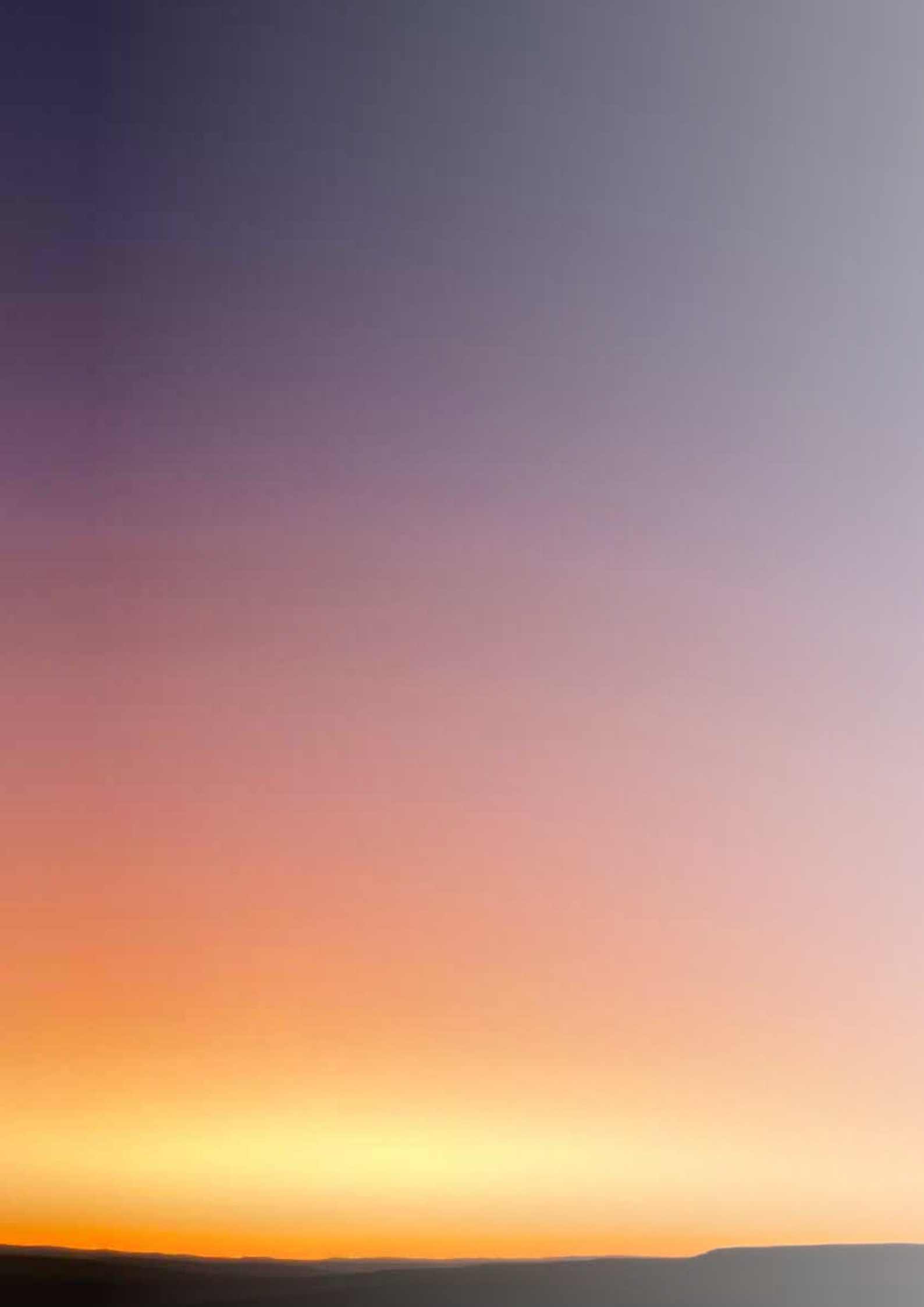
Technical lead for the project, **Dr Richard McCracken** from Heriot-Watt University

Astrocombs produce a spectrum of hyperfine optical frequencies, each separated from one another by a fixed amount, like the teeth on a comb. We know the frequency, or colour, of each comb tooth with extreme certainty, so the astrocomb acts as an optical ruler for the spectrograph. This will allow the SALT team to measure the starlight more precisely. For some exoplanets, the change in the position of a spectral line on the spectrograph due to the 'wobble' of the star can be far less than a single pixel. Only an astrocomb can provide the frequency calibration needed to measure this change.

Having the new astrocomb permanently in place at SALT means we'll be able to continuously upgrade and improve the comb, adapting it to incorporate cutting-edge technologies. It's a very exciting prospect.

Excitement when the first on-sky spectra appeared on the screen.

Celebratory breakfast on the way to the airport the next morning. From left to right: Shan Cheng, Richard McCracken, Malcolm Scarrott and Lisa Crause (behind the camera).



Southern African Large Telescope

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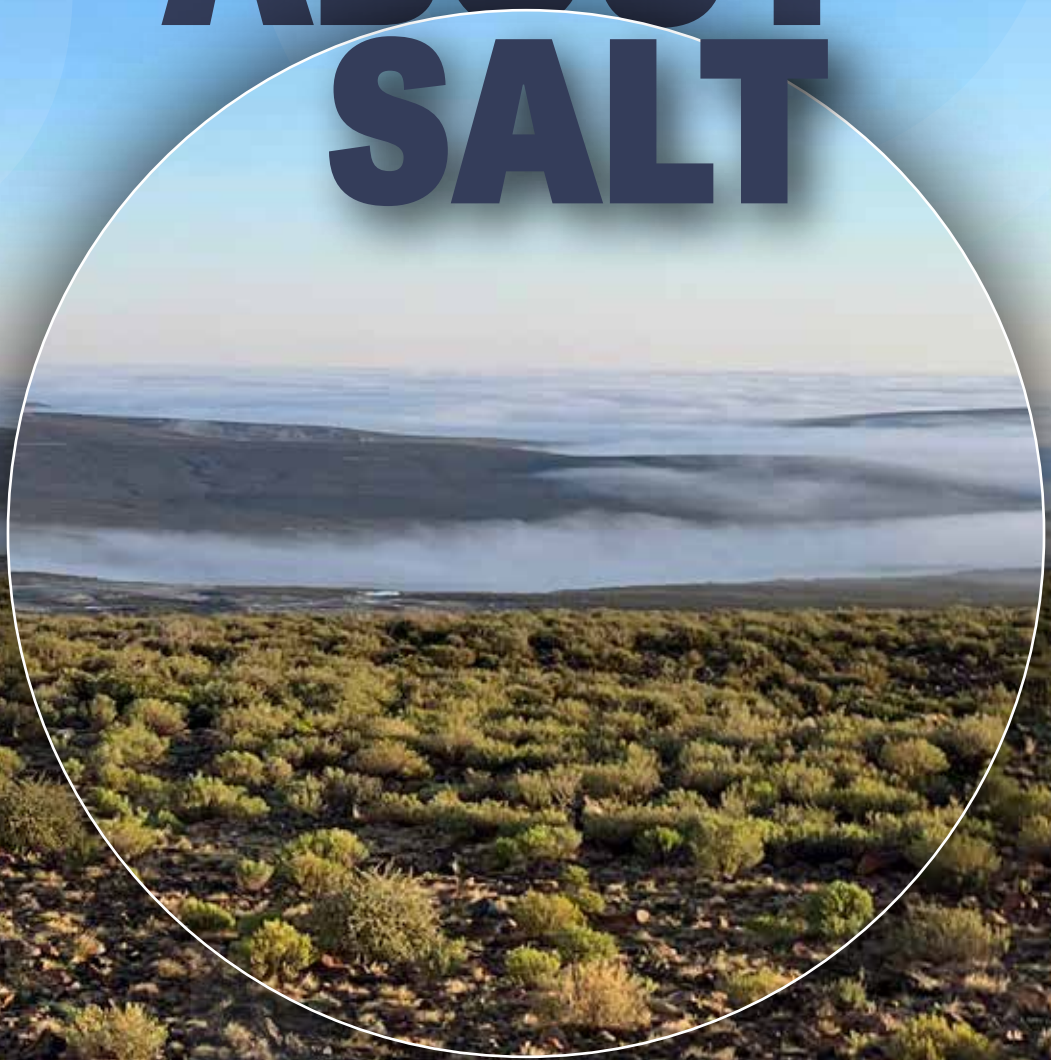
ABOUT SALT



About SALT

The Board of the Southern African Large Telescope (SALT) is proud to present its Annual Performance Report for the period 1 January 2024 to 31 December 2024. This report offers an overview of the activities and performance of SALT, highlights a selection of SALT research projects, and introduces the SALT partner institutions/consortia.

SALT is the largest single optical telescope in the southern hemisphere and amongst the largest in the world. It has a hexagonal primary mirror array 11 metres in diameter, consisting of 91 individual 1-m hexagonal mirrors. It is the non-identical twin of the Hobby–Eberly Telescope (HET) located at McDonald Observatory in West Texas (USA). The light gathered by SALT's huge primary mirror is fed into a suite of instruments (an imager and three spectrographs) from which astronomers infer the properties of planets, stars and galaxies, as well as the structure of the Universe itself.

SALT is owned by the SALT Foundation, a private company registered in South Africa. The shareholders of this company include universities, institutions and science funding agencies from Africa, India, Europe and North America. The South African National Research Foundation (RSA) is the major shareholder, owning approximately one third of the shares. Half of the operating costs are currently covered by the NRF, ensuring that significant observing time is available to the South African community. Other large shareholders are Rutgers University (RU), the Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences (POL), Dartmouth College (DC), the University of Wisconsin–Madison (UW), and the Inter–University Centre for Astronomy and Astrophysics in India (IUCAA). Smaller shareholders include the American Museum of Natural History (AMNH) and the UK SALT Consortium (UKSC), with the latter representing the Universities of Central Lancashire, Keele, the Open University and the Armagh Observatory. The size of the shareholding of each partner determines the access to the telescope that they enjoy. The HET Consortium, although not a shareholder, received ten percent of the telescope time for the first ten years of operation, in return for providing all of the designs and plans from the HET, as well as assistance during the construction of SALT. Three of the original shareholders, Göttingen University (GU), the University of Canterbury (UCN) and the University of North Carolina (UNC), as well as the Universities of Nottingham and Southampton of the UKSC, left the SALT Foundation. The SALT Foundation is currently looking for new shareholders.

SALT is located at the observing site of the South African Astronomical Observatory (SAAO), near the small Karoo town of Sutherland, about 370 km northeast of Cape Town. This site has been host to a number of other smaller telescopes since the early 1970s, and benefits from its location in a semi-desert region with clear, dark skies. The quality of this site for optical astronomy is preserved by South African legislation.

Vision

Africa's Giant Eye on the Sky: Inspiring society by exploring the Universe.

Mission

Lead the advancement and development of optical astronomy on the African continent and inspire and educate new generations of scientists and engineers worldwide.

Provide a world-class large telescope research facility cost-effectively to astronomers in an international community.

Strategic objectives of SALT

1 Enable world-leading astrophysical research

To provide high-quality data that result in highly-cited papers published in front-rank journals. This is achieved by maximising SALT's scientific productivity, i.e., minimising technical downtime and optimising operational efficiency. Which is contingent on having the financial resources to support operational needs and to nurture and retain a cohort of skilled and creative staff, and enabling them to identify and pursue key scientific and technical initiatives.

2 Pursue instrumentation development

To establish the local skills and capacity required to design and build internationally competitive astronomical instrumentation. This calls for leveraging expertise available within the SALT partnership and other international instrumentation groups, to build active collaborations that drive technological innovation and skills transfer, and ultimately enhance SALT's capabilities. This, too, relies on securing the necessary financial support, for both equipment and people (staff, students, interns and apprentices spanning a broad range of levels).

3 Drive human capital development and science engagement

To employ this iconic facility and the ubiquitous appeal of astronomy to encourage widespread interest in science and technology, through outreach to undergraduates, schools and the general public; to train graduate students; to have a special focus on developing and leading professional astronomy and high-tech astronomical instrumentation on the African continent; to promote SALT as a global flagship optical telescope, increasing its visibility and growing its reputation in the international scientific community, as well as national and international media.

This report offers an overview of the activities and performance of SALT, highlights a selection of SALT research projects, and introduces the SALT partner institutions/consortia.

SALT TIDINGS

In-House Happenings

2024 has been a year of significant changes to the SALT staff complement at SAAO. First there was the decision to appoint a dedicated director of SALT, to take over the management of SALT from the SAAO Director (Petri Väisänen). Knowing that Petri was set to take up a new position in Finland early in 2024, Rosalind Skelton took over as Acting SAAO Director in March 2024 (and, since January 2025, as the new Managing Director of SAAO). Encarni Romero Colmenero became the SALT Director and Paul Rabe moved to the SAAO, leaving their positions as the heads of the Astronomy and Technical Operations Teams, respectively, open. Currently acting in these positions are SALT Astronomer Danièl Groenewald for Astro Ops and Senior Electronics Engineer Willem van der Westhuizen for Tech Ops. Finally, it is with sadness that we report the sudden passing of Surayda Moosa, a crucial member of the SALT finance team.

Director of SAAO — Rosalind Skelton

This year saw significant changes in the leadership of SALT and SAAO. Our previous director, Petri Väisänen, moved back to his home country of Finland to take up a position as the Director of the Finnish Centre for Astronomy with ESO at Turku University. We are grateful to him for his many years of service and dedication to SALT, first as a SALT Astronomer, later as Head of SALT Astronomy Operations and finally as Managing Director of the SAAO, and wish him and his family all the very best for their next chapter.

Following Petri's departure in March 2024, Dr. Rosalind Skelton was appointed Acting Managing Director of the SAAO and assumed the role of Managing Director in January 2025. Ros earned her BSc Honours in Theoretical Physics and an MSc in Astronomy through NASSP at UCT. She then pursued her PhD on "Galaxy Formation and Evolution" at the Max Planck Institute for Astronomy in Heidelberg, Germany, graduating in 2010 through the University of Heidelberg. Her academic journey included a postdoctoral fellowship at Yale University in the USA, followed by an NRF Professional Development Programme postdoctoral fellowship at the SAAO in 2013. She joined the SALT Astronomy Operations team as a core member in 2016. Over the years, her career at SAAO has advanced through various leadership roles, including Head of Research, culminating in her current position.

Driven by a passion for nurturing the next generation of scientists, Ros has made significant contributions to NASSP as a supervisor, lecturer, SAAO's representative, and Chair of the national NASSP Partnership. She also holds close ties with the University of Cape Town as an Honorary Research Associate. Her research group focuses on the processes and interactions influencing galaxies in diverse environments using multiwavelength observations. Ros plays an active role in numerous international collaborations, such as the 4MOST Hemisphere Survey, where she serves as the science policy lead, and multiple projects on South Africa's flagship telescopes, SALT and MeerKAT. Additionally, she co-chairs a science working group for the LADUMA Large Survey Project at MeerKAT and serves as a member of the South African National Committee for Astronomy of the IAU and South African Women in Science and Engineering.

Ros is excited to guide SAAO into a new phase of multiwavelength and multi-messenger astronomy, using technological advancements to develop the SAAO's capabilities, in conjunction with cutting-edge international facilities and surveys. Together with the new SALT director, SAAO's Deputy Director Encarni Romero Colmenero, and their dedicated teams, she aims to shape a dynamic and innovative future for the organisation.

SAAO says goodbye to Petri.

Director of SALT — Encarni Romero Colmenero

Encarni Romero Colmenero was born in Elche, near Alicante in Spain. She obtained a BSc (Hons) in Physics with Astronomy from the University of Southampton and a PhD in Astronomy from the MSSL, which is part of University College London. She has been associated with the SAAO since 1999 and played a key role in the development and operations of SALT from its inception. In 2004, she became the first-ever SALT Astronomer. In that role, Encarni was instrumental in designing the SALT Science Database and the observation scheduling software. She played a key role in commissioning several of the telescope's critical instruments, including the Fabry-Pérot and the polarimetry modes of the RSS. In 2018, Encarni became the Head of SALT Astro Ops, where she led numerous key projects, including the launch of the SALT Data Archive and the development of new data reduction pipelines. Her leadership ensured the continued success of SALT's scientific endeavors and operational growth.

In July 2024, Encarni took on the role of the newly created position as SALT Director, bringing with her a wealth of experience and a deep commitment to SALT's mission. In this capacity, she is dedicated to advancing groundbreaking astronomical research, facilitating collaboration within the scientific community, and overseeing the operation of one of the world's largest optical observational facilities. Encarni looks forward to guiding the team toward new discoveries that will expand our understanding of the universe and inspire the next generation of scientists. Alongside her management responsibilities, Encarni remains actively involved in astronomical research, focusing on AGNs. Her active engagement in research bridges the gap between operational goals and scientific advancement, ensuring that SALT remains at the forefront of cutting-edge astronomy.

Acting Head of Astro Ops — Danièl Groenewald

In July 2024, Danièl assumed the role of Acting Head of SALT Astronomy Operations, taking over from Encarni. In this capacity, she is responsible for ensuring the continued smooth operation of the Astro Ops team and overseeing key projects.

Danièl earned her PhD in 2016, focusing on the formation and evolution of Brightest Cluster Galaxies, with an emphasis on the role of mergers. That same year, she began a postdoctoral fellowship under Stephen Potter, where she was introduced to the polarimetry mode on SALT. As part of her research, she worked extensively with polSALT, the official software for reducing SALT spectropolarimetric observations, gaining in-depth expertise in its functionality and applications.Building on this experience, she successfully applied for and was appointed as a SALT Astronomer in 2018. Since then, she has collaborated closely with Ken Nordsieck (from UW), the original RSS Principal Investigator, to provide user support for SALT polarimetry users and to develop calibrations for, but not limited to, the linear spectropolarimetry mode. Their collective efforts over the past seven years have culminated in a release in March 2025.

Acting Head of Tech Ops — Willem J. van der Westhuizen

After Paul Rabe, who had been the Tech Ops manager since December 2019, moved to the SAAO Intelligent Observatory Team in October 2024, Willem van der Westhuizen became Acting SALT Technical Operations Manager. He is a highly experienced electronics engineer specialising in operations management, maintenance and research and development, and has held the position of SALT Senior Electronics Engineer since December 2022.

His career includes over two decades at Denel, a weapons systems testing facility near Arniston, providing comprehensive testing and evaluation services for the aerospace, defense, and related industries. At the Denel Overberg Test Range, he progressed through increasingly responsible positions. His technical expertise was instrumental in managing the complex tracking and search radar systems crucial for test operations, developing long-term maintenance and capital procurement plans for these systems, and optimising test plans for various radar configurations. Utilising system engineering principles in the upgrading and maintenance of the radar systems, he ensured its optimal performance and reliability within the demanding test environment. His leadership experience includes serving as System Manager: Radars and Head: Hardware Development. He also managed computer hardware and network maintenance, which involved integrating modern electronics with legacy systems, including mainframe computers over 30 years old. Throughout his tenure, he ensured adherence to ISO 9001 quality management standards.

His technical skills encompass a broad range of disciplines, including operations management, engineering management, research and development, system engineering and strategic planning.

Obituary — Surayda Moosa

It's with heavy hearts that we remember and honour Surayda Moosa, a remarkable soul who has left an indelible mark on each of us privileged enough to have worked closely with her. In the early hours of Saturday, 26 October, after a brief hospital stay, Surayda passed away, leaving behind a void that feels almost impossible to acknowledge, much less to fill.

Surayda dedicated 20 years of her life to the observatory, beginning as a Debtors Clerk in the finance office, and, in 2013, transitioned into the role of SALT Finance Officer, a position she embraced with dedication and pride. Her professionalism and integrity earned her the respect of colleagues and leadership alike. Her impact, however, was not confined to her professional achievements. She was a kind and vibrant presence, known for bringing warmth and joy into the lives of those around her. A calming presence during stressful moments, she had a way of making everyone feel valued and appreciated. She also had an undeniable love for food, always eager to share a smile, a snack, or a meal, and her lovely company. Surayda made every moment spent together feel special. A devout individual, Surayda was deeply committed to her faith and cherished her family above all else. Her untimely passing is all the more poignant because she was due to retire in a few months and was looking forward to spending more time with them.

Her memory will live on in the many lives she touched, both personally and professionally.

RIP Surayda. We miss you.

Chairman's Overview

The year 2024 has been a busy year at SALT, highlighted by two First Light events: the Laser Frequency Comb for the HRS and the SMI-200 slitmask IFU on the RSS.

Commissioning of the SMI-200 IFU went smoothly and this new mode for RSS was made available for shared risk science observations in the 2025-1 semester. The laser frequency comb, being built by Heriot-Watt University in Edinburgh, is making steady progress and should be available for shared risk observations later in 2025.

Another highlight of 2024 was the hiring of the first SALT Observatory Director, Encarni Romero Colmenero. Encarni is well known to the SALT community, as she has been a founding member of the astronomy operations team, and the Head of Astronomy Operations for the last six years. Encarni now focuses solely on SALT operations and developments. The heads of astronomy operations and technical operations, along with the SALT observatory scientist all report directly to the SALT observatory director. In turn, the SALT observatory directory will report jointly to the SAAO managing director and the SALT Board. SAAO recently completed a search for a new managing director with the hiring of Rosalind Skelton, a former SALT astronomer. The SALT board is looking forward to working closely with Ros and Encarni in the coming years.

In 2024, negotiations were started to renew the SALT operations and management agreement with SAAO. These discussions have proceeded in a collegial fashion, and both parties agreed that the new agreement will incorporate a number of key performance indicators, which will be used to monitor the success of SAAO in operating SALT. SAAO is funded and managed by the South African National Research Foundation (NRF) and the new agreement will be finalised and signed by SALT and SAAO/NRF in the first quarter of 2025. The SALT board is looking forward to a continued close relationship with SAAO.

One of the key challenges faced by the SALT board in 2024 was the announcement by several members of the UKSC that they would be withdrawing from SALT due to financial constraints. The SALT board was disappointed by this development, as the UKSC was one of the founding members of SALT and has been an important contributor to SALT since its inception. Currently, the NRF is paying operations costs associated with some of the UKSC shares which are on loan to the NRF. The remaining UKSC member, Armagh Observatory, is actively searching for new members of the UKSC, and the SALT board is hopeful that Armagh Observatory will be successful in its efforts.

Membership of the SALT board saw considerable change in 2024, as Matthew Bershady (University of Wisconsin-Madison), Philip Charles (UKSC), Vanessa McBride (NRF) and Fulufhelo Nelwamondo (NRF) all resigned from the board. I'd like to thank all four of them for their dedicated service to the board over the years. The board was pleased to welcome four new members in 2024, Eric Wilcots (University of Wisconsin-Madison), Sherona Urquhart (UKSC), Angus Paterson (NRF) and Rosalind Skelton (NRF). The expertise and perspectives that these new members bring to the board will help to keep SALT moving forward in the coming year.

The SALT board continues to be grateful for the excellent work being done by SALT staff. SALT operates on a relatively lean budget, and is able to do so due to the focus and dedication of the SALT astronomy and technical operations teams. This year has been challenging for them due to a number of vacancies, but the SALT staff have risen to the occasion and ensured that SALT has been in productive science operations throughout the year. The SALT board is extremely pleased that in 2024 there were 81 publications based upon SALT data, which is a record for the observatory.

Prof. Brian Chaboyer
Chairperson, SALT Board

Director's Report

The year 2024 has been productive for SALT with above average science time at the telescope and a record number of publications.

The high fraction of science time is partly due to our efforts to improve our acquisition efficiency — we have reduced our acquisition overheads by about 50 – 100s for RSS and HRS. Part of the gain is due to applying machine learning to stabilise SALT's focus, in combination with the project to pre-position the guiders in the correct location for each instrument, which speeds up the acquisition process.

Good news also on the RSS Big 5 project: three of the projects have been concluded. The long-slit mask project is nearing completion with the final set of masks expected to be delivered to the telescope in early 2025. The new detector project is progressing well, with assembly of the components expected later in 2025.

The SALT Users Group for Astronomical Resources (SUGAR) was established early in 2024 to provide an independent point of contact for users to raise requests, concerns, suggestions, or to provide feedback to the SALT team. This involves data quality, scientific performance, software bugs, SALT provided documentation and support issues, as well as requests for new software, or new features to be added to existing software. SUGAR is also responsible for soliciting input from users on scientific directions for upcoming instrumentation and telescope capabilities. Users can contact SUGAR via the dedicated email address sugar@salt.ac.za, or via the online form at https://forms.gle/79WbduuHzWhmr5pbA (where one has the choice of remaining anonymous, or providing one's details). We are looking forward to working with the SALT user community to help to improve the end user experience of SALT.

We have also updated our SALT status webpage (https://astronomers.salt.ac.za/status) to automatically reflect individual instrument and mode status and, if these are down, when they are expected to return to service.

An eagerly awaited update on the polarimetry calibrations is now available, and polarimetry users can expect a calibration release within the next few months.

Since the introduction of the proposal category of large science projects (LSP), there have been only two such projects, until last year when two more were suggested and accepted by the respective TACs. One of these makes use of the new instrument NIRWALS. The most successful LSP, David Buckley's "Observing the transient Universe", has been renewed a fourth time.

I would like to extend my heartfelt gratitude to all members of the various SALT teams. Your dedication and hard work have been instrumental in our progress this year.

Dr Encarni Romero Colmenero
SALT Observatory Director

SALT PARTNERS

Introduction

SALT is an international consortium consisting of a number of partners that share the costs of the telescope, in return for corresponding fractions of the available observing time. Some of the partners have also made in-kind contributions, in the form of instruments and/or other intellectual property, to secure their membership. Each partner country or institution has their own time allocation committee, and scientists outside the consortium that wish to use SALT are welcome to collaborate with those affiliated with partner institutions. SALT also offers a limited amount of free Director's Discretionary Time* (DDT) for the opportunistic pursuit of high-impact science, as the flexibility of SALT's queue-scheduled operation supports the rapid response to new top-priority targets.

The SALT Foundation now also invites researchers from around the world to purchase their own guaranteed SALT time. This can be in the form of normal time divided into the default priority categories ("P0" to "P3"), to be inserted in the service observing (at a rate of ~$2600/h). It may also be in the form of the highest priority time only, which is guaranteed to be observed fully, at a rate of ~$3400/h. Note that any partner institution may also purchase time beyond their normal share, and reduced rates apply in that case. Finally, the consortium is seeking an additional 10%-level partner (~$10.5M) to support significant second-generation instrumentation development. Interested parties should contact the chair of the SALT Board of Directors, Brian Chaboyer.

* https://astronomers.salt.ac.za/proposals/directors-discretionary-time/

Republic of South Africa

South Africa's National Research Foundation (NRF) is the majority shareholder in SALT, with approximately a one-half share. The South African Astronomical Observatory (SAAO), contracted to host and operate SALT, is also one of the NRF's several national facilities. As the intermediary agency between the policies and strategies of the government of South Africa and the country's research institutions, the NRF's mandate is to promote and support research through funding, human resource development and the provision of the necessary facilities, in order to facilitate the creation of knowledge, innovation and development in all fields of science and technology (including indigenous knowledge), and to thereby contribute to improving the quality of life of all South Africans. The country's considerable investment in astronomy, both in optical and radio, is due in no small part to this field's extraordinary potential to capture the imagination and hence to encourage the brightest young minds to pursue scientific and technical qualifications.

SALT is located at the Sutherland site of the SAAO in the Karoo desert (about 370 km from Cape Town), making it one of the darkest observing sites in the world. SAAO hosts all the SALT Astronomers, responsible for liaising with PIs and making the observations, as well as all the technical and support staff associated with SALT. The Observatory's mechanical and electronics departments at the SAAO headquarters in Cape Town include large workshops and a dedicated CCD lab. SALTICAM and the RSS detector packages, as well as the fibre-instrument feed and various auto-guiders for the SALT instruments, were designed and built here. The maintenance and servicing of all instruments and telescope sub-systems are done in Sutherland by the Technical Operations team.

One of SALT's strategic objectives is Human Capital Development which is particularly important for South Africa and, even more so, for the African continent. Thus the SALT Collateral Benefits Programme (SCBP) was established during the construction of SALT and the objectives of this programme were clearly directed at the benefits derived by society from building this large telescope. The SCBP is mainly directed at schools but also includes outreach to the general public.

South Africa's astronomical community has grown significantly since SALT was built, with SALT and later the MeerKAT initiatives spurring much of this growth. The entire South African community has access to SALT. There are now over two hundred PhD astronomers, and students are encouraged to participate in SALT projects and to propose for time. The recent decision to have two additional board members from South Africa will provide further opportunities to develop leadership expertise and to continue to drive optical astronomy research.

South African researchers are active across a wide range of the multi-wavelength astronomy domain. The strategic vision for SALT, developed by the South African community in 2017, identified two main focus areas for future development, which tie in closely with both MeerKAT, the country's precursor to the SKA, and local high-energy astrophysics research. These are transient science and galaxy evolution (particularly understanding the fuelling of star formation and recycling of gas in the baryon cycle). Exoplanet research and building instrumentation capacity have also been highlighted as growth points for the future, resulting in the current improvements of the high-stability mode of the HRS.

SALT Board members:
Sharmila Goedhart, SARAO
Itumeleng Monageng, SAAO/UCT
Angus Paterson, NRF
Rosalind Skelton, SAAO/NRF

Rutgers University (USA)

Rutgers, the State University of New Jersey, is a large public research university in the United States. Originally chartered as Queen's College in 1766 during the colonial era, in 1825 it was renamed Rutgers College after a wealthy benefactor. Rutgers became the New Jersey land-grant institution in 1864 and in the mid-20th century, it was designated the State University of New Jersey by the state legislature. Rutgers University has expanded far beyond its modest colonial roots and now includes campuses in Newark and Camden as well as the flagship campus in New Brunswick. Across the state, more than 8000 Rutgers faculty instruct over 49,000 undergraduate as well as 19,000 graduate students. There are more than 150 undergraduate majors and 200 graduate programs.

Astronomy was part of the curriculum at Rutgers since its earliest days. The current Department of Physics and Astronomy at Rutgers–New Brunswick traces its origins to the late 19th century. Significant expansion in the astronomy programme began in the 1990s with the addition of a number of research-active astronomers and an increase in the number of graduate students. In 2001, Rutgers joined the SALT consortium. The astronomy group in 2024 comprised nine faculty (which includes one faculty member on leave at NASA), three emeritus faculty, six postdoctoral associates (including one LSSTC Catalyst Fellow and three joint Rutgers-Flatiron Postdoctoral Fellows), and 26 graduate students. Four Rutgers astrophysics graduate students defended their PhD theses in 2024, one of whom worked with SALT observations.

Rutgers hosted two visits under the SALT Scholarships and Visits Programme. Xola Ndaliso, a PhD student at the University of the Witwatersrand, visited for six weeks in May/June 2024 and Narges Hatamkhani, a postdoctoral fellow at SAAO, visited for four weeks in July 2024. Xola and Narges both worked with J. Hughes on galaxy cluster studies. Xola analysed the eROSITA X-ray data on the low redshift cluster Abell 3408 to study the X-ray properties of the cluster and its member galaxies. Narges reduced RSS/MOS slit mask observations of PSZ1 G278.78+08.5, a moderate redshift cluster discovered by the Planck satellite, to constrain the dynamical state of this complex merging cluster. These visits were highly successful with Xola and Narges making progress on multiple research fronts and enhancing their own careers through networking and experiencing graduate student life in another country.

Rutgers' astronomers, led by T. Williams, participated in the design, development and fabrication of the RSS and led the effort to build the Fabry–Pérot (FP) Imaging Spectrophotometer subsystem. Williams and his colleagues used this instrument to carry out the RSS Imaging spectroscopy Nearby Galaxies Survey (RINGS) of nearby, normal galaxies to characterise their structure using measurements of Hα velocity fields.

S. Jha uses SALT/RSS to study supernova (SN) explosions, observing mostly type Ia SNe to investigate their nature and, more broadly, to answer key questions in SN Ia cosmology. Jha has been measuring binary orbital parameters of a sample of candidate white dwarf binaries with the HRS and has used RSS spectroscopy to observe a sample of *GAIA* hypervelocity stars.

The main focus of J.P. Hughes' current research is the astrophysics of supernova remnants and clusters of galaxies. In collaboration with colleagues in South Africa, Hughes is studying the brightest cluster galaxies in massive clusters detected by the AdvACT. The goal is to trace the evolution of AGN feedback (both radio and quasar mode), stellar populations, and the growth of central galaxies in clusters over a 3.4 Gyr time period ($0.3 < z < 0.8$). Hughes also has an on-going SALT project for confirmation and redshift measurement of Planck cluster candidates.

A. Baker is involved in two large SALT collaborations: the "SALT Gravitational Lensing Legacy Survey" targets sub-mm-band sources from the Herschel space mission that are likely high-redshift ($z \sim 2 - 4$), gravitationally-lensed star-forming galaxies. The second project, "Preparing for LADUMA: SALT Redshift Measurements", aims at obtaining redshifts of galaxies in the LADUMA field to allow stacking of 21-cm H I spectra. Baker is Co-PI of the LADUMA radio survey with the South African MeerKAT array to study the evolution of neutral gas in galaxies over cosmic time.

E. Gawiser is working with a group of undergraduate students to observe low redshift ($z < 0.4$) [O II]-emitting galaxies from HETDEX, thereby revealing key properties of these star-forming galaxies.

SALT Board member:
Jack Hughes

Poland

Poland is a country with a long astronomical tradition. For example, Nicolaus Copernicus (1473–1543) was the creator of the heliocentric system, and Johannes Hevelius (1611–1687) was the founder of lunar topography. After World War II, Polish astronomy started to slowly build up its resources but it was only after the communist regime fell in 1989 that Poland could join ESO, ESA and other international astronomical organisations. About 250 astronomers are employed at six separate universities and two institutes of the Polish Academy of Sciences (PAS). Some of these form the Polish SALT Foundation, which has a 10% share in the construction and running costs of SALT. There are five main SALT partner institutions.

The **Nicolaus Copernicus Astronomical Center** (CAMK, or NCAC in English) of the PAS is the leading astronomical institute in Poland. It is located in Warsaw and was established in 1978. It is the coordinator of the SALT project, with K. Hełminiak being Poland's Board director and the Chair of the STC. J. Mikołajewska is also a member of the STC, being highly involved in several SALT committees. At present, 80 scientists are working at CAMK along with ~30 PhD students. They are involved in a number of major international observational projects (*e.g.*, CTA, *Athena*, SALT, LIGO-VIRGO, BRITE, PLATO, Ariel), and collaborate with scientists all over the world. Scientific research conducted at CAMK with SALT include: the search for symbiotic stars and the study of individual systems; classical and recurrent novae; post AGB binaries; multiple stellar systems; characterisation of exoplanet host stars; dark matter studies using spectroscopic long term monitoring of selected quasars.

The **Astronomical Observatory of the Jagiellonian University** is a part of the Faculty of Physics, Astronomy and Applied Computer Science of the Jagiellonian University. The Observatory was founded in 1792 and comprises a number of small radio and optical telescopes that are located at Fort Skała on the outskirts of Kraków. The Observatory is involved in exploiting large facilities such as H.E.S.S., CTA and SALT and runs one of the LOFAR telescope stations. SALT data is used in studies of giant-size radio galaxies, accretion discs in AGNs using Doppler tomography and timing analysis of their multi-wavelength light curves.

The **Institute of Astronomy of the Nicolaus Copernicus University** in Toruń, located in Piwnice village, 15 km north of Toruń, is home to a VLBI station and a few optical instruments. The telescopes are used mainly for student training and modest research projects. SALT researchers are interested in symbiotic stars, novae, PNe, and follow-up of the *GAIA* mission alerts.

Founded in 1919, the **Institute Astronomical Observatory (IAO) of Adam Mickiewicz University** runs a Global Astrophysical Telescope System (GATS) consisting of two robotic instruments (Poland and Arizona) used for photometry and spectroscopy. The third node — a cluster of 0.7-m and 0.3-m telescopes for space debris tracking — is under construction. IAO uses SALT for photometric and spectroscopic observations of asteroids. T. Kwiatkowski is a member of the newly created SUGAR committee.

The **Astronomical Institute of the Wrocław University** is located in the eastern part of Wrocław. Research concentrates on the investigation of solar activity (with a coronagraph located near Wrocław) and on pulsating stars (with SALT among others). Satellite observations also play an important role in these investigations.

SALT Board member:
Krzysztof Hełminiak, CAMK

Dartmouth College (USA)

The Shattuck Observatory on campus.

Founded in 1769, Dartmouth College is one of the leading liberal arts universities in the United States. Dartmouth has forged a singular identity for combining its deep commitment to outstanding undergraduate liberal arts and graduate education with distinguished research and scholarship in the Arts & Sciences, and its three leading professional schools: the Geisel School of Medicine, the Thayer School of Engineering, and the Tuck School of Business. Dartmouth College educates the most promising students (approximately 4300 undergraduates and 2000 graduate students) and prepares them for a lifetime of learning and of responsible leadership, through a faculty dedicated to teaching and the creation of knowledge.

Astronomy has a long history at Dartmouth, with the Shattuck Observatory (built in 1853) being the oldest scientific building on campus. The first photograph of a solar prominence was obtained by the Shattuck Observatory (in 1870).

Today, the astronomy group at Dartmouth is housed within the Department of Physics and Astronomy and has a 25% share in the MDM observatory (consisting of a 2.4-m and 1.3-m telescope in Kitt Peak, Arizona, USA) in addition to its ~10% investment in SALT. Astronomers at Dartmouth have a broad range of research interests and have used SALT to study supernovae, active galactic nuclei and metal-poor stars, among other projects. Currently, the astronomy group consists of six faculty members, two post-doctoral fellows and about ten graduate students.

SALT Board member (chair)
Brian Chaboyer

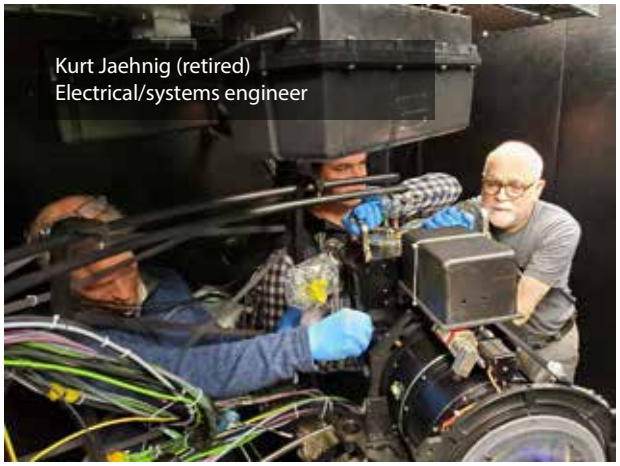
University of Wisconsin–Madison (USA)

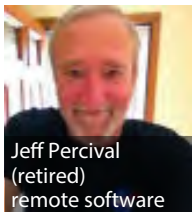
The University of Wisconsin–Madison (UW-Madison) is a public, land-grant institution that offers a complete spectrum of studies through 13 schools and colleges. With more than 52,000 students from every U.S. state and 130 countries, UW–Madison is the flagship campus of Wisconsin's state university system. UW–Madison is a formidable research engine, ranking sixth among U.S. universities as measured by dollars spent on research. Faculty, staff, and students are motivated by a tradition known as the Wisconsin Idea that the boundaries of the university are the boundaries of the state and beyond. One of two doctorate-granting universities in the University of Wisconsin System, UW–Madison has the specific mission of providing "a learning environment in which faculty, staff and students can discover, examine critically, preserve and transmit the knowledge, wisdom and values that will help ensure the survival of this and future generations and improve the quality of life for all."

UW–Madison is a member of the SALT partnership and contributed to the construction in addition to the designing and building of the Prime Focus Imaging Spectrograph, which has since been renamed the Robert Stobie Spectrograph (RSS). UW-Madison recently completed and delivered a cutting-edge near-infrared, integral-field spectrograph for SALT called NIRWALS, which was used for science observations in 2024.

UW-Madison astronomers have traditionally used SALT to measure the distribution of mass in galaxy clusters from redshift surveys; to understand the kinematics and distribution of ionised gas in and around galaxies; and to study the stellar content and dynamics of nearby galaxy discs. Now there is also interest in high-resolution spectroscopy of multiple stellar systems, and in a large-scale quasar reverberation mapping program with NIRWALS. With the launch in 2024 of an inter-disciplinary center at UW-Madison across seven departments for the study of the origins of life, called the Wisconsin Center for Origins Research, there may be future demand for high-stability spectroscopy on SALT for the identification and characterisation of exoplanet systems.

SALT Board member:
Eric Wilcots





The NIRWALS commissioning team.

Inter-University Centre for Astronomy & Astrophysics (India)

The Inter-University Centre for Astronomy & Astrophysics (IUCAA) was established in 1988 by the University Grants Commission of India in Pune. The main objectives of IUCAA are to provide a centre of excellence within the university sector for teaching, research and development in astronomy and astrophysics, as well as to promote nucleation and growth of active groups in these areas in colleges and universities. Besides conducting a vigorous research programme of its own, workers from Indian universities, teachers and students are enabled to visit IUCAA for any length of time to participate in research and to execute developmental projects. IUCAA also actively collaborates with universities in initiating and strengthening teaching and research in Astronomy & Astrophysics in the university system.

Research interests of IUCAA members and associates include (i) gravitation, cosmology, large scale structures in the Universe, gravitational wave physics and data analysis; (ii) cosmic microwave background theory and data analysis, cosmic magnetic fields; (iii) galaxies, quasars, quasar absorption lines, intergalactic and interstellar matter; (iv) X-ray binaries, accretion disc theory, radio and X-ray pulsars, gamma-ray bursts; (v) solar physics, stellar physics, stellar spectral libraries, machine learning; (vi) observations in optical, radio and X-ray bands, astronomical instrumentation and (viii) data-driven astronomy, virtual observatory. IUCAA runs a 2-m telescope at Girawali to support various observational projects. Members of IUCAA are actively involved in various national large science projects such as the Indian participation in TMT, SKA and LIGO–INDIA etc., and IUCAA has a 7% share in SALT. It is used to identify and study extragalactic sources (large scale outflow, quasars, radio galaxies and field galaxies producing absorption lines in quasar spectra), high-resolution spectroscopy of stars and coordinated observations of time-varying sources. Astronomers from IUCAA are also involved in various Indian space observatories like *Astrosat* and *Adithya-L1*.

IUCAA's technical contribution to SALT is the SIDECAR Drive Electronics Controller (ISDEC) which is used as the control and data acquisition system for the H2RG detector in the new NIRWALS spectrograph.

SALT Board member:
Raghunathan Srianand

View of IUCAA's campus.

UK SALT Consortium

An early and enthusiastic supporter of the SALT project, the UK's consortium (UKSC) originally consisted of six astronomy groups, reducing to five with the exit of Nottingham following a retirement. All of UKSC have had a long-standing involvement with astronomers in South Africa (SA), including providing support for visiting graduate students and postdocs to SA. UKSC has successfully hosted a half-dozen SALT–Stobie scholarships, greatly enhancing the production of SA astronomy PhDs. From 2018 – 2020, the "Global Challenges" research funding was used to support SA post-docs to visit the UK for extended periods, and follow-up visits have continued. UKSC have a wide range of SALT science interests and are involved as collaborators in a number of major SALT science projects, in particular playing a leading role in the X-ray binaries component of the SALT Transients Large Programme. The following institutions form the UKSC.

SALT scientists at the **University of Central Lancashire** (UCLan) include G. Bromage, A. Sansom, D. Kurtz and D. Holdsworth. Bromage was UKSC's previous Board director and has been active in other SALT committees, currently as a member of FAC. UCLan has made extensive contributions to the SCBP, has hosted successful SALT–Stobie scholarships, has provided UCLan's distance learning university-level Astronomy courses (at discounted rates) for SALT staff, and is supporting visiting graduate students. SALT science interests involve collaborations within UKSC (with Keele and Armagh) and with SA (mostly with NWU and SAAO).

At the **Open University**, science interests range from the "Dispersed Matter Planet Project" (C. Haswell), which has identified a key population of rocky exoplanets orbiting bright nearby stars and catastrophically disintegrating planets, to studies of variable star populations and unique individual variables from SuperWASP (A. Norton, M. Lohr). Norton has recently focussed on close-contact red giant eclipsing binary candidates which may be red nova progenitors. S. Serjeant, S. Urquhart (who has taken over as UKSC Board director for SALT in 2024) and L. Marchetti (UCT) coordinate the "SALT Gravitational Lensing Legacy Program", which combines *Herschel* wide-area sub-mm observations with multi-wavelength ancillary data to generate the largest (> 500) sample to date of homogeneously selected lens candidates, obtaining SALT spectroscopy for most of them. These data will be used in conjunction with Urquhart's recent results, the Bright Extragalactic ALMA Redshift Survey (BEARS), identifying redshifts of bright gravitationally-lensed galaxies from the *Herschel* ATLAS.

SALT science at **Armagh Observatory & Planetarium** focuses on stellar remnants, massive stars, ultra-compact binary systems, and solar-system science, with extensive effort on stellar pulsations and abundance analyses using SALT's RSS and HRS, with collaborations within UKSC and with SA (SAAO, UCT and UWC). People involved at Armagh are S. Jeffery, M. Burton, G. Ramsay, J. Vink, G. Doyle as well as M. Sarzi, who has taken on the role of representing Armagh on UKSC. AOP is now the UKSC administrating institution.

The photo was taken at the UKSC management committee meeting in Keele in November 2017.

At **Keele University**, J. van Loon's interests in SALT have been to exploit the RSS-FP mode to map emission as well as absorption features in nearby galaxies, and long-slit spectroscopy of various types of stars but mostly a series of AGN. This work is generally done as part of PhD projects including students from underprivileged countries. It has featured in press releases and in a science-art outreach project at Sutherland's High School.

P. Charles from the **University of Southampton** (UKSC Board director for SALT from 2015 to 2024) was SAAO Director for seven years (2004 – 2011) and, together with many of the Southampton Astronomy Group, is actively involved in the SA-led SALT-LSP "Observing the Transient Universe". Southampton's interests focus on black-hole, neutron star and white dwarf X-ray binaries, usually in association with other ground-based (e.g., ASASSN, OGLE, MASTER) and space-based (*e.g.*, *Swift*, *MAXI*, *Astrosat*) facilities, frequently arranging for simultaneous or contemporaneous observing. M. Sullivan is involved in SN–cosmology studies, which is part of the SALT long-term programme on supernovae. SALT is also used for rapid follow-up spectroscopy of outbursting X-ray sources in the SMC arising from the ongoing *Swift's* S–CUBED monitoring (M. Coe). Also interested in SALT science are C. Knigge, D. Altamirano, T. Bird, P. Gandhi and M. Middleton.

SALT Board member:
Sheona Urquhart, Open University

The American Museum of Natural History (USA)

The American Museum of Natural History (AMNH) is one of the world's preeminent scientific and cultural institutions. Since its founding in 1869, the Museum has advanced its global mission to discover, interpret, and disseminate information about human cultures, the natural world, and the Universe through a wide-ranging programme of scientific research, education, and exhibition. With 200 active researchers, including curator/professors, postdoctoral fellows, PhD and Masters degree students as well as research associates and assistants, AMNH is the only institution in North America that is both a research university and a museum, hosting over five million visitors each year.

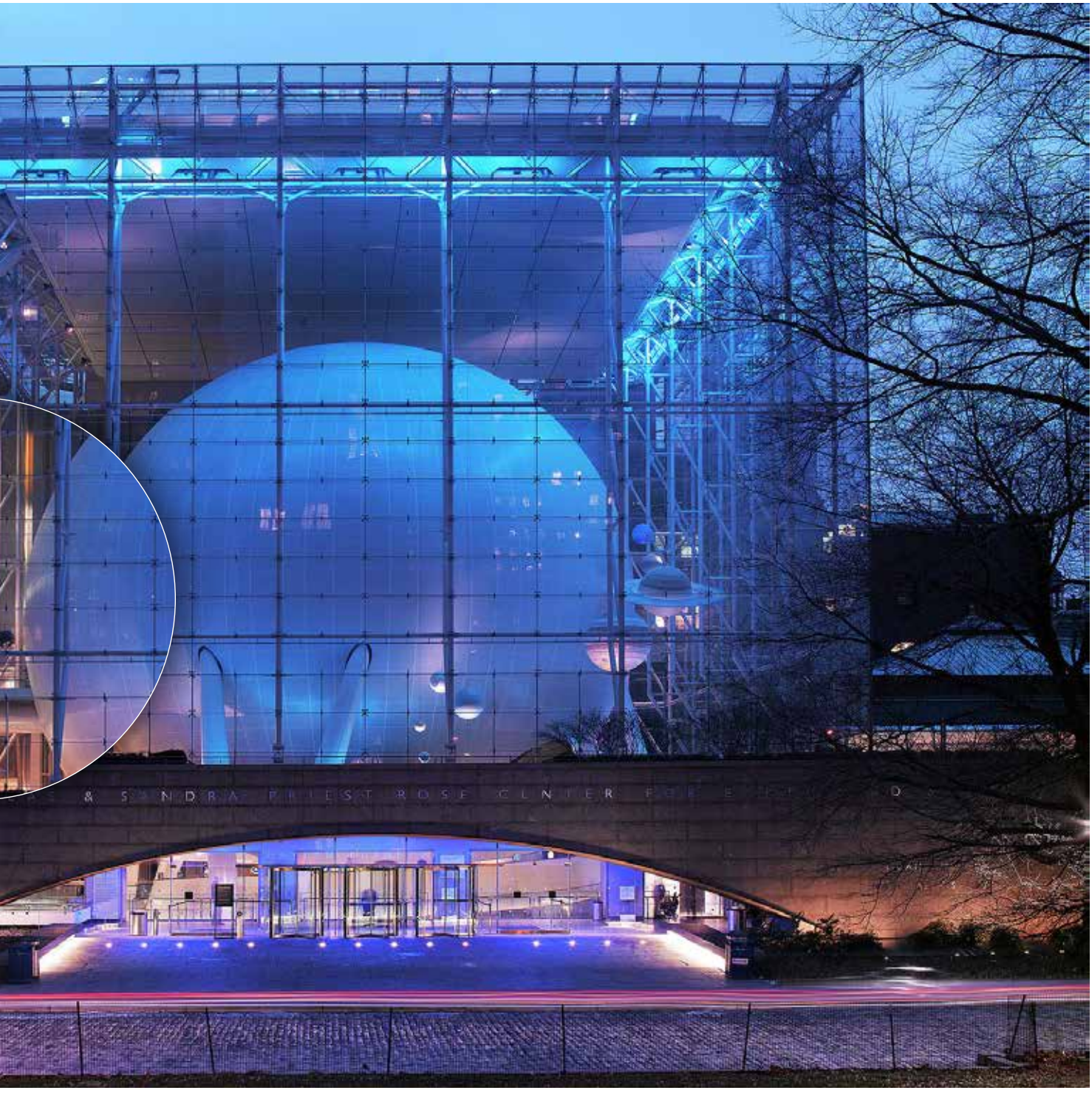
Astronomy has been part of AMNH since the opening of the Hayden Planetarium, partly funded by philanthropist Charles Hayden, in 1934. The completely rebuilt Planetarium, opened in 1999, is a 30-m diameter sphere inside an eight story-high glass cube, which houses the Star Theater. The theatre uses high-resolution full-dome video to project space shows based on scientific visualisation of current astrophysical data. A customised Zeiss Star Projector system replicates an accurate night sky as seen from Earth. The AMNH Astrophysics research department is responsible for the content of space shows, for conducting research in astrophysics, and for training graduate students and postdoctoral fellows.

AMNH became a member of SALT in 2008 on the basis of a gift from the late Paul Newman. AMNH astrophysicist Michael Shara became Chairman of the SALT Board in 2012 and served in that position until 2021. Shara uses SALT to study cataclysmic binary stars — novae, the stars that give rise to them, and the ways that they hide from astronomers during the millennia between eruptions. He is also interested in mass transfer in such binaries that spins up the black hole progenitors — O stars in O+Wolf-Rayet star binaries — to high speeds.

In collaboration with Shara, post-doctoral Fellow Laura Rogers (University of Cambridge and University of Arizona) continues to use SALT/HRS to characterise white dwarfs heavily polluted with metals, probably via accretion of asteroids and dust. City University of New York astronomers Saavik Ford and Barry McKernan are using SALT to characterise afterglows of black hole mergers in AGN discs.

SALT Board member:
Michael Shara

The American Museum of Natural History's Rose Center for Earth and Space in New York City.



SCIENCE HIGHLIGHTS

SCIENCE HIGHLIGHTS

Extragalactic Astronomy

Star formation histories of galaxies in the Fornax A group

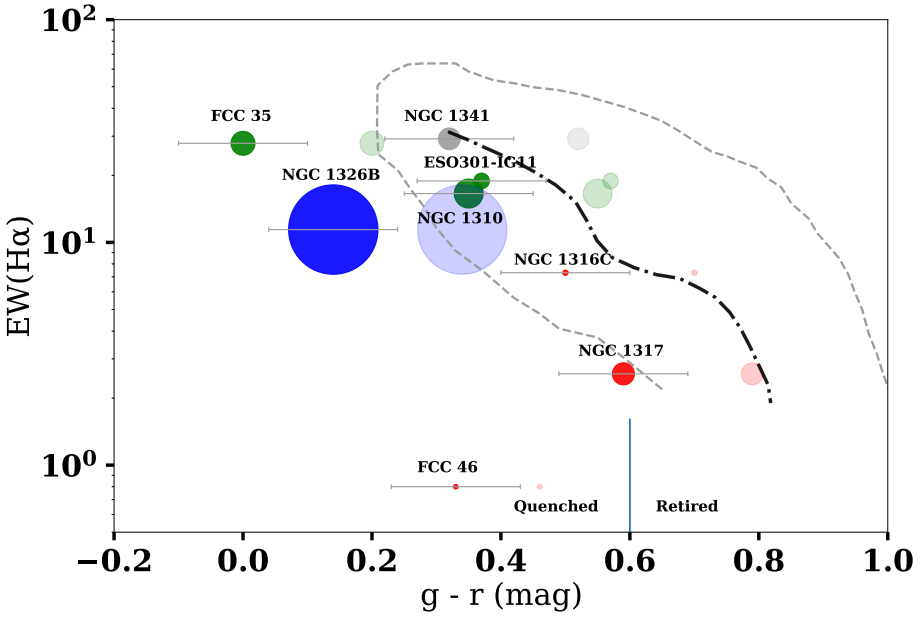
Loubser, S. I., et al. 2024/01, MNRAS 527, 7158: The star formation histories of galaxies in different stages of pre-processing in the Fornax A group

It is fundamental for us to understand the physical process(es) that describe the transition of star-forming blue galaxies to red galaxies. Galaxies evolve along the star formation main sequence until star formation ceases and the galaxy joins the passive red population. If there is a sharp break in star formation, implying a rapid transition to quiescence (< 1 Gyr), it is often referred to as 'quenching'. This contrasts with 'ageing', which describes the normal star formation sequence in which a blue galaxy will eventually end up as a red galaxy with old stellar populations without the need for a particular event that impedes star formation.

Physical processes that lead to quenching are strongly determined by the environment. Although the influence of the environment has been well demonstrated in galaxy clusters, environmentally driven star formation quenching also occurs in groups before they fall into clusters (called pre-processing). Different mechanisms are expected to quench star formation on different time-scales, and studying these time-scales can constrain the physical processes. The Fornax cluster is nearby (20 Mpc) and its galaxy processes can be studied in great detail with southern-hemisphere facilities including SALT and MeerKAT. Two virial radii south-west of the Fornax cluster centre lies the galaxy group Fornax A, an ideal system to study pre-processing in group environments. Its galaxies have published classifications of different stages of pre-processing (early, ongoing, advanced) according to their neutral hydrogen (HI) morphology and content (based on MeerKAT data).

To constrain time-scales, we need to probe the stellar populations of galaxies, and this is particularly useful where we can compare stellar populations with studies of the cold gas distribution. Since observations only provide a single snapshot during the evolution of a galaxy, we need to devise parameters that can describe the specific star formation rate (sSFR) of a galaxy over different time-scales. For example, the Hα emission line from [H II] regions traces the recent SFR of the last 10 Myr, while the $g - r$ colour roughly traces the SFR averaged over the last 800 Myr. Together, these optical features allow for a view into the change in the star formation rate. Ilani Loubser and her team used SALT to study the stellar populations of 10 galaxies in the Fornax A galaxy group. They constructed an ageing diagram (AD) of the equivalent width of Hα, EW(Hα), in the outer regions of the galaxies against their $g - r$ colours, and fitted stellar population models to describe the relative star formation histories of the galaxies in their centres and in their outskirts.

The authors find that the very recent star formation corresponds closely to the stage of pre-processing. The AD shows that NGC 1326B (early), FCC 35 (ongoing), and FCC 46 (advanced) have histories significantly different from secular ageing within the last Gyr. This strongly suggests an environmental effect such as ram pressure stripping, since strangulation, for example, would take several Gyr. The fact that most galaxies are on the secular evolution sequence implies that pre-processing has a negligible effect, at least on the stellar properties, compared to secular evolution. The team also analysed the EW(Hα) profiles and find outside-in pre-processing, which strongly suggests environmental processes, as opposed to internally triggered quenching mechanisms such as AGN or supernovae.



The AD for Fornax A for the outer parts of the galaxies. The black dot-dashed line indicates the secular ageing sequence. The colour of the data points corresponds to their pre-processing category (blue for early, green for ongoing, red for advanced), and the size of the symbol to the amount of HI. The solid symbols include an estimated correction for dust extinction. The vertical blue line separates the 'Quenched' and 'Retired' parts of the diagram.

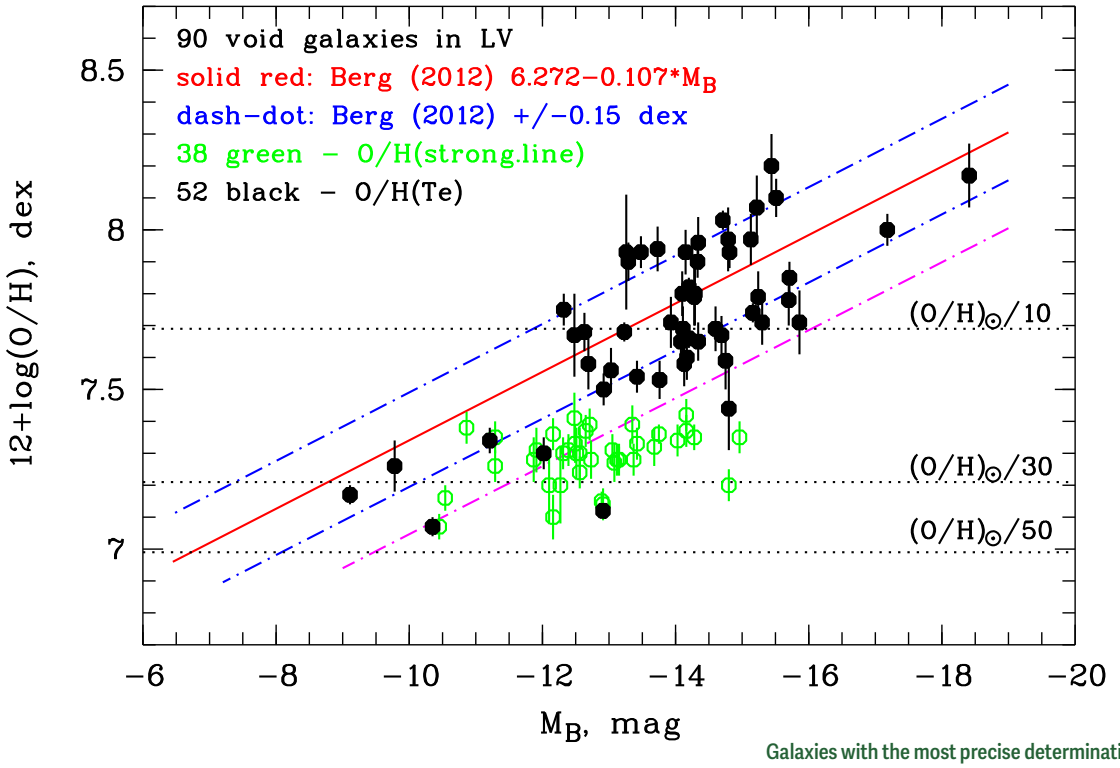
Dwarf galaxies in nearby voids

Pustilnik, S. A., et al. 2024/02, MNRAS 527, 11066: Dwarfs in nearby voids: results of SALT spectroscopy

Voids are the most rarefied elements of large-scale structures. They occupy 3/4 of the Universe's volume and contain roughly 15% of its mass. Due to the voids' specific conditions, both for galaxy formation and their evolution, one expects to meet in voids the most unevolved representatives of galaxies in the local Universe. It is expected that due to the shallow gravitational potential the least massive galaxies are more susceptible to the effects of the global environment. Indeed, in previous studies of nearby void galaxies, a group of about twenty eXtremely Metal-Poor (XMP) dwarfs was found with gas metallicities Z of (0.02 – 0.03) $Z_\odot$. They appear very gas-rich (*i.e.*, gas mass comprising 95 – 99% of the baryonic mass) and having a predominantly blue stellar population that hints at their unevolved state.

For better understanding of the void galaxy population as a whole, Simon Pustilnik and his team worked on a project studying all 236 void galaxies that fall within the Local Volume (LV; R < 11 Mpc). This allows comparison with the well studied population of the LV galaxies residing in the denser environments. The project explores void galaxies across both hemispheres via the synergy programmes at SALT and the SAO RAS's BTA 6-m telescope. As a first step the team obtained spectra of the galaxies' [H II] regions and derived the galaxy gas metallicity as one of the evolutionary parameters.

The spectral programmes at SALT and BTA-6 over the last few years allowed the authors to obtain spectra (and — for the majority — to derive metallicities) for about 2/3 of the 222 late-type void galaxies in the LV. The new data confirmed the reduced (on average) gas metallicity in void galaxies and showed the increased scatter in comparison to the known reference relation for the LV galaxies. Furthermore, in addition to the three known ones, seven new XMP dwarfs were discovered within the LV.



Galaxies with the most precise determinations of O/H (intermediate results), showing 12+log(O/H) versus blue luminosity M_B. Black and green dots are O/H estimates with the direct and the Izotov+2019 strong-line methods, respectively. The red and blue lines represent the reference relation from Berg +2012.

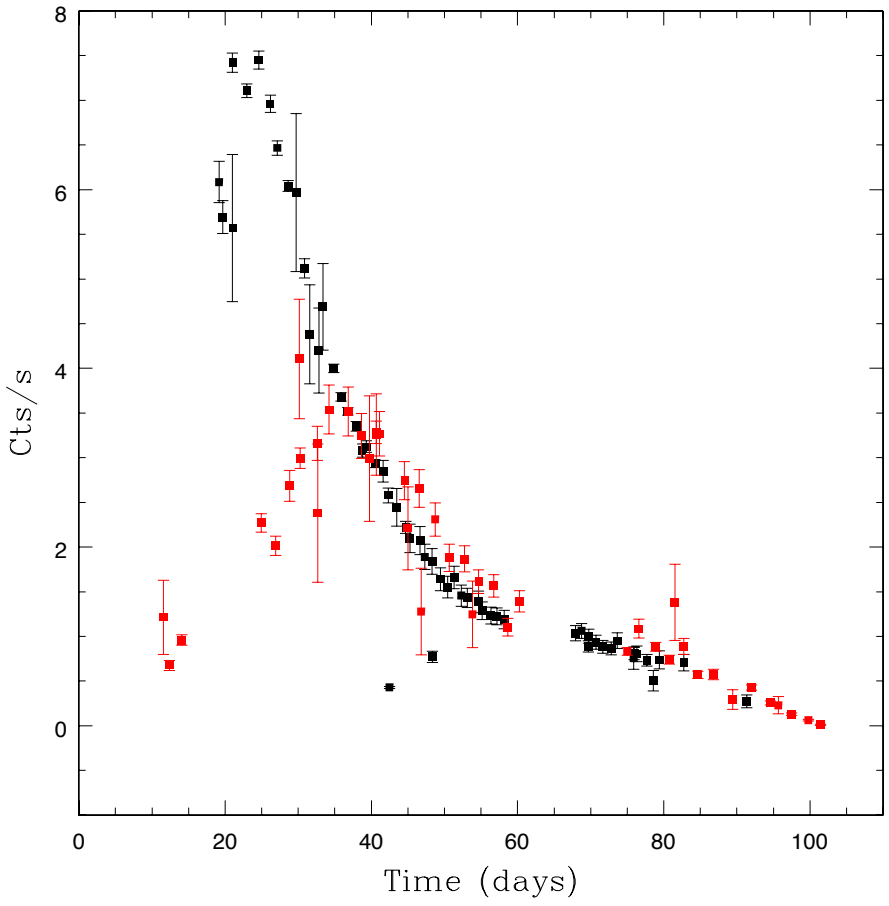
SALT witnesses the 2022 super-Eddington outburst of SMC X-2

Coe, M. J., et al. 2024/03, MNRAS 528, 7115: The 2022 super-Eddington outburst of the source SMC X-2

SMC X-2 exhibits X-ray outburst behaviour that makes it one of the most luminous X-ray sources in the Small Magellanic Cloud (SMC). In the last decade it has undergone two such massive outbursts — in 2015 and 2022. The first outburst is well reported in the literature, but the 2022 event is fully described and discussed in a paper by Malcolm Coe from the University of Southampton and his colleagues. In particular, the outburst profiles of the two events are compared. This reveals clear similarities in decay profiles, believed to be related to different accretion mechanisms occurring at different times as the outbursts evolve. The Hα emission line indicates that the Be disc undergoes complex structural variability, with evidence of warping as a result of its interaction with the neutron star (NS).

This source was studied as part of the collaborative transients programme between the S-CUBED (*Swift* SMC Survey) X-ray project and SALT. The SMC is mapped approximately every week using the NASA *Swift* telescope, seeking either new sources or major outbursts from known ones (with this study of SMC X-2 falling into the second category). The main thrust of the observations is the need for a rapid response at both X-rays and optical so as to catch the source in an exceptionally active mode. This was successfully achieved in June 2022 when S-CUBED noticed a rapid flux rise in SMC X-2 and SALT/RSS spectral monitoring began within a couple of days. This outburst rapidly rose in intensity to exceed the Eddington Limit (X-ray luminosity in excess of 10^{38} erg/s). The SALT data revealed a strong, double-peaked Hα profile, which was interpreted as evidence for a circumstellar disc around the companion Be star. Using the characteristics of this Hα profile, the team was able to estimate the size of the disc and show that it was larger than the orbit of the companion NS, thereby concluding that it was material from the disc that was feeding the exceptional X-ray luminosity of the NS.

It was important that both X-ray and optical observations occurred contemporaneously and rapidly to permit the detailed modeling of such an exceptionally bright X-ray outburst. Both *Swift* and SALT fortunately provide such access via their Transients programmes.



The X-ray profiles (XRT counts/s in 0.3 – 10 keV range) of the 2015 outburst (black) overlaid on top of the 2022 outburst (red).

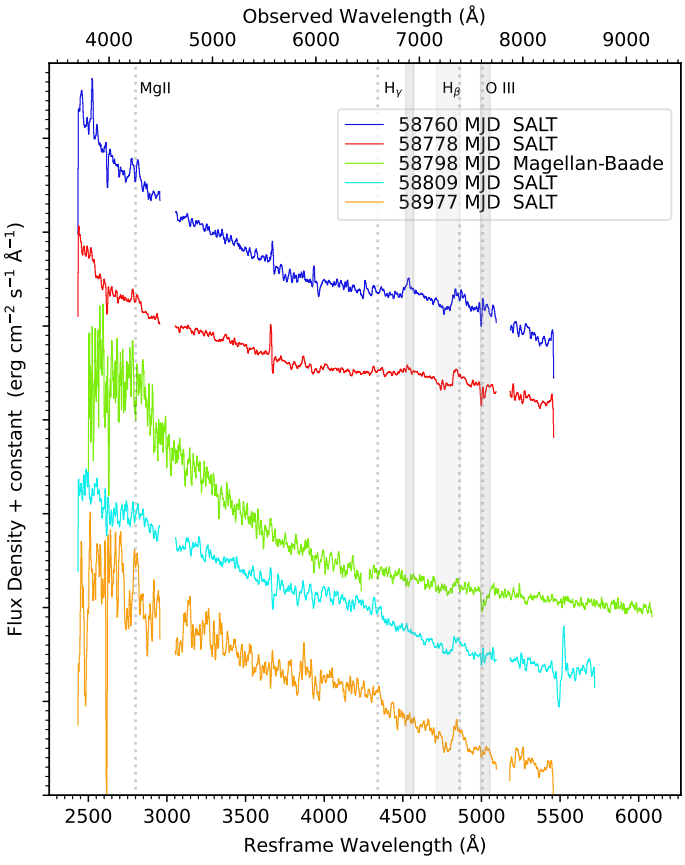
A supermassive black hole starts feeding

Oates, S. R., et al. 2024/05, MNRAS 530, 1688: Swift/UVOT discovery of Swift J221951-484240: a UV luminous ambiguous nuclear transient

Swift J221951-484240 (J221951) was discovered by the *Neil Gehrels Swift* Observatory Ultraviolet/Optical Telescope (*Swift*/UVOT) during the follow-up of gravitational wave alert S190930t on 30 September 2019. The *Swift*/UVOT team was searching for a kilonova, which accompanies a neutron star merging with another neutron star or black hole; the kilonova is expected to be initially blue, then become redder and fade on a timescale of days. Instead, they discovered J221951, a new luminous slow-evolving blue transient, which they monitored for over three years.

Multiple telescopes were triggered to follow-up J221951 and determine its nature, including SALT taking a series of spectra to follow the evolution of J221951. The SALT spectra are blue and almost featureless except for a double-peaked emission line, which was later confirmed as [Mg II] 2800 Å, an emission line common to AGNs. A UV spectrum from the HST ruled out the association of J221951 with the gravitational wave event as it showed that J221951 occurred at z ~ 0.52, in contrast to the gravitational wave signal, which occurred at a close ~100 Mpc. At z ~ 0.52, J221951 is one of the most luminous transients ever detected.

Several key pieces of evidence point to J221951 resulting from a massive black hole feeding very rapidly. A red galaxy was observed at the location of J221951 prior to its detection, and the location of J221951 is consistent with its centre, where a massive black hole would naturally reside. It started to shine very suddenly (no more than 10 months prior to initial detection, according to *WISE* data), meaning the black hole started feeding very quickly after being quiet for some time. The UV spectrum shows absorption features consistent with material pushed outwards by the huge energy release. This, combined with its high luminosity, makes it one of the most dramatic 'switches-on' of a black hole ever seen. Two possible mechanisms could explain this extreme feeding of a supermassive black hole. It could be caused by a tidal disruption event (the disruption of a star as it passes close to the supermassive black hole at the centre of its galaxy) or it may be produced by an AGN 'changing state' from dormant to active (with J221951 being the signal that a dormant black hole at the centre of the host galaxy has begun to feed on material from an accretion disc). J221951 belongs to a small but growing collection of objects with similar ambiguity, called Ambiguous Nuclear Transients (ANTs).



Top: Artist's impression of a star being tidally disrupted by a black hole. – Credit: ESO/M. Kommesser

Left: SALT and LCO-Magellan-Baade optical spectra of J221951 at various epochs. The spectra have been smoothed using a 1D Box filter kernel, with a kernel width of 5 and 10, respectively. The LCO–Magellan–Baade spectrum is markedly different in shape compared to the SALT spectra. The *B* band flux from the acquisition image matches well, suggesting the flux calibration at the *B* band is correct, however, one cannot rule out the shape difference as being due to calibration issues because of lack of photometric measurements at multiple wavelengths taken at the same time. The grey bands show the telluric bands. The darker grey bands absorb more strongly than the light grey band. The SALT spectra have a telluric correction applied.

SALT monitors a transient event in NGC 1566

Ochmann, M. W., et al. 2024/06, A&A 686, A17: The transient event in NGC 1566 from 2017 to 2019. I. An eccentric accretion disk and a turbulent, disk-dominated broad-line region unveiled by double-peaked Ca II and O I lines

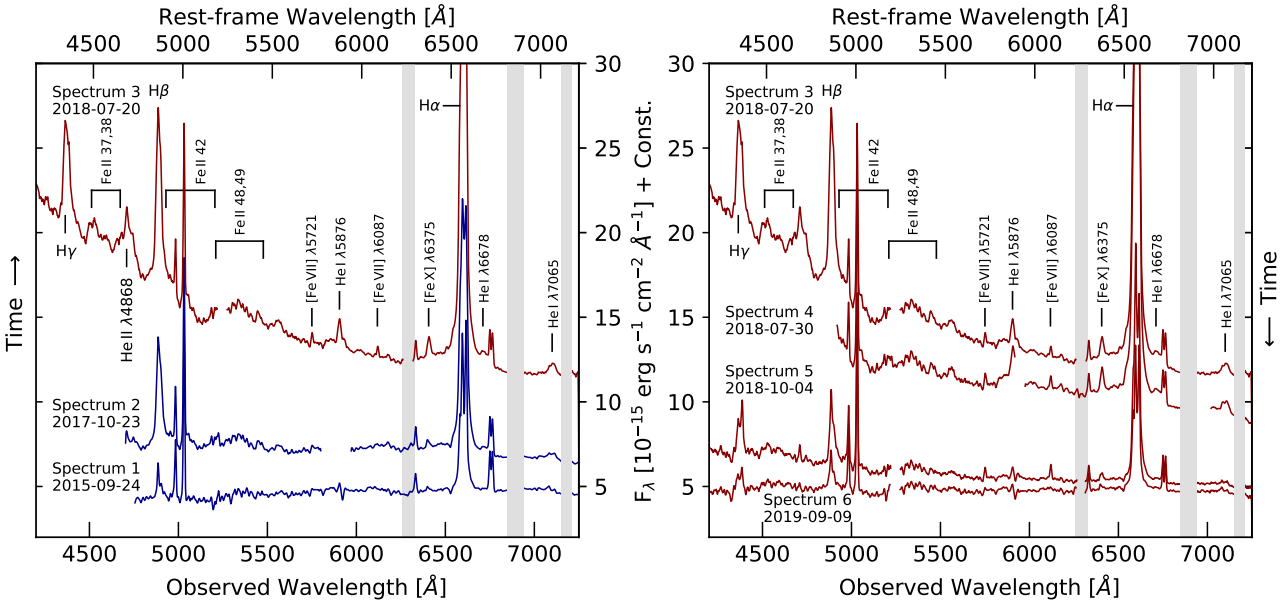
Kollatschny, W., et al. 2024/10, A&A 690, L2: Evidence for gravitational self-lensing of the central supermassive black hole binary in the Seyfert galaxy NGC 1566

Transient events in AGNs offer a unique possibility to study the broad line region (BLR) and its (apparent) variations induced by the huge changes in incident ionising flux. From a spectroscopic point of view, such changing-look events are characterised by a change of spectral classification, implying significant changes in the BLR line profiles. However, detailed variability studies of the BLR during such events are scarce, primarily due to the lack of spectroscopic data obtained directly before and during the event's peak.

For the first time, an international team of astronomers led by Martin Ochmann and Wolfram Kollatschny at the University of Göttingen conducted a comprehensive spectroscopic monitoring campaign with a high signal-to-noise ratio of a transient event in the nearby (z = 0.005) Seyfert galaxy NGC 1566. Using SALT/RSS and archival VLT/MUSE data, the team obtained spectra *before, during,* and *after* the transient event, which began in 2017, peaked in June 2018, and faded to near pre-transient levels by 2019 – 2020. These observations enabled a full characterisation of the spectral changes during the event and provided insights into the kinematics and dynamics of the BLR through a detailed analysis of the broad-line profiles.

The study revealed the emergence and subsequent fading of a strong power-law-like blue continuum, alongside significant variations in the Balmer, [He I], and [He II] emission lines and the coronal lines [Fe VII], [Fe X], and [Fe XI]. Detailed modeling of the broad emission lines suggested that the profiles are consistent with emission from a low-inclination elliptical accretion disc (i ~ 8°), influenced by scale-height-dependent turbulence. The data indicated that each line species is emitted from a distinct region with specific turbulence properties, pointing to a vertical stratification of the BLR. Additionally, a blueward shift in the line profiles with increasing luminosity could be interpreted as evidence for the emergence of a low-velocity disc wind. Despite these changes in line flux and profile shifts, the overall kinematics of the BLR remained largely unchanged during the event.

This work underscores the enormous potential of high signal-to-noise ratio optical spectroscopic variability campaigns with SALT/RSS. It demonstrates the potential to probe the innermost structures of AGN and to unravel the nature of extreme variability events, even with limited temporal sampling.



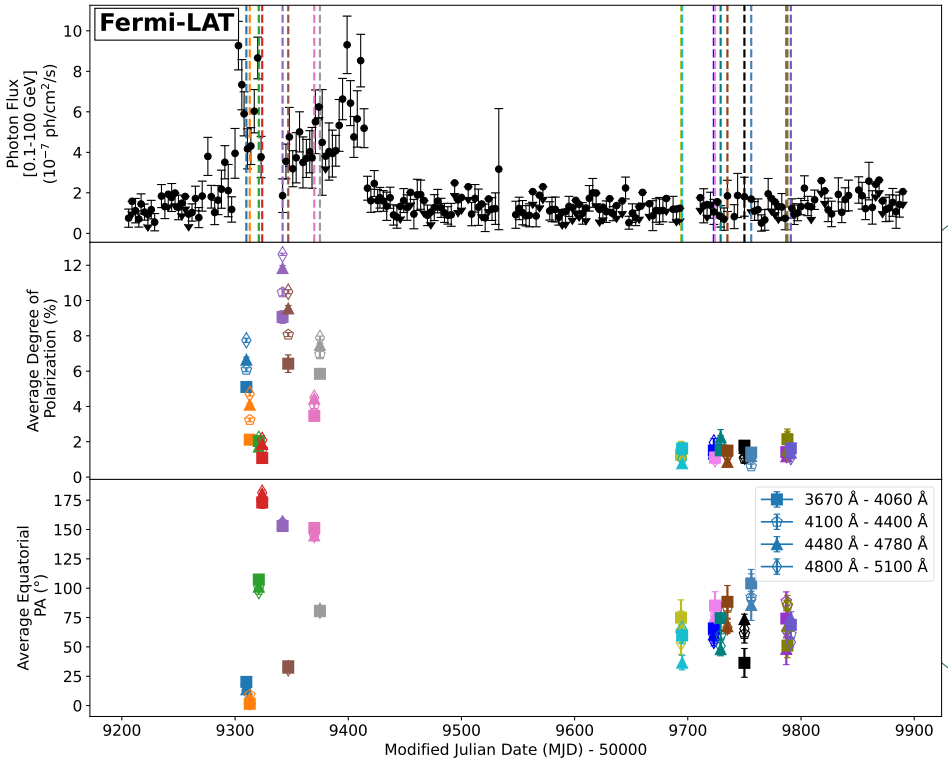
Spectra obtained during the rising (*left panel*) and declining (*right panel*) phase of the transient event in NGC 1566. SALT/RSS spectra are shown in red, VLT/MUSE spectra in blue.

The optical spectropolarimetric behaviour of high-energy blazars

Barnard, J., et al. 2024/08, MNRAS 532, 1991: The optical spectropolarimetric behaviour of a selection of high-energy blazars

Active galactic nuclei (AGN) are the central active cores of galaxies, in which material is accreted onto a supermassive black hole. Blazars are a subclass of AGN in which the relativistic jet-component closely aligns with our line of sight. At optical wavelengths, the emission received from blazars is a superposition of thermal and non-thermal emission components. The thermal emission, arising from the accretion disc, torus and line emitting regions, dilutes the non-thermal, polarised emission from the relativistic jet of the blazar. This effect is stronger for Flat Spectrum Radio Quasars (FSRQs) which show stronger thermal emission. Optical spectropolarimetry can be used to disentangle the thermal and non-thermal emission which, in turn, allows for constraints to be placed on particle populations and acceleration mechanisms that produce the non-thermal emission. This will shed light on the leptonic/hadronic nature of the high-energy (X-ray to gamma-ray) of blazars. As the contribution of the thermal/non-thermal emission fluctuates between periods of activity/quiescence, it is crucial to observe these sources in both states and over longer time periods to investigate the polarisation characteristics of blazars.

Using SALT's spectropolarimetric capabilities with the RSS, Joleen Barnard from South Africa's University of Free State and her colleagues observed 18 blazars in different states between 2016 and 2022. These observations were complemented by optical photometric data obtained with the Las Cumbres Observatory Telescope Network, along with publicly available *Fermi*-LAT data. Three of the sources (AP Lib, PKS 1034-293, and PKS 1510-089) were observed over a long period of time, and the remaining sources were observed around periods of enhanced activity. The data obtained was used to investigate the polarisation during transitions from flaring to quiescent states, as well as the long-term evolution of the polarisation in an attempt to understand the behaviour of the blazar population as a whole. Overall, the results of this campaign were found to be in agreement with the findings of RoboPol. The spectropolarimetric observations further allowed the authors to investigate the frequency-dependence of the degree of polarisation in the observations, and how this is affected by factors such as the ordering of the jet's magnetic field. This project highlights that in-depth and long-term observing campaign and modelling of the polarisation and its frequency dependence is necessary to understand these highly energetic sources, and will form part of future work.



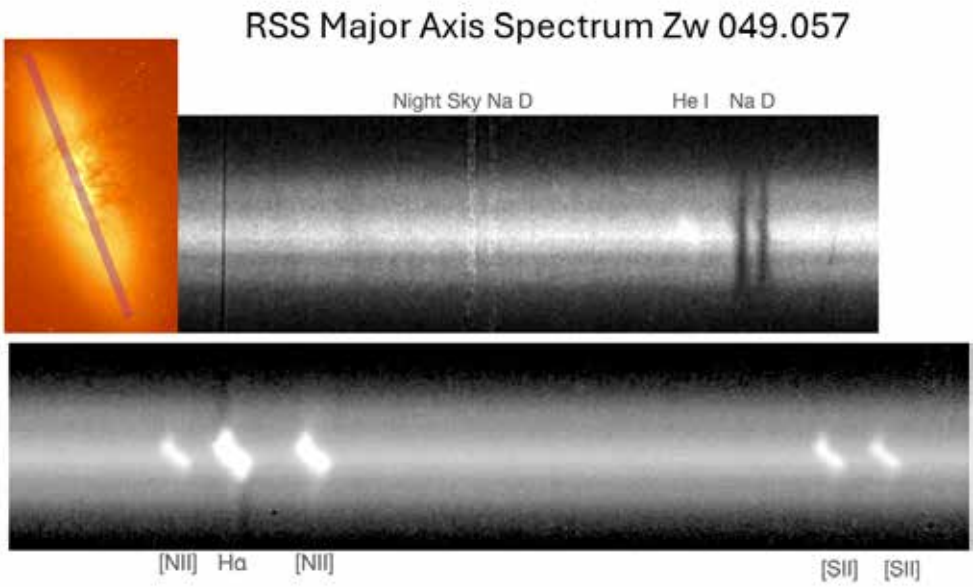
Gamma-ray (*top panel*) light curve of the FSRQ PKS 1510–089, along with the average degree of polarisation and equatorial polarisation angle in four different wavelength bands, reported for each SALT observation (*middle and bottom panel, respectively*) between 6 April 2021 and 31 July 2022.

SALT explores a dusty compact obscured nucleus galaxy

Gallagher, J. S., et al. 2024/09, ApJS 274, 3: An Imaging and Spectroscopic Exploration of the Dusty Compact Obscured Nucleus Galaxy Zw 049.057

The luminous infrared early-type galaxy Zw 049.057 is a member of a rare class of nearby systems with a compact obscured nucleus or CON that is completely obscured from the X-rays to submillimeter by dusty gas with column densities of approximately 10^{25} atoms/cm^2, the astrophysical equivalent of a concrete wall. The origins, evolutionary implications, and power sources in CONs are not understood. Clearly these galaxies are in remarkable situations with more than 100 million solar masses of dense, dusty molecular gas concentrated within a few tens of parsecs around the nucleus.

John Gallagher and his team combined high resolution imaging from the HST and SALT/RSS long-slit spectroscopy to investigate the nature of the CON host galaxy Zw 049.057. In addition to previously identified distinctive dusty features marking powerful outflows from the vicinity of the hidden CON, the authors discovered dusty polar ring structures, indicating a past minor merger. In addition to the polar rings, deep photometry revealed circular outer stellar isophotes that could originate from a highly warped stellar disc from a merger. The RSS spectra added to the picture of Zw 049.057 as a kinematically disturbed galaxy. While the inner disc shows the expected rotation in nebular emission and stellar absorption lines, the interstellar Na D sodium absorption lines remarkably show no significant gradient in radial velocity over 6000 pc along the galaxy's major axis. Given the measured modest velocity dispersion of 50 – 60 km/s, this non-rotating, diffuse neutral gas is likely located in a nearly face-on disc enveloping much of the inner galaxy. The amazing CON thus appears to be a product of a gas-rich interaction where mis-aligned rotation axes allowed a huge mass of low angular momentum interstellar gas to collect around the nucleus.



Upper left:
Cartoon of the RSS slit along the major axis of the HST/WFC3 F555W V-band image of Zw 049.057.

Upper spectrum:
Linear Na D absorption lines and weak [He I] λ 5876 Å emission that is inclined due to rotation; faint stellar absorption lines showing pronounced rotation can be seen blueward of the Na D lines.

Lower spectrum:
Strong nebular lines from [N II], Hα, and [S II], showing rotation in the same sense as stellar absorption Hα lines in the outer disc. Diffuse [N II] emission is visible beyond the central star-forming disc.

SCIENCE HIGHLIGHTS

Stellar and Galactic Astronomy

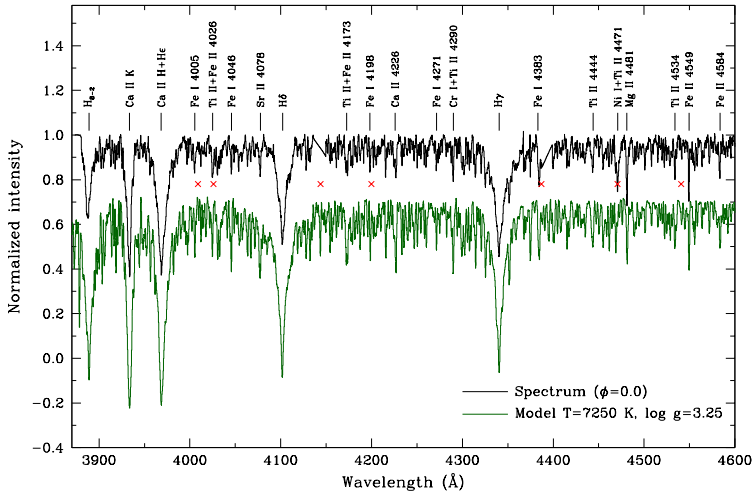
SALT discovers a rare intermediate-mass X-ray binary

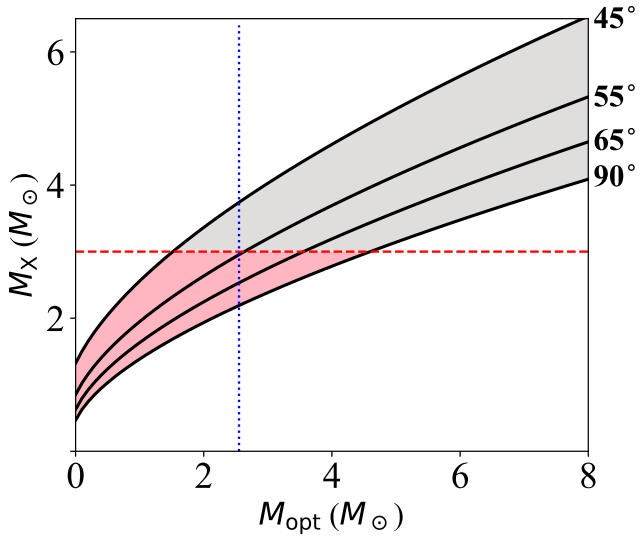
Monageng, I. M., et al. 2024/01, MNRAS 527, 5293: 4U 1210-64: a new member of the rare intermediate-mass X-ray binary subclass

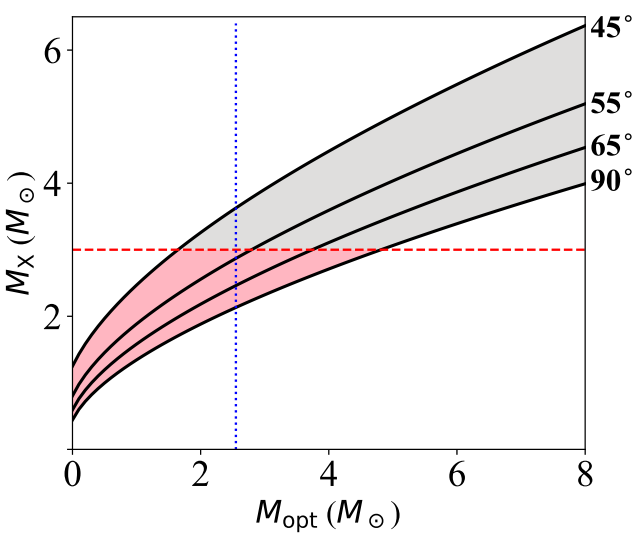
X-ray binaries are binary star systems in which one of the stars is a compact object (either a neutron star, black hole, or, less commonly, a white dwarf) that accretes matter from its companion star. These systems emit large amounts of X-rays due to the extreme processes that occur when matter falls onto the compact object. Based on the type of donor star, X-ray binaries can be classified into high-mass, low-mass, and intermediate-mass categories. Intermediate-mass X-ray binaries are particularly rare because of their relatively low X-ray luminosity, which makes them difficult to identify. Additionally, the mass transfer in these systems occurs on short timescales due to the high mass ratio of the binary. So far, only two intermediate-mass X-ray binaries have been confirmed, compared to hundreds of low- and high-mass X-ray binaries.

Itu Monageng and his collaborators decided to monitor the Galactic system 4U 1210-64 using the RSS at SALT. 4U 1210-64 has undergone several identity changes: it was classified as a cataclysmic variable when discovered by the Uhuru satellite, while a later study reclassified it as a high-mass X-ray binary. This new study re-examined the spectral classification of the donor star, which, based on the features observed in the SALT spectra, is identified as an A7 III-IV star. This classification places 4U 1210-64 in the rare category of intermediate-mass X-ray binaries.

The authors also investigated the binary parameters of the system by performing a radial velocity analysis on the series of SALT spectra. Due to modest orbital phase coverage, they considered both a sinusoidal fit and an eccentric Keplerian fit for the radial velocities. The mass function derived from these orbital parameters can be used to examine the nature of the compact object. The results of the mass function suggest that a neutron star is favoured as the compact object over a black hole.







Left: The normalised spectrum of 4U 1210-64 taken with the PG3000 grating (black) and the Kurucz synthetic spectrum model used for spectral classification (green).

Below: Mass–mass plot from the calculated mass function showing the mass constraints of the two objects as a function of inclination angle for the sinusoidal Keplerian fit to the RV measurements. The vertical line in both plots indicates the mass of the donor star of 2.55 M⊙. *Left panel*: fixed orbital period and free eccentricity. *Right panel*: fixed orbital period but fixed eccentricity (circular orbit).

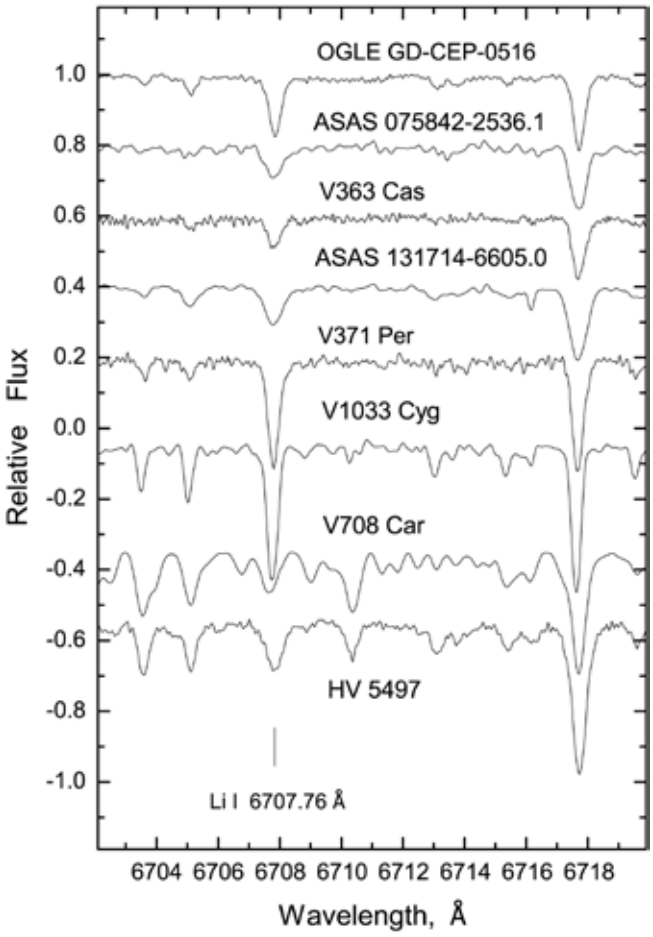
Lithium Cepheid V708 Car has an unusual chemical composition

Kovtyukh, V. V., et al. 2024/04, A&A 684, A145: Lithium Cepheid V708 Car with an unusual chemical composition

Classical Cepheids are pulsating supergiant stars with spectral classes from F to K. They pulsate in radial mode(s). The pulsational instability of a Cepheid occurs when the star enters the so-called instability strip in the Hertzsprung–Russell diagram before and after a previous red giant stage. The progenitors of Cepheids in the main-sequence (MS) stage are O-B type stars, whose masses range from approximately 3 to 20 $M_\odot$ or more. These stars are quite suitable probes of metallicity in the Galactic disc for several reasons: (1) they are luminous, and thus can be seen at large distances even in the regions with increased extinction; (2) their effective temperatures are not too low (*i.e.*, spectra are almost free of molecular features), thus many atomic lines of different species seen in their spectra can be used for the analysis (via the derivation of their abundances); (3) methods of the abundance analysis for the stars of F – G spectral classes are well established, guaranteeing that abundance results will be reliable; (4) they are not very evolved stars, therefore abundances of only a limited number of chemical elements can be modified in their atmosphere due to dredge-up (*e.g.*, carbon, nitrogen, sodium), while abundances of the other elements are not altered by evolution; (5) Cepheids are rather young stars, not having had enough time to move far from their birthplaces, thus reflecting the present-day chemical picture of the disc.

Over the past decade, Valery Kovtyukh (Astronomical Observatory, Odessa National University) and Alexei Kniazev (SAAO/SALT) with their collaborators have obtained spectroscopic observations of a large sample of Cepheids using SALT/HRS. The detailed spectroscopy of such a large sample of Cepheids led to several unique results and notably the discovery of the lithium-rich Cepheid V708 Car. This newly found lithium-rich star, together with six already known lithium Cepheids and two lithium-rich non-variable supergiants, form a small group of lithium-rich yellow supergiants.

V708 Car also exhibits an anomalous chemical composition. The measured abundances of the chemical elements show a clear correlation with their condensation temperature that could be explained as the result of dust-gas separation in the envelope (or extended atmosphere) of V708 Car. Through this mechanism, refractory elements form dust grains in the envelope that are swept out of the envelope by the radiative pressure of the star. The gaseous fraction, enriched in volatile elements, is accreted by the star, and eventually its atmosphere acquires the observed peculiarity. The authors suggest that they probably caught the star at a very short-term evolutionary stage of interaction with the shell.



Lithium line (indicated) in the spectrum of V708 Car and other lithium-rich Cepheids.

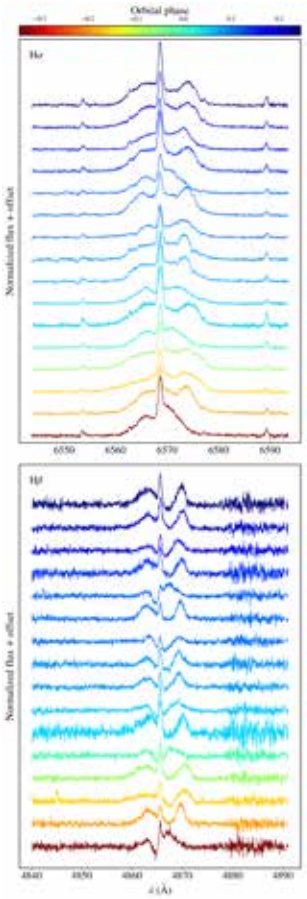
A blue supergiant with companion-driven, enhanced mass loss

Kołaczek-Szymański, P. A., et al. 2024/06, A&A 686, A199: Exploring extreme brightness variations in blue supergiant MACHO 80.7443.1718: Evidence for companion-driven enhanced mass loss

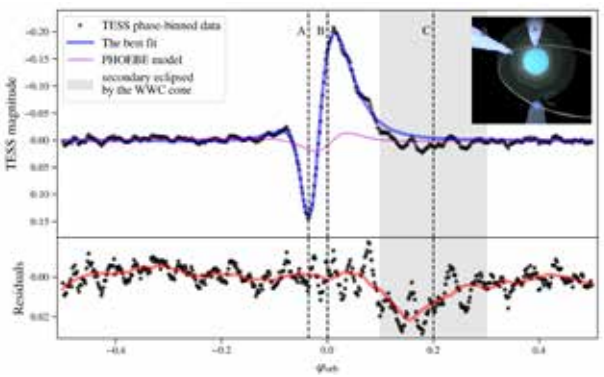
MACHO 80.7443.1718 is an exceptionally eccentric and massive binary system located in the LMC. The primary component of this system is a blue supergiant, likely orbited by a late O-type dwarf approximately every 32 days. While the system can be classified within the broad category of eccentric ellipsoidal variables (sometimes dubbed as 'heartbeat stars'), it can be argued that MACHO 80.7443.1718 is the most intriguing among them all. This distinction arises due to the extreme amplitude of its brightness variations — up to 0.4 mag — which cannot be explained by the standard combination of ellipsoidal, irradiation/reflection, and Doppler boosting effects. Conventional light curve models yield brightness variations approximately an order of magnitude smaller than those observed. This system has sparked considerable discussion in the scientific literature, with several studies over recent years devoted exclusively to it. One of the theoretical explanations, supported by hydrodynamic modeling, suggests that MACHO 80.7443.1718 represents the first observational example of a 'heartbreak star'. In such a system, tidal effects are so intense that during periastron passage the outer layers of the primary component are stripped away, and the massive, highly nonlinear tidal bulge collapses onto the surface of the blue supergiant. For these reasons, the system offers a rare opportunity for observational studies of strong, nonlinear tidal interactions.

Despite numerous efforts to understand the source of variability in MACHO 80.7443.1718, it remains a subject of considerable uncertainty. To move closer to providing a definitive answer to this question, Pioter Kolaczek-Szymanski and his team carried out a comprehensive analysis of the system based on available broad-band multicolour photometry, light curves across different passbands, and optical spectroscopy. A pivotal role in their research was played by SALT and the HRS instrument. The team was able to collect a series of spectra for MACHO 80.7443.1718, almost evenly covering the entire range of its orbital phase. Due to the low brightness of this object (V ~ 13.5 mag) and the necessity of obtaining spectra with a resolving power greater than 10,000, SALT belongs to an exclusive group of telescopes capable of meeting these requirements within a reasonable amount of observation time. The spectra obtained allowed the team to supplement the existing radial velocity curve and to achieve a significantly more precise orbital solution. Additionally, the SALT/HRS spectra provided conclusive evidence that MACHO 80.7443.1718 is not a B[e] blue supergiant, as previously suggested. Therefore, its variability cannot originate from a decretion disc emanating from the primary component. Furthermore, the authors demonstrate that the emission profiles of Balmer hydrogen lines exhibit distinct temporal variations. However, there is no evidence of emission disappearance at periastron passage, contradicting earlier works that proposed this phenomenon as supporting the hypothesis of a cyclically vanishing disc.

Kolaczek-Szymanski and his team investigated an alternative explanation for the strong variability observed in MACHO 80.7443.1718 — the collision of stellar winds. They found that, with a sufficiently strong wind from the primary component, it is possible to reproduce many features of the system's light curve as well as its behaviour observed in optical spectra. In this scenario, proximity effects play a secondary role in shaping the light curve, while the dense region of colliding winds takes center stage, effectively scattering light toward the observer. The authors hypothesise that the primary component of MACHO 80.7443.1718 is an exceptional observational example of a blue supergiant, whose mass-loss rate due to stellar wind may be up to 100 times larger than the nominal value. This enhancement could result from tidal interactions, rapid rotation, and large amplitude tidally excited oscillations.



Left: A series of SALT/HRS spectra around the hydrogen Hα and Hβ lines. The colour corresponds to the orbital phase. A broad emission is clearly visible, which varies significantly with the orbital phase.



Below: The phase-averaged *TESS* light curve, along with the proposed wind-wind collision model (blue line) and a model accounting only for variability due to proximity effects (pink curve). It is evident that the latter model is insufficient. Points A, B, and C correspond to the moments marked in the top-right inset depicting the geometry of the system as seen in the plane of the sky.

Accretion funnel reconfiguration during an outburst in a YSO

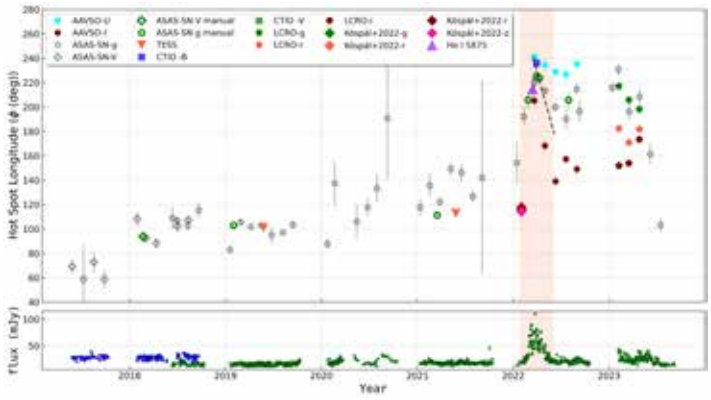
Singh, K., et al. 2024/06, ApJ 968, 88: Accretion Funnel Reconfiguration during an Outburst in a Young Stellar Object: EX Lupi

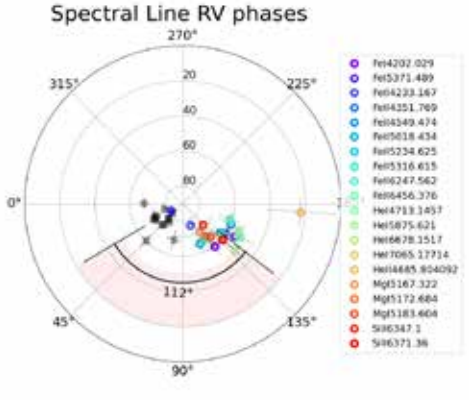
Low-mass young stellar objects (YSOs, ≤ 1 – 2 M⊙, 1 – 3 Myr) undergo luminosity variation by factors from a few to 100s. The variations, known as outbursts, are driven by accretion variability and can occur on time scales of months to centuries. PhD student Koshvendra Singh (Tata Institute of Fundamental Research, India) and collaborators used the 'SALT Transient programme' to study an outburst in a well-renowned YSO named EX Lupi, where the accretion rate was enhanced ~7 folds over a month's time. SALT observed EX Lupi at a high cadence over two and half months, collecting 16 epochs of spectra with the HRS at a resolving power of 37,000. This was supplemented with multiband optical photometric observations from other observatories. The group tracked the location of the 'hotspot' (the shock-heated region caused by accretion onto the YSO's surface) for 15 years (2007 – 2022) with the HRS and archival spectra and for six years with multiband photometry (2017 – 2023).

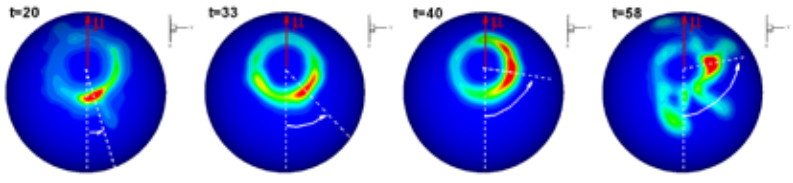
The authors found that the hotspot stayed dormant at its location over the stellar surface for 15 years during the steady accretion rate of the pre-outburst phase. They discovered, however, that the hotspot migrated to a larger azimuth (by 112°) and lower latitude (by ~10°) during the outburst. This migration was earlier predicted through 3D Magnetohydrodynamic (MHD) simulations. They further performed 3D MHD simulations for the instances of the outburst. The simulations revealed that the hotspot migration is caused by azimuthal migration of the accretion pathway.

The authors also obtained insights into how the outburst changed the thermal structure of the hotspot by mapping it. They found that while it was thermally symmetric before the outburst, during the outburst it became asymmetric, such that the front end along the azimuth is the hottest followed by the cooler and cooler regions.

This study has a broad impact on our understanding of how (and effectively where in azimuth) the disc material is prone to accretion onto the star and enables a better understanding of the accretion–outflow balance at the star–disc boundary.







Top Left:
The measured RV phases for 15 years. The polar angle represents the longitudinal position (–90°) of the hotspot and the radial value represents the latitudinal position of the hotspot. Grey squares and blue pentagon correspond to data from 2007 – 2019 and coloured circles represent the various spectral lines from HRS time series spectra taken during the outburst. The longitudinal position inferred from HRS RV is 112° ahead of the pre-outburst RV estimates.

Top Right:
The hotspot's longitudinal location over the stellar surface as estimated by various datasets. Bottom: The ASAS-SN *V* and *g* band lightcurves for the same period. The outburst period is shaded by a light-red colour. The hotspot stayed at around 100° – 120° for nearly 4.5 years before the outburst but migrated to 220° – 230° during the outburst peak. The hotspot stayed migrated for 1.5 years after the outburst.

Above:
Results of 3D MHD simulations for the instances of the outburst; t = 20 and t = 58 correspond to the onset and peak of the outburst. The hotspot location is shown over the stellar surface, where the vertical dashed white line represents the pre-outburst location of the hotspot and the slanted dashed line shows the current location of the hotspot. The simulation showed a migration of ~100° supporting the observations.

Evolution of mass transfer rate through ancient nova shells

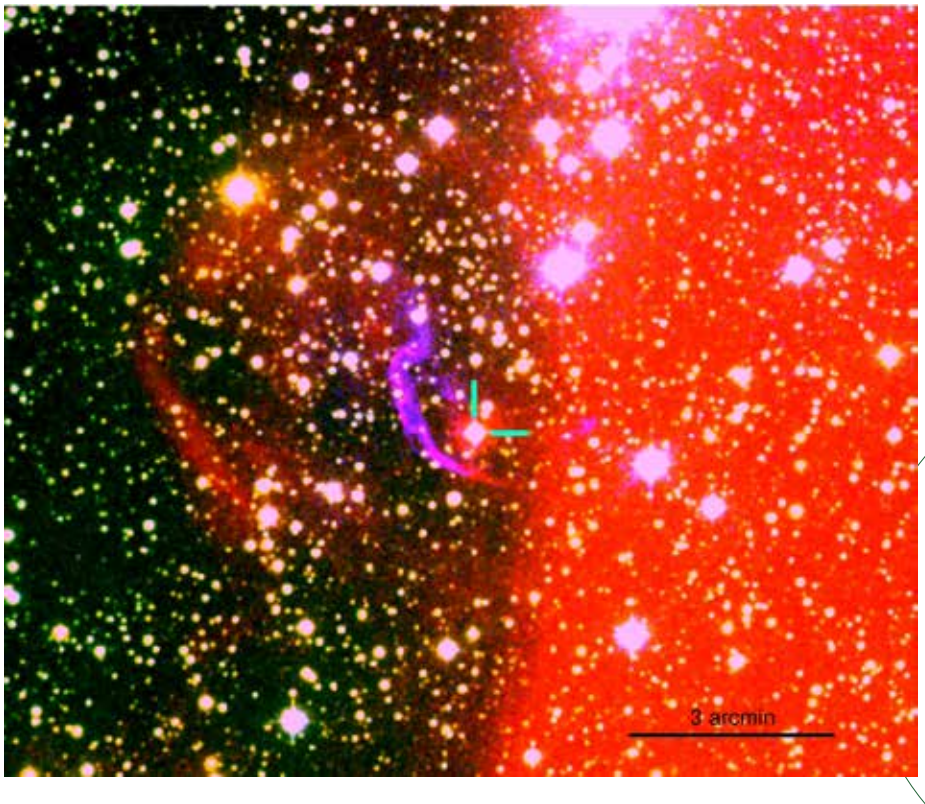
Iłkiewicz, K., et al. 2024/09, ApJL 972, L14: Ancient Nova Shells of RX Pup Indicate Evolution of Mass Transfer Rate

Symbiotic stars, such as RX Pup, are binary systems where a white dwarf or neutron star accretes material from a red giant companion. These systems can undergo classical nova eruptions, triggered by thermonuclear runaways on the accreting white dwarf's surface. The ejected material forms long-lived nova shells, offering an opportunity to explore their dynamic evolution and interactions with the interstellar medium. While classical nova eruptions in symbiotic stars can manifest as either fast, recurrent or extremely slow novae, RX Pup's historical and recent activity places it firmly among the latter, with its last confirmed outburst beginning in the 1970s.

Krystian Iłkiewicz from the Astronomical Observatory at Warsaw and his colleagues used narrow-band imaging at SALT to investigate RX Pup's surrounding nebula. The images uncovered two distinct shells around RX Pup: a closer shell located ~43 arcseconds east of the star and a faint, extensive half-ring of Hα emission approximately 4 arcminutes in radius.

Using SALT/RSS spectra, the team constructed emission diagnostic diagrams that confirmed the nova remnant nature of the younger shell, showing evidence of shock in the shell that formed due to its interaction with the interstellar medium. Archival observations allowed them to estimate the age of the 43-arcsecond shell to be ~1300 years, while the larger, 4-arcminute shell likely represents an even older remnant, potentially ~7000 years old.

The discovery of these multiple nova shells, along with RX Pup's 1970s outburst, indicates a significant reduction in the nova recurrence time, from approximately 5700 years to around 1250 years. This shift implies that the mass transfer rate in RX Pup increased by roughly a factor of three during the last 10,000 years. This represents the first measurement of variable mass transfer rates in binary stars on millennial timescales, offering insights into the long-term evolution of such systems.



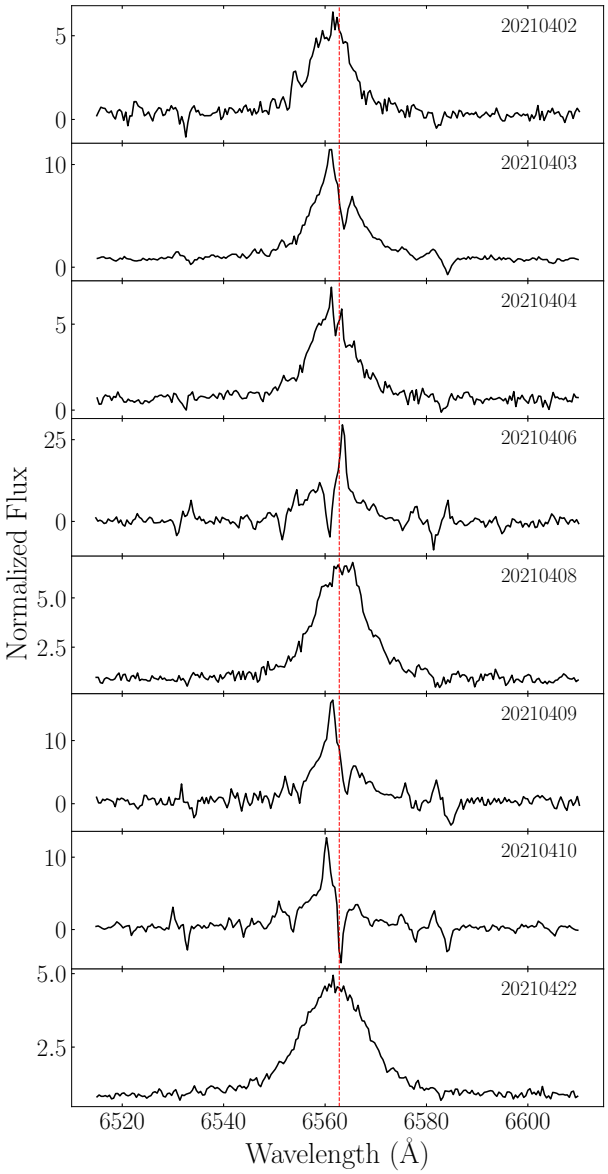
False-colour image of RX Pup, with [O III] shown in blue, *R* in green, and Hα in red. North is at the top, and east is to the left. RX Pup is located at the center of the image, marked by turquoise ticks. The region to the west of RX Pup is dominated by Hα emission from an unrelated nearby [H II] region. The ~1,300-year-old nova shell is visible as a bright [O III] and Hα emission located 43 arcseconds east of RX Pup. A potential ~7000-year-old shell is seen as a bright Hα emission surrounding RX Pup, with a radius of 240 arcseconds.

Multi-wavelength short-term variability of a transitional pulsar candidate

Coti Zelati, F., et al. 2024/10, A&A 690, A220: Short-term variability of the transitional pulsar candidate CXOU J110926.4-650224 from X-rays to infrared

Transitional millisecond pulsars (tMSPs) are pivotal for understanding the evolutionary bridge between accreting neutron stars in low-mass X-ray binaries and radio millisecond pulsars as well as the interaction between matter and magnetic fields in extreme conditions that cannot be reproduced on Earth. CXOU J110926.4–650224 (hereafter J1109) is a binary system exhibiting properties similar to confirmed tMSPs in their X-ray 'subluminous' disc state, thereby presenting an excellent opportunity to explore these dynamics in greater depth. Francesco Coti Zelati from the Institute of Space Sciences in Barcelona, Spain, and his colleagues devised a project that was centered on comprehensively characterising the optical and near-infrared variability properties of J1109 and establishing its connection with the peculiar mode-switching phenomena observed in X-rays.

A significant aspect of this study was the extensive usage of the RSS to perform time-resolved medium-resolution spectroscopy. The collected spectra were crucial in analysing the properties and time variability of the emission lines from the accretion disc surrounding the pulsar. The team detected significant changes in the emission line profiles, which they attributed to either mode switching or flaring activity. They also detected other spectral features that allowed them, for the first time, to constrain the spectral type of the companion star to between K0 and K5. Overall, the integration of SALT spectroscopic data with observations from other facilities provided a comprehensive multi-wavelength perspective of this system.



Plot illustrating the variability of the most prominent emission line in the optical spectra, Hα. This visual representation effectively highlights the time variability of optical emission lines and the pivotal role SALT played in detecting such variability.

A study of super-slowly rotating Ap stars

Mathys, G., et al. 11/2024, A&A 691, A186: Super-slowly rotating Ap (ssrAp) stars: Spectroscopic study

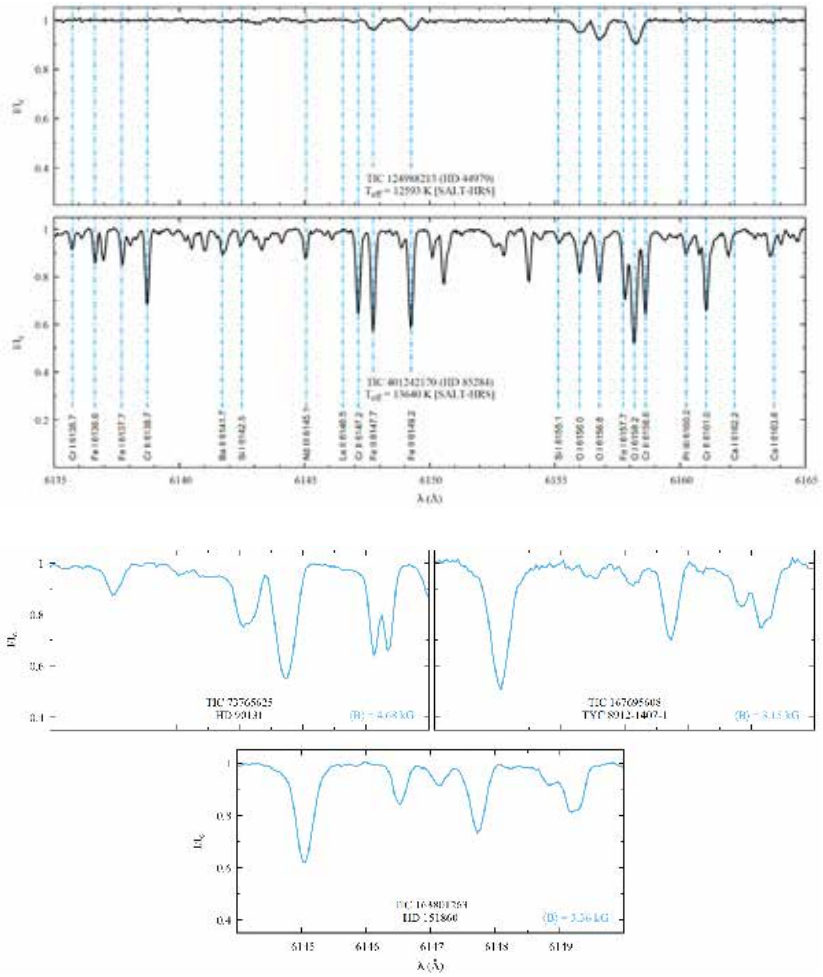
The chemically peculiar Ap stars show rotation periods of the order of days to centuries. Those with periods greater than 50 days are called the super slowly rotating A (ssrAp) stars. This presents an interesting challenge to understand such a variation in terms of both the cause and impact of such a dramatic range of periods.

In their previous works, Gautier Mathys and his team focused on detecting ssrAp stars through the analysis of light curves obtained by NASA's *TESS* mission — the chemical peculiarities that give the Ap stars their name form stable stellar spots which modulate the light output of the star over its rotation period. If the star is known to belong to the Ap class but does not show light variations over the observation period, it becomes a candidate of the ssrAp class. To confirm its ssrAp nature, the star must be spectroscopically observed to measure the Doppler broadening of its absorption features.

The authors have used SALT/HRS, along with other telescopes, to measure the projected rotational velocity of 10 candidate stars. Five of the observed stars show spectral line broadening consistent with super slow rotation, while the remaining stars are either moderately rotating, or misclassified Ap stars. The SALT spectroscopic observations validate the methodology the team applied in their earlier photometric studies.

Where stars are found to show sharp spectral lines, the authors were able to determine the mean quadratic magnetic field strength by measuring the broadening of magnetically sensitive lines. For the SALT spectra, this was achievable for four stars. In doing so, the team was able to investigate how the magnetic field may play a role in forming an ssrAp star.

This ongoing project will run over the next several semesters until the team has observed all candidate ssrAp stars, with which they can then explore the statistics of occurrence in a more robust manner. They will also use the results from SALT to inform proposals to measure the magnetic field strength of stars where the detection limit is below SALT's sensitivity.



SALT/HRS high resolution spectra of two ssrAp candidate stars. The top panel shows HD 44979 which was determined not to be an ssrAp, while the bottom panel shows HD 85284 which was confirmed to be a ssrAp star.

SALT/HRS high resolution spectra of ssrAp stars from which the team derived the mean quadratic magnetic field, shown in the lower right corner.

SCIENCE HIGHLIGHTS

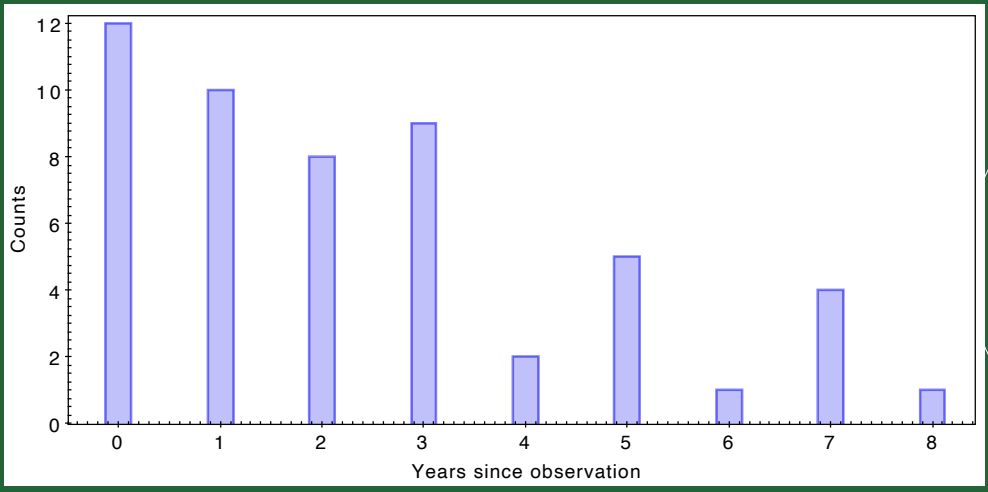
Ongoing Research

A number of exciting SALT science projects are either close to being published or are longer-term projects that may lead to publications on selected objects of interest, awaiting completion of the final science goals. We give here an overview of a small selection of these.

Over the two semesters in 2024 (2023-2 and 2024-1) a total of 105 **proposals** were accepted by the various TACs (another 23 had been carried over from previous semesters). Nine of these were DDT proposals, receiving a total of 57 kiloseconds of observing time. There were seven commissioning proposals (COM), dealing with polarimetry, commissioning of the new instruments, RSS throughput and the magic pixel project (313 kiloseconds). Though there was one gravitational wave event proposal (GWE) in 2024-1, observations could not be taken due to observing constraints.

There were three Large Science Proposals (LSP) submitted in the two semesters. The longest lasting is the Transient Universe project led by David Buckley. New are a proposal on Radial velocities of very short period main sequence binary stars by Chris Koen from UWC in South Africa and a proposal by Marsha Wolf from UW on Post-Starbursts as Laboratories using NIRWALS. Finally, there were 75 normal science proposals (SCI), 30 multi-semester proposals (MLT) and three OPTICON-Radionet proposals (ORP).

While nine **DDT proposals** were submitted in the semesters 2023-2 and 2024-1, there are nine refereed publications in 2024 presenting results from past DDT proposals, ranging widely from the 2015-1 semester up to a very recent one in the 2024-1 semester. The figure shows the time between DDT observation and publication, based on 52 publications. Seven DDT proposals led to more than one publication (with the first multi-messenger event GW170817 observed in August 2017 resulting in a record of six papers).



Histogram of years between DDT proposal observations and official publication date. While about a quarter of publications appear within a year of the observations, only 43% DDT proposals have led to a publication by the end of 2024 (based on proposals with an observing date before the end of 2023).

Observing the transient Universe

The SALT Large Science Programme on transients, begun in 2018 and led by David Buckley (SAAO/UCT/UFS), has continued during 2024 and was renewed for another three years from semester 2024-2, starting 1 Nov 2024. To date the programme has resulted in over 130 refereed publications. During 2024, the main thrust of the programme has been follow-up of candidate cataclysmic variables discovered as X-ray transient or variable sources by eROSITA, ART-XC (instruments on-board the German-Russian *Spektrum-Röntgen-Gamma* satellite) and the *Einstein Probe* (*EP*), a Chinese X-ray satellite launched in February 2024. Several other *EP* transients, some extragalactic in nature, were also observed. A number of new CV discoveries were made during the year, and follow-up observations were conducted of several of them. The programme on monitoring of super soft X-ray sources, begun in 2021, continued. One such source was a new Be-white dwarf system in the SMC, detected as an X-ray flaring system by the *EP*. During the latter part of the year, a number of transients discovered by the BlackGEM telescopes in Chile were observed, many of them core-collapse supernovae, luminous red novae or novae.

In 2024, a total of 167 observing blocks were observed for a total of 117 targets, of which several had repeat visits, for a total of 429,951 seconds. Below is the breakdown for the year.

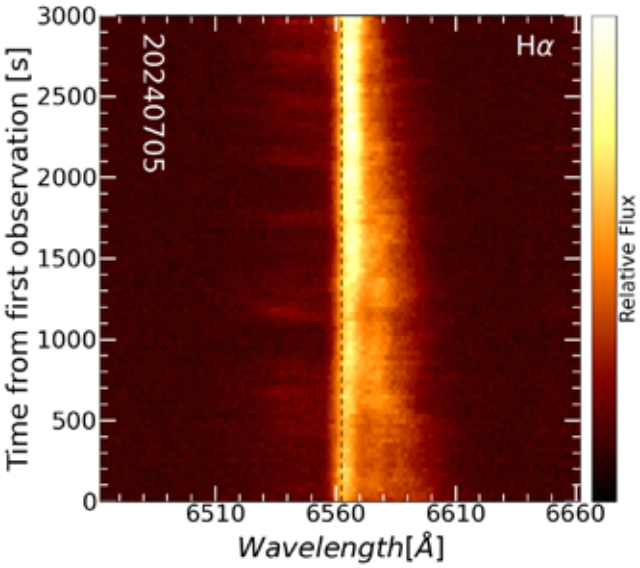
Candidate cataclysmic variables (CVs)	– 34.6%,	64 targets
Compact WD binaries/CVs	– 14.4%,	6 targets
Super soft X-ray sources (SSSs)	– 11.1%,	5 targets
Be X-ray binaries (HMXBs)	– 8.5%,	5 targets
AGNs & blazars	– 5.1%,	6 targets
Novae/luminous red novae	– 5.4%,	5 targets
Misc. objects (FBOT, GRBs, GW, microlens, WD pulsars)	– 5.5%,	7 targets
Supernovae (SNe)	– 3.5%,	4 targets
T Tauri stars	– 2.5%,	1 target
Radio stars	– 1.2%,	5 targets
Unclassified objects	– 3.8%,	5 targets
Low mass X-ray binaries (LMXBs)	– 3.3%,	2 targets
Extragalactic objects	– 1.1%,	2 targets

Here are a couple of science highlights for 2024.

Following the discovery of **EP J115415.8-501810** as a likely magnetic CV from a SALT spectrum, intensive follow-up observations of this source was undertaken by Stephen Potter and David Buckley (SAAO) using SAAO telescopes and SALT. The investigations demonstrated that the source is a new intermediate polar, a class of asynchronous magnetic cataclysmic variables, exhibiting an orbital period of 3.76 hours and a WD spin period of 3.97 minutes. The orbital period was identified through *TESS* observations, while high-speed photometric data, obtained using the SAAO 1.9-m and Lesedi 1.0-m telescopes, revealed both the spin and beat periods. Orbitally phase-resolved spectroscopic observations using the SAAO 1.9-m telescope, specifically centered on the Hβ emission line, revealed two emission components that exhibit Doppler variations throughout the orbital cycle. High time resolution (30 s) SALT spectroscopy using RSS in Frame Transfer mode has revealed clear evidence of extended outflows and what appears to be episodic mass ejections, which are blue shifted, consistent with a magnetic propeller.

Prompted by X-ray brightening detected with the *Einstein Probe*, SALT observed **RX J0032.9-7238** in November using RSS and HRS. The RSS slit angle was oriented so that it covered the two proposed optical counterparts. The blue spectra of both objects indicate that they are early-type B stars (B0.5 – 1.5). The object proposed to be the likely target of interest from X-ray observations showed Hα in absorption, while the other source shows Hα in strong single-peak emission with EW = 33.31 ± 0.90 Å. Results were published in ATel#16904.

Following its discovery in 2023 as a bright black hole transient, **Swift J1727.8-1612** has been observed as part of UCT student Kyle Solomon's PhD study. The outburst was covered by SALT in 2023, and in 2024 we obtained spectra during the low-hard state, when the object was a lot fainter. Trailed [He II] spectra show evidence of multiple components, modulated on the orbital period.



Trailed Hα spectra of EP J115415.8-501810 (30 sec exposures) showing evidence of mass ejections and propellering.

Spectroscopic studies of open clusters containing Cepheids

Igor Usenko from the Astronomical Observatory at Odessa, Ukraine, is working on a long-term project on open clusters containing Cepheids that includes SALT observations. Since 2018, intermittent results were published in the Odessa Astronomical Publications (OAP) and presented at the Gamow conferences in Odessa.

The project is directed at solving several problems. First of all, there is the determination of atmospheric parameters, rotation speed, radial velocities and chemical composition of cluster members. The results make it possible to determine the stars' membership in the cluster, clarify the values of their reddening, and find elements that may be indicators of stellar evolution. In these clusters, the main mass comprises main sequence (MS) stars of different spectral classes, (late B to early G) cold giants and Cepheids (sometimes two or three). The latter obey the period–luminosity–colour and mass–luminosity relationships, and spectroscopic estimates of their effective temperatures and gravity allow the team to determine their absolute magnitudes, radii, masses, reddenings, and, most importantly, distances, therefore obtaining distances for these clusters. If there are stars with low rotation rates in the clusters, their chemical composition can be calculated and a comparative analysis made. With the presence of cold giants, the age of clusters can be determined by comparison with evolutionary models. Finally, the exact distances to the clusters will help to derive the radii of the Cepheids located in them.

Usenko and his team obtained stellar spectra for nine clusters with SALT/RSS. Preliminary results obtained for four of them seem to indicate a problem: the estimates of distances and reddenings for their MS stars differed notably from those listed in the *GAIA* catalogues. This fact aroused their suspicion, so they carried out detailed studies on MS stars around the Cepheid Polaris, which is located between the remnants of two open clusters dissolved among field stars at a distance > 100 parsecs. Usenko and his collaborators could demonstrate that the *GAIA* data were unreliable and overestimated. Consequently, some of the Cepheids that were considered members of open clusters according to *GAIA* distances, turned out to be outside these clusters.

Post-starbursts as laboratories

Marsha Wolf (from UW and PI of the NIRWALS project) and her team have started an LSP proposal using the new instrument NIRWALS on "Post-Starbursts as Laboratories: Probing Star Formation Quenching and Late Phases of Stellar Evolution". So far, 67 ksec have been observed.

An outstanding question in modern astrophysics is how galaxies quench their star formation. Galaxies show a pronounced bi-modality in their stellar populations, with quenched galaxies occupying a distinct red sequence. Star formation quenching is clearly an integral part of the galaxy evolution process, yet much about it remains poorly understood. New insight into the quenching process can be gained through near infrared (NIR) nebular lines that are tracers of dust-obscured star formation, AGN activity, and shocks. At the same time, the NIR stellar continuum can provide a critical test of modern stellar population synthesis models at the stellar ages and wavelengths where the thermally-pulsing asymptotic giant branch (TP-AGB) star contribution is dominant. Wolf and her team are studying these two areas with a NIRWALS integral field spectroscopic survey of 50 post-starburst galaxies over a period of three years as part of a Large Science Programme, funded by a grant from the U.S. National Science Foundation. The survey will be the first of its kind in terms of its wavelength coverage, resolution, and spatial coverage.

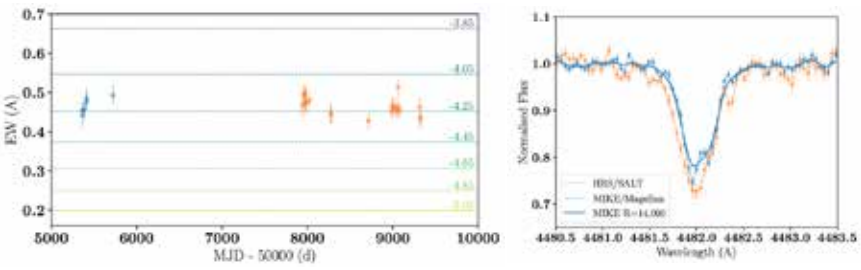
The science goals require observations of 2 – 3 spectral regions per galaxy, each of which is obtained in a separate visit that includes three dithered 600 second exposures on target and a 600 second exposure offset to blank sky. The programme began during NIRWALS commissioning in the 2023-2 semester, during which seven galaxies were observed as part of guaranteed time observations for the instrument team. The programme transitioned to an LSP beginning in the 2024-1 shared risk semester, during which an additional four galaxies were completed (plus four more with half the required spectral coverage). The team is using these initial observations and data to refine NIRWALS observing strategy and optimise data reduction and sky-subtraction techniques.

SALT investigates accretion rates onto polluted white dwarfs

Polluted white dwarfs that have accreted planetary material provide a unique opportunity to directly study the bulk composition of exo-planetary bodies. Elements such as oxygen, magnesium, calcium, iron, silicon and carbon from an accreted exo-planetary body show up in the spectrum of an otherwise pristine white dwarf atmosphere. However, emerging theories suggest that interpreting these compositions may be more complex than initially thought. For example, models propose that asynchronous accretion, where different elements accrete at different times, could significantly affect observed abundances. Understanding whether the abundances of the metals in white dwarf atmospheres changes over time is critical to verifying whether these systems can reliably trace the bulk composition of planetary material.

Laura Rogers (University of Cambridge) and her collaborator Michael Shara (AMNH) have been using SALT/HRS to address this challenge by investigating whether the amount of material present in the atmospheres of six white dwarfs is variable over time. For five of these white dwarfs, the abundances of the metals in their atmospheres remain remarkably stable over time, suggesting that there is steady accretion and diffusion for these stars. However, for one white dwarf in the sample, WD0106-328, comparing new SALT/HRS data to historic MIKE/Magellan data (taken between 2007 and 2009) has shown a 35% increase in the strength of the [Mg II] doublet.

This observation has led to a Hubble Cycle 32 programme aimed at confirming the result and providing further information regarding the variability of additional metals. If verified, this would be the first evidence for sporadic or asynchronous accretion of planetary material onto a white dwarf and would transform our understanding on how planetary material is delivered to white dwarfs.



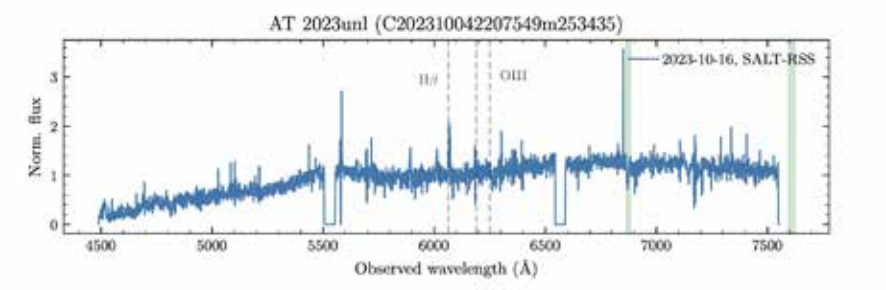
Left: The equivalent width (EW) of the [Mg II] doublet (4481 Å) over time for WD 1929+011, showing no significant changes in EW. Orange dots are SALT data, light blue dots are Magellan data. The horizontal lines mark different [Mg/H] abundances, highlighting that all variation is at a lower level than typical abundance errors of 0.2 dex. *Right*: A comparison between historic MIKE/Magellan data (with darker blue line showing the spectra at the same resolution as HRS/SALT) and HRS/SALT data for WD0106-328 showing a clear change in the strength of the [Mg II] doublet.

SALT looks for extreme flares in AGNs

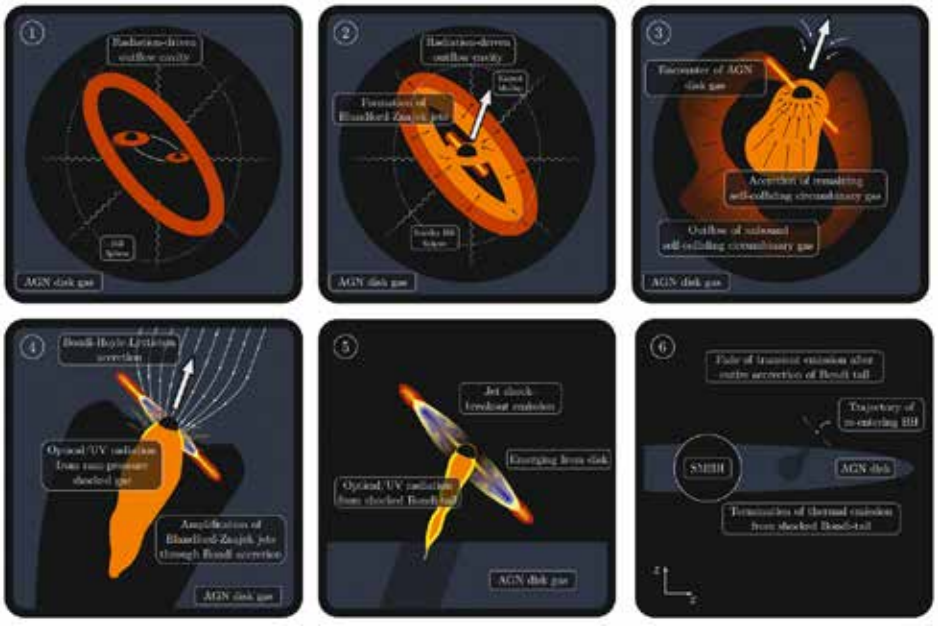
Cabrera, T., et al. 2024/12, PhRvD 110, 123029: Searching for electromagnetic emission in an AGN from the gravitational wave binary black hole merger candidate S230922g

Saavik Ford and Barry McKernan (City University of New York and AMNH), together with their team, have been conducting an ongoing monitoring campaign of AGN in presumed high mass LIGO-Virgo-KAGRA (LVK)-detected binary black hole (BBH) merger error volumes to examine short-term variability of such AGN, with the possibility of conducting follow-up observations for electro-magnetic (EM) counterparts to such gravitational wave events. Because AGN are intrinsically variable sources (and many sources are merely suspected of being AGN, based on colour information alone), the team has been attempting to follow up promising candidates to look at both the breadth of variability phenomena in all AGN and possibly capturing early time observations of BBH merger-triggered flares in real time (see the flare triggering model in Fig. 1). To date, the team has only successfully triggered spectroscopic follow-up on one published candidate.

The team observed the transient AT 2023unl with SALT/RSS on 16 October 2023 as a possible candidate counterpart to the LVK alert S230922g. The obtained spectrum provides inconclusive evidence for the nature of the source; however, the source was observed to redden in later epochs, and so is disfavoured by their assumed counterpart model. On the other hand, triggering the observation demonstrated that SALT can provide important constraints on variable AGN candidates and their flaring behavior in real time. The team is continuing to monitor LVK alerts and conduct photometric follow up in the expectation that eventually more candidate sources will flare, and rapid spectroscopic follow up from SALT will be a critical tool at that point.



Spectrum of AT2020unl captured by SALT/RSS with labeled Hβ and [O III] lines; regrettably the candidate was disfavored as a BBH counterpart due to subsequent photometric colour changes.



Multi-panel schematic showing the mechanism believed to underpin luminous EM counterparts to BBH mergers in AGN discs. *Panel 1*: the pre-merger BBH accretes from mini-discs within its Hill sphere in the AGN disc midplane and blows a cocoon within the disc via feedback. *Panel 2*: the merger happens, forming a highly spinning BH (dimensionless spin parameter $a \sim 0.7$ typically). A jet is presumed to form at this stage (although it has yet to be established whether such a jet can persist for long, or whether it is choked off by high mass accretion). Mass and spin asymmetries in the progenitor BHs lead to a kick at merger (depicted by the arrow in panel 2). *Panels 3 and 4* show the development of Bond-Hoyle-Lyttleton accretion as the newly merged BH exits its original Hill sphere into the rest of the AGN disc, powering a luminous transient. *Panel 5*: the BH emerges from the AGN disc, dragging disc gas with it. *Panel 6*: the EM emission fades as the disc material is consumed and the BH continues on an inclined orbit around the supermassive BH, and will re-enter the AGN disc on half the orbital timescale.

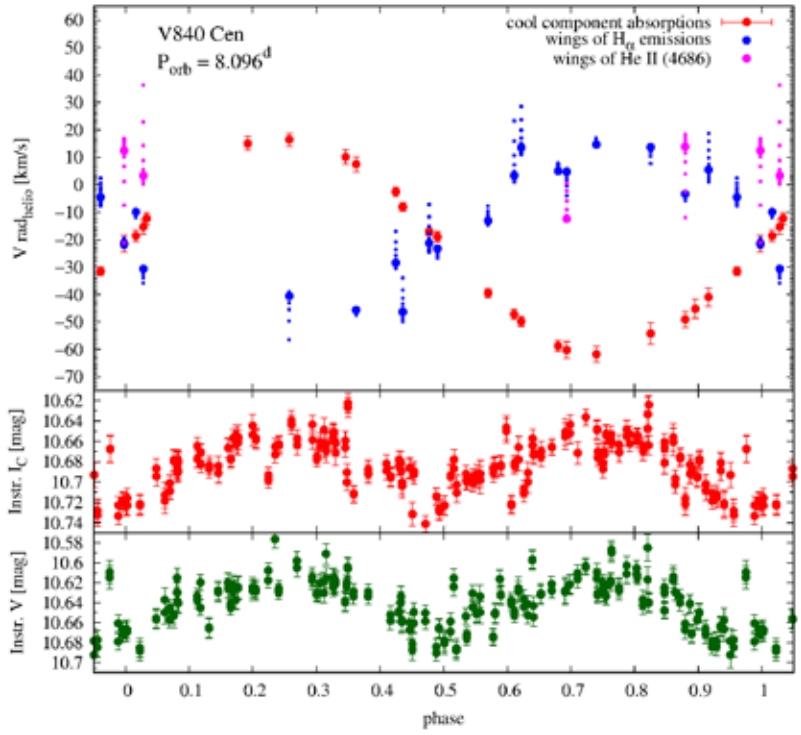
HRS monitoring of symbiotic stars with yellow giants

Galan, C., poster presentation at 'Symbiotic stars, weird novae, and related embarrassing binaries', June 3-7, 2024, Prague, Czech Republic

In 2019, Cezary Gałan and Joanna Mikołajewska from CAMK in Poland started a long term project to monitor a sample of 21 yellow symbiotic systems (SySt) with SALT, most of which did not have spectroscopic orbits. Earlier results of the team's chemical composition analysis in the S-type SySt suggested that the parameters of the systems with known orbits may need to be revised. The project has therefore two main objectives: (i) determination of the chemical composition, preferably from the spectra obtained when the contribution from the hot component is not significant (*i.e.*, phases of low activity/occultations), basic stellar parameters, and evolutionary status of the cool components, and (ii) the long-term monitoring of the radial velocity (RV) changes over the several orbital cycles to derive spectroscopic orbits.

The team uses SALT's HRS in medium-resolution mode (R ~ 40000) with a particular interest in the region ~5700 – 8000 Å where spectral features from red giants are located. Spectroscopic monitoring has been continuing for ~6 years. The known orbital periods for these systems are in the range typically of ~2/3 up to ~4 years, and above 6 years in the case of Hen 3-1591. For most of the sample (11 objects with known orbital periods), the team now has more than the entire orbital cycle covered with roughly evenly-spaced spectra, which enable a reliable analysis of spectroscopic orbits. Inspection of the HRS spectra reveals the presence of a strong lithium line (6707.8 Å) for four objects: Hen 3-1591, WRAY 15-157, AS 269, and V840 Cen. The first three are classified as the D' type systems which contain rapidly rotating G-type giants. This [Li I] line compared to nearby [Fe I] lines indicates significant lithium overabundance — higher than observed in single K- and M-type giants. Gałan and Mikołajewska will investigate this to check if it could be due to triple/binary evolution. The high rotational velocity of the giant could be a manifestation of a merger that could have happened in the past, thus the current state of these systems could be the result of evolution from former triple systems.

A particularly interesting result concerns the case of V840 Cen, where the orbital period obtained from the RV curve of the cool component is unexpectedly short (~8.1 days; see below). This period is confirmed by the RV curve of the hot companion obtained from measurements of the wings of Hα emission. The photometric changes show an ellipsoidal effect indicating that the giant is filling or nearly filling its Roche lobe.



The radial velocity curves of the giant and the hot companion in V840 Cen derived from HRS spectra compared with high-cadence photometry collected in *V* and I_C bands using a 0.8 m 'Zibi' telescope equipped with 2k×2k Andor iKon-L 936 camera at the Cerro Murphy Observatory in Chile.

Radial velocities of very short period main sequence binary stars

Chris Koen from UWC and his colleagues from SAAO started a new LSP project in 2023, titled "Radial velocities of very short period main sequence binary stars". The project requests a total of 2.5 Msec, distributed over six semesters; about 180 ksec had been observed by the end of 2024.

There is a dearth of well studied short period (P < 0.25 d or so) main sequence binary stars. For example, of almost 100,000 variables classified as eclipsing binaries in the "International Variable Star Index", only 230 are assigned periods shorter than 0.2 d, and of these only 50 systems are candidate main sequence (probably M+M) binaries. One obvious reason for the scarcity of short period main sequence binaries in the literature is, of course, the intrinsic faintness of the stars. Also, in general the incidence of low mass binaries is lower than that of double systems containing massive stars. Possible reasons are that (i) systems with low mass primaries are more prone to dynamical disruption in the clusters where they form, (ii) such systems have short lifespans, (iii) the formation rate is low.

There are several difficulties associated with finding short period main sequence binaries: (i) Light curves may be similar to those of late type rapidly rotating spotted stars. (ii) Candidate variable star catalogues may be unreliable. As an example, the authors of the Petrosky *WISE* catalogue estimate that more than 90% of their quoted periods may be half of the true values. (iii) In practice, most of the short period red binaries consist of a red dwarf (which dominates the light output) and a white dwarf.

It is well known that radial velocity measurements are needed to uniquely model binary star systems. Yet, to date velocities have been measured for fewer than 10 late type binary stars. The reason for this lack of information is not difficult to see: the component stars belong to the lower main sequence (K and M dwarfs) and are therefore intrinsically faint. Coupled with the short periods which necessitate relatively short exposure times, large telescopes are needed to acquire spectra.

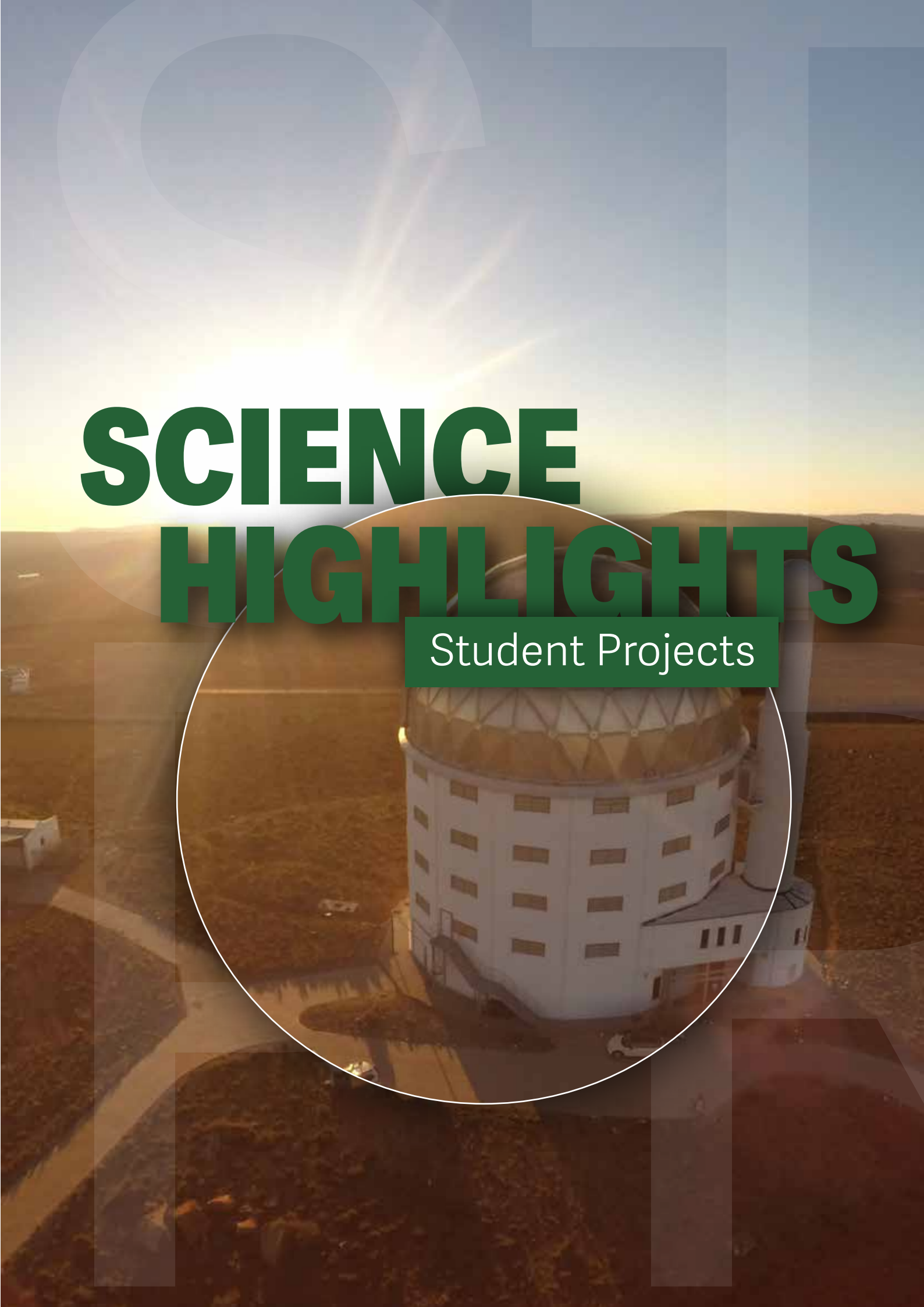
The LSP project devised by Koen and his colleagues aims to improve the situation by determining radial velocity curves for several dozen faint late type stars. The binary nature of the targets, and their periods, have been verified by multi-filter photometry. This has also allowed them to exclude systems with white dwarf components. Combining the velocities with good quality multi-filter photometry will also enable accurate modelling of the binaries.

Of the target stars, 23 are K-type systems with periods in the range 0.21 – 0.26 d. For this group, 168 RSS spectra have been acquired, *i.e.*, a mean of seven spectra per star. The majority of the ~60 other targets have periods shorter than 0.18 d and mid-M spectral types. For these, a further 202 spectra have been obtained. Since the observing strategy was partially designed to fill gaps in the observing schedule, the aim is to accumulate spectra over several seasons, rather than to try to complete individual systems.

Spectra rise rapidly in the red, hence the original instrumental configuration focussed on the extreme red. The severe negative impact of fringing led the team to revise the wavelength range bluewards. A consequence of this is that it is difficult to reach sufficiently high signal-to-noise ratios in the necessarily limited exposure times. The team has therefore made use of the fact that many of the systems have very strong Hα lines to focus in this spectral region.

SCIENCE HIGHLIGHTS

Student Projects



In compliance with SALT's strategic objective of Human Capital Development, a large number of projects involve students or are initiated by students. Some examples of student projects are presented here. Projecats with refereed publications in 2022 can also be found in the research section.

MSc student **Lobone Nchoe** from NWU in South Africa, under his supervisor Thebe Medupe, is working on a project to resolve a controversy regarding the type of the pulsating pre-main sequence star HD68695: is it a δ Scuti or λ Böotis star? They have received SAT/HRS data in October. Nchoe has made a preliminary inspection of the data and has now begun the detailed analysis.

Supervised by Gerald Handler at CAMK, PhD student **Christian Eze** works on "Characterising the variability of a sample of massive pulsators in eclipsing binaries observed with *TESS*". Massive stars exhibit a mismatch between their inferred masses from different observational techniques (*e.g.*, spectroscopy), and those from evolutionary models, posing a significant challenge to our understanding of stellar evolution and structure. This discrepancy is believed to be caused by the underestimation of the convective core masses. The efficiency of such measurement is usually impaired by a lot of processes at work in the interior of the stars such as convective core overshooting and interior rotation. By integrating the precision of asteroseismology, which provides insights into the internal structure and dynamics of stars, with the detailed observational constraints offered by eclipsing binary systems, Eze's thesis aims to precisely characterise a sample of massive pulsators in eclipsing binaries to infer their interior properties and evolutionary state geared towards resolving the discrepancy problem. A sample of over ten massive pulsators in eclipsing binary systems are followed up spectroscopically with SALT. The orbital elements as well as the basic stellar parameters of the targets in the sample are fitted to derive the geometry of their orbits as well as their absolute parameters. The asteroseismic properties of the targets are also obtained, which unravel their core dynamics and profiles. This is a precursor work that provides detailed characterisation of the targets in the sample for future theoretical modeling.

In 2020, a "changing look" Seyfert AGN exhibited optical and X-ray continuum flaring that was detected by ZTF and eROSITA, respectively, and likely originated from an accretion disc instability. As part of his thesis "Morphology of circumnuclear accreting gas in active galactic nuclei", **Tathagata Saha** from CAMK made use of data obtained during a three-year multi-wavelength follow-up campaign, which involved optical spectroscopic monitoring from, among others, SALT/RSS. The purpose of the observations was to track the broad line region's response to the flare. The SALT/RSS spectra proved essential in tracking the long-term flux behavior of the broad Hβ line emission and Saha could demonstrate that the BLR's structure remained stable during the flaring event.

Under supervision by Brian van Soelen at UFS in South Africa, PhD student **Joleen Barnard** has undertaken a project called SPOTS (SPectropolarimetric Observations of TeV Sources), a large-scale systematic spectropolarimetry survey of TeV emitting blazars. This is an important study since there is very limited spectropolarimetric research available on blazars. SALT's queue-scheduling, along with the spectropolarimetric capabilities of the RSS, provides a unique opportunity to undertake such a survey. Since November 2023, Barnard has been monitoring 18 TeV blazars with the RSS. These observations have been complemented by optical photometric observations from the LCO Global Telescope Network and, where applicable, X-ray and gamma-ray observations of selected sources. Barnard presented first results at the "AGN Populations Across Continents and Cosmic Time" conference that took place in the UK in July and leads a paper described in the Science highlight section. Barnard is in the process of automating the reduction process, which will allow rapid analysis of the data, as well as rapid response to any flaring event that might occur. The data collected will be used to investigate the overall behaviour of TeV blazars as a population, simultaneously model the emission and polarisation of each source, and match the observational data to numerical jet and polarisation simulations.

New insight into the orbital parameters of a gamma-ray binary

Matchett, N., et al. 2024/11, arXiv2411.12499: New insight into the orbital parameters of the gamma-ray binary HESS J0632 + 057

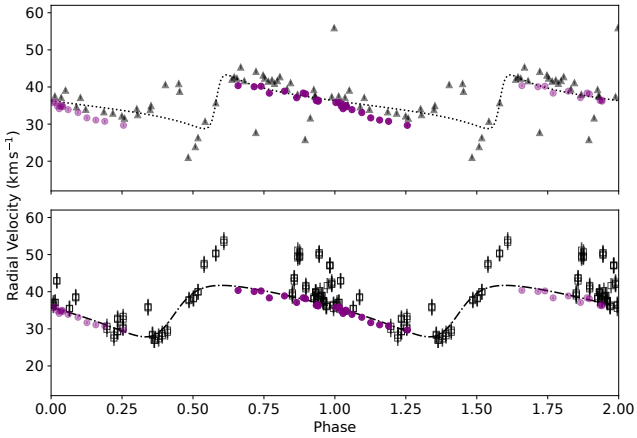
Natalie Matchett,
UFS (South Africa), MSc 2024

Gamma-ray binaries are a subclass of high mass binary systems that produce persistent, orbitally modulated non-thermal emission, which is detected up to very high energy gamma-rays (in the TeV range). For these systems to be able to continuously produce such high energies, very special conditions must be occurring for these systems. The main consensus is that these sources all contain a young pulsar, and that particle acceleration occurs in a shock that forms between the pulsar and stellar winds. In this model, there is no accretion onto the compact object. However, pulsed radio/gamma-ray emission has only been detected for three of the nine known systems. The more recent detection of very high energy gamma-rays from known accretion-driven microquasars, however, shows accretion processes can produce very high energy emission.

For the last several years, the interpretation of the multi-wavelength emission from the gamma-ray binary HESS J0632+057 has been complicated by two different, and incompatible, orbital solutions. The X-ray and TeV lightcurves from this source display two maxima, which are likely due to the interaction between the compact object and the circumstellar disc of the Be companion around periastron of the ~317 d orbit — similar to what is seen in another Be gamma-ray binary, PSR B1259-63. However, neither of the existing orbital solutions are able to sufficiently explain the maxima of the light-curves.

To address the confusion around the orbital solutions, independent radial velocity measurements are being obtained from ongoing long-term monitoring of the bright Be companion

(*V* ~ 9.1 mag) with SALT/HRS. Over four non-consecutive semesters between 2020 and 2024, 38 observations covering ~75 percent of the orbit have been obtained. The results of the first three semesters have recently been published, along with a new, preliminary, orbital solution obtained with the SALT data which provides better interpretation of the observed emission. Continued monitoring of this source over the next two years should provide full-phase coverage which will result in the publication of an independent orbital solution from the SALT data alone.



New average SALT radial velocity values (purple circles) are fitted with the Moritani+2018 data (*top*) and Casares+2012 Hα data (*bottom*) to provide new orbital solutions.

A comprehensive study of low-mass compact hierarchical triples

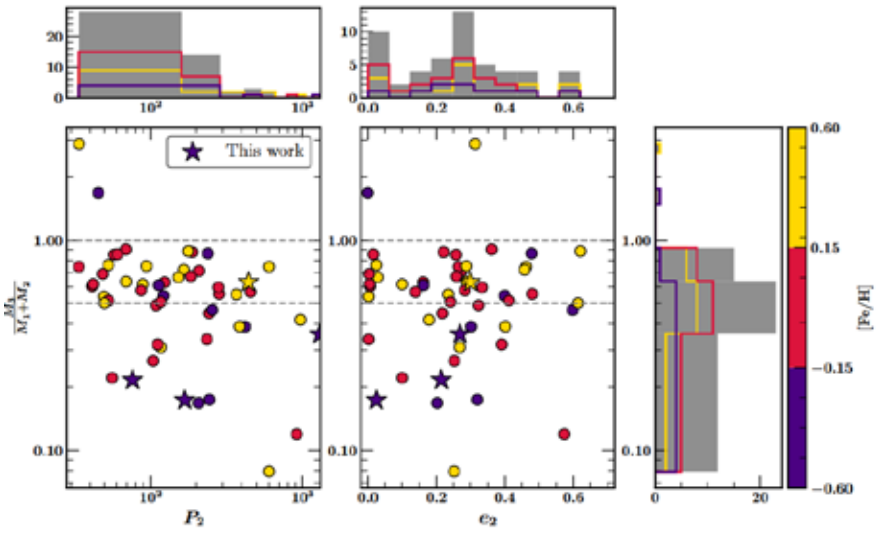
Moharana, A., et al. 2024/10, A&A 690, A153: Spectroscopy of eclipsing compact hierarchical triples: I. Low-mass double-lined and triple-lined systems

Ayush Moharana,
Nicolaus Copernicus Astronomical Center (Poland), PhD 2024

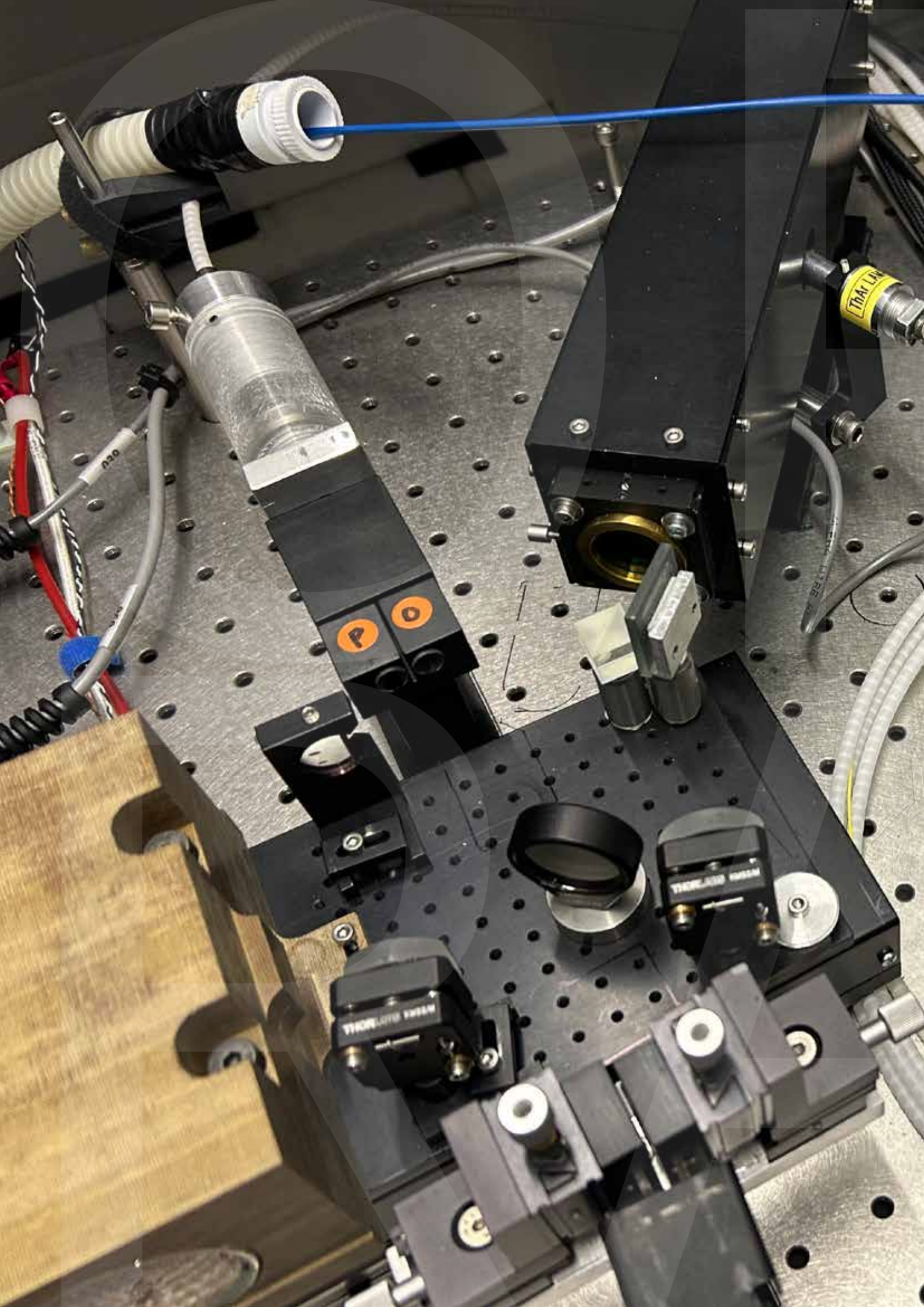
The theory of formation, evolution, and stability of multiple-star systems is a field that has many unanswered questions. One of the least studied aspects is the evolution of hierarchical triple systems. Triple systems have been used as an explanation for the formation of close binaries, blue stragglers, planetary nebulae, and also the merger of several black holes. But most of these systems have long outer periods and their dynamic effects can have timescales of years and decades. Therefore studying them in detail can be a time-consuming process. However, a subset of these triples, called Compact Hierarchical Triple (CHT), offers more potential for observational astrophysics. These triple systems have an outer orbit period of fewer than 1000 days. CHT were once considered to be rare but with new observations from photometric space missions, more of such systems are discovered.

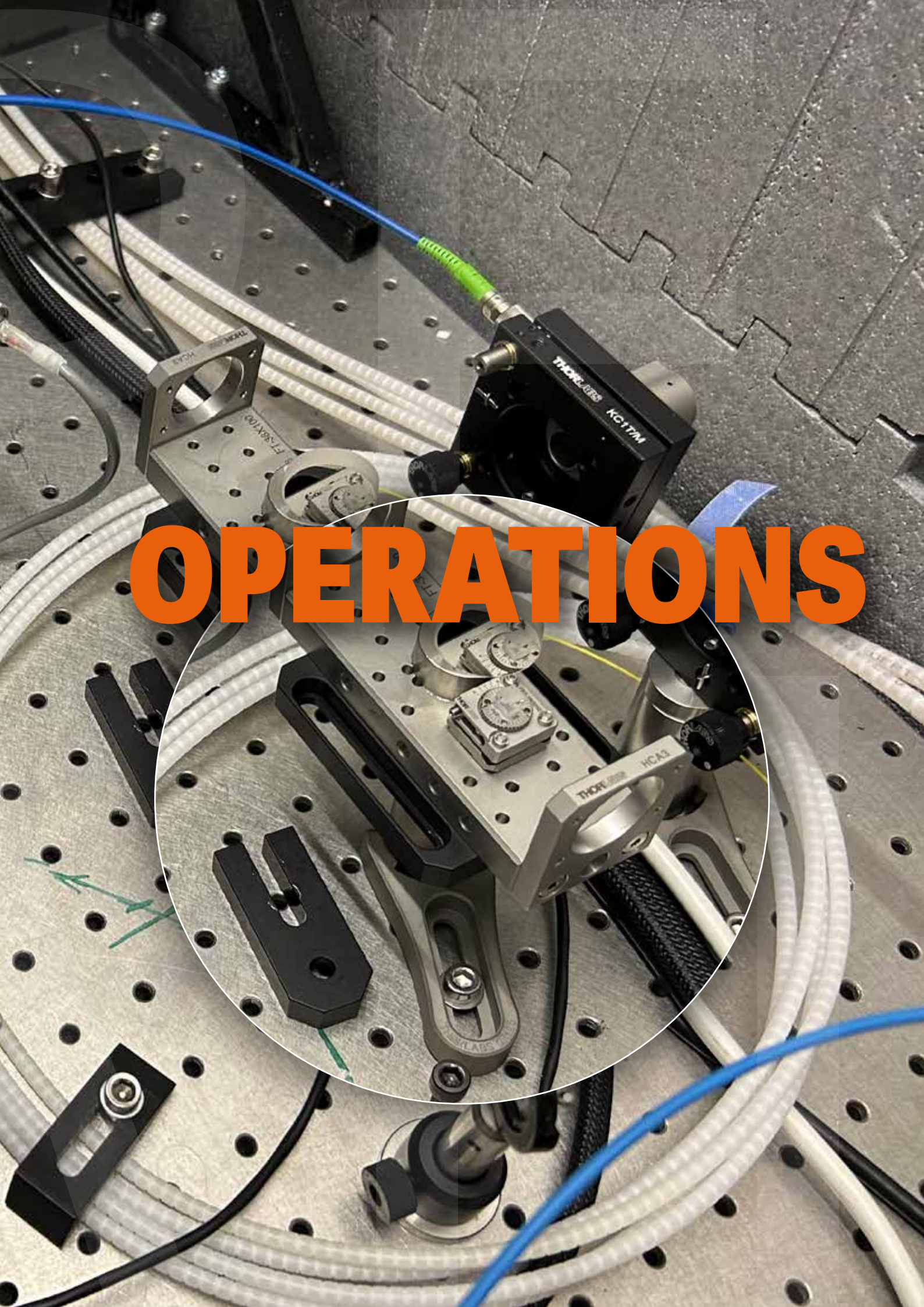
For his thesis, Ayusha Moharana from CAMK, Poland, used CHTs with low-mass eclipsing binaries to study the formation, evolution, and dynamics of these systems. This requires high quality time series observations of both photometric and spectroscopic nature. While photometry is easily available from space-based photometric missions like *TESS* and *Kepler*, a large and stable spectrograph is required to obtain high-resolution and high-SNR spectroscopy to ensure precise radial velocities (RVs) and to disentangle component spectra from the composite spectra. Moharana and his supervisor, Krzysztof Hełminiak, devised a long-term programme to use SALT/HRS to provide spectroscopy for the CHT candidates for this thesis.

As a result, Moharana reports on the discovery of nine low-mass CHTs, of which six were analysed in detail. Adding to this sample 43 known CHTs with similarly detailed spectral analysis, Moharana has visualised the distribution of various parameters and studied their implication on the current CHT formation and evolution theories.



Distribution of the tertiary mass-ratio M3/(M1+M2) with the tertiary period P2 (left panel) and with the eccentricity e2 of the outer orbit for CHTs (right panel) with metallicity estimates. The colours code for systemic metallicity, where metal-poor (< −0.15 dex) systems are purple, near solar-metallicity (−0.15 dex < [Fe/H] < 0.15 dex) ones are red, and metal-rich (> 0.15 dex) CHTs are yellow. The narrow panels on each axis represent the histograms of the respective parameters, with the coloured histograms representing the distributions for each metallicity group.





OPERATIONS

OPERATIONS

Astronomy Operations

One of the major highlights of the year was the release of the RSS science pipeline, which was launched on 1 August 2024, marking a significant advancement for SALT users. Among the new products are wavelength-calibrated and rectified 2D spectra. A Docker container is also provided, offering tools for sky extraction and flux calibration.

Another highlight of the year was the first light of the slitmask IFU in February 2024. This new RSS mode has been commissioned in the first part of the year and, after being handed over to our team, offered on a shared risk base to the SALT users in the latter part, along with providing users with a manual data processing pipeline.

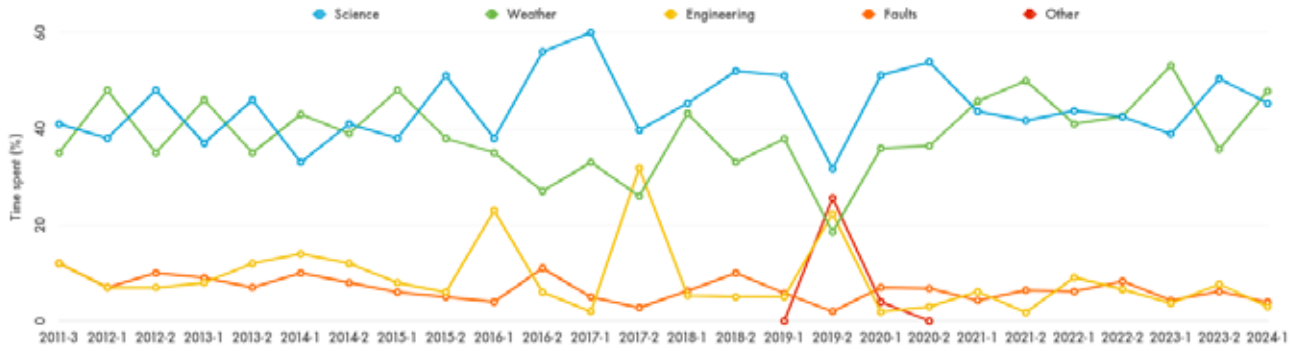
In addition, we made the difficult decision to halt further NIRWALS science observations for the near future. While the instrument is technically ready for science observations, the latest NIRWALS science reductions revealed the need for further refinement and a deeper understanding of the data reductions. The team is actively addressing these outstanding issues.

Semester statistics

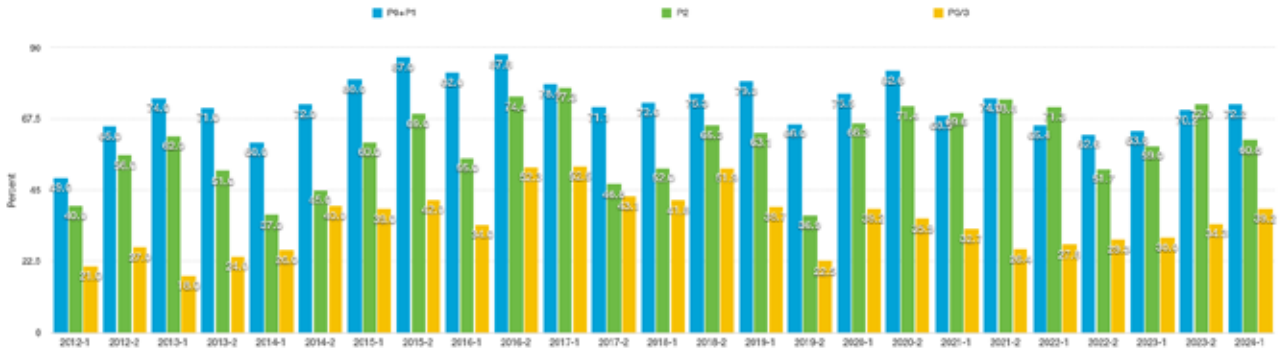
While weather-related downtime for the 2023-2 semester was at 36% at its lowest since 2018 (not counting the COVID-19 affected downtimes), the 2024-1 semester exceeded the average winter weather loss of 40%, reaching around 48%. Engineering activities accounted for 8% and 3%, respectively. Although higher than expected, this was not surprising, as it included NIRWALS commissioning observations and tests for the RSS slitmask IFU. Technical downtime, which took the telescope offline, accounted for a low 6% and 4%, respectively. The remaining time was used for science observations, comprising a high 50% in the 2023-2 semester and 45% in the 2024-1 semester.

It is notable that the time spent on science observations has been relatively high in these semesters compared to previous ones. This can be attributed, in part, to the integration of NIRWALS observations, which contributed to a fuller queue, as well as the positive effects of the SALT Efficiency project, which enabled faster acquisitions and reduced overheads, allowing the observers to complete more blocks. These improvements are also reflected in our priority completion statistics, which showed significant progress in higher-priority blocks over the last two semesters when compared to previous semesters.

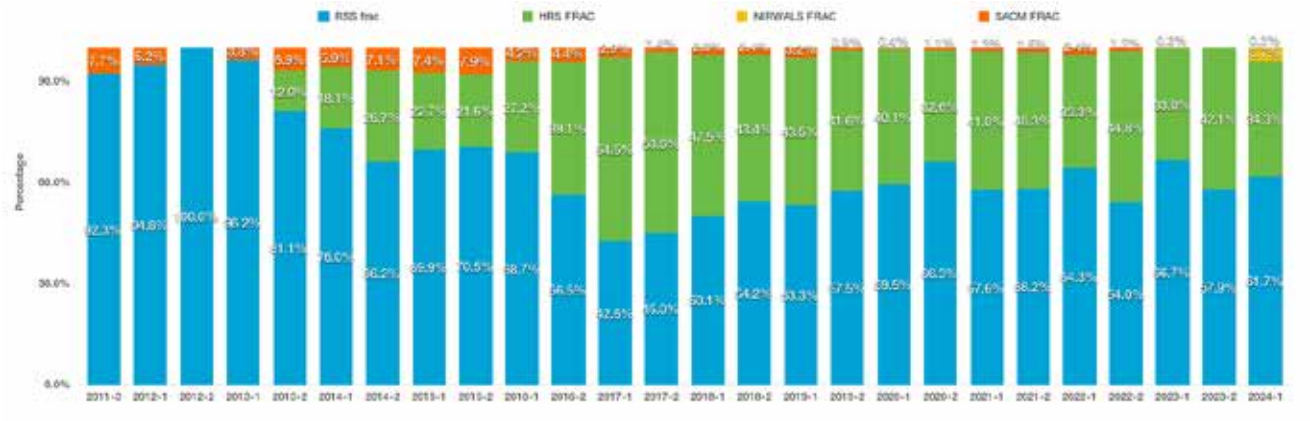
In terms of instrument usage, RSS continues to be our primary workhorse, particularly during the best observing conditions — dark, clear nights with good seeing. HRS, on the other hand, remains the dominant instrument for bright nights and poorer seeing conditions. SALTICAM, due to its lack of guidance and focus control, is primarily used as an acquisition instrument. For the first time, NIRWALS usage has been tracked during the 2024-1 semester, accounting for 4% of the total instrument usage.



SALT time usage per semester, including the lockdown period (as 'other').



Completeness per priority in percent. The oversubscription factor for P3s has not been taken into account.

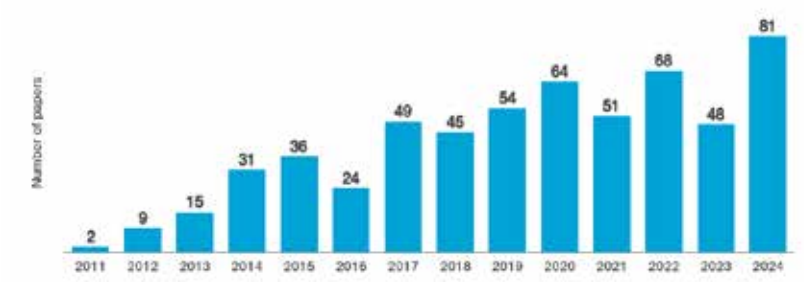


SALT instrument usage per semester.

Publication statistics

The number of SALT publications per year has generally trended upward, with a whopping 81 papers published in 2024 — the highest annual count since the start of science operations by far! In terms of cost per paper, SALT continues to deliver excellent value, with much lower costs than similarly-sized single telescopes around the world. This year, there were almost the same number of publications on Galactic (34) and extragalactic (35) sciences, with twelve additional papers on supernovae.

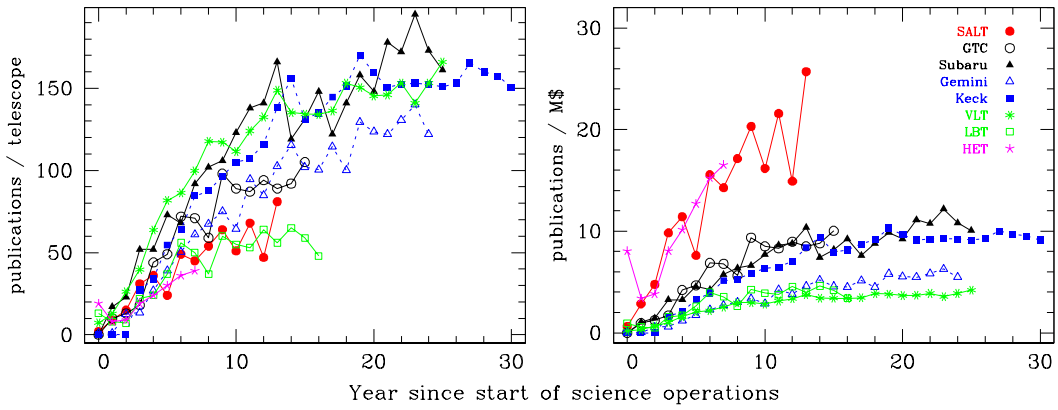
RSS remains the primary contributor to SALT publications, while HRS has steadily increased its share, accounting for approximately a third of publications in recent years. In contrast, SALTICAM's lack of guidance and challenges in maintaining focus have made it less attractive to users, resulting in very few publications over the past few years. The BVIT instrument is no longer available.



Refereed publications based on SALT science data and including instrument-related publications, from the start of science operations in 2011.

Refereed publications since science operation started for major telescopes. Left: publications per year and per telescope; right: publications per year and per operation cost in million US Dollars.

Below:
Instrument usage in SALT publications.



User support

Science data products for RSS normal and frame transfer long-slit spectroscopy exposures became available and were included in the daily data distribution starting 1 August 2024. Additionally, all such exposures dating back to semester 2015-1 (1 May 2015) were fully reduced and made accessible to PIs. These products included wavelength-calibrated and rectified reference (arc) exposures, as well as processed object exposures with bad pixel replacement, cosmic ray cleaning, CCD gap filling, wavelength calibration, and rectification, with additional flat-fir and auto-gain correction where applicable.

Over the past year, significant improvements were made to the PIPT, including updates related to NIRWALS, such as automated arc and flat detail updates to reduce submission errors, and the addition of a reference star option for acquisitions. Furthermore, development advanced on a major PIPT upgrade, which will introduce a simplified XML schema, enhanced stability, and improved responsiveness, with its release expected in early 2025.

A new feature was added to the Fault Tracker site, allowing telescope and instrument statuses to be updated directly. This information is now available on SALT's status page for the user's convenience (https://astronomers.salt.ac.za/status/).

SALT Astronomer Danièl Groenewald has been collaborating with the original RSS PI, Ken Nordsieck (UW), on user support and calibrations for linear spectropolarimetry. The highly anticipated release of the polarimetry calibrations, along with updates to the reduction software, is expected in early 2025. Their work was published in the 2024 SPIE conference proceedings and available on the polSALT GitHub page.

Conferences and workshops

Then Head of Astro Ops, Encarni Romero Colmenero, attended the annual AfAS conference in April 2024, where she promoted the use of SALT among other African countries. She contributed with an oral presentation and led a workshop on how to submit proposals for SALT.

The 2024 SPIE conference in Japan featured several contributions from both sides of the SALT operations team. SALT Astronomers Moses Mogotsi and Danièl Groenewald presented papers on NIRWALS and spectropolarimetry calibrations, while Encarni Romero Colmenero had her paper on "Updates to SALT Astronomy Operations" accepted as an oral presentation. SALT Observatory Scientist Lisa Crause gave an invited talk on SALT instrumentation developments, and although SALT Astronomer Enrico Kotze withdrew his initially accepted three papers due to project delays, he later submitted a consolidated paper to the SPIE journal JATIS .

The Astro Ops team made significant contributions to the IAU General Assembly held in Cape Town in August 2024. Danièl and Moses presented posters, while Encarni, Lisa, Moses, and Lee delivered oral talks. The team also played an active role in supporting the event, serving on the SOC, managing the SAAO/SALT booth, and organising weekend tours of SALT for visitors.

Personnel

There were four resignations from SALT Astro Ops positions in 2024:

- SALT Astronomer Solohery Randriampandry's contract concluded in March 2024. He has since returned to Madagascar to take up a lecturing position at the University of Antananarivo.
- Thea Koen, one of our SALT Operators, resigned in May 2024 to pursue a Master's degree in Archaeology at the National and Kapodistrian University of Athens.
- Enrico Kotze, who had initially announced his decision not to renew his contract in March 2024, remained with SALT until September 2024 to complete several pipeline projects he was involved in.
- Chaka Mofokeng, one of SALT's software developers, resigned in December 2024 to take up a position at Amazon.

Three new people joined the team in 2024:

- We welcomed two new SALT Operators, Austun Louw and Nomzamo Mokoena, who joined the team in August and September 2024, respectively. Both are currently completing their Master's degrees.
- Antoine Mahoro formally commenced his employment as a SALT Astronomer in January 2025.

The SALT project welcomes the new leaders:

- Encarni Romero Colmenero, former Head of SALT Astronomy Operations, was appointed Director of SALT in July 2024. We wish her all the best in this new role.
- Danièl Groenewald, former SALT Astronomer, became Acting Head of Astronomy Operations in July 2024.
- In January 2025, former SALT Astronomer Rosalind Skelton was appointed Managing Director of SAAO. The team wishes her success in this leadership role.

OPERATIONS

Technical Operations

The Technical Operations (Tech Ops) team has made significant strides in maintaining and improving the facility throughout 2024. Despite a dynamic environment, the team successfully ensured the reliability of key systems, optimised spare parts management, and advanced critical maintenance projects. These efforts have contributed to the continued efficiency of the telescope.

A key highlight of the year was the enhancement of maintenance workflows and asset management processes. The team implemented improvements in inventory tracking, ensuring essential components remain available when needed. Engineering documentation and technical records were also updated to streamline future maintenance and support long-term operational stability.

Investment in infrastructure upgrades and asset renewal projects has further strengthened telescope performance. Planned upgrades to network infrastructure, ventilation systems, and cooling systems have laid the groundwork for continued operational excellence. In addition, the team has been actively preparing for a full telescope shutdown for March – April 2025 to address urgent issues with the primary mirror and do essential maintenance on the subsystems while they are on the ground.

Looking ahead, Tech Ops remains committed to continuous improvement, leveraging innovation and collaboration to enhance telescope operations. The dedication and resilience of the team have positioned SALT for continued success.

Key projects and initiatives

One of the main priorities this year was to improve the way spare parts are managed. The team reorganised the storage area, making it more efficient and ensuring that essential components are easily accessible. An extensive review of inventory is underway to remove outdated parts and update the database with current needs. Work also began on updating the stock system to better track stock levels and alert staff when supplies are running low. This initiative is expected to help reduce downtime, which decreased to 4.4% in the period 2023-01 until 2023-12 and was mainly attributed to equipment failures in the payload, tracker and RSS subsystems.

The departure of several key team members placed additional strain on the remaining staff, who had to take on increased responsibilities while ensuring the telescope remained operational. The impact of this has been particularly evident in the maintenance and repair processes. With fewer team members available, completing scheduled maintenance and addressing unexpected failures has become increasingly difficult. To mitigate this, the team has prioritised the most critical repairs and delayed non-essential maintenance where possible. Knowledge transfer and cross-training efforts have been implemented to ensure that essential skills are retained within the team.

Significant progress was made to improve the way technical information is organised and maintained. Updates to design models will ensure that they accurately reflect the current state of the telescope. A structured process for managing engineering changes was introduced, making it easier to track and document modifications. Additionally, detailed records are being created for major systems such as the telescope tracker, dome drive, and primary mirror assembly to support future troubleshooting and maintenance.

To enhance reliability, a systematic approach to identify potential failures and risks was implemented. The team is working on analysing possible failure points and finding ways to prevent issues before they occur. Furthermore, a structured system for tracking and resolving faults is being investigated to provide better insight into common issues and to allow for more efficient troubleshooting.

Preparations are being made for replacing sections of the telescope dome's ventilation system to improve airflow and reduce dome seeing that degrades the telescope's delivered image quality. A structural engineer assessed the facility, and initial tests were conducted with new ventilation equipment. A plan was developed to gradually replace the existing components of the ventilation system.

Asset renewal projects also included upgrades to network infrastructure to improve stability. Improvements were made to the maintenance workflow, particularly in fault tracking and knowledge transfer among team members, to ensure that experienced staff can focus on high-level tasks while junior staff handle routine maintenance.

Planning for the scheduled shutdown in March 2025 is another area of focus. A detailed maintenance plan was created, outlining the steps required to inspect and repair key systems. The tasks include checking and adjusting the primary mirror, maintaining scientific instruments, and inspecting the mechanical components of the telescope. The goal is to ensure that all systems are in top condition once operations resume, despite current staffing constraints.

Planned procurements

A current key procurement is the replacement of the ageing laser cutter used for cutting MOS masks for the RSS instrument. The current laser is no longer supported. It was decided to replace the laser cutter with a more advanced fibre laser that can cut MOS masks with greater accuracy while also supporting additional materials. The proposed machine meets or exceeds all technical requirements, including accuracy, minimum hole diameter, and repeatability. Additionally, it offers the capability to cut metal (including mild steel, stainless steel, and aluminum), thus reducing lead times for custom components and enhancing the problem-solving capabilities at SALT.

Another essential procurement is the replacement of the SALT chiller, which provides cooling for various telescope systems. The current air-cooled liquid chiller, installed in 2014, supplies temperature-controlled glycol for essential instrument cooling and air conditioning. Although the chiller is still functional, it has experienced operational issues in recent years, prompting the decision to procure a new unit and to retain the existing one as a backup for redundancy. The replacement chiller will offer improved durability and reduced maintenance requirements.

Outlook

Looking ahead to 2025, the team will continue working on major projects, including completing the ventilation system upgrades and improving the spare parts tracking system. Efforts to better analyse and prevent technical issues will remain a priority, ensuring that maintenance is proactive rather than reactive. The upcoming shutdown in March 2025 will be a major event, requiring close coordination to complete all scheduled work efficiently. However, the ongoing staff shortages remain a critical concern, and addressing workforce gaps will be essential to sustain the long-term operational efficiency. These initiatives will support SALT's mission of providing high-quality astronomical observations while ensuring the long-term sustainability of the telescope.

Personnel

Unfortunately, quite a number of people left the Tech Ops team in 2024:

- Richard Banda — Mechatronics Engineer, Sutherland
- Janus Brink — Software Contractor
- Bryne Chipembe -— Software Engineer, Sutherland
- Timothy Fransman — Mechanical Technician, Sutherland
- Deon Lategan — Consultant, Cape Town
- Paul Rabe — Technical Operations Manager, Cape Town
- Melanie Saayman — Optical Engineer, Cape Town
- Malcolm Scarrott — Efficiency Software Developer, Cape Town

We welcome our new staff:

- Devakshan Naicker — Senior Software Engineer, Cape Town
- Sam Ndumo — Mechanical Design Engineer, Sutherland
- Michael Sam — Senior Mechanical Technician, Sutherland
- Chrey Sookha — Head of the Tech Ops software team, Cape Town

Sam Ndumo started in June 2024 as the SALT Mechanical Design Engineer: Configuration Manager in Sutherland. He holds a Bachelor of Engineering and an Honours degree in Mechanical Engineering. Previously, he worked as a mechanical engineer at the Council for Scientific and Industrial Research (the materials manufacturing department), specialising in design and simulation. He is proficient in creating data packs to the ISO 10110-1:2019 standard. His work involved designing, redesigning, and simulating components using FEA (finite element analysis) in Siemens NX, as well as performing NDT (non-destructive testing), metrology and quality assurance on manufactured components. Additionally, he also used some Python programming for data analysis and interpretation.

Michael Sam started in July 2024 as the SALT Senior Mechanical Technician in Sutherland. He is a mechanical technologist and focused on "Tool design and manufacturing technologies" in his studies. His career has primarily been in product development, spanning research, manufacturing and defence industries. He had tenures at Cape Peninsula University of Technology – Advanced Mechatronics Technology Laboratory (CPUT–AMTL) and Rheinmetall Denel Munition.

Devakshan Naicker and Chrey Sookha will be introduced in the software section.

Health and safety

We are happy to report that no injuries to staff occurred during the reporting period.

A significant challenge faced during the year was an unexpected failure of the dome rotation system in late October. During routine maintenance, the dome moved uncommanded, posing a risk to personnel and equipment. An investigation found that incorrect encoder system feedback caused by the encoder losing contact with the dome caused the problem. Software limitations and gaps in the maintenance process also contributed to the failure. To prevent similar incidents, the team replaced and improved mechanical parts and introduced stricter inspection procedures. Additional safety features are being considered to enhance system reliability.

OPERATIONS

Instrument News

The Big 5 — progress on the RSS upgrades

The RSS Big 5 have become the Big 2, with the remaining long-slit masks nearing completion and the new detector development is ongoing.

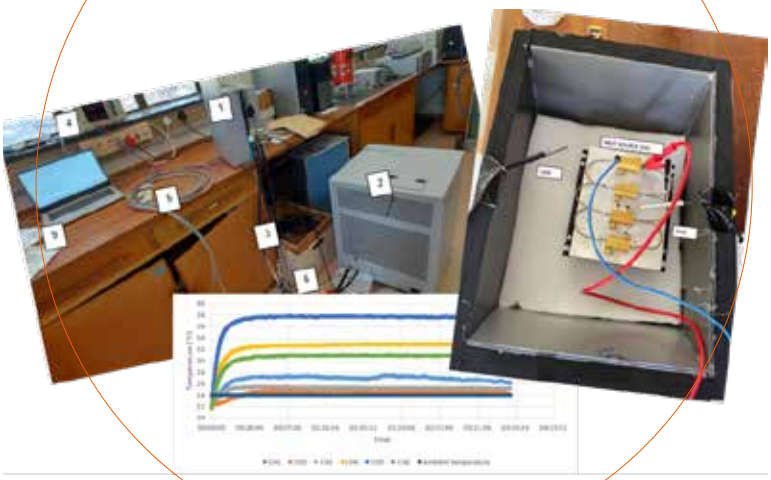
New suite of long-slit masks is almost complete

The project to replace the entire suite of RSS science slitmasks is due to enter its final stage in early 2025. During 2024, the SAAO workshop manufactured a large fraction of the 8′ long-slits and some spares, as well as our most utilised 4′ polarimetry masks. These masks were initially tested as and when they were sent up to the telescope, but we soon realised that this testing needed to be redone in a more consistent manner. In December, every mask that had been manufactured was installed at the telescope for mass testing. This was done with a closed dome and a stabilised light source (not the calsys lamps), and with a consistent telescope and instrument setup, ensuring a stable environment throughout.

An important step in this testing was the development of a more thorough cleaning process after a mask had been manufactured. During ad-hoc testing, we found what appeared to be defects in some of the masks, identified in flat field images. However, happily, this turned out to be material that could be cleaned away in many cases. A combination of ultrasonic cleaning and several iterations with Kim wipes and acetone or isopropyl alcohol, finishing off with a blast of compressed air, did a great job of cleaning remaining residue and metal shavings from the masks.

The data from this test run is currently being analysed by the Astro Ops team, which will determine whether all of the new masks can be incorporated into regular operations. Indeed, we have been using some of these new masks for science observations for several months already. The SAAO workshop is also busy producing the remaining masks; mostly the polarimetry ones, but also the Frame Transfer and Slotmode masks. We are expecting delivery of this batch at the end of February 2025, after which they will also be sent up to the telescope, thoroughly cleaned and tested as described above.

Thermal testing for one of the enclosures.

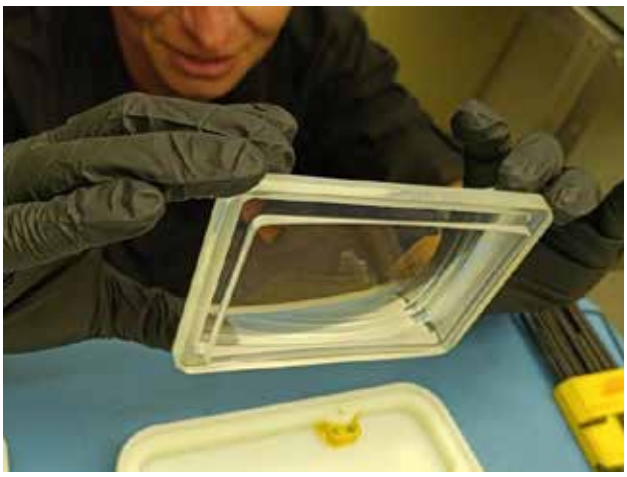


New detector project is progressing well

The RSS detector upgrade field flattener lens, ordered in May 2023, was finally delivered to the detector development team at the end of January 2025, after accepting the inspection report provided by the vendor. The lens was inspected by Lisa Crause and Kathryn Rosie in Cape Town, and confirmed to be in good order (see photo below).

Other project developments include continuing work on upgrades to the control software that we use whilst observing at the telescope, and finalising of the structures and housings for all the supporting equipment up on the tracker structure. Thorough tests and analyses were done to ensure that the added mass, heat, and proposed attachments would not affect the optical performance of the instrument. The team subsequently carried out a successful mechanical review towards the end of 2024, which had good engagement from the various technical teams, as well as external instrumentation experts.

Aims for early 2025 are to finalise manufacturing drawings for physical parts, and accelerate procurement of standard components in readiness for assembly.



Commissioning of the new slitmask IFU

The SMI-200 (SlitMask IFU 200 µm) mode is currently being used in the ongoing 2024-2 semester of SALT observations. The development of the SMI has been detailed in previous reviews and reports, so here we provide a brief update from operations this semester.

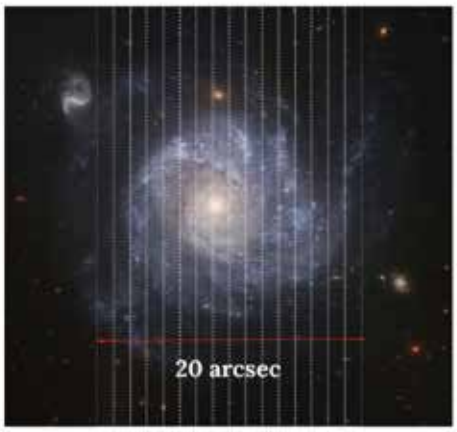
This new mode for RSS required the SALT Astronomers to familiarise themselves with its operation, with particular focus on correctly offsetting the acquired target from a regular long-slit (slit view) exposure, to the IFU. Another key aspect of this procedure is to understand the appropriate calibrations that need to accompany any science observations. It was established that flat and arc exposures are required alongside every SMI-200 observation to correctly calibrate the data. However, since SMI-200 has only been tested in a single configuration (PG0900, camera angle = 30.25 deg, grating angle = 15.125 deg) during science verification, exposure times and lamp choices for other configurations were undetermined.

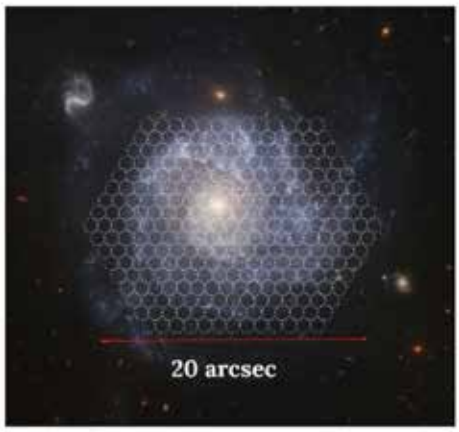
To minimise overhead time during observations, the Astro Ops team determined the optimal calibration settings for each of the configurations requested by PIs in the 2024-2 semester. They used on-telescope tracking to determine the correct set of exposures that can be used for calibrations. Additionally, they perform the full calibration process to ensure that spectral extraction and wavelength calibration meet the required standards.

In terms of best operating modes, their findings indicate that 4×2 or 4×4 binning is not feasible with SMI-200, as the fibre-to-fibre separation is less than four pixels. While 2×2 binning may be possible, it would be on a best-effort basis. The only configuration for which the team can confidently provide calibration settings is 1×1 binning, which they recommend to users for the current and next semester. With this guidance, PIs have begun obtaining observations, and data analysis is ongoing.

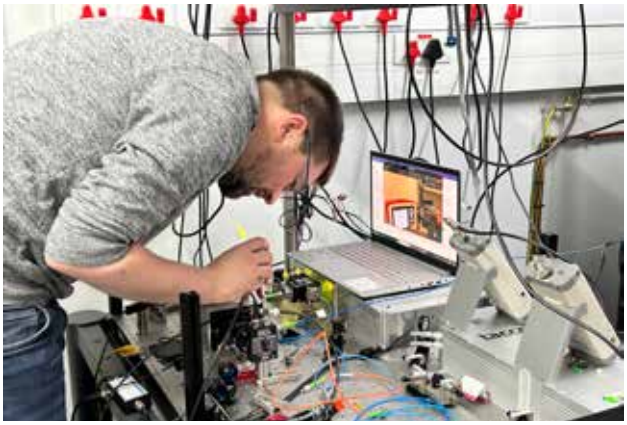
The team is also working on an SMI handbook that will include comprehensive information on data reduction, useful tips and tricks, and important guidelines. However, this handbook will only be available for the 2025-2 semester. In the meantime, if users have any questions or concerns, they are encouraged to contact the Astro Ops team.

Difference in spatial coverage for extended sources for 16 × 1.3 arcsec long-slit exposures (left) versus one SMI-200 exposure (right). In other words, the 1.3 arcsec long-slit would require 16 exposures to cover the same area of the galaxy covered by SMI-200 in a single exposure.





Laser frequency comb development



A custom-built laser frequency comb (LFC) will provide precision wavelength calibration for the high stability (HS) mode of SALT's High-Resolution Spectrograph (HRS). This new hardware will be accompanied by a specialist HS data pipeline to support precision radial velocity (PRV) science, the demanding field associated with the search for and characterisation of exoplanets. The LFC was built by Heriot–Watt University (HWU) in Edinburgh, in collaboration with the SAAO and SALT. The comb is for the Red channel of the HRS (555 – 890 nm) and will be used in conjunction with the HS mode's original simultaneous Thorium-Argon feed. However, the comb provides vastly superior calibration features, in the form of comb lines that are equally spaced in frequency, stable over time, unblended, unsaturated and fully traceable.

Having HWU building the comb at SALT rather than at their labs has been extremely valuable for us, but it has complicated the integration process. Technical problems that needed to be resolved back in Edinburgh have led to various delays and so there is still work to be done to complete the development of the SALT LFC. This includes finalising the hardware, the software interface and the data pipeline, all of which are highly interdependent. That said, great progress was made during the April/May integration campaign at the telescope (including the excitement of achieving both engineering and on-sky first-light for the comb) and during a subsequent visit in November/December that put more of the remaining pieces in place. We now look forward to at least one more LFC campaign during the second half of 2025 to complete the hardware installation and then implement the new pipeline for the HS mode.


bin
zoom
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OPERATIONS
Software Updates

Along with supporting operations, the Tech Ops software team has continued with its commitment to improve the engineering processes used at SALT, notably with expanding the software coding standards. Writing neat, well documented code specifically designed to be easily maintained by a small engineering team is of strategic importance to SALT, as this will reduce time spent supporting systems and allow more time to be dedicated to improvement and optimisation projects. The coding standard, which emphasises a modular architecture, allows engineers to co-develop systems by sharing the modules between team members, thereby facilitating the shared understanding of the project between team members. The modular design primarily aims to reduce time spent investigating problems as it would be easier to isolate problems to the owning module.

Efficiency project

The SALT Efficiency project made great progress in 2024 and was able to implement some high-priority projects that have contributed to increasing the observational efficiency of the telescope.

The various projects include:

- Implementation of a machine learning model to adjust the telescope focus, which has improved the focus dependence on telescope azimuth.
- Completing the Guider Pre-Positioning (GPP) project that now gives pre-positioning functionality to all current SALT instruments. This has significantly decreased the target acquisition overheads for the telescope. This project also included work done on the instrument-specific 'Magic Pixel', which is the location that the instrument needs the science target to be placed on. The GPP has streamlined the process of placing the target.
- A large amount of work has been put into the Observation Control System (OCS). SALT can now have its calibration system automatically configured thanks to the efforts on the Auto-Cal project. A new web interface for the OCS has been in development and aims to make remote observing easier for the astronomers.
- There have been proposed software changes which, along with a small mechanical change to the Fibre Instrument Feed (FIF) guider, will allow for instantaneous focus feedback that will reduce the number of manual focus adjustments needed to be done. This would improve the quality of the data for HRS and NIRWALS.
- The Efficiency project has also been able to work with the Laser Frequency Comb (LFC) group from Heriot-Watt University. They have been building the newest instrument for SALT, and the Efficiency project has advised on how the LFC can be integrated into the current telescope software.

The telescope overheads over the past few years prove the success of the Efficiency project. In 2022, it took an average of 600 seconds for a science target to be acquired. The Efficiency project has been running since 2023, and, as of January 2025, it can take as little as ~500 seconds for a science target to be acquired. Saving ~100 seconds of telescope time per observation adds up quickly and allows SALT Astronomers to perform more observations on average.

Quality management system for the mirror coating process

The mirror coating plant provides a vital service, ensuring that each mirror segment of SALT is re-coated periodically throughout the year. Significant effort has been invested to study and analyse the various process parameters which drive the success of our coating process. This is used to pre-emptively address any shortcomings that may arise, which can affect the quality of the mirror coatings. Logging this information to spreadsheets has been performed manually in the past, which is laborious, and although these data are useful, it is not in a format that is user-friendly.

A solution has been developed using a Django website which allows the user to capture and view the data for the entire mirror coating process, from the removal of the segment back to the re-installation of the segment.

Dashboard for the Mirror Coating Software displaying the status of segment 2 on the 16th of January.

Astro Ops support

Work on the new **Web Manager** (https://wm-new.salt.ac.za/) continued. Amongst others, the overall layout of proposal pages was improved to be more readable. The new Web Manager is approaching feature parity with the old one, and we plan to decommission the latter in 2025.

A substantial fraction of the work done on the **PIPT** concerned changes related to NIRWALS. In addition, arc and flat details are now automatically updated whenever the PIPT is launched. This is a first step to avoid submission errors due to outdated details on the user's computer. Furthermore, the capability to add a reference star to an acquisition is now available. Work on the planned major PIPT upgrade with a simplified XML schema, better stability and improved responsiveness continued. This new version is expected in early 2025.

A comprehensive analysis was conducted of tools for making data available as part of the **Virtual Observatory**. Given the available skill set and resource constraints within the Astro Ops software team, it was concluded that the best option will be Daiquiri, a Django-based server published by the Leibniz-Institute for Astrophysics Potsdam.

Work on the web-based SALT Astronomer man-machine interface (**WebSAMMI**) focused on two changes: First, the interface is automatically prepopulated with the pointing event details. Second, night logs can be created which are tailored to specific observations and don't include details which are not relevant for them.

A page for updating the telescope status was added to the **Fault Tracker site**. The status information is displayed on SALT's status page (https://astronomers.salt.ac.za/status/).

PyAstroSALT, the Python library for interacting with the SALT API (which powers the Web Manager), was rewritten to be more user-friendly, in particular for making proposal submissions and following their progress. The library is available via pip.

Farewells and introductions

The Astro Ops software team had to bid farewell to one of its team members, Chaka Mofokeng, who resigned at the end of the year after more than three years of service to SALT. We wish him well for his future endeavours.

The Tech Ops software team has seen a number of members leave in the past few years, so it is with sadness that we say goodbye to both Bryne Chipembe and Malcolm Scarrott. Bryne has accepted a position with the SAAO instrumentation team where he continues to contribute to SALT through their projects. Malcolm is returning to his studies at UCT. Malcolm's contributions over the past year have been significant, in particular on the Efficiency project. We hope that we will be able to draw on his expertise again in the future.

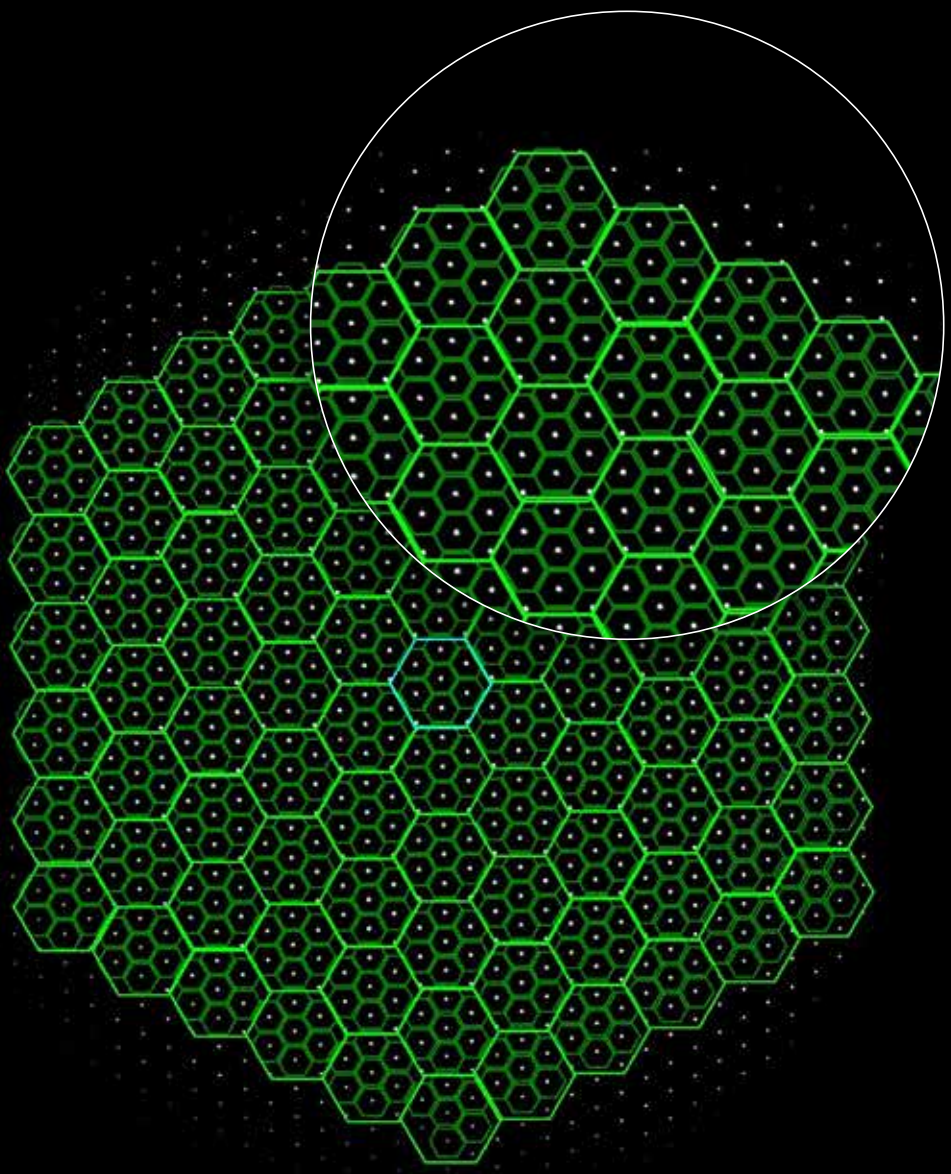
The Tech Ops software team welcomes two new members to the team.

Devakshan Naicker is a senior software engineer with a background in electrical and electronic engineering. He holds a Bachelor of Engineering (BEng) in 'Electrical and Electronic Engineering' and recently completed his Master of Engineering (MEng) in the specialised fields of 'Artificial Intelligence and Robotics' from the University of Johannesburg. In 2024, Devakshan joined the team at SALT, where he has contributed significantly to various key projects aimed at improving operational efficiency and the integration of advanced technology within the organisation. His active involvements include:

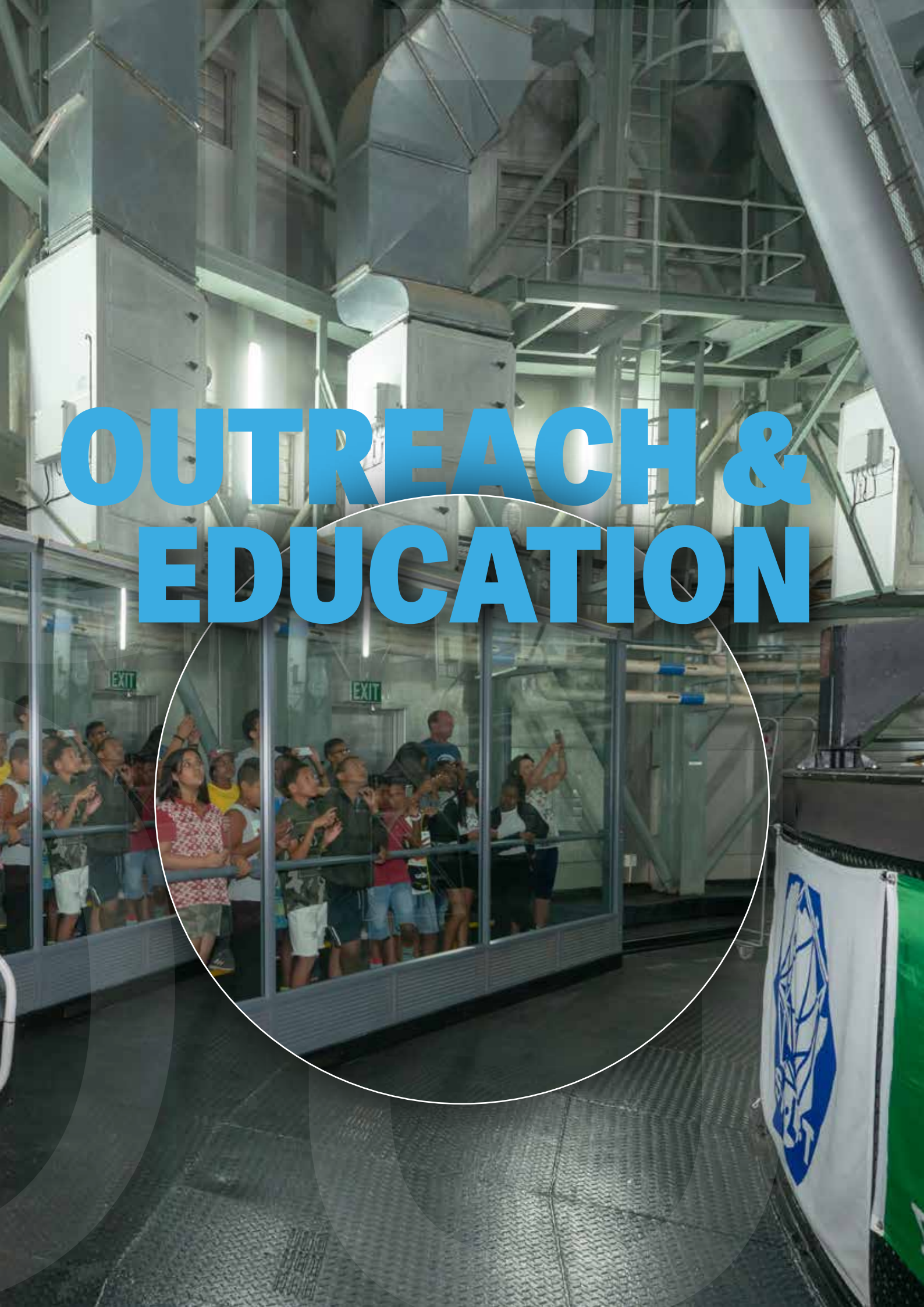
- Software procedure improvements: Enhancing the efficiency and effectiveness of software procedures to streamline operational workflows and improve performance.
- QMS project management: Leading a project focused on the development and enhancement of the Quality Management System (QMS), aimed at providing valuable analytics to optimise the operational processes of the telescope, improving efficiency and precision.
- BMS and HRS software leadership: Taking charge of the BMS and HRS software, to ensure their seamless operation, and driving improvements to support operational goals.
- Health and safety contribution: Recently sworn in as a first-aider, he has also joined the health and safety team, further strengthening SALT's commitment to maintain a safe and supportive working environment.
- Telescope operations support: In addition to his software-related work, he has been actively involved in the overall maintenance and operation of the telescope, contributing to ensuring its smooth and efficient performance.

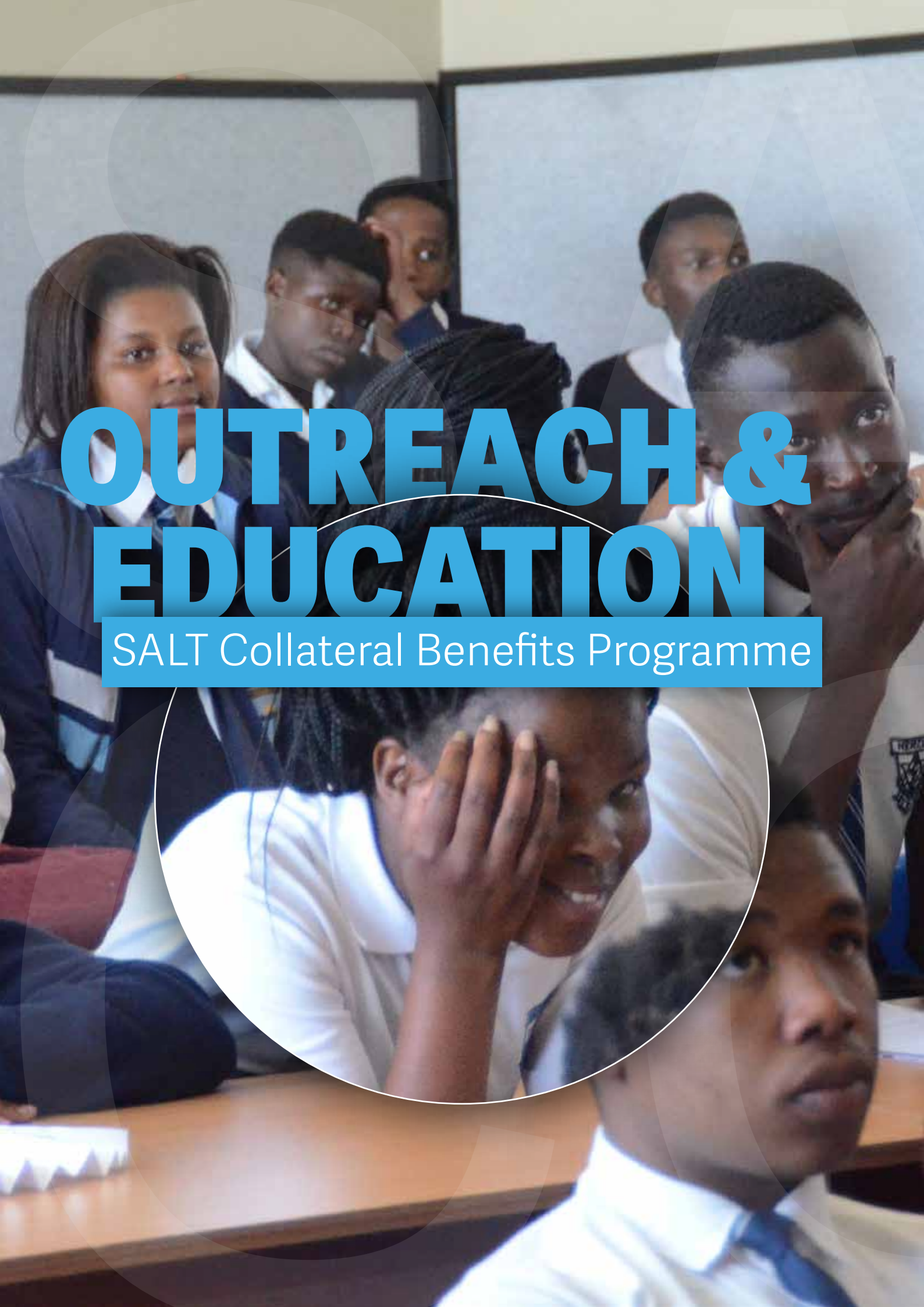
Chrey Sookha is a professionally registered Mechatronics Engineer (Pr Eng), specialising in the integration of mechanical, electronic, and software systems. With over a decade of engineering experience, he now proudly serves as the new head of the SALT software engineering team. His professional journey has been defined by an unwavering passion for leveraging advanced technologies to drive innovation and improve operational efficiencies. Prior to joining SALT, he held senior roles at Transnet Engineering, where he led multidisciplinary teams in the development of cutting-edge digital platforms, cloud solutions, and embedded systems, including pivotal contributions to Transnet's locomotive and port engineering projects. His academic credentials include a Bachelor of Science in "Engineering Mechatronics" from the University of Cape Town and an Master of Engineering in "Engineering Management" from the University of Pretoria, where his research focused on the adoption of robotic process automation within industrial contexts. Throughout his career, Chrey has also pursued specialised training in systems engineering, artificial intelligence, data science, and cloud computing, equipping himself to bridge the gap between complex engineering systems and innovative software solutions.

At SALT, Chrey's focus is on advancing software engineering initiatives that support South Africa's leadership in astronomical research. As Head of the SALT Software Engineering division, he will oversee strategic planning, team management, and the development of robust software systems that power one of the most advanced optical telescopes in the world. He is committed to fostering collaboration, driving technological excellence, and ensuring that SALT's systems remain at the forefront of scientific discovery. His journey reflects a dedication to both engineering innovation and the transformative potential of science and technology in South Africa.



OUTREACH & EDUCATION





OUTREACH & EDUCATION

SALT Collateral Benefits Programme

The SALT Collateral Benefits Programme (SCBP) was established during the construction of SALT, with the objectives of this programme being clearly directed at the benefits derived by society from building this large telescope. Its focus points are education in mathematics, science, engineering and technology; science communication and awareness; socio-economic development, and public engagement. Today, the SCBP activities are run by the SAAO science engagement personnel.

2024 has been a prosperous and successful year for the SCBP, as the team, with the support of SAAO staff, continued to implement science education, science communication, science awareness programmes and Sutherland community development and support initiatives. The SCBP is committed to communicating the beauty, relevance and power of astronomy. Through our efforts in 2024, a total of 34 598 people participated in various programmes including teacher development workshops, learner empowerment programmes, public engagement, open nights, exhibitions, tours and community development programmes. This included 8 902 learners, 985 teachers and 24 711 members of the general public. In addition, more than 80 000 people attended the Rand Easter show in which the SAAO and SALT exhibited, though this number is not auditable.

2024 saw the first IAU General Assembly held on African soil. This provided new opportunities for public engagement and the promotion and popularisation of astronomy, our own research infrastructure (SALT including other telescopes) and science in general. More than 50 000 participants (learners, teachers and members of the public) benefited from the IAU GA linked activities (also not auditable).

Teacher training, support and development

The SCBP is committed to teacher support, development and training. This is achieved through workshops, teacher based competitions, support for teacher participation in conferences, teaching and learning materials development and team teaching. The SCBP continues to collaborate with various science centres, national and provincial departments of education, science centres and education based non-governmental and non-profit organisations. The SCBP education team is led by education officer Ms Buzani Khumalo and Head of SCBP, Mr Sivuyile Manxoyi. Various interventions have been implemented in 2024, involving 985 teachers from six provinces: the Western Cape, Free State, Mpumalanga, Eastern Cape, KwaZulu Natal and Limpopo.

In collaboration with the Limpopo Provincial Education Department (PED), Buzani and Sivuyile facilitated a one-day teacher development and support workshop on 24 April for 34 Grade 8 – 9 teachers at Tidima Sekgosese West High school in Batlokwa. The workshop focused on providing the relevant astronomy content, introducing creative pedagogical approaches and sharing interactive and engaging hands-on resources. This was the first ever "Earth and Beyond" workshop for these rural based educators. There is a need to provide continuous support to educators based in areas far from cities and in particular to encourage them to make use of the dark skies in their areas as a resource for teaching astronomy related content.

Working with the Eastern Cape PED, the science education teams at SAASTA, SARAO and SAAO facilitated a 4-day teacher development and support workshop in July for 61 curriculum advisers and senior Grade 8 – 9 teachers in Queenstown. The workshop focused on providing the relevant astronomy content, introducing creative pedagogical approaches and sharing interactive and engaging hands-on resources. Since the audience comprised curriculum advisers and lead/senior teachers, the workshop was facilitated as a train-a-trainer approach/cascading model. The workshop was well received, and the audience felt that the SCBP should also join them in their roll-out workshops in various zones.

The third workshop, in collaboration with SAASTA and implemented for 41 Grade 7 educators, was held at the Maths, Science and Technology academy in Emalahleni in the Mpumalanga province on 25 July. The teachers were drawn from various towns and were accommodated at the academy. Based on the "Earth and Beyond" theme, it focused on the Grade 7 curriculum content, addressed misconceptions and introduced the teachers to various hands-on practical activities, sky based observation exercises and simulations using planetarium based software such as Celestia and Stellarium.

In collaboration with IAU Office of Astronomy for Education (OAE) and NASE, a workshop based on using practical activities to teach astronomy was implemented at SAAO on 16 August, reaching 19 teachers. The workshop was facilitated by Dr Mirjana Povic and focused on how to use home based materials to observe and explain various astronomical phenomena.

The SCBP unit, working with the Primary Science Project (PSP), hosted and facilitated on 27 August a one day workshop based on the phases of the moon and seasons for 18 primary school teachers. Dr Amanda Sickafoose, a former SAAO astronomer, presented and facilitated aspects of the workshop. The PSP has identified the SAAO as a key partner in its teacher development programmes and seeks to involve the SAAO in all its teacher based activities on an annual basis.

Another series of teacher workshops was implemented jointly with SAASTA and the Free State PED in September in the towns of Sasolburg, Kroonstad, Welkom and Virginia. The workshop, based on the "Earth and Beyond" theme, was primarily organised for the Grade 6 and Grade 7 teachers and focused on seasons, tides, the solar system, galaxies and telescopes. Resources from SAASTA, SARAO, and SAAO were shared with the educators. They were also exposed to

various websites, which can be used for teaching purposes, and various astronomy software packages, such as the World Wide Telescope (WWT) and Celestia. A total of 198 teachers participated.

In collaboration with the Western Cape PED and SAASTA, the SAAO science education team facilitated three teacher development and support workshops for Grades 4 – 5, 6 – 7, and 8 – 9 on three consecutive days in October. They were held virtually using a set-up developed by the Cape Town Science Centre, focusing on providing the relevant astronomy content, introducing creative pedagogical approaches and sharing interactive and engaging hands-on resources. A total of 371 intermediate phase teachers and 188 senior phase teachers attended the workshops, which were well received. The audience felt that the NRF, in the form of SAAO, SARAO and SAASTA, should also join them in their roll-out workshops in various circuits and zones.

Funded by the IAU OAE and in collaboration with the KZN PED, a set of three full-day workshops were implemented for 15 Grade 4 – 7 educators at the Beeches Primary school in Durban on 14 – 16 October. The workshops focused on teaching about phases of the moon and the tides. This was done through the use of models, demonstrations and hands-on activities.

Following the successful collaboration in September, a virtual workshop was organised by the Free State PED on 7 November, with 25 teachers participating. This workshop addressed various misconceptions and curriculum content that the teachers were struggling to understand.

Learner activities

The SCBP learner based programmes include curriculum aligned activities such as lab based workshops, co-curricular activities such as the astronomy quiz and astronomy debates, and extra curriculum programmes such as career info based activities, robotics, holiday and girls-focused programmes. In 2024, 8 902 learners were reached this way. Some of the activities are presented below.

A special visit by the Generation School Imhoff, consisting of 78 Grade 1 – 3 learners, visited SAAO on four days in February. Their activities, led by SCPB education officer Mr Cedric Jacobs, included a site tour, the solar system presentation and a binocular building workshop.

St Kizito (an organisation which caters for vulnerable children and feeds, clothes and assists them in their school work) collaborated with SAAO in delivering a highly interactive programme for 54 children on 13 April at SAAO. The programme sought to use astronomy to inspire the young children and to excite and stimulate their interest in science using astronomy. The programme included a planetarium show, site tour, presentations and hands-on activities.

In support of iThemba Labs science club initiative, an astronomy based programme was held at SAAO for 10 teachers and 50 Grade 7 learners from 10 schools (that is, 5 learners per school) on 12 June. The programme comprised a planetarium show, tour of the site, hands-on workshops and a presentation on basic astronomy and astronomy related careers. The group intended to visit Sutherland later in the year and encouraged the learners to apply for the SAAO job shadow programme.

The Women's Communication Network, a women-based non-profit-organisation which strives to keep youth away from the streets, brought 28 learners for a holiday programme at SAAO on 18 June. The learners were exposed to the inspirational aspects of astronomy through presentations, hands-on activities and planetarium shows.

SAAO hosted the Tomorrow Trust's group of 30 Grade 11 learners for a holiday programme on 19 June. Tomorrow Trust is a non-governmental organisation based in Gugulethu. The trust supports high school learners from historically disadvantaged communities and seeks to expose them to STEM based careers. The group spent the day at SAAO with presentations and a tour of the site including the workshops, and enjoyed a number of hands-on activities. The Tomorrow Trust brought their first group last year, and due to the success of the visit they decided to include SAAO permanently in their programme.

This year's astronomy and space debate involved learners from the Thandokhulu High in Cape Town and Broadway High school from Kabwe, Zambia, and was held virtually over Zoom. Dr Amanda Sickafoose and Dr Peter Snow (SANSA) acted as judges/adjudicators. The topic of the debate was "Is colonisation of Mars a great idea?". The aim of the debate is to teach the learners research skills and to improve their critical thinking, reasoning skills and, most importantly, the ability to weigh evidence and to present persuasive and valid arguments. Each school was represented by a team of four learners. Thandokhulu also invited 15 learners to be part of the audience. Some members of the public, including parents, joined in on Zoom. The arguments and facts presented by

both sides reflected the level of effort and commitment the learners had put in preparing for this debate. This was the first international debate as previous ones only involved Cape Town schools. The plan is to build this into an Africa-wide project.

Two special group visits were paid by Living Diakonia in Sutherland and Adventure Youth Club in Cape Town. The Living Diakonia group consisted of 10 learners and visited Sutherland on 2 November. The group toured the site, which included various telescopes. They were given presentations and hands-on activities including building telescopes, ending with a stargazing event in the evening, thus getting the full experience of astronomy at Sutherland. The Adventure Youth Club, consisting of 18 learners from various grades, visited the Cape Town site on 9 November. They were given a tour of the site, including the new visitor centre and the McClean Telescope, offered presentations, and they completed a number of hands-on activities.

The Rising Star tutoring project

A Grade 12 physical science tutoring project named "The Rising Star", in collaboration with the nearby Thandokhulu High school located in Mowbray, was initiated in 2023 and continued this year. This is an after-school tutoring project aimed at improving the physical science performance at the school by providing extra classes, creating opportunities for learners to complete some exercises based on the curriculum content, and by creating opportunities for learners to raise questions for clarity on their studies. The tutoring sessions are held on a weekly basis on alternative Wednesdays and Thursdays. Tutors are drawn from SAAO staff, postgraduate students and UCT science students. Thanks to Ms Justine Crook, who is now pursuing her doctoral studies in astrophysics, for this brilliant initiative and meticulous organisation. The programme has again delivered 100% percent passes in physical science. The National Youth Service volunteers, who joined the SAAO in 2025, will assist with the implementation of the programme going forward.

Career-based activities

The career based programmes serve to disseminate information on various science and technology based careers, introduce the learners to role models, and generally inform and inspire learners about the relevance and significance of science-based studies on development and society.

The job shadow programme

The year 2024 was an extremely successful year to the SAAO Job Shadow programme, as an unprecedented number of inquiries and applications were received. The popularity of the programme has grown over the years, with learners from various provinces attending, including Gauteng, Eastern Cape and North West Province, as well as in-province participants from towns and cities outside Cape Town. SAAO's Job Shadow programme is unique among the NRF facilities by being all-inclusive, that is, reaching across various departments including the OAD. The programme creates an opportunity and platform for learners to learn about and explore the various SAAO careers in astronomy, engineering, information technology, software development. The learners also receive information on tertiary studies and about scholarships and bursaries.

The two highly successful 2-day sessions were held during the July and September school holidays. While 14 learners participated in the July session, 13 learners came in September. The feedback from both the facilitators and the participants was positive and indicated that the programme was well received.

The SCBP is immensely grateful to the Job Shadow team, drawn from various SAAO departments, and to the Job Shadow programme manager Natalie Jones, for their commitment and dedication in continuously delivering programmes exceeding the expectation and needs of the participating learners. The SAAO Job Shadow programme continues to be a beacon of enlightenment and hope for diverse groups of learners from different schools, areas and backgrounds, all searching for their possible future career paths. From the feedback received (though not all the learners responded), over 40 learners are pursuing degrees in science, with 18 of them studying astrophysics.

Career based exhibitions

The SCBP, jointly with other NRF facilities, exhibited at the World of Work exhibition, which was held at the Feather Market Hall in Gqeberha (previously known as Port Elizabeth) from 20 – 22 February. The exhibition sought to inform learners, teachers and members of the general public about various careers and work opportunities available in various industries across South Africa. A total of 12 963 people, including 9 424 Grade 10 – 12 learners and 182 teachers, passed through and interacted with the part of the exhibition shared by all NRF facilities. The exhibition presented a more holistic view and the multi-wavelength concept of the astronomy facilities (including SALT, MeerLicht and MeerKAT) and was a great success. The shared NRF exhibition won the first prize for being well curated, coordinated and informative.

SCBP member Mr Cedric Jacobs participated in the Theewaterskloof Municipality Career's Day held on 12 April in Villiersdorp, a small rural town in the Overberg district of the Western Cape. A total of 532 Grade 9 – 12 learners and parents learned about science careers, bursary opportunities and university studies. Learners in this area are usually not exposed to education and training events, and this was a first for this small town. The event was a great success and information on SAAO and other stakeholders was well received and found valuable.

The SCBP education unit also participated at the Harry Gwala District Career exhibition held in May. The programme was organised by the Harry Gwala Education District and was aimed at inspiring and informing high school learners (Grade 9 – 12) about STEM careers. To ensure effective participation and reach, the exhibition was held in each of the towns of the district (Kokstad, Umzimkhulu, Little Flower, Ixopo, Pholela). A total of 2 472 learners were provided with info on STEM careers, career based books and brochures and were encouraged to apply early for universities and bursaries.

As part of the NRF's 25th anniversary celebrations and a contribution to South Africa's National Youth Day (16 June), SAAO and all other NRF facilities jointly held a career exhibition in Soweto on 13 June. The aim of the programme was to inform and expose the youth to various science and technological careers and to excite the youth about science and technology. A total of 223 high school learners participated in the programme, which included a career exhibition, presentations, science shows and science-based demonstrations.

The SCBP team participated in the Mangaung STEAM (Science, Technology, Engineering, Art and Mathematics) Expo held in September. The expo aimed to expose learners to different STEAM based careers, to disseminate info on the various studies and scholarships and to create opportunities for learners to interact with various science- and technology-based role models. The SAAO exhibition included SALT and the SAAO telescopes and promoted astronomy as a career. The SAAO iPad-based exhibit was very popular and attracted many participants. A total of 990 learners participated in the exhibition.

The SCBP team in Sutherland, in collaboration with partners from the provincial Department of Economic Development and Tourism, the National Empowerment Fund, and the University of Johannesburg, facilitated a Sutherland Career Guidance programme at the Sutherland High School on 17 September. A total of 64 learners were provided with information on a wide range of academic as well as entrepreneurial opportunities. The success of the programme has led to plans to host similar events in the nearby towns of the Northern Cape.

On National Heritage Day (24 September), 20 Roggeveld Primary school learners, together with their parents, visited the SAAO 1.9-m telescope and SALT to see what astronomers do when they are observing. The programme was a response to a small sample study done by Thembela Mantungwa, which found that while there is a lot of science engagement done in Sutherland, there are some knowledge gaps, and among those is an understanding of what astronomers do when they are observing at night, and how one gets to see those gorgeous images. SALT astronomers Dr Rudi Kuhn and Dr Danièl Groenewald explained that the main difference between a normal camera and a scientific one is that the latter only measures intensities (greyscale) not colours, and astronomers obtain proper colour images by using filters that only allow certain colours to pass through (something similar to differently tinted sunglasses) and combining the thus obtained images (*e.g.* in red, green, and blue). The young visitors had now the rare opportunity to see a supernova observation on the screen. They asked many other questions about astronomy, space travel, the possibility of asteroids hitting Earth, extraterrestrial life, etc. At the 1.9-m telescope, Mr Francois van Wyk showed the fascinated learners the control room and how to set up the telescope. Many of the parents remembered the construction of SALT, and some reminisced about growing up on the site of an observatory. It was a well-celebrated Heritage Day and an NRF 25th anniversary event.

Girl-focused programmes

The SAAO celebrated the International Day of Girls and Women in Science on 29 February. While women make up a small percentage of the STEM-based workforce, the percentage of deaf and autistic people is even worse. Inspired by the need to promote inclusivity, SAAO's celebration of the International Day of Girls and Women in Science focused on the deaf and autistic schools. The programme was implemented by the SCBP education officer Ms Buzani Khumalo and Mr Lusani Vanghani of CPUT at the Noluthando School for the Deaf. The programme focused on food science, exploring the chemistry of various food products and the effect of additives. A school teacher, Ms Madikane, acted as a sign interpreter. The programme was well received and the 20 learners and six teachers participated actively.

Ms Buzani Khumalo, working jointly with Dr Gcina Mhlophe, led the Spirit of Light celebration of International Women's Day (8 March) at the Durban Jewish Hall in Durban. The aim of the event was to inspire girls to pursue science and technology careers. The theme of the 2024 International Women Day campaign was to "Inspire Inclusion". Women from different science fields and non-governmental organisations shared the stage to inspire and encourage girls and women and to communicate the value of inclusion in driving social justice and meaningful change. Buzani spoke on astronomy and space related careers and shared brochures and other resources with the audience and particularly the learners. The programme also included choral music, poetry and dance by learners from Edendale High school, led by Gcina. The event was a great success.

A special visit of 24 girls from the Rhenish Girls High School to Sutherland took place on 9 March. The day-and-night programme consisted of engagement with an engineer (Mr Eben Wiid of SALT) on the design, technology and function of a telescope, followed by an in-depth tour of the Sutherland site including SALT. It ended in the evening with the exploration of celestial objects and the night sky using telescopes. The programme was led by the Sutherland public outreach officer, Mr Jeremy Stuurman, and was well received by the learners and teachers.

Public engagement and awareness

The science engagement unit worked collaboratively with Theatre Arts to host a captivating performance titled "Eat the Stars" on 22 – 26 February. The unique collaboration between theatre and astronomy brought together an audience eager to explore the mysteries of the Universe as displayed through performance in a novel and immersive way. The aim of the performance was to inspire an appreciation of the dark skies and stars, explore how art can be used to inspire curiosity in astronomy, and to deliver an engrossing artistic performance that combines art, music and dance, compelling the audience to appreciate dark skies and stars. A total of 160 people attended the performances. In addition, the participants were offered opportunities to view the stars through Dobsonian telescopes and through the iconic and historical McClean telescope at SAAO. The reception of "Eat the Stars" was overwhelmingly positive, with audience members lauding the production for its creativity, depth, and ability to evoke a sense of wonder and awe. Hosting Theatre Arts at SAAO proved to be a resounding success, highlighting the potential for synergy between seemingly disparate disciplines.

SAAO and SARAO joined an AfAS initiated "Astronomy in the Park" event that was held on 6 – 7 March at the Emmarentia Botanical Gardens in Randburg, Johannesburg, The event was aimed at celebrating astronomy as a fundamental science and fostering a deeper appreciation of astronomy through exhibitions, artistic expressions and hands-on activities. The SAAO team, led by Ms Duduzile Khubeka, held an astronomy exhibition and provided hands-on activities. This was well received by the audience that consisted of 360 primary school learners and their 22 educators, as well as 422 high school learners and their 12 educators. The host expressed an intention to organise the programme again next year.

A successful and prolific stargazing event called "Silver Seas Camp: Under the African Skies", hosted at a private game reserve, Sadawa, was conducted in partnership with the company South African Experiences Trading (Pty) Ltd. on 27 March. The tour guide and the outreach officer from SCBP Sutherland delivered a memorable event for 165 American tourists, fulfilling the science engagement goals of sharing the relevance of astronomy, profiling the achievements of South African astronomy and its research infrastructure but also popularising Sutherland as tourist destination and generating income for the SAAO and its science engagement programme in particular. The success of this event lays a basis for exploration of future collaboration with the private sector.

A new set of arts and culture inspired open nights have been introduced as part of the "Africa Look Up to the Arts" (ALUTTA) campaign. It formed part of the build up to the IAU GA in August. The aim of these nights was to explore and use different art forms to communicate astronomy. The first of these nights was held on 20 April and involved a presentation on cultural astronomy, storytelling and performance by a dancing and musical group called Ithemba Youth Choir. The next ALUTTA open night featured an art exhibition that displayed sketches by the Urban Sketchers of Cape Town group and involved the audience in sketching the current state of the Observatory. The event also included opera singers, storytellers and poets exploring the beauty and relevance of astronomy to Africa and the world. A total of 130 people participated in the ALUTTA nights. This is part of the growing Observatory efforts to use arts to communicate astronomy.

The SAAO science engagement team, jointly with other NRF business units, exhibited at the NRF Symposium for Young Researchers held at the Birchwood Hotel in Boksburg in October. The symposium was aimed at creating a platform for postgraduate students to interact and connect with young and emerging researchers. A total of 250 post graduates, researchers and members of the public participated in the symposium and interacted with the exhibitions.

Science communication

Ms Thembela Mantungwa has updated and renewed the look of the SAAO "Astronomy as a career" brochure. This brochure is used in conjunction with the SAAO Career Brochure which features different careers linked to SAAO, produced by Mrs Natalie Jones.

Mr Sivuyile Manxoyi led and coordinated the production of two new documentaries. The first one called "Beyond the Stars" features the then SAAO Acting Director, Dr Ros Skelton, SALT Director Dr Encani Romero and members of the Sutherland community. The documentary explores and highlights how SALT has had a huge impact on Sutherland and how it contributes to socio-economic development and educational upliftment.

The second documentary celebrates both modern and indigenous astronomy through highlighting the discovery of the planet WASP 62b and how it got to be named Krotoa (a historical Khoi princess) through a national competition. It includes a series of interviews involving Prof. Lerothodi Leeuw from UWC and Mr Jeremy Stuurman of SCBP Sutherland, among many others.

Three science capacity building programmes were implemented in 2024.

The first programme involved the Sutherland-based public outreach officer offering training to the SARAO-based Astro Guides in Carnarvon. The 2-day training session was aimed at enhancing a guide's knowledge and skills in astronomy and preparing them to offer enriched stargazing experiences to the visitors. The first evening of training focussed on the setting up and alignment of Dobsonian Telescopes. The guides eagerly participated, learning the intricacies of telescope handling to ensure precise and effective stargazing. Such practical experience is invaluable in boosting their confidence in using the equipment and in identifying the objects in the sky. The second day was dedicated to the theoretical aspects of astronomy, tailored specifically for guides. This session covered essential astronomical concepts and observational techniques. In the evening, theory was put into practice with the observation of a range of deep sky objects. The guides were particularly fascinated by the Omega Centauri globular cluster, the Sombrero galaxy, and the Jewel Box open cluster, marvelling at the beauty and complexity of these celestial wonders. The feedback from the participants was overwhelmingly positive. They found the training highly informative and expressed a strong interest in a follow-up session. This was set up at the Sutherland site and included interaction with the various exhibits at the SAAO visitor centre, hands-on experience at the visitor telescopes and interaction with the visitors.

The second programme was held on 3 June and was based on astronomy for mental health. It focussed on how to use astronomy within education and outreach programmes for the mental health of various target audiences including learners, teachers and general members of the public. The participants identified moments and ideas that could be used to address mental health using astronomy related content and concepts. Resources including booklets and images from the IAU OAD were also shared with all the participants.

The third science capacity development programme was facilitated by Ms Buzani Khumalo, Mr Sivuyile Manxoyi and Mr Simphiwe Madlanga from SARAO at the Albertina Sisulu Science centre in Cofimvaba. The aim was to provide guidance, training and support to science communicators based at the centre and focused on astronomy exhibitions, astro-based education programmes, use of the planetarium, indigenous astronomy and how to host and relate to visitors at the science centre.

Festivals and expos

In collaboration with SAASTA, SAAO exhibited at the Rand Easter Show in Johannesburg on 28 March – 1 April. The exhibition sought to communicate the NRF brand, its excellence and impact. SAAO focussed on sharing information on astrophysics (both research and infrastructure) and on the socio-economic impact through astro-tourism. In total, 80 000 people participated in the exhibition.

Mr Sivuyile Manxoyi and Ms Buzani Khumalo represented SCBP at the Eiding International Science Festival held in Polokwane on 22 – 26 April. The festival is an annual event aimed at promoting careers in science and technology and raising awareness, understanding and appreciation of science, technology, engineering, mathematics and innovation. The programme included presentations, exhibitions, science shows and career related small group discussions. A total of 847 Grade 7 – 9 learners from the Capricorn district participated in the activities. The science-based organisations presenting at the festival included CSIR, SANSA, NECSA, SANBI, SA Weather Services, WRC, SAPS Forensic unit, Limpopo Science Centre and the universities.

An SAAO-based PhD in astrophysics candidate, Hannes Breytenbach, presented workshops and public stargazing at the Rocklands Highline Festival held on the 29 March, where 33 members of the public participated in the activities.

The National Science Week was celebrated this year from 3 – 10 October, while its launch was held on 28 September at the Central University of Technology in Bloemfontein. SAAO joined the other NRF facilities, universities and science councils at the launch, which was attended by ~250 members of the public. During the week, SAAO conducted school based outreach in the Northern Cape, where 1 695 learners were given presentations on SALT, SAAO and astronomy in general. They were also offered opportunities to engage in hands-on activities based on astronomy. In Cape Town, SAAO offered free tours to members of the general public and conducted public stargazing sessions at the VA Waterfront on 4 – 5 October with about 200 attendees. The chosen dates for the National Science Week coincided with the celebration of the IAU 100 Hours of Astronomy and also the World Space Week.

National conferences

SAAO through SCBP hosted a highly successful SAASTEC conference from 25 – 28 November. This provided an opportunity to share resources and experiences from the IAU General Assembly and to celebrate the 25th anniversary of the NRF with the science and technological centres of Southern Africa. Other activities included assisting science centres on how astronomy can be accommodated and implemented in the programmes and to promote and highlight the contributions of SALT and SAAO to public engagement and the societal impact of astronomy. A total of 180 delegates participated in the conference, including international delegates from Angola, Mauritius and the United States. The Head of SCBP, Mr Sivuyile Manxoyi, was elected as deputy chairman of the SAASTEC Board.

The annual national Science Forum of South Africa was held from 3 – 6 December in Pretoria. The programme included an event on the impact of astronomy on society. The Director of the IAU OAD, Mr Kevin Govender, shared how the OAD uses astronomy for a better world, while the Head of SCBP, Mr Sivuyile Manxoyi, shared the beautiful story of how SALT has transformed Sutherland from a purely agricultural town into one of the prime astro destinations in the continent and how this translated into socio-economic development for the town. He further outlined all the various interventions, including how SALT contributes, through the employment of Mr Thabo Banda, in the teaching of science and mathematics in Sutherland, the role of the community development centre, and the Sutherland donation programme. Finally, he outlined how the success of SCBP has inspired the development of the national astro-tourism strategy.

University students engagement programmes

The Observatory has built a healthy relationship with UCT and other universities, like Venda, Sol Plaatjie, Cape Peninsula University of Technology, University of Western Cape and Stellenbosch University. Journalism, science and science education students have in the past visited the Sutherland and Cape Town sites for various purposes linked to their studies, research and for career related reasons.

The NASSP Honours group, comprising 26 students, visited SAAO on 16 February where they were offered a comprehensive tour that allowed them to gain insights into various facets of astronomical research and technology. The programme included a brief overview of the observatory by Acting Director Dr Rosalind Skelton, an engaging presentation followed by a lively Q&A session with SALT Astronomer Dr Moses Mogotsi, and an exploration of the intricacies of astronomical instrumentation and electronics via a hands-on experience led by engineers Ms Kathryn Rosie and Mr Kgomotso Makolomakwe.The students' experience was further enriched through an informative history tour led by Dr Christian Hettlage and Mr Shamin Doman.

The NASSP MSc group, consisting of 16 students, visited the Sutherland site from 30 May – 1 June. They visited various telescopes, including SALT, and learned about the respective observational techniques from the instrumentation lecturers at SAAO.

A group of 55 UCT Astro 1000 students visited SAAO in October and were addressed by various astronomers. They also participated in a tour of the site and had an opportunity to do stargazing. The purpose of the visit was to inspire the students, expose them to the site and also develop relations with various astronomers and SAAO employees.

Open nights

The Cape Town observatory continues to host open nights on every second and fourth Saturday of each month. These include a public lecture by an astronomer, PhD student or technician. The lectures are followed by a site tour and stargazing through small telescopes. The open nights serve to bridge the gap between science and the general public, to demystify the scientists and as a platform for direct engagement, dialogue and discussion between scientists and the general public.

A total of 2019 people participated in 23 open nights in 2024. Many speakers were SAAO based, with the most notable being the director of SAAO, Petri Väisänen, and the most prolific speaker being Dr Christian Hettlage, a SALT software developer. The topics ranged from the latest in astronomy research, to astronomical methods and instrumentation, to recent developments at the SAAO and the future vision of South African astronomy, to how students reason in astronomy.

Nine extra open nights were implemented during all the days while the IAU General Assembly was in session (6 – 15 August). The speakers were both drawn from local and international astronomers and included, among others, SALT Observatory Scientist Lisa Crause, Ewine van Dishoeck (previous IAU president and professor of astrophysics from Leiden University), Mark Clampin (NASA Astrophysics Director), and Joseph Lazio (Chief Scientist, Jet Propulsion Laboratory).

Sutherland activities

Jeremy Stuurman represented SAAO in acknowledgement of the donation made to the Griquas Women's Regional Tournament held on 20 April. As the outreach officer in Sutherland, Jeremy used the opportunity to highlight the importance of community support in regional sports. Jeremy commended the teams for their outstanding performances and the organisers for hosting a well-coordinated and spirited tournament.

In May, SAAO received acknowledgement and thanks for their sponsorship of the Sutherland High School's netball team's transport for a tournament in Williston.

During the first week in June, the SCBP team in Sutherland facilitated a supply chain roadshow where partners were invited to expose the Sutherland community to additional resources. This roadshow helped the SAAO and its partners to attract new suppliers/service providers, provide information and support to existing suppliers/service providers, improve supply chain and procurement transparency, identify entrepreneurial qualities, enhance Small Business Skills and bring service delivery closer to the Sutherland community. And the roadshow unlocked so much more. For example, as the Department of Economic Development and Tourism was part of the roadshow, a young man, who had previously applied for funding to the SAAO to launch his graphic design business, now has access to contacts who may assist him with operational costs and support to establish his business. The proprietor of a crèche in Sutherland was informed that she needs to formally register her business to tap into funding available to her to equip her crèche. Last but not least, following a visit to the High School in Sutherland, a career day was provisionally scheduled for later in the year.

Winter in Sutherland was heavy this year. July started with experiencing three days of snow, which disrupted operations as the site was forced to close for safety reasons. Three days later, visitors could only access the Visitor Centre in Sutherland as the access to SALT on the plateau was still too dangerous due to the underlying ice, which resulted in slippery conditions. During the second week of July, inclement weather resulted in a power outage in Sutherland. The SCBP team shopped for ingredients following consultation with three organisations in Sutherland to make warm food available to the Sutherland community. The team also assisted one of these organisations with the distribution of soup to the community.

On 7 August 7, Jeremy Stuurman visited the Sutherland Library to conduct an engaging telescope-building workshop. The event attracted 27 enthusiastic children, all members of the library's reading club. He explained the basic principles of how telescopes work, emphasising the importance of these instruments in exploring and understanding the Universe. The hands-on session saw the children eagerly assembling their own telescopes from kits provided by SALT. Under Jeremy's expert guidance, they learned to identify different parts of the telescope and how to align the lenses to achieve a clear view of distant objects. The workshop not only provided a practical learning experience but also encouraged teamwork and problem-solving among the participants.

In August, a collaborative effort between SAAO and the Sutherland Community Policing Forum resulted in efforts to feed the community of Sutherland in honour of Mandela Day. This event had been postponed due to the inclement weather experienced. SAAO contributed the chicken, while the community was challenged to bring their own ingredients for their secret potjie recipes as a contribution to these efforts.

SAAO supported the local Pigeon Racing Club by contributing money towards the required bird feed for their champions in August. The club members were happy to talk about their excitement and their experiences of the sport, expressing their eagerness to attract more of the youth to join their community. They wished for larger support of their sport as it would provide the youth with an alternative to the limited options currently available to them in Sutherland.

The SCBP team received a request to assist Sutherland High School with their Science Day on 16 September. This

entailed providing the Grade 9 learners with access to available telescopes on the plateau, along with engaging in a fun activity, which involved the learners building their own balloon cars. SAAO sponsored the transport of the learners to and from the school, lunch, and the required materials for their activity.

On 16 – 19 September, Sutherland's SCBP team hosted partners from the Department of Economic Development & Tourism, the National Empowerment Fund, the South African Institute of Chartered Accountants, the University of Johannesburg, the Department of Labour, the National Energy Regulator of South African, the National Credit Regulator, and the National Consumer Commission to help the community to gain access to these departments as well as to convey career options for the learners at Sutherland High School. The partners engaged more than 50 members of the community, which, once again, highlighted the socio-economic challenges the Sutherland community faces. The engagement with the High School was opened by Mr D. Christians, a senior manager at the Department of Economic Development & Tourism, who joined the event online from Kimberley and reached 64 learners. The partners ensured that the learners were provided with information on a wide range of academic as well as entrepreneurial opportunities available to them and which were aligned to the subjects offered at the school. As a result, the SCBP team has plans to collaborate on the next event to be hosted in other towns of the Northern Cape.

The Johenco Old Age Home requested assistance from SAAO in the form of transport. On 4 October, Koos April kindly transported the elderly to Blesfontein, which is situated approximately 30 km outside of Sutherland, where the elderly were treated to a meal and were able to enjoy the wild flowers on display throughout the journey.

The Sutherland Community Development Centre

On 14 March, the SCBP team in Sutherland invited the community to collect donations received at the Sutherland Community Development Centre. With tables laden with a wide array of clothing items, including coats, scarves, gloves, and hats, the team worked tirelessly to ensure that everyone in attendance found garments to meet their needs. "We are thrilled to see the impact of our collective efforts as we distribute these donated clothes to our neighbours", said Claudine Stuurman, employee of the SAAO and a resident of Sutherland. "This event embodies the spirit of community and compassion that defines Sutherland." Residents, many of whom arrived early, expressed their gratitude for the opportunity to access much-needed clothing items free of charge. For some, the distribution event meant relief from the burden of having to choose between purchasing warm clothing and meeting other essential needs. These donated clothes make a significant difference for a family, especially as winter lies ahead.

On Heritage Day, 24 September, all donations that were received up to that date were distributed to the Sutherland community with the assistance of the Sutherland Community Policing Forum members, who also used the chicken donated by the SAAO to feed the community with curry, as well as the required braai for the day.

With donations received from both the SAAO staff as well as the International French School of Cape Town, with the assistance of Mr Kevin Govender of the OAD, the SCBP team in Sutherland was able to invite the Sutherland community to the Community Centre on 5 December to receive the donations. Apart from clothing, the donations also included early Christmas presents for children in the form of donated toys. Other donations included stationery, which was distributed among the three schools, sports kits distributed to sports clubs and food given to the Johenco Old Age Home in Sutherland.

Tours in Sutherland

Sutherland Observatory was visited by 6 460 people in 2024, ranging between 226 and 774 for a day tour and 64 and 130 for a night tour. The tours serve to inform the public of SAAO infrastructure and research, inspire the public about the beauty of dark skies and excite them about the Universe through stargazing. While the tours are also a source of income generation for the facility, they contribute to the empowerment of the community and the Sutherland town through tourism.

Word of Gratitude and acknowledgement

2024 has been an awesome and great year for science engagement and socio-economic development. We are grateful to the SALT Board and the SAAO Director and management for all the support given to SCBP. Sivuyile Manxoyi is grateful to all SCBP staff in Cape Town and Sutherland for their commitment to all our science education, science communication, science awareness and socio economic development programmes. While we welcome Mr Julio in the Sutherland team, we have had to bid our goodbye (sadly) to Mr Cedric Jacobs, who has retired after 40 years of service to the Observatory. Thank you Cedric for all your tireless contributions.

SCBP highlight: Activities at the IAU-GA

IAU General Assembly – a great opportunity to communicate and engage with the public

For the very first time in the history of the International Astronomical Union (IAU), its triannual General Assembly (GA) was held on the African continent, taking place in Cape Town from 6 – 15 August. The SCBP team seized the opportunity for communities to engage and interact with the attending national and international astronomers and science engagement specialists. The programme included a daily outreach programme to primary and high schools, a teacher workshop, a Women Day's programme that involved IAU GA participants as role models and speakers, nine Open Nights, tours for the participants to SAAO in Cape Town and to Sutherland, and the exhibition at the Cape Town International Convention Centre (CTICC), which was visited on two days by high school learners.

The education initiative was implemented and coordinated by BRICS Astronomy Project Coordinator Duduzile Kubheka and saw Cedric Jacobs driving GA delegates to various schools in the Western Cape. There was a different set of delegates each day, and both teachers and learners from all of the schools were very excited to interact with them, especially with the delegates from NASA. The delegates mostly gave presentations, with one or two of them presenting hands-on activities.

Four delegates from the Iowa State University, USA, University of Antananarivo, Madagascar, and members of the Latin American Oswaldo Cruz Foundation (Fiocruz) and theSouth African Adaptation Network, visited two schools on 7 August, namely Summerdale and Aloe High schools.They interacted with the learners, gave presentations and launched vinegar and bicarbonate based rockets. A total of 212 learners from Summerdale and 43 learners from Aloe High participated in the event. On 8 August, a team consisting of an astronomer from the Vera Rubin Observatory, and two Guatemalans, one from the IAU OAE National Astronomy Education Coordinator team and one from the American School of Guatemala, interacted with 315 learners from Newfields Primary School. On 12 August, a group consisting of delegates from University College in Dublin, INAF in Italy, the University of California in the USA, NASA Headquarters and the NASA Marshall Space Flight Center, as well as two locals from SARAO and UCT, visited St John's Primary and interacted with 291 learners. The same group interacted with 66 learners from Rahmaniyeh Primary school on 13 August. Two delegates from NASA and one from the University of Namibia presented to 124 learners from Hazendal Primary on 15 August. The Mobile Planetarium team from Namibia brought their own inflatable planetarium, which was a source of joy and excitement for the learners.

In addition to the Cape Town school visits, a team of four IAU delegates from the University of California, USA, NASA Headquarters, the Shanghai Astronomical Observatory and the University of Nairobi in Kenya travelled with the SCBP team to Vredenburg and Saldanha on the west coast. They gave inspirational career talks and also motivated learners to pursue science and technology related careers.

Nine special Open Nights were held, one on each of the days of the GA. Speakers included Dr Lisa Crause (SAAO and SALT), Prof. Ewine van Dishoeck (Leiden Observatory and former President of the IAU), Prof. Natalia Lewandowska (State University of New York), Dr Mark Clampin (NASA Astrophysics Director), Senkhosi Simelane (MSc Candidate, Wits University, SA), Dr Joseph Lazio (Chief Scientist, NASA Jet Propulsion Laboratory, USA), Melissa Solares (American School of Guatemala), Dr Christina Thone (Astronomical Institute of the Czech Academy of Sciences) and Ms Anna Lena Schiable (postgraduate student, Heidelberg University, Germany).

A total of 163 guests visited the Cape Town site for tours during the GA, and 75 delegates visited Sutherland. A group of astronomers were also given a tour of the Sutherland plateau and SALT by Dr Lisa Crause.

South Afican's Women's Day on 9 August was a rainy and cold Friday. This was expected to reduce attendance, but it turned out to be a big surprise and a scramble to find extra seats at the SAAO Auditorium. Teachers and Grade 11 learners from Summerdale High School, Belgravia Secondary, Isilimela High School, Masibambisane, Zisukhanyo, Mondale and Groote Schuur High School came out in large numbers to attend the annual "Girls in STEM: Workforce of the Future" event, reaching 82 girls. The celebration of National Women's Day aims to inspire young female learners by using role models as a tool to pursue careers in Science, Technology, Engineering and Mathematical (STEM). Programme Director Dr Lusani Vhangani kicked off the event with energy, instantly engaging the audience. The audience was privileged to hear inspiring and informative talks from five international astronomers attending the IAU GA. These included Dr Lieke Van Son (Princeton, USA), Dr Cyrielle Opitom (University of Edinburgh, UK), Ms Ola Ali (NRIAG, Egypt), Dr Federica Spoto (Harvard & Smithsonian, USA), and Dr Julia Blue Bird (NRAO, USA). A key highlight of their presentations, which resonated very much with the audience, was the fact that all of them never imagined a career in Astronomy or in a scientific field.

A full day workshop was held at the SAAO in Cape Town, which was attended by 19 high school teachers. The main facilitator and presenter was Prof. Mirjana Povic from Serbia, now based in Ethiopia. The workshop covered both theoretical and practical aspects of astronomy. The teachers received resources as well as a sponsored Galileoscope from the IAU OAD.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OUTREACH & EDUCATION

SALT Partner Outreach Programmes

SALT scholarships and visits programme

The Stobie-SALT Scholarship initiative was launched in 2003 and ran until 2013 as part of the SCBP, aimed at training the next generation of astronomers. South African students had the opportunity to pursue doctoral studies at SALT consortium institutions through this scholarship. The program successfully trained ten students, most of whom now hold leadership positions in astronomy around the world. Additionally, the initiative strengthened the connections between SALT partners and South African astronomers.

To further support the training of emerging researchers in South Africa, the NRF has provided funding to restart an extended programme in 2021 that not only enables postgraduate students, but also postdoctoral fellows and early-career researchers, to spend time at SALT partner institutions. This programme aims to maintain and strengthen collaborations within the SALT partnership, allowing these institutions to work with exceptional young researchers. It also offers emerging researchers the opportunity to gain international exposure and begin building professional networks early in their careers.

In the latest call for proposals, announced at the end of 2024, researchers at SALT partner institutions were invited to submit potential projects to host South African researchers. The submitted projects are then advertised to the South African community, encouraging applicants to reach out to potential hosts to discuss project details and collaborate on their applications.

At the moment it is planned to have at least one call every year around March, depending on how much funding is available. Visits are usually scheduled to take place between June and December.

For more information about the scholarship and calls for application, please visit: https://www.salt.ac.za/jobs/scholarships-and-visits/. Any inquiries can be sent to: scholarshipsandvisits@salt.ac.za.

Narges Hatamkhani, postdoc at UCT (top), and Xola Ndaliso, PhD student at the University of Witwatersrand (bottom), visited Rutgers University in 2024 for a few weeks to work with Jack Hughes, one of the SALT Board members.

OUTREACH & EDUCATION

Visiting SALT

Delegations and official visits

In 2024, the following parties visited SALT.

11 – 12 November:
SALT Board members

Prof. Brian Chaboyer, SALT Board member (DC) and chair
Prof. Jack Hughes, SALT Board member (RU)
Prof. Kris Helminiak, SALT Board member (POL)
Dr Lisa Crause, SALT Observator Scientist
Mrs Lizette Labuschagne, SALT CFO and Business Manager

As part of the yearly SALT Board meeting in November, some of the Board members opted to squeeze in an overnight visit to the telescope. Members of the Tech Ops team joined the group for a wonderful braai at a local restaurant in Sutherland and then the visitors popped in at SALT to catch the observers (Moses and Nomzamo) taking full advantage of a beautiful Karoo night.

Board members visiting Boorgat, which features a vast collection of crazy old stuff.

From left to right: Kris, Brian, Lizette and Jack.

Media visits to SALT

October 2024 — Extreme Telescopes

James Dawson, a SARAO-based postdoc, along with his trusty camera man Jared Hoole, documented the nearly 400 kilometre journey from Cape Town to SALT in October. The film forms part of an outreach series entitled "Extreme Telescopes". The series focuses on narrowing the connection gap between major hubs of the general public and the technological marvels that we have become accustomed to in major televised outreach films and documentaries. Think Top Gear meets Brian Cox!

To soak up a better feel for the beauty of the adventure, from the Mediterranean-like Cape Town to the scorching Karoo desert, the two made the journey by motorbike. Their travels took them over mountains and through the Great Karoo desert, finally ending at SALT with a brief tour, narrating to the audience just what makes SALT an extreme telescope. The film is set to debut in early 2025.

SALT exhibitions at science meetings

7 – 11 January:
AAS Annual Meeting, New Orleans, USA

SALT had a prominent exhibition booth at the American Astronomical Society (AAS) Annual Meeting in New Orleans. The participation highlighted SALT's commitment to fostering international collaboration and enhancing the role of Africa in the global astronomy community.

The week began with a presentation to the AAS Strategic Assembly on Sunday, setting the stage for SALT's involvement. The following day, Session 123 focused on "Exploring New Frontiers: Strengthening Africa-US Collaborations in the Golden Age of Astronomy in Africa Towards IAU-GA2024 and Beyond", underscoring the importance of partnerships between Africa and the USA in advancing astronomical research. The same day, Session 144 discussed "Astronomy for a Better World", emphasising the societal impacts of astronomical sciences. Tuesday featured a brief presentation by Dr Khotso Mokhele (special advisor to the South African minister of Science and Technology) during the morning plenary session, further emphasizing SALT's contributions to global astronomy. The day concluded with the "Black in Astro" networking dinner, promoting diversity and inclusion within the astronomical community. Wednesday offered an engaging

"In conversation with Khotso" session at the exhibition theatre space, providing insights into the achievements and future aspirations of SALT.

Overall, SALT's involvement at the AAS Annual Meeting showcased its pivotal role in advancing astronomical research and education, fostering international collaborations, and promoting diversity and inclusion within the field.

15 – 20 April: AfAS 2024: Engagement and Impact, Marrakech, Morocco

SALT had a strong presence at the 4th annual conference of the African Astronomical Society (AfAS), held in April at the Oukaïmeden Observatory and Cadi Ayyad University in Marrakech, Morocco. This landmark event, the first AfAS annual conference held outside South Africa since its 2019 relaunch, provided a crucial platform for collaboration, knowledge exchange, and professional development within the African astronomy community.

SALT representatives actively contributed to discussions on the future of African astronomy, particularly in the context of observational facilities and collaborative research. SALT featured in a panel discussion on the next generation of telescopes in Africa, where participants explored strategies for integrating new facilities with existing infrastructure to maximise scientific output and training opportunities for African astronomers.

Dr. David Buckley, Lead Investigator and South African Co-PI, provided an update on the status of the African Integrated Observation Systems (AIOS). His presentation highlighted SALT's contributions to transient and time-domain astronomy, its role within the SAAO Intelligent Observatory project, and ongoing efforts to expand observational capabilities across the continent. Discussions also covered SALT's involvement in international collaborations, such as the BRICS flagship programme, and its efforts to develop young scientists and engineers through research training initiatives.

As part of its commitment to fostering research excellence, SALT hosted a dedicated proposal writing workshop aimed at equipping African astronomers — particularly early-career researchers and students — with the skills necessary to develop competitive proposals for SALT observations. The session provided practical guidance on structuring proposals, articulating scientific justifications, and optimising observational strategies. Participants also gained insights into the review process and criteria used for proposal selection.

SALT's participation at AfAS 2024 reinforced its commitment to advancing astronomy in Africa through research partnerships, capacity building, and knowledge sharing. The discussions and engagements at the conference underscored the importance of strengthening networks across the continent, leveraging existing infrastructure, and ensuring that African astronomers have access to world-class observational facilities.

With AfAS 2025 set to take place at the University of South Africa (UNISA), SALT looks forward to continuing its engagement with the African astronomy community, supporting research excellence, and promoting access to observational resources for astronomers across the continent.

6 – 15 August: IAU General Assembly, Cape Town, South Africa

SALT played a prominent role in the 32nd General Assembly of the International Astronomical Union (IAU GA) held for the first time on African soil. The exhibition booth and related activities during the event emphasised SALT's contributions to public outreach, media presence, and engagement with local and international attendees.

SALT tours during the GA

SALT was a focal point during the exclusive tours held at the SAAO Visitors Centre in Cape Town. A total of 523 participants, including GA delegates and the public, visited the Visitors Centre, where the SALT exhibit was one of the key attractions. These tours showcased the advanced capabilities of SALT and its role in cutting-edge astronomical research, highlighting South Africa's leading position in astronomy and the telescope's impact on global projects.

In addition, the SAAO Sutherland site hosted 99 visitors during the GA, with special tours arranged, where SALT scientists and engineers provided in-depth insights into the telescope and its work.

SALT was also featured prominently in one of the public talks during the GA. SALT Observatory Scientist Dr Lisa Crause delivered an insightful presentation, focusing on the fascinating world of exoplanet science and sharing how SALT's HRS is positioned to make groundbreaking discoveries. This talk, part of a broader expert-led series, was well received, drawing an audience of international astronomers, students, and the general public.

Booth engagement

The SALT booth at the IAU GA was a significant hub of activity. The exhibition attracted over 3000 visitors, including students, learners, and international delegates, based on estimated footfall. SALT's booth was especially popular among young scientists and astronomers eager to learn about the telescope's contributions to both local and global science.

The booth featured an interactive SALT model and a team of SALT representatives who engaged visitors and answered questions about the telescope's functions, capabilities, and recent discoveries. Approximately 1000 learners from Cape Town and surrounding areas interacted with the exhibit during high school visits on 7 and 14 August.

Media coverage

SALT garnered significant media attention throughout the GA, featuring prominently in both broadcast and print coverage. It was also highlighted in the keynote address by the Minister of Science, Technology, and Innovation, Dr Blade Nzimande. Standout mentions included coverage on "IAU-GA" segments aired on SABC's Morning Live and Expresso on S3, where SALT's role in the assembly and its broader contribution to astronomical research was presented.

Conclusion

SALT's presence at the IAU GA was a notable success, contributing to international outreach, education, and public engagement. The exhibit and talks fostered meaningful interactions with thousands of delegates and the public, reinforcing SALT's position as a cornerstone of astronomical research in South Africa and globally. The extensive media coverage further amplified SALT's profile, ensuring that the telescope remains at the forefront of scientific and public discourse.

CORPORATE GOVERNANCE

The affairs of the SALT Foundation are regulated by the Shareholders' Agreement, signed at the formation of the Company. In terms of this agreement, the Company is controlled by a Board of Directors comprising two members from the National Research Foundation, one member from each of the remaining partner institutions and two additional members. The Directors are elected at the Annual General Meeting of the Company and serve for a period of three years, following which they may be re-elected. All Board members are independent, Non-Executive Directors.

In this reporting period, the Board comprised of the following members:

Prof. Brian Chaboyer (Chair)
Dartmouth College, USA

Prof. Matthew Bershady (Resigned October 2024)
University of Wisconsin–Madison, USA

Prof. Phil Charles (Resigned May 2024)
United Kingdom SALT Consortium, UK

Dr. Sharmila Goedhart
South African Radio Astronomy Observatory, South Africa

Prof. Krzysztof Hełminiak
Nicolaus Copernicus Astronomical Centre, Poland

Prof. John P. Hughes
Rutgers University, USA

Dr. Vanessa McBride (Resigned January 2024)
National Research Foundation, South Africa

Dr. Itumeleng Monageng
University of Cape Town, South Africa

Dr Fulufhelo Nelwamondo (Resigned July 2024)
National Research Foundation, South Africa

Dr. Angus Paterson (Appointed April 2024)
National Research Foundation, South Africa

Prof. Michael Shara
American Museum of Natural History, USA

Dr. Rosalind Skelton (Appointed November 2024)
South African Astronomy Observatory, South Africa
National Research Foundation, South Africa

Prof. Raghunathan Srianand
Inter–University Centre for Astronomy & Astrophysics, India

Dr. Sheona Urquhart (Appointed May 2024)
United Kingdom SALT Consortium, UK

Prof. Eric Wilcots (Appointed October 2024)
University of Wisconsin–Madison, USA

Other officers of the Company include
Mrs Lizette Labuschagne (Chief Financial Officer, Company Secretary and Business Manager).

The Board meets twice a year, usually in May and November.
The SAAO Director and senior staff involved in the operation of the telescope also attend the Board meetings.

Operations Contract

SALT is operated on behalf of the SALT Foundation by SAAO and managed by the SALT Director, Dr Encarni Romero Colmenero. The majority of the staff who carry out the day-to-day operational activities are SAAO employees. Engineering operations are managed by the Acting SALT Technical Operations Manager, Mr Willem van der Westhuizen, while Dr Danièl Groenewald is the Acting Head of the Astronomy Operations team. The operations plan and budget are presented by the SALT Director at the November Board meeting for the following financial year.

The Board Executive Committee (BEC)

The Board has delegated authority to the Board Executive Committee (BEC) to manage the Company during the period between Board meetings. The BEC meets once or twice between Board meetings and receives reports on the operations and development of the telescope from the SALT Director and other senior staff with the relevant responsibilities. The BEC comprises four Board members. In this reporting period, they were: Prof. Brian Chaboyer (Chair), Prof. Jack Hughes, Prof. Raghunathan Srianand and Dr Angus Paterson (Dr Fulufhelo Nelwamondo and Prof. Michael Shara part of the year).

The Finance and Audit Committee (FAC)

Although the full Board takes responsibility for the Annual Financial Statements of the Company, the Board has appointed a Finance and Audit Committee (FAC) to interrogate the management of the financial affairs of the Company at a detailed level. This committee meets at least twice a year, shortly before Board meetings, and presents a report at the Board meeting. In this reporting period, the members of the FAC were: Prof. Jack Hughes (Chair), Dr Rosalind Skelton, Prof. Eric Wilcots, Mrs Kate Soule and Prof. Brian Chaboyer (ex officio) (Prof. Jack Hughes, Prof. Gordon Bromage part of the year).

Scientific and Technical Committee (STC)

The Scientific and Technical Committee (STC) was established in November 2018, as per recommendations arising from the SALT External Review. The fundamental purpose of this committee is to improve all levels of technical and scientific communication within the SALT collaboration, with the explicit goal of increasing the scientific productivity of the telescope. The SALT Observatory Scientist is a member of the committee. The STC reports to the SALT Board via the chair of the committee. In this reporting period, the members are: Prof. Krzysztof Hełminiak (Chair), Dr Lisa Crause, Prof. Paul Groot, Mr John Booth, Prof. Joanna Mikołajewska, Dr David Buckley and Dr Encarni Romero Colmenero (Prof. Matt Bershady part of the year).

SALT Director 2024

Encarni Romero Colmenero*

SALT Observatory Scientists 2024

Lisa Crause

Technical Operations Team 2024

Paul Rabe* (Head until October 2024)
Willem van der Westhuizen* (Acting Head since October 2024)

Shamiel Adams
Richard Banda*
Janus Brink*
Bryne Chipembe*
Willa de Water
Timothy Fransman*
Denville Gibbons
Johan Hendricks
Nicolaas Jacobs
Anita Jonker
Sunnyboy Kabini
Anthony Koeslag
Deon Lategan*
Thabelo Makananise
Devakshan Naicker*
Tasheen Naicker
Sam Ndumo*
Jonathan Pieterse
Paul Rabe*
Melanie Saayman*
Michael Sam*
Malcolm Scarrott*
Etienne Simon
Chrey Sooka*
Nicolaas van der Merwe
Willem van der Westhuizen
Eben Wild

Astronomy Operations Team 2024

Encarni Romero Colmenero* (Head until July 2024)
Danièl Groenewald* (Acting Head since July 2024)

Danièl Groenewald*
Christian Hettlage
Thea Koen*
Alexei Kniazev
Enrico Kotze*
Rudi Kuhn
Austun Louw*
Nhlavutelo Macebele
Antoine Mahoro*
Chaka Mofokeng*
Moses Mogotsi
Nomzamo Mokoena*
SoloheryRandriamampandry*
Anja Schröder*
Rosalind Skelton*
Lee Townsend
Veronica van Wyk

Corporate Governance Team 2024

Lizette Labuschagne
Surayda Moosa*

* part-time and/or part of the year

LIST OF PUBLICATIONS

Refereed Publications*

Andrews, J. E., et al. 04/2024: "SN 2022jox: An Extraordinarily Ordinary Type II SN with Flash Spectroscopy", ApJ, 965, 85

Arcodia, R., et al. 04/2024: "The more the merrier: SRG/eROSITA discovers two further galaxies showing X-ray quasi-periodic eruptions", A&A, 684, A64

Aromal, P., et al. 02/2024: "Time variability of ultra-fast BAL outflows using SALT: C IV absorption depth based analysis", MNRAS, 527, 12298

Aydi, E., et al. 01/2024: "Revisiting the classics: on the evolutionary origin of the 'Fe II' and 'He/N' spectral classes of novae", MNRAS, 527, 9303

Bachelet, E., et al. 07/2024: "A Close Binary Lens Revealed by the Microlensing Event Gaia20bof", AJ, 168, 9

Barnard, J., et al. 08/2024: "The optical spectropolarimetric behaviour of a selection of high-energy blazars", MNRAS, 532, 1991

Cabrera, T., et al. 12/2024: "Searching for electromagnetic emission in an AGN from the gravitational wave binary black hole merger candidate S230922g", PhRvD, 110, 123029

Castro Segura, N., et al. 01/2024: "Shedding far-ultraviolet light on the donor star and evolutionary state of the neutron-star LMXB Swift J1858.6-0814", MNRAS, 527, 2508

Chernyakova, M., et al. 03/2024: "The radio to GeV picture of PSR B1259-63 during the 2021 periastron passage", MNRAS, 528, 5231

Coe, M. J., et al. 03/2024: "The 2022 super-Eddington outburst of the source SMC X-2", MNRAS, 528, 7115

Coti Zelati, F., et al. 10/2024: "Short-term variability of the transitional pulsar candidate CXOU J110926.4-650224 from X-rays to infrared", A&A, 690, A220

D'Ammando, F., et al. 03/2024: "Optical spectroscopy of blazars for the Cherenkov Telescope Array - III", A&A, 683, A222

da Silva, R., et al. 08/2024: "Ariel stellar characterisation. II. Chemical abundances of carbon, nitrogen, and oxygen for 181 planet-host FGK dwarf stars", A&A, 688, A193

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Dorsch, M., et al. 11/2024: "Discovery of three magnetic helium-rich hot subdwarfs with SALT", A&A, 691, A165

Doze, P., et al. 10/2024: "A Multiwavelength Approach to Constraining the Merger Properties of ACT-CL J0034.4+0225", ApJ, 974, 49

Driessen, L. N., et al. 01/2024: "FRB 20210405I: a nearby Fast Radio Burst localized to sub-arcsecond precision with MeerKAT", MNRAS, 527, 3659

Gallagher, J. S., et al. 09/2024: "An Imaging and Spectroscopic Exploration of the Dusty Compact Obscured Nucleus Galaxy Zw 049.057", ApJS, 274, 3

Gaudin, T. M., et al. 11/2024: "CXOU J005245.0-722844: discovery of a Be star/white dwarf binary system in the SMC via a very fast, super-Eddington X-ray outburst event", MNRAS, 534, 1937

Gaudin, T. M., et al. 04/2024: "Discovery of a Rare Eclipsing Be/X-Ray Binary System, Swift J010902.6-723710 = SXP 182", ApJL, 965, L10

Gerasimov, I. S., et al. 04/2024: "Stellar feedback impact on the ionized gas kinematics in the dwarf galaxy Sextans B", MNRAS, 529, 1138

Goldoni, P., et al. 11/2024: "Hidden by a star: The redshift and the offset broad line of the flat-spectrum radio quasar PKS 0903–57", A&A, 691, L5

Greenwell, C. L., et al. 08/2024: "The NuSTAR Serendipitous Survey: The 80 Month Catalog and Source Properties of the High-energy Emitting Active Galactic Nucleus and Quasar Population", ApJS, 273, 20

Guha, L. K., et al. 01/2024: "Host galaxies of ultra-strong Mg II absorbers at z 0.7", MNRAS, 527, 5075

Guha, L. K., & Srianand, R. 08/2024: "Strong nebular emissions associated with Mg II absorptions detected in the SDSS spectra of background quasars", MNRAS, 532, 3056

Gutiérrez, C. P., et al. 12/2024: "CSS 161010: A Luminous Fast Blue Optical Transient with Broad Blueshifted Hydrogen Lines", ApJ, 977, 162

Hatamkhani, N., et al. 09/2024: "The K _s-band Luminosity Function of the Rich Cluster VC04 in the Vela Supercluster", ApJ, 972, 57

Hema, B. P., & Pandey, G. 06/2024: "Measuring Hydrogen-to-Helium Ratio in Cool Stars", BSRSL, 93, 395

Iłkiewicz, K., et al. 09/2024: "Ancient Nova Shells of RX Pup Indicate Evolution of Mass Transfer Rate", ApJL, 972, L14

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Jacobson-Galán, W. V., et al. 08/2024: "Final Moments. II. Observational Properties and Physical Modeling of Circumstellar-material-interacting Type II Supernovae", ApJ, 970, 189

Jeffery, C. S., et al. 05/2024: "EC 19529-4430: SALT identifies the most carbon- and metal-poor extreme helium star", MNRAS, 530, 1666

Kamiński, T., et al. 02/2024: "A radical transition in the post-main-sequence system U Equulei", A&A, 682, A133

Katkov, I. Y., et al. 02/2024: "Probing the History of the Galaxy Assembly of the Counterrotating Disk Galaxy PGC 66551", ApJ, 962, 27

Kirkpatrick, J. D., et al. 04/2024: "The Initial Mass Function Based on the Full-sky 20 pc Census of ~3600 Stars and Brown Dwarfs", ApJS, 271, 55

Koen, C., & Kniazev, A. Y. 01/2024: "WISE J152614.95-111326.4, an unusual variable star", PASA, 41, e108

Kollatschny, W., & Chelouche, D. 10/2024: "Evidence for gravitational self-lensing of the central supermassive black hole binary in the Seyfert galaxy NGC 1566", A&A, 690, L2

Kovtyukh, V. V., et al. 04/2024: "Lithium Cepheid V708 Car with an unusual chemical composition", A&A, 684, A145

Kołaczek-Szymański, P. A., et al. 06/2024: "Exploring extreme brightness variations in blue supergiant MACHO 80.7443.1718: Evidence for companion-driven enhanced mass loss", A&A, 686, A199

Krishnan, S., et al. 11/2024: "An X-ray flaring event and a variable soft X-ray excess in the Seyfert LCRS B040659.9–385922 as detected with eROSITA", A&A, 691, A102

Loubser, S. I., et al. 01/2024: "The star formation histories of galaxies in different stages of pre-processing in the Fornax A group", MNRAS, 527, 7158

Malkov, O. Y., et al. 06/2024: "Modern Stellar Astronomy 2023", ARep, 68, 610

Malyali, A., et al. 06/2024: "Transient fading X-ray emission detected during the optical rise of a tidal disruption event", MNRAS, 531, 1256

Mao, Y.-Y., et al. 11/2024: "The SAGA Survey. III. A Census of 101 Satellite Systems around Milky Way–mass Galaxies", ApJ, 976, 117

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Moharana, A., et al. 10/2024: "Spectroscopy of eclipsing compact hierarchical triples: I. Low-mass double-lined and triple-lined systems", A&A, 690, A153

Monageng, I. M., et al. 01/2024: "4U 1210-64: a new member of the rare intermediate-mass X-ray binary subclass", MNRAS, 527, 5293

Mróz, P., et al. 12/2024: "Millinovae: A New Class of Transient Supersoft X-Ray Sources without a Classical Nova Eruption", ApJL, 977, L37

Oates, S. R., et al. 05/2024: "Swift/UVOT discovery of Swift J221951-484240: a UV luminous ambiguous nuclear transient", MNRAS, 530, 1688

Ochmann, M. W., et al. 06/2024: "The transient event in NGC 1566 from 2017 to 2019. I. An eccentric accretion disk and a turbulent, disk-dominated broad-line region unveiled by double-peaked Ca II and O I lines", A&A, 686, A17

Ok, S., et al. 06/2024: "Discovery of the magnetic cataclysmic variable XMM J152737.4-205305.9 with a deep eclipse-like feature", A&A, 686, A175

Orio, M., et al. 09/2024: "V407 Lup, an intermediate polar nova", MNRAS, 533, 1541

Painter, S., et al. 08/2024: "Spectro-photometric follow-up of the outbursting AM CVn system ASASSN-21br", MNRAS, 532, 4205

Pearson, J., et al. 01/2024: "Strong Carbon Features and a Red Early Color in the Underluminous Type Ia SN 2022xkq", ApJ, 960, 29

Podjed, S. A., et al. 06/2024: "Optical Spectropolarimetric Variability Properties in Blazars PKS 0637–75 and PKS 1510–089", ApJ, 968, 130

Potravnov, I., et al. 02/2024: "Doppler imaging of a southern ApSi star HD 152564", MNRAS, 527, 10376

Potter, S. B., et al. 07/2024: "Optical spectroscopic and photometric classification of the X-ray transient EP240309a (EP J115415.8-501810) as an intermediate polar", MNRAS, 532, L21

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Pustilnik, S. A., et al. 02/2024: "Dwarfs in nearby voids: results of SALT spectroscopy", MNRAS, 527, 11066

Rothermich, A., et al. 06/2024: "89 New Ultracool Dwarf Comoving Companions Identified with the Backyard Worlds: Planet 9 Citizen Science Project", AJ, 167, 253

Sacchi, A., et al. 02/2024: "A soft and transient ultraluminous X-ray source with six-hour modulation in the NGC 300 galaxy", A&A, 682, A151

Shah, P., et al. 07/2024: “The dark energy survey: detection of weak lensing magnification of supernovae and constraints on dark matter haloes”, MNRAS, 532, 932

Shara, M. M., et al. 03/2024: “Introducing the Condor Array Telescope - IV. A possible nova super-remnant surrounding the putative recurrent nova KT Eridani”, MNRAS, 529, 224

Sharina, M. E., et al. 03/2024: “Horizontal branch structure, age, and chemical composition for very metal-poor extragalactic globular clusters”, MNRAS, 528, 7165

Shi, F., et al. 11/2024: “Magnetic field of the roAp star KIC 10685175: Observations versus theory”, A&A, 691, A272

Shrestha, M., et al. 02/2024: “Evidence of Weak Circumstellar Medium Interaction in the Type II SN 2023axu”, ApJ, 961, 247

Shrestha, M., et al. 09/2024: “Extended Shock Breakout and Early Circumstellar Interaction in SN 2024ggi”, ApJL, 972, L15

Siebert, M. R., et al. 01/2024: “Ground-based and JWST Observations of SN 2022pul. I. Unusual Signatures of Carbon, Oxygen, and Circumstellar Interaction in a Peculiar Type Ia Supernova”, ApJ, 960, 88

Singh, K., et al. 06/2024: “Accretion Funnel Reconfiguration during an Outburst in a Young Stellar Object: EX Lupi”, ApJ, 968, 88

Sneppen, A., et al. 10/2024: “Emergence hour-by-hour of r-process features in the kilonova AT2017gfo”, A&A, 690, A398

Sneppen, A., et al. 12/2024: “Helium features are inconsistent with the spectral evolution of the kilonova AT2017gfo”, A&A, 692, A134

Stoop, M., et al. 01/2024: “The early evolution of young massive clusters. II. The kinematic history of NGC 6618/M 17”, A&A, 681, A21

Sun, L., et al. 12/2024: “Recurring tidal disruption events a decade apart in IRAS F01004-2237”, A&A, 692, A262

Swayne, M. I., et al. 03/2024: “The EBLM Project- XI. Mass, radius, and effective temperature measurements for 23 M-dwarf companions to solar-type stars observed with CHEOPS”, MNRAS, 528, 5703

Wang, Z.-Y., et al. 11/2024: “Massive stars exploding in a He-rich circumstellar medium: X. Flash spectral features in the Type Ibn SN 2019cj and observations of SN 2018jmt”, A&A, 691, A156

Wu, Z., et al. 08/2024: “Gaia22dkvLb: A Microlensing Planet Potentially Accessible to Radial-velocity Characterization”, AJ, 168, 62

Zajaček, M., et al. 03/2024: “UV FeII emission model of HE 0413−4031 and its relation to broad-line time delays”, A&A, 683, A140

Zhu, Y.-M., et al. 01/2024: “A two-component jet model for the optical plateau in the afterglow of GRB 191221B”, MNRAS, 527, 1638

Other SALT Publications**

Refereed Non-ISI publications

Kołaczek-Szymański, P. A., et al. 12/2024: "Solving the mystery of extreme light variability in the massive eccentric system MACHO 80.7443.1718", BSRSL, 93, 50

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Buckley, D. A. H., et al. 03/2024: "Identification of EP J115415.8-501810 as a Cataclysmic Variable with a 3.762 h orbital period", ATel, 16554, 1

Monageng, I. M., et al. 03/2024: "Optical spectroscopic follow up of the EP X-ray transient, EP240305a (EPW20240305aa), with the Southern African Large Telescope (SALT)", ATel, 16529, 1

Monageng, I. M., et al. 09/2024: "Optical spectroscopic follow-up of the EP X-ray transients, EP240809a and EP240709a, with the Southern African Large Telescope (SALT)", ATel, 16801, 1

Monageng, I. M., et al. 11/2024: "Unusual spectroscopic (SALT) and photometric (OGLE) behaviour observed in the potential optical counterparts of RX J0032.9-7238.", ATel, 16904, 1

Rea, N., et al. 04/2024: "EP240408a: SALT optical spectroscopy and NICER X-ray follow-up observations", ATel, 16589, 1

Conference abstracts and proceedings

Alabi, A., & Loubser, I. 08/2024: "Stars and Ionized gas in MHONGOOSE galaxy UGCA 320", IAUGA, 2517

Brink, J. D., & Lategan, D. R. 07/2024: "Status of the dual-beam spectrograph upgrade project for transient follow-up with SALT", SPIE, 13096, 130969N

Chattopadhyay, S., & Bershady, M. A. 07/2024: "Early commissioning results of slit mask integral field units on the Southern African Large Telescope", SPIE, 13096, 130962R

** not complete

Crause, L. A., et al. 07/2024: "Southern African Large Telescope (SALT) instrumentation update", SPIE, 13096, 1309607

de Villiers, M. 08/2024: "Probing for optical and HI diffuse gas in MHONGOOSE galaxy UGCA 250", IAUGA, 705

Distler, A., et al. 06/2024: "A Rigorous Age-Dating of the Ursa Major Moving Group", AAS, 244, 305.02

Eze, C., et al. 07/2024: "Characterizing the variability of a sample of massive pulsators in eclipsing binary systems observed with TESS", eas..conf, 156

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Gasymov, D., & Katkov, I. 05/2024: "Non-parametric stellar LOSVD analysis", ASPC, 535, 279

Groenewald, D., & Nordsieck, K. 08/2024: "Investigating the pupil dependence of the polarimetric sensitivity on SALT", IAUGA, 2422

Groenewald, D., & Nordsieck, K. 07/2024: "Investigating the pupil dependence of the polarimetric sensitivity on SALT", SPIE, 13096, 130962Q

Khangale, Z., et al. 08/2024: "Phase-resolved spectroscopy and circular spectropolarimetry of magnetic cataclysmic variables EF Eridani during the high state", IAUGA, 2592

Kharchilava, G., et al. 02/2024: "SALT-RSS Multi-Object Spectroscopic Data Reduction to Reveal Physical Properties of [O II]-Emitting Galaxies from HETDEX & ODIN", AAS, 243, 308.09

Kharchilava, G. V., et al. 05/2024: "SALT-RSS Multiobject Spectroscopic Data Reduction to Reveal Physical Properties of [O II]-emitting Galaxies from HETDEX and ODIN", RNAAS, 8, 125

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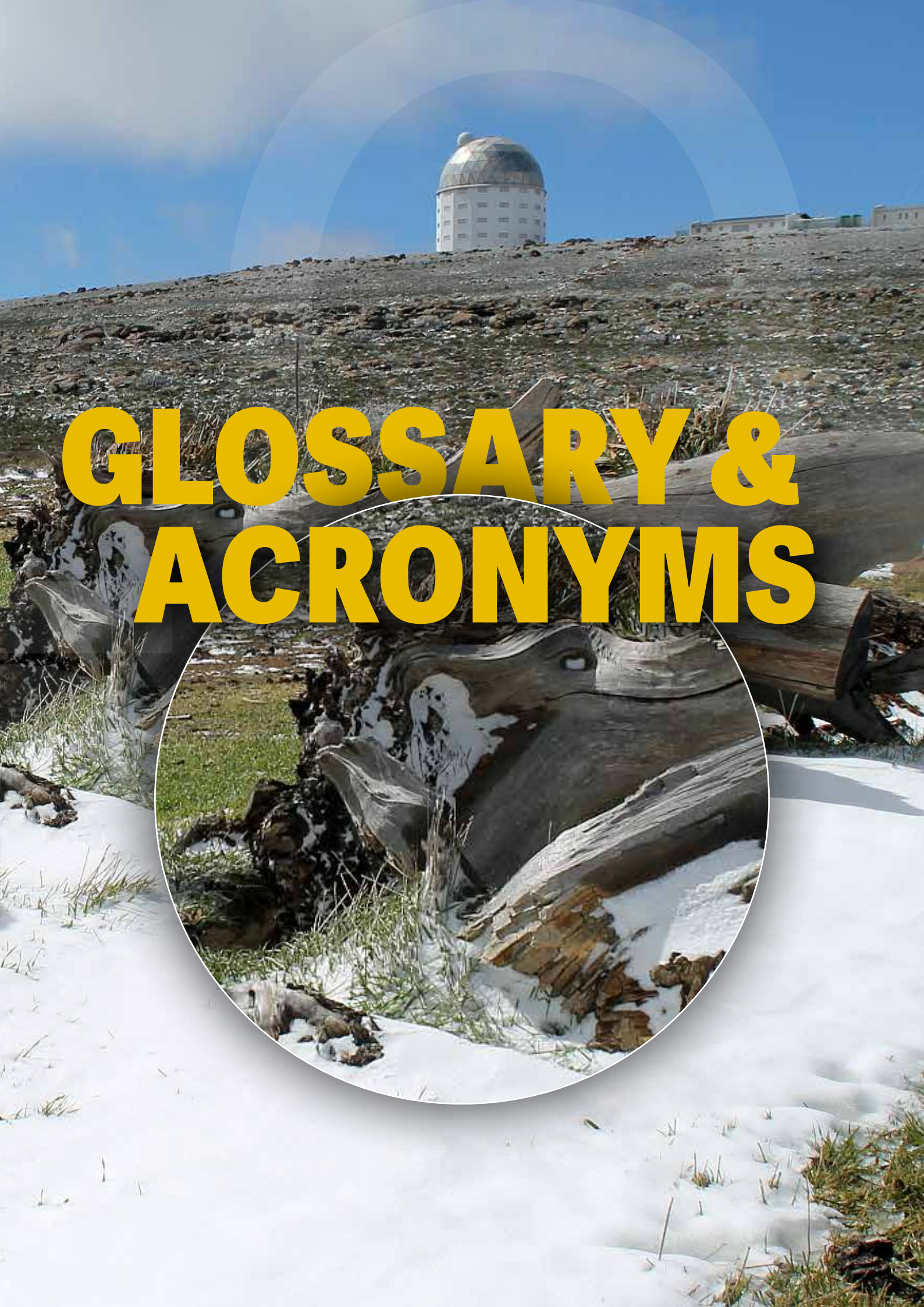

GLOSSARY & ACRONYMS

1D, 2D, 3D	one, two, three dimensional
4MOST	4-metre Multi-Object Spectroscopic Telescope
4U	4th Uhuru catalogue (object name prefix)
AAS	American Astronomical Society
ACT	Atacama Cosmology Telescope
AD	ageing diagram
AdvACT	Advanced Atacama Cosmology Telescope
AfAS	African Astronomical Society
AGB	asymptotic giant branch
AGN	active galactic nucleus
AIOS	African Integrated Observation Systems
ALMA	Atacama Large Millimeter/ submillimeter Array
ALUTTA	Africa Look Up to the Arts
AMNH	American Museum of Natural History
AMTL	Advanced Mechatronics Technology Laboratory
AMU	Adam Mickiewicz University
ANT	ambiguous nuclear transients
AOP	Armagh Observatory & Planetarium
API	application programming interface
ART-XC	Mikhail Pavlinsky Astronomical Roentgen Telescope X-ray Concentrator
ASASSN	All Sky Automated Survey for SuperNovae
AT	astronomical transient (object name prefix)
ATel	The Astronomer's Telegram
ATLAS	Asteroid Terrestrial-impact Last Alert System
BBH	binary black hole
BEARS	Bright Extragalactic ALMA Redshift Survey
BEC	board executive committee
BEng	Bachelor of Engineering
BLR	broad line region
BMS	building management system
BRITE	BRIght-star Target Explorer
BTA-6	Bolshoi Teleskop Altazimutalny 6-m
CAMK	Nicolaus Copernicus Astronomical Center
CCD	charge-coupled device
CFO	chief financial officer
CHT	compact hierarchical triple
COM	SALT commissioning proposal
CON	compact obscured nucleus
Co–PI	co–principal investigator
COVID-19	coronavirus disease 2019
CPUT	Cape Peninsula University of Technology
CSIR	Council for Scientific and Industrial Research
CTA	Cherenkov Telescope Array
CTICC	Cape Town International Convention Centre
CV	cataclysmic variable star
CXOU	Chandra X-ray observatory unregistered (object name prefix)
DC	Dartmouth College
DDT	director's discretionary time
EM	electro-magnetic
EP	Einstein Probe, X-ray satellite
eROSITA	extended ROentgen Survey with an Imaging Telescope Array
ESA	European Space Agency
ESO	European Southern Observatories
EW	equivalent width
FAC	finance and audit committee
FBOT	fast blue optical transient
FCC	Fornax cluster catalogue
FEA	finite element analysis
Fermi-LAT	Fermi Large Area Telescope collaboration
FIF	fibre instrument feed
FP	Fabry–Pérot
FSRQ	flat spectrum radio quasar
GA	general assembly of the IAU
GATS	Global Astrophysical Telescope System
GPP	guider pre-positioning
GRB	gamma-ray burst
GTC	Gran Telescopio Canarias
GU	Göttingen University
GW	gravitational wave (object name prefix)
GWE	SALT gravitational wave proposal
H2RG	HAWAII–2RG detector
HD	Henry Draper catalogue
Hen	Henize (object name prefix)
H.E.S.S.	High Energy Stereoscopic System
HET	Hobby–Eberly Telescope
HETDEX	HET Dark Energy eXperiment
HMXB	high-mass X-ray binary
HRS	high-resolution spectrograph
HS	high-stability
HST	Hubble Space Telescope
HWU	Heriot-Watt University
IAO	Institute Astronomical Observatory
IAU	International Astronomical Union
IFU	integral field unit
INAF	Italian National Institute for Astrophysics
ISDEC	IUCAA SIDECAR Drive Electronics Controller
ISI	international scientific indexing
ISO	International Organization for Standardization
IUCAA	Inter–University Centre for Astronomy & Astrophysics
JATIS	Journal of Astronomical Telescopes, Instruments, and Systems
KAT	Karoo Array Telescope
KZN	University of KwaZulu-Natal
LADUMA	Looking At the Distant Universe with the MeerKAT Array
LBT	Large Binocular Telescope
LCO	Las Campanas Observatory
LFC	laser frequency comb
LIGO	Laser Interferometer Gravitational wave Observatory
LMC	Large Magellanic Cloud
LMXB	low-mass X-ray binary
LOFAR	LOw Frequency ARray
LSP	SALT large science programme
LSSTC	Large Synoptic Survey Telescope Corporation
LV	local volume (~ < 10 Mpc)
LVK	LIGO-Virgo-KAGRA network
MACHO	MAssive Compact Halo Object
MASTER	Mobile Astronomical System of the TElescope–Robots network
MAXI	Monitor of All-sky X-ray Image
MDM	Michigan–Dartmouth–MIT Observatory
MEng	Master of Engineering
MHD	magneto-hydrodynamic
MIKE	Magellan Inamori Kyocera Echelle spectrograph
MLT	SALT multi-semester proposal

MOS	multi-object spectrograph
MSc	master of science
MSSL	Mullard Space Science Laboratory
MUSE	Multi Unit Spectroscopic Explorer
NASA	National Aeronautics and Space Administration
NASE	Network for Astronomy School Education
NASSP	National Astrophysics and Space Science Programme
NCAC	Nicolaus Copernicus Astronomical Center
NDT	non-destructive testing
NECSA	South African Nuclear Energy Corporation
NGC	New General Catalog
NIR	near-infrared
NIRWALS	Near InfraRed Washburn Astronomical Labs Spectrograph
NRAO	National Radio Astronomy Observatory
NRIAG	National Research Institute of Astronomy and Geophysics
NRF	National Research Foundation
NS	neutron star
NWU	North–West University
OAD	Office of Astronomy for Development
OAE	Office for Astronomy Education
OAP	Odessa Astronomical Publications
OCS	observation control system
OGLE	Optical Gravitational Lensing Experiment
OPTICON	Optical Infrared Coordination Network for Astronomy
ORP	OPTICON/Radio-Net Pilot project proposal
P0 … P4	priority 0 – 4
PAS	Polish Academy of Sciences
PED	Provincial Education Department
PhD	doctor philosophiae
PI	principal investigator
PIPT	Principal Investigator Proposal Tool
PLATO	PLAnetary Transits and Oscillations of stars
POL	SALT partner Poland
PrEng	Professional Engineer
PRV	precision radial velocity
PSP	Primary Science Project
Q&A	question and answer session
QMS	quality management system
RINGS	RSS Imaging spectroscopy Nearby Galaxies Survey
RSA	Republic of South Africa
RSS	Robert Stobie Spectrograph
RU	Rutgers University
RV	radial velocity
RX	ROSAT survey (object name prefix)
S3	SABC 3
SA	South Africa
SAAO	South African Astronomical Observatory
SAASTA	South African Agency for Science and Technology Advancement
SAASTEC	South African Association of Science and Technology Centres
SABC	South African Broadcasting Corporation
SALT	Southern African Large Telescope
SALTICAM	SALT Imaging CAMera
SAMMI	SALT Astronomer Man Machine Interface
SANBI	South African National Biodiversity Institute
SANSA	South African National Space Agency
SAO RAS	Special Astrophysical Observatory of the Russian Academy of Science
SAPS	South African Police Service
SARAO	South African Radio Astronomy Observatory
SCBP	SALT Collateral Benefits Programme
SCI	SALT science proposal
S–CUBED	Swift SMC Survey
SFR	star formation rate
SIDECAR	system image, digitising, enhancing, controlling, and retrieving
SKA	Square Kilometre Array
SMC	Small Magellanic Cloud
SMI	slit mask IFU
SN	supernova
SNR	signal-to-noise ratio
SOC	scientific organising committee
SPIE	Society of Photo–optical Instrumentation Engineers
SPOTS	SPectropolarimetric Observations of TeV Sources
sSFR	specific star formation rate
ssrAp	super slowly rotation Ap stars
SSS	X-ray super-soft source
STC	scientific and technical committee
STEAM	science/technology/engineering/art/mathematics
STEM	science/technology/engineering/mathematics
SUGAR	SALT User Group for Astronomical Resources
SySt	symbiotic system
TAC	time allocation committee
TESS	Transiting Exoplanet Survey Satellite
tMSP	transitional millisecond pulsar
TMT	Thirty Meter Telescope
TP-AGB	thermally pulsing AGB
U	university
UCLan	University of Central Lancashire
UCN	University of Canterbury
UCT	University of Cape Town
UFS	University of Free State
UKSC	United Kingdom SALT Consortium
UNC	University of North Carolina – Chapel Hill
UNISA	University of South Africa
UV	ultraviolet
UVOT	Swift's UltraViolet and Optical Telescope
UW	University of Wisconsin–Madison
UWC	University of the Western Cape
VLT	Very Large Telescope
WASP	Wide Angle Search for Planets
WD	white dwarf
WFC3	HST Wide Field Camera 3
WISE	Wide-field Infrared Survey Explorer
WRAY	Wray 1966 (object name prefix)
WRC	Water Research Commission
WWT	World Wide Telescope
XML	extensible markup language
XMP	extremely metal-poor
YSO	young stellar object
Zw	Zwicky (object name prefix)
ZTF	Zwicky Transient Facility

The SALT consortium is seeking an additional 10%-level partner (~$10.5M) to support significant second-generation instrumentation development. Interested parties should contact the chair of the SALT Board of Directors, Brian Chaboyer*.

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