SALT NEWSLETTER

ISSUE DECEMBER 2017

Southern African Large Telescope,
Sutherland, South Africa
Cover Image: Thea Koen

TOPICS

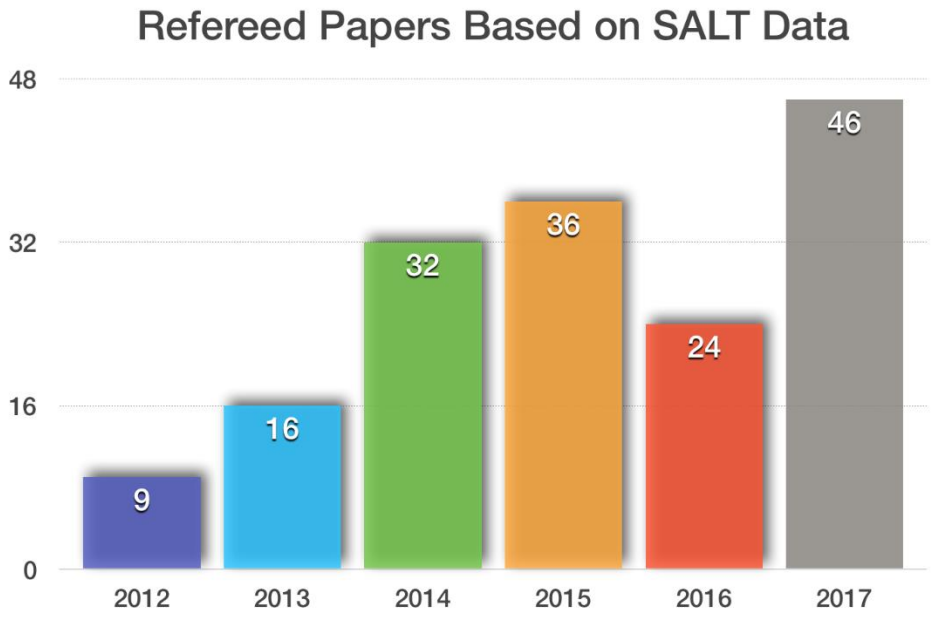
Above: PDET with Keith Browne & Ockert Strydom

Contributors to this issue: Petri Väisänen, Encarni Romero Colmenero, Steve Crawford, Retha Pretorius, Saurabh Jha, Christian Hettlage, Thea Koen (editor).

LETTER FROM HEAD OF ASTRO OPS

Dear SALT community –

In exciting SALT news, we are very proud to have been one of the very first observatories getting a spectrum of the ground-braking multi-messenger LIGO GW170817 gravitational wave event. Read this Newsletter for more details and a link to a SALT-specific PR release. The 2017 calendar year has been great for SALT science in general as well – we have clearly beaten previous annual SALT paper records with 46 published SALT articles so far, see the Figure below. Thank you to all of you who publish your data; that is the ultimate gauge of a successful observatory. An interesting, though expected, trend is the rising number of HRS papers now that the pipeline came online at the beginning of this year.



Drought continues in South Africa. This has meant that while farmers are suffering, shower time is limited, and SAAO has to think of back-up plans for sanitation, science time on telescopes has risen to new levels. The month of July saw better weather than any summer month. And the nights were long… huge thanks for the all the observers during the winter months. In fact, over the whole semester of 2017-1, which ended in October, SALT racked up 300 hours more science time than any other Semester before. Observing records were broken, and we often ended up doing P4 observations when all charged-time targets were cleaned up from the

queue. We want to remind the PIs that new targets *can* be submitted to replace any which have set. Not many PIs responded to our emails about a thinning queue in August and September.

Regrettably, RSS was offline for a period of about 3 weeks in September/October due to broken cabling in the cryostat. While the other instruments were online, high-priority late-semester RSS programs did take a hit. And we have also struggled recently with image quality issues, where the best Sutherland conditions at <1.3" seeing cannot be matched by SALT image quality on the detectors, like it has been the case otherwise after installation of the active mirror alignment system, SAMS in mid 2016. While this affects only programs requiring the best conditions, we are furiously investigating the source of the problem to eliminate it as soon as possible.

Importantly, we are happy to report that a months long SALT strategy discussion process has been completed. See more details in the "SALT Strategic Plan" below. The final report of the process is available at: https://cloudcape.saao.ac.za/index.php/s/smrQah6xqjL7xfu

On a personal note, this is my last posting as the Head of SALT Astronomy Operations. I'm very excited to be handing over the reigns of directing the observational strategy and efficiency of SALT to my long-time colleague Dr. Encarni Romero Colmenero. I'm sure most of you have received help and email support from her over the years; more about her below in this Newsletter. I will not disappear, however, as I will replace the SAAO Director Prof. Ted Williams who is retiring at the end of the year.

From my part and on behalf of SALT Ops, we wish to state our deep gratitude to Ted (see below) for his years of leadership at SALT and SAAO. Please see the "Farewell Ted" section in this Newsletter!

Petri Väisänen
Head of SALT Astronomy Operations

PS. Never hesitate to contact *salthelp@salt.ac.za* with any questions or feedback you have, and with lessons learnt from your SALT data analyses.

SALT CATCHES A GRAVITATIONAL WAVE

An otherwise seemingly normal Friday, 18 August 2017 quickly became an exciting day at SALT. An urgent phone call around midday from Mike Shara alerted the team about a possible electromagnetic counterpart to a gravitational wave detection. The TechOps team rushed to prepare the observatory for observations that night while Veronica van Wyk and Petri Väisänen, the SALT Operator and Astronomer on duty, waited for details about the target. As it turned out, they would only have a small window during early twilight to catch observations of the transient object in NGC 4993, some 130 million light-years away.

With support from Cape Town including Encarni Romero Colmenero, Steve Potter, Ted Williams, and Steve Crawford, they obtained a low resolution spectrum of the kilonova that resulted from GW 170817, a merger of two neutron stars. The spectrum, obtained barely a day after the initial detection, was heavily contaminated by twilight light and was blended with the host galaxy. However, after careful extraction, the spectrum revealed the still hot fireball that resulted from the explosion.

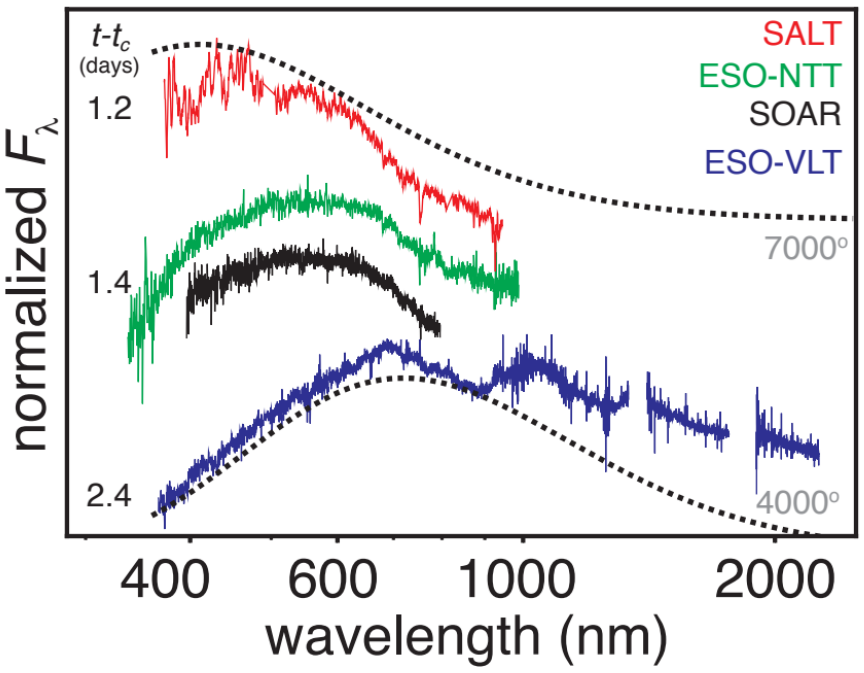


Figure 1. Spectra of the kilonova resulting from the merging of two neutron stars observed after the GW170817 event. SALT was the third facility to observe the event and was able to catch these observations in early twilight. Image from Abbot et al. (2017), the main paper describing the world-wide follow-up of the gravitational wave.

Spectra were attempted the following nights as well, before the object completely disappeared from the SALT visibility window after 20 August. Combined with observations from other observatories, they helped track how the kilonova rapidly cooled (see Curtis et al. 2017). SALT was the third facility to obtain a spectrum of the event and provided important coverage between observations made in Australia and Chile. The SALT spectrum was highlighted in the Multi-messenger paper (Abbott et al. 2017) that announced the beginning of a new era of astrophysics that combined electromagnetic and gravitational wave observations.

These observations, along with a number of other supporting observations made from Sutherland, are described by Buckley et al. (2017). This type of event really highlights the capability of the SALT and SAAO to play an important role in transient astrophysics. The hard work of the operations team at SALT enabled this type of observation to happen, and future potential developments to further enhance this capability are also described in this Newsletter.

When this event was announced to the world in October 2017, SAAO held a press conference to describe our part in this momentous discovery. In addition to the four papers listed below that the SALT spectra contributed to, a short film produced by Kai Staats was also released describing the events of that day.

Papers

- *Multi-messenger Observations of a Binary Neutron Star Merger,* Abbot et al., 2017, ApJl, 848, L12, http://adsabs.harvard.edu/abs/2017ApJ...848L..12A
- *The Rapid Reddening and Featureless Optical Spectra of the Optical Counterpart of GW170817, AT 2017gfo, during the First Four Days,* McCully et al., 2017, ApJl, 848, L32, http://adsabs.harvard.edu/abs/2017ApJ...848L..32M
- *Follow up of GW170817 and its electromagnetic counterpart by Australian-led observing programs*, Andreoni et al., 2017, PASP, Accepted, http://adsabs.harvard.edu/abs/2017arXiv171005846A
- *A comparison between SALT/SAAO observations and kilonova models for AT 2017gfo: the first electromagnetic counterpart of a gravitational wave transient - GW170817*, Buckley et al., 2017, MNRAS, Accepted, http://adsabs.harvard.edu/abs/2017arXiv171005855B

Press Release:

http://www.salt.ac.za/news/breaking-news-salt-gravitational-waves/

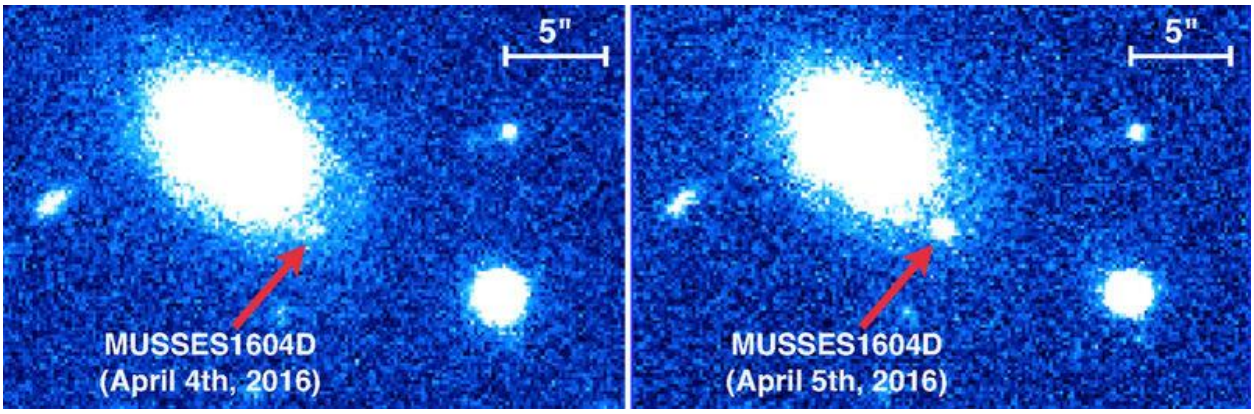
Video:

*A new era in astrophysics***,** Produced by Kai Staats, 2017,

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

SCIENCE HIGHLIGHT

SALT Observations of a Supernova Exploding from the Outside In

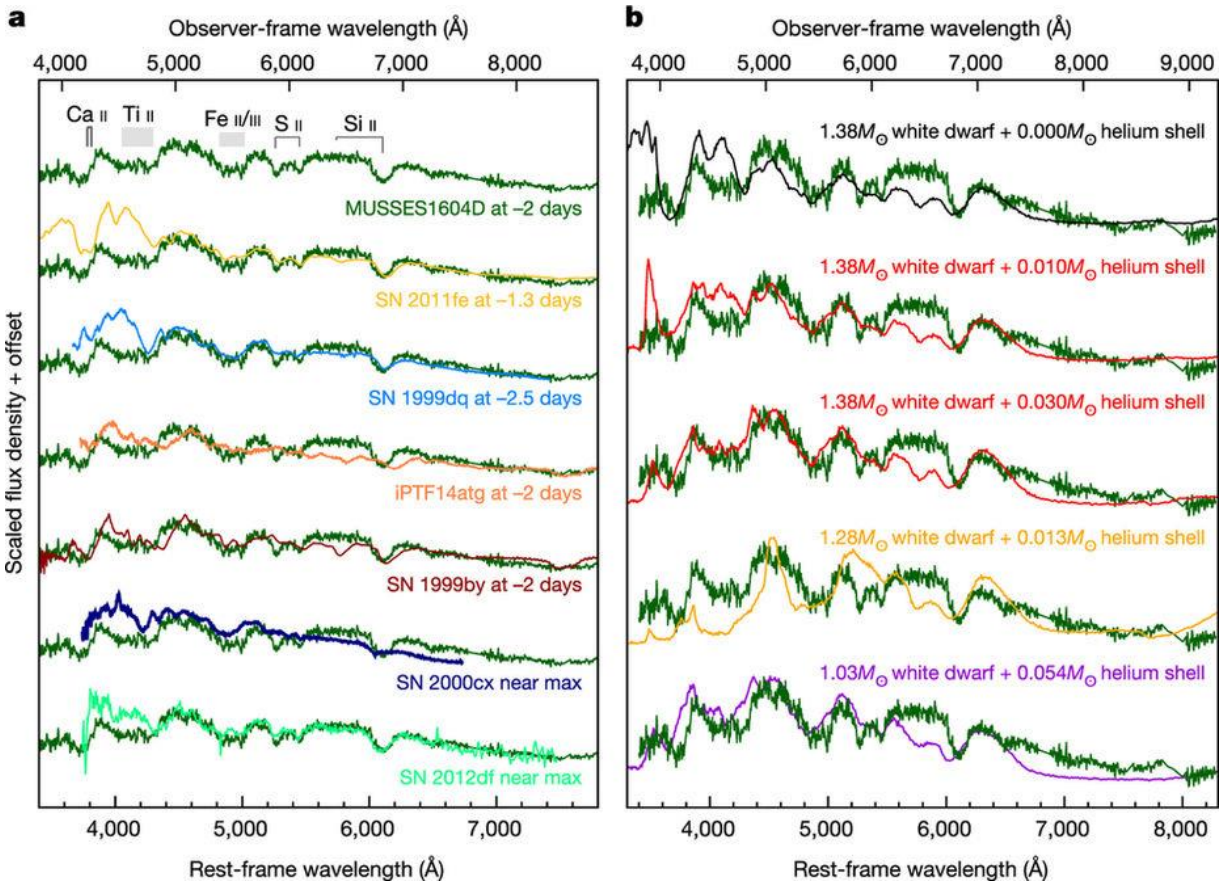


Type Ia supernovae (SN Ia) are thought to be the thermonuclear explosions of white dwarfs that accrete material from a binary companion star. Though the exact nature of the progenitor system and the physics of the subsequent explosion are not completely understood, SN Ia are nonetheless used as cosmological distance indicators, and were responsible for the discovery that the expansion of the Universe is accelerating, driven by dark energy.

Recently, a team led by University of Tokyo graduate student Ji-an Jiang began a program to find SN Ia soon after explosion, enabling early-time observations that can provide clues to the nature of SN Ia explosions. In the MUSSES project, Jiang and colleagues imaged a large swath of sky nightly with the Subaru telescope (with HyperSuprime-Cam) to find young SN Ia. In April 2016, they discovered MUSSES-1604D, likely within 12 hours of its explosion (see figure).

The early light curve showed some peculiar behaviour, making this object a prime target for spectroscopic follow-up.

SALT RSS spectroscopy of MUSES-1604D was undertaken by Saurabh Jha of Rutgers University (program 2015-1-MLT-002), and showed that the supernova was at a redshift of z = 0.12. Though the spectrum was clearly that of a type-Ia supernova, it had some odd features, more like a "hybrid" of other SN Ia (see figure). Jiang, Jha, and colleagues interpret the SALT spectrum as evidence for a detonation of helium on the surface of a near-Chandrasekhar mass white dwarf, that then triggered the subsequent explosion of the carbon/oxygen core. These observations provide a new wrinkle on models of SN Ia explosions. The results are published in the 2017 October 5 issue of Nature (Jiang et al. 2017, Nature, 550, 80; arXiv:1710.01824).



Figures, from https://www.nature.com/articles/nature23908 — the green spectrum in the figure panels are all the same spectrum, from SALT on 20160423. More information is in the caption at https://www.nature.com/articles/nature23908/figures/4

SALT STRATEGIC PLAN

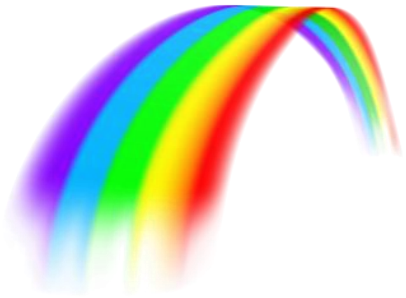
A months long strategy discussion process has been completed. The recommendations made by the community were discussed at the SA Astronomy Town Hall meeting in Oct, & importantly at the SALT Board meeting in early Nov. The science focus directions were ratified, as well as ideas for next generation instruments. The first steps were defined. The recommendations and immediate actions are as follows. Feedback from SALT users is still welcome however.

- *Transient and time domain science*: A new very high efficiency simple low-resolution spectrograph for SALT was proposed (see below). It is being designed at the moment while funding is being sought. It would give a massive boost for any science currently using RSS PG300 and PG900 gratings. The aim is to have it on the telescope within 2 years to have a significant overlap with MeerKAT/MeerLICHT operations for unique radio transient research. The concept is pegged as a generation 1.5 instrument. Furthermore, longer term ideas of advanced intelligent software linking Sutherland telescopes in the LSST era, and a "mini-tracker" concept potentially utilizing the full 100+ deg^2 field-of-view of SALT are being investigated. MeerLICHT images below.

- *Exo-planets*: SALT already has the instrument to play a significant role in high precision radial velocity observations needed in conjunction with several large exo-planet missions around the world. It was hence decided that the HS-mode pipeline needs a special focus in the short term to cater for this science, while the need for a Laser Frequency Comb (an LFC visited SALT in 2016 as you might remember) will be investigated thoroughly.

- *Baryon cycle and the low surface brightness universe*: The Sutherland site characteristics, the extremely dark skies and modest seeing conditions, are a perfect fit for competitive science of the low-redshift, but faint, universe. This requires wide-field, ideally deployable, IFUs for spatially resolved spectroscopy. SALT will start looking for funding mechanisms for such a 2nd generation instrument with time scale of about 5 years.

GEN 1.5 SPECTROGRAPH



Proposed SALT Gen1.5 instrument:
The MaxE (Maximum Efficiency) spectrograph

With MeerKAT operations starting next year, and LSST not far off, we are about to be hit by a flood of transient discoveries. Large advances in survey capabilities offer an opportunity to observe extremely energetic events, learn about the outcomes of stellar and binary evolution, study gravitational wave sources, and perhaps discover completely new classes of objects. The study of transients has been identified as a top priority in the SALT science strategy for the coming years.

A low-resolution optical spectrum will usually be the key step in determining the nature of a transient source. This is what is needed to pick out the most interesting sources for further detailed follow-up, and to understand the radio and optical transient populations. Obtaining these identification spectra is expected to be the main bottleneck in exploiting transient surveys. The ability to take ID spectra efficiently is also lacking at SALT. In order to make the most of the unique MeerKAT+MeerLICHT combination, we need to address this urgently.

We are proposing a simple, reliable, high-throughput spectrograph as a SALT generation 1.5 instrument. Janus Brink and Ockert Strydom are designing an instrument called MaxE (for Maximum Efficiency) based on Darragh O'Donoghue and Chris Clemens's Spherical Transmission Grating Spectrometer (STGS). It will deliver spectral resolution of around 700 over the wavelength range 3800 to 7600 Ångström. The novel design means that it can fit in the auxiliary bay of the payload. The advantage of MaxE over RSS for ID spectroscopy will be simple operation, adequate resolution over a wide band in a single exposure, and much improved throughput (a factor greater than 2, perhaps 3).

Although this is a very simple instrument, it will allow us to develop the new STGS technology, which may turn out to be very important in future spectrograph design. We hope to demonstrate this novel design in a working spectrograph, while doing timely, high-impact science when MeerKAT reveals the radio transient sky, and on into the SKA and LSST era.

CALL FOR PROPOSALS

It's that time of the year again...

On 20 December we will release the call for proposals for semester 2018-1. The semester will run from 1 May to 31 October. We recommend that you use the latest version of the software, as listed in the call document.

The call document will be available at: http://astronomers.salt.ac.za/proposals/

You may find all the software required for planning& submitting your proposal at: http://astronomers.salt.ac.za/software/

The phase 1 deadline will be on 31 January at 18:00 SAST (16:00 UT).
The phase 2 deadline will be communicated in the call document.

If you have any questions regarding the submission process, you should contact salthelp@salt.ac.za - we are always glad to help!

SALT CONFERENCE 2018

Mark your calendars: a preliminary plan is to have the next SALT Science Conference on November 14-16, 2018 in Pretoria at the new NRF conference facility. To be confirmed early in the year. An opportunity for visitors to perhaps also go see Kruger.

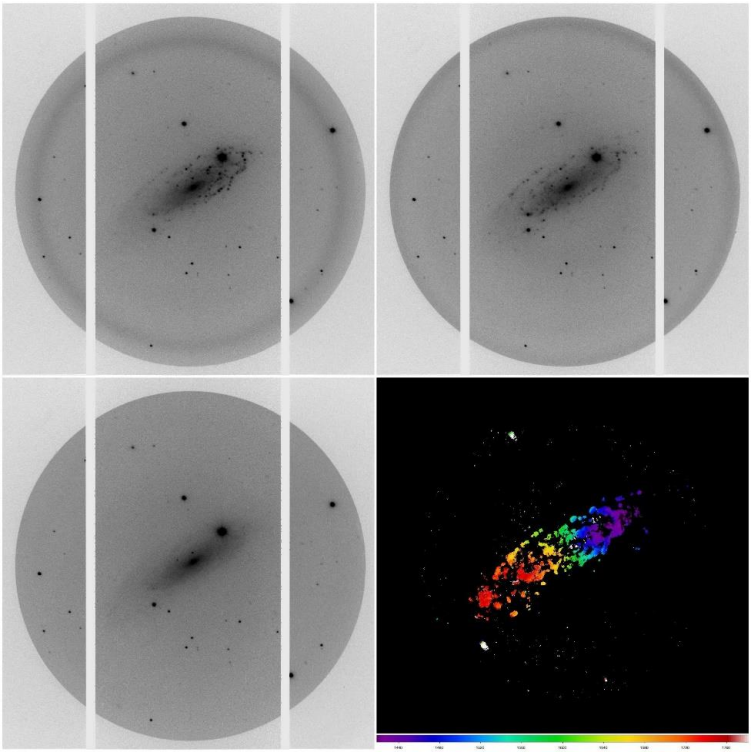
FAREWELL TO PROF TED WILLIAMS

At the end of this year, Ted Williams will be retiring after a career of over 40 years in Astronomy. Ted has been director of SAAO for the last five years, but his involvement with SALT started well before then. With a visit in the late 1990s, Ted lead Rutgers University to become a partner in SALT. Ted has helped steer SALT from the beginning, having participated in 42 SALT board meetings, and was the SALT board chairperson before becoming SAAO director.

In addition, Ted also led the development of the Fabry Pérot system for RSS. The Fabry-Pérot system [http://www.salt.ac.za/news/fabry-perot/] has produced some amazing data since the start of operations including the use of the first-ever dual etalon, high resolution observations. Some of these beautiful observations are reproduced below. The system is now in regular use on the telescope and with a soon to be refurbishment, it is expected to perform even better in future.

All throughout this time, Ted has continued to produce new research on the dynamics of galaxies. He has supported a number of graduate students that have used SALT observations and provided help to other astronomers using the Fabry-Pérot system from South Africa and the other partners.

Early this year, Ted commissioned remote observing with SALT from Maine — just in time for his retirement. We wish him all the best – and anticipate better than ever Fabry-Pérot support, as he will have all time in the world now to follow his RSS/FP passion!



Left: *Fabry-Pérot observations of the galaxy NGC 1325.*

MEET THE TEAM: DR ENCARNI ROMERO COLMENERO

Tell us a bit about yourself

I was born in Elche, near Alicante, on the South East coast of Spain. As a typical city child, I had never paid much attention to the skies or the stars - too many street lights! So I actually "blame" my Dad for my becoming interested astronomy. My Dad was a high-school teacher, and he started teaching an optional course in astronomy. So he took me along one night, when I was 13, to see the night sky and learn about the constellations, legends, colours, distances… and that was the beginning of my relationship with the stars. I fell in love with our city skies, I fell even more in love with dark skies and astronomy - and the more I learned, the more I wanted to know. Later on I discovered there was such a thing as a professional astronomer - and my fate was sealed. I studied Physics with Astronomy in Southampton University in the UK, followed by a PhD at Mullard Space Science Laboratory, located in a beautiful manor house in Surrey that was part of the University College London.

I met my husband during our PhDs in the UK, after which we decided to tackle the 2-body problem in astronomy by following whomever got the coolest job - and he won with a 2 year postdoc in Cape Town! A year later, the SALT project got the green light and I officially joined the SAAO, first with a postdoc and then becoming the first ever SALT Astronomer.

We have now been in South Africa for 18 years and we have 2 beautiful South African human children, one beautiful South African dog and 4 beautiful South African fish!

Tell us about your science

I mainly work on using a technique called echo mapping to determine the mass of the super-massive accreting black holes that live in the nuclei of active galaxies, for which SALT is eminently suited. This technique uses the time delay between brightening/dimming of the light that comes from very close to the black hole and the response to this brightening/dimming (light echoes) of fast-moving clouds which orbit the black holes to calculate the distance between the clouds and the black hole. This distance can then be used to calculate the mass of the super-massive black hole.

Oh, and I also occasionally work on cataclysmic variables just because they are fun!

What has been your role in the SALT team?

I have been involved in the SALT project from the very beginning, so I have done many different things! For example, I originally designed, implemented and I still manage the SALT Science Database, and I was heavily involved in the development of the planning tools and the scheduler we currently use at the telescope (which I wrote in LabVIEW, the programming language that the telescope control software and all the subsystems is written in). I am also responsible for the Fabry-Pérot and polarimetry modes of RSS, I wrote the prototype for the night logs, and you may also know me from answering salthelp emails.

I am now really looking forward to start my new role in the team, taking over from Petri as Head of SALT Astronomy Operations from 1 January. Can't wait!

What have been some of the challenges you've faced?

The two body problem in astronomy was tough - following my then partner to a foreign country, having no job myself but hoping that I would soon find my own position.
Also balancing a family life, my career as a SALT Astronomer and my husband's own astronomical career, has proven quite challenging. But we're both very supportive of each other and regularly become single-parents while the other travels away from home, either for observing runs or international conferences - and the children are also wonderfully understanding!

What do you enjoy doing outside Astronomy?

Lots of things! I love traveling, hiking with my family and friends, swimming, snorkelling and scuba diving (but in warm waters!), dancing... I also really enjoy learning martial arts (I have a blue-belt in Taekwondo and I'm about to start Kung Fu) and I often practise yoga. And reading - I love reading. I enjoy most type of novels, from sci-fi to historical novels, through everything in between!

SALT SCIENCE PAPERS

Below is the list of SALT publications since our last newsletter (for our full list of publications, please visit http://astronomers.salt.ac.za/data/publications/). We encourage SALT users to inform us of any papers making use of SALT data, and to double check the link above after publication.

- Abbott, B. P.; Abbott, R.; Abbott, T. D.; et al. 2017/10. Multi-messenger Observations of a Binary Neutron Star Merger. *ApJ*, 848, 12. http://adsabs.harvard.edu/abs/2017ApJ...848L..12A
- Alfonso-Garzón, J., Fabregat, J., Reig, P., et al. 2017/11. Long-term optical and X-ray variability of the Be/X-ray binary H 1145-619: Discovery of an ongoing retrograde density wave. *A&A*, 607, A52. http://adsabs.harvard.edu/abs/2017A%26A...607A..52A
- Boettcher, Erin; Gallagher, J. S., III; Zweibel, Ellen G. 2017/8. Detection of Extraplanar Diffuse Ionized Gas in M83. *ApJ*, 845, 155. http://adsabs.harvard.edu/abs/2017ApJ...845..155B
- Böttcher, Markus; van Soelen, Brian; Britto, Richard; et al. 2017/9. SALT Spectropolarimetry and Self-Consistent SED and Polarization Modeling of Blazars. *Galaxies*, 5, 52. http://adsabs.harvard.edu/abs/2017Galax...5...52B
- Czerny, B.; Li, Yan-Rong; Hryniewicz, K.; et al. 2017/9. Failed Radiatively Accelerated Dusty Outflow Model of the Broad Line Region in Active Galactic Nuclei. I. Analytical Solution. *ApJ*, 846, 154. http://adsabs.harvard.edu/abs/2017ApJ...846..154C
- Jeffery, C. Simon. 2017/9. GALEX J184559.8-413827: a new extreme helium star identified using SALT. *MNRAS*, 470, 3557. http://adsabs.harvard.edu/abs/2017MNRAS.470.3557J
- Jiang, Ji-An; Doi, Mamoru; Maeda, Keiichi; et al. 2017/10. A hybrid type Ia supernova with an early flash triggered by helium-shell detonation. *Nature*, 550, 80. http://adsabs.harvard.edu/abs/2017Natur.550...80J

- Macfarlane, S.A., Woudt, P.A., Groot, P.J., et al. 2017/02. The Omega White survey for short-period variable stars – III: follow-up photometric and spectroscopic observations. *MNRAS*, 465, 434. http://adsabs.harvard.edu/abs/2017MNRAS.465..434M
- Macfarlane, S. A.; Woudt, P. A.; Dufour, P.; et al. 2017/9. The OmegaWhite Survey for short-period variable stars - IV. Discovery of the warm DQ white dwarf OW J175358.85-310728.9. *MNRAS*, 470, 732. http://adsabs.harvard.edu/abs/2017MNRAS.470..732M
- Malacaria, C., Kollatschny, W., Whelan, E., et al. 2017/07. Optical spectroscopy of the Be/X-ray binary V850 Centauri/GX 304-1 during faint X-ray periodical activity. *A&A*, 603, A24. http://adsabs.harvard.edu/abs/2017A%26A...603A..24M
- McCully, Curtis; Hiramatsu, Daichi; Howell, D. Andrew; et al. 2017/10. The Rapid Reddening and Featureless Optical Spectra of the Optical Counterpart of GW170817, AT 2017gfo, during the First Four Days. *ApJ*, 848, 32. http://adsabs.harvard.edu/abs/2017ApJ...848L..32M
- Miszalski, B.; Manick, R.; Mikołajewska, J.; et al. 2018/1. SALT HRS discovery of a long-period double-degenerate binary in the planetary nebula NGC 1360. *MNRAS*, 473, 2275. http://adsabs.harvard.edu/abs/2018MNRAS.473.2275M
- O'Malley, Erin M.; Kniazev, Alexei; McWilliam, Andrew; Chaboyer, Brian. 2017/9. High-resolution Spectroscopic Abundances of Red Giant Branch Stars in NGC 6681. *ApJ*, 846, 23. http://adsabs.harvard.edu/abs/2017ApJ...846...23O
- Park, Songyoun; Woo, Jong-Hak; Romero-Colmenero, Encarni; et al. 2017/10. Reverberation Mapping of PG 0934+013 with the Southern African Large Telescope. *ApJ*, 847, 125. http://adsabs.harvard.edu/abs/2017ApJ...847..125P
- Parsons, S. G.; Hermes, J. J.; Marsh, T. R.; et al. 2017/10. Two white dwarfs in ultrashort binaries with detached, eclipsing, likely sub-stellar companions detected by K2. *MNRAS*, 471, 976. http://adsabs.harvard.edu/abs/2017MNRAS.471..976P
- Roberts-Borsani, G. W.; Jiménez-Donaire, M. J.; Daprà, M.; et al. 2017/8. Multiwavelength Characterization of an ACT-selected, Lensed Dusty Star-forming Galaxy at z = 2.64. *ApJ*, 844, 110. http://adsabs.harvard.edu/abs/2017ApJ...844..110R
- Shara, M. M.; Iłkiewicz, K.; Mikołajewska, J.; et al. 2017/8. Proper-motion age dating of the progeny of Nova Scorpii AD 1437. *Nature*, 548, 558. http://adsabs.harvard.edu/abs/2017Natur.548..558S
- Sharina, M. E.; Shimansky, V. V.; Kniazev, A. Y. 2017/10. Nuclei of dwarf spheroidal galaxies KKs 3 and ESO 269-66 and their counterparts in our Galaxy. *MNRAS*, 471, 1955. http://adsabs.harvard.edu/abs/2017MNRAS.471.1955S
- Townsend, L. J., Kennea, J. A., Coe, M. J., et al. 2017/11. The 2016 super-Eddington outburst of SMC X-3: X-ray and optical properties and system parameters. *MNRAS*, 471, 3878. http://adsabs.harvard.edu/abs/2017MNRAS.471.3878T
- Väisänen, Petri; Reunanen, Juha; Kotilainen, Jari; et al. 2017/10. Shutting down or powering up a (U)LIRG? Merger components in distinctly different evolutionary states in IRAS 19115-2124 (the Bird). *MNRAS*, 471, 2059. http://adsabs.harvard.edu/abs/2017MNRAS.471.2059V
- Valenti, Stefano; David; Sand, J.; et al. 2017/10. The Discovery of the Electromagnetic Counterpart of GW170817: Kilonova AT 2017gfo/DLT17ck. *ApJ*, 848, 24. http://adsabs.harvard.edu/abs/2017ApJ...848L..24V