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Report on the ESO Workshop

The La Silla Observatory — From Inauguration to the Future

held at Universidad de La Serena, Chile, 25–29 March 2019

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This five-day workshop celebrated the achievements of ESO's first observatory, La Silla, on the occasion of its 50th anniversary. La Silla, officially inaugurated on 25 March 1969, was the culmination of the vision of European astronomers to create a major observatory in the southern hemisphere. In the following decades, La Silla served as a testbed enabling the development of scientific, technical and operational expertise in the European astronomical community, establishing communication — channels with the public at large, and working to increase interaction and collaboration with the host country Chile as well as with other astronomical facilities in the Andes mountains. Today, La Silla continues to serve as a superb site hosting the ESO 3.6-metre and NTT telescopes, as well as a number of community-led experiments.

Introduction

La Silla was the main observational resource of European astronomers in the southern hemisphere for the first three decades of ESO's existence. The observatory's many telescopes, with a range of different apertures, provided the tools to drive many discoveries. La Silla was also the testbed for innovations in telescope and instrument technology. The 2.2-metre Max-Planck-Gesellschaft (MPG) telescope with its simple dome and, of course, the many new features implemented in the New Technology Telescope (NTT) in 1989 were critical for ESO's path towards the Very Large Telescope (VLT). Many new instrument concepts were brought to the La Silla telescopes. The focal reducer spectrograph was first introduced with the ESO Faint Object Spectrograph and Camera (EFOSC) instruments and it was copied with the FOcal Reducer/low-dispersion Spectrograph (FORS) instrument on the VLT and at many other observatories. Infrared instruments made gigantic steps over La Silla's history, from single-pixel detectors to the large arrays in use today. La Silla also experienced the transition from photographic plates and simple electronic detectors to charge-coupled devices (CCDs) and today's infrared arrays. La Silla also hosted the first large submillimetre dish in the southern hemisphere. Different operational schemes were tested at La Silla; some new adventures in running observatories included remote observing with the NTT and the Coudé Auxiliary Telescope (CAT), and the introduction of service observing at the NTT.

The workshop celebrated the scientific, technological, operational and societal achievements over the past half century and charted the possible futures of 4-metre-class telescopes in the era of extremely large telescopes. Many workshop participants had personally experienced and participated in the history of the La Silla Observatory. Their reports reminisced on the remarkable changes in our understanding of the Universe, galaxies, stars and planets. At the same time, the workshop also attracted many young people who presented newer results and their visions for possible future uses of the La Silla telescopes.

The workshop took place in the special auditorium called El Pentagono on the campus of the Universidad La Serena (ULS). The site overlooks the city of La Serena and the bay of Coquimbo, which offered a spectacular setting for the workshop. The conference dinner was at La Silla and included a tour of the observatory.

Workshop overview

The workshop programme was built around five topics: history, science, hosted projects, the future, and contributed talks[1]. These topics were interspersed throughout the workshop so that every day covered several aspects. Hosted Projects — formerly called "National Telescopes" — are telescopes and experiments installed on La Silla that are operated by universities or consortia.

History

The workshop opened with welcome addresses by the Rector of Universidad de La Serena (ULS) Nibaldo Avilés Pizarro, by Mayor of the Higuera municipality Yerko Galleguillos, and by President of the ESO Council Willy Benz. Also in attendance were Vice-Dean of Research and Development of ULS Eduardo Notte, and Director of Research and Development of ULS Sergio Torres.

The historical context of astronomical observatories in Chile was given by Bárbara Silva from the Pontificia Universidad Católica de Chile. The earliest astronomical site explorations by US astronomers were carried out around the end of the 19th and the beginning of the 20th centuries and identified the Atacama Desert around Copiapó and north of La Serena as potentially excellent sites for nighttime observations. The International Geophysical Year in 1958 brought the Chilean sites to the attention of American astronomers again and site explorations by Jürgen Stock — originally for the University of Chicago and later for the Association of Universities for Research in Astronomy (AURA) — identified mountains around Vicuña as possible observatory sites. After the US National Science Foundation selected Cerro Tololo as their southern station, ESO also became interested (through Stock's former advisor Otto Heckmann, then ESO Director General). This was a rather abrupt change from the original plan to place the ESO observatory in southern Africa. Within a few years the La Silla mountain was selected and developed. Silva finished her presentation by displaying a stamp showing the ESO 1-metre telescope, which was issued by the Chilean Postal Office in 1973.

The relationship between Chile and ESO was explored by Claudio Melo, stressing the friendly spirit that has guided this relationship over the years. Chilean astronomy has expanded tremendously over the past few decades and has made the country one of the leading nations in astronomical research.

Relations between the various observatories in Chile were described by Mario Hamuy and Leopoldo Infante. Hamuy has

worked extensively at the Cerro Tololo Inter-American Observatory and is a professor at the Universidad de Chile. A leader of a Chilean Millenium project, he was recently head of the Chilean science foundation (Comisión Nacional de Investigación Científica y Tecnológica, CONICYT), and as of October 2019 he is the representative of the Association of Universities for Research in Astronomy (AURA) in Chile. Leopoldo Infante is the director of the Las Campanas Observatory. They stressed the friendly competition between the observatories, but also the assistance they have provided each other, for example, the loan of the first CCD detector from Cerro Tololo to La Silla.

The friendly challenge of the "observatory olympics" is held every few years, featuring competitions in various sports. Doug Geisler reminded the audience of the joint workshops held by the observatories. Several memorable meetings could be reported (for example, the structure of the Milky Way, Galaxy Bulges, SN 1987A). A common concern of all observatories is light pollution; for example, the new illumination of the Panamericana near La Frontera leads to light pollution at the La Silla and Las Campanas observatories. Guillermo Blanc reported on the efforts undertaken by the Oficina de Proteccíon de la Calidad del Cielo del Norte de Chile (OPCC), a collaboration of the observatories and the Sociedad Chilena de Astronomía (SOCHIAS) to maintain the dark skies in northern Chile. Sergio Ortolani gave an account of the sky brightness above La Silla and its long-term evolution. He noted that La Silla has a very dark sky at the zenith and a long-term pattern of cloud coverage. About 70% of nights on La Silla are photometric.

Jorge Melnick began the scientific discussions by offering his list of the top ten results obtained with La Silla telescopes. He first demonstrated the ever-increasing demand for La Silla telescopes by showing the surge in the number of proposals from fewer than 100 at the beginning to nearly 600 proposals for Period 54, before the start of the NTT Big Bang (1995–96) and the introduction of the VLT (1999, Period 63). Results from the early years include many stellar topics, studies of the Magellanic Clouds, the identification of quasar absorbing systems as galaxies and the observation of ultra-luminous galaxies. A bibliometric analysis for results published after 1996, when the ESO bibliographic records are complete, lists nearly 6680 published papers based on data from La Silla telescopes until 2018. Among the top results are the discovery of the accelerated expansion of the Universe, the discovery of the peculiar gamma-ray burst GRB 980425/SN 1998bw, the survey of G dwarf stars to map the solar neighbourhood, tracing the nature of the Galactic centre via the orbits of stars, the connection between host-star metallicity and the probability of hosting a planet, the high fraction of binarity among massive stars, and chemical trends in stars in the thin and thick discs.

The historical development of the ESO telescopes was presented by Massimo Tarenghi, who had participated in the commissioning of the 3.6-metre telescope and led the construction of the 2.2-metre MPG telescope, the NTT and the VLT. He gave an overview of the changing scientific and technical landscapes and the technological advances which led ultimately to the VLT telescopes. Michel Dennefeld gave a first-hand history of some early developments of telescopes and instrumentation. The first large project on La Silla was the Quick Blue Survey, which provided full photographic coverage of the southern sky. The ESO Schmidt Telescope was specifically built for this purpose and Michael Naumann presented some of the original plates. The objective-prism mode of the ESO Schmidt had been used in spectroscopic surveys, for example the Hamburg–ESO Survey, to search for white dwarfs and quasars. Ana Cristina Armond presented new plans to take up objective-prism spectroscopy with the SOuthern Astrophysical Research (SOAR) telescope.

Gerardo Ihle led us on a journey down memory lane, sharing his thoughts about the development of the Mechanical Engineering Group on La Silla; the highlight was the design, manufacture, and commissioning of a new M2 unit for the 3.6-metre telescope, which fixed its image quality issues some 30 years after first light. The La Silla telescopes and instruments were maintained and improved over the years — a critical part of the successful operations. An inside view of the construction of the NTT was given by Sergio Lopriore, who was the project engineer at the time, followed by Jason Spyromilio who recounted stories of the NTT Big Bang, bringing the NTT up to VLT standards. A further legacy of La Silla is the provision of new technologies and Cesare Barbieri charted the path from the NTT to the Telescopio Nazionale Galileo (TNG) on La Palma. Dietrich Baade reported on the impact of remote observing with the NTT, the 2.2-metre MPG telescope and the Coudé Auxiliary Telescope (CAT).

Instrumentation development for La Silla underwent a long and arduous path. Originally, many instruments followed American developments — in some cases copies of successful instruments were purchased. Other instruments were temporarily installed at La Silla telescopes (visitor instruments) to obtain observations of the southern skies. Sandro D'Odorico described how the 2.2-metre MPG telescope and the NTT required new instrumentation that paved the way for many VLT instruments.

The prominent NTT instruments, EFOSC, ESO Multi-Mode Instrument (EMMI), SUperb Seeing Imager (SUSI) and Son of ISAAC (SofI) were important stepping stones. High-resolution spectroscopy has become a strength of La Silla and Luca Pasquini presented its history. The Coudé Echelle Spectrometer (CES) for the 3.6-metre and the CAT was followed by the Cassegrain Echelle Spectrograph (CASPEC) on the 3.6-metre, which was the only high-resolution spectrograph with polarimetric capabilities, as described by Gautier Mathys. Another high-resolution spectrograph, the Fibre-fed Extended Range Optical Spectrograph (FEROS), was initially mounted at the ESO 1.5-metre telescope and then moved to MPG 2.2-metre. HARPS on the 3.6-metre remains a unique facility for measuring accurate radial velocities.

Christian Gouiffes followed the various attempts at high-time-resolution photometry undertaken at La Silla and gave a very nice account of the ESO rejection of a putative pulsar in SN 1987A found at

another observatory. New instruments will equip the 3.6-metre telescope (the Near Infra-Red Planet Searcher, NIRPS) and NTT (Son Of X-shooter, SOXS) in connection with large dedications of observing time for powerful surveys of the next decade. Colin Snodgrass also presented a proposal for a high-resolution imager (GravityCAM) for the NTT.

Many infrared instruments debuted at La Silla and Ulli Käufl gave an overview of infrared instrumentation on La Silla over four decades. The first instruments were bolometers, followed by the first spectrographs (IRSPECs) and cameras (IRACs) and the extension into the thermal infrared with the Thermal Infrared MultiMode Instrument (TIMMI) instruments. The most prominent TIMMI result came from following the impact of comet Shoemaker-Levy 9 on Jupiter.

Experiments occasionally came to La Silla, for example the millimetre-wave heterodyne receivers brought to the ESO 1.5-metre and later the 3.6-metre telescopes to measure CO(2–1). Thijs de Graauw took part in these early observations and recounted how they eventually led to ESO’s hosting the Swedish–ESO Submillimeter Telescope (SEST) on La Silla. Lars-Åke Nyman presented the many successes of the SEST during its 15 years of operation and its important role as precursor to the current submillimetre telescopes in Chile.

Science

Birgitta Nordstrom presented one of the most successful programmes that used La Silla telescopes, showing how the Geneva–Copenhagen Survey of the Solar Neighbourhood changed our views of the Milky Way. This project, which lasted for over 15 years and required more than 1000 observing nights, collected the space motions of over 14 000 F- and G-type stars within ~ 100 pc (complete out to 40 pc) of the Sun. Distances, absolute magnitudes, effective temperatures, metallicity, proper motions (from the HIPPARCOS satellite) and radial velocities for all the stars were determined. About a third (34%) of the stars are binaries. From these observed values, several quantities (ages, space motion and orbital parameters) were derived. The oldest stars reflect the chemical abundance in the early Universe before chemical enrichment took place.

Figure 1. Conference participants at sunset on La Silla.

Monique Spite gave a historical introduction to the recognition of metal-poor stars and their importance in understanding chemical enrichment. She described the contributions by La Silla telescopes, in particular the searches by the Hamburg–ESO objective-prism survey with the ESO Schmidt telescope and follow-up high-resolution spectroscopy. These studies were continued with one of the first VLT Large Programmes on the “first stars” with the UV-Visual Echelle Spectrograph (UVES). The importance of stellar binarity (and multiplicity) was described by Hans Zinnecker. The ever-improving image quality led to the “breaking up” of the most massive known stars into smaller constituents and the La Silla telescopes played an important role, particularly in resolving the stars in the Tarantula Nebula. Similarly, the young stars in the Orion star formation region are mostly binaries, and it has since become clear that nearly all massive stars are in close binaries.

Michel Mayor, the guiding light behind the High Accuracy Radial velocity Planet Searcher (HARPS), presented the evolution of exoplanet discoveries with this instrument. Later in the year, Michel received (together with Didier Queloz) half of the 2019 Nobel Prize in Physics for essentially founding the field of exoplanet research as it is conducted today. The dedication of a large fraction of observing time over nearly two decades, coupled with the exquisite wavelength accuracy of HARPS, has contributed to the field’s progressing from the discovery of gaseous giant planets to finding rocky super earths and uncovering several planetary systems. Radial velocity searches have been performed over many years with the (hosted) Euler telescope and Stéphane Udry described the many successes. By now, planets with orbits of longer than 10 000 days (> 27 years!) have been found. Francesco Pepe charted the successes of HARPS and how it is now part of a suite of instruments used to study exoplanets. The prospects for this field are bright, with NIRPS on the 3.6-metre opening up the possibility to search for planets around low-mass stars, as presented by Francois Bouchy. Thierry Forveille (on behalf of Xavier Bonfils) showed how small telescope projects, like the three robotic ExTrA hosted telescopes on La Silla, can be used to search for transiting planets around M dwarfs and to study their atmospheres. A similar project focusing on the brightest stars is the Multi-site All-Sky CAmeRA (MASCARA), which is run by Ignas Snellen.

André Maeder presented La Silla's contributions to stellar astrophysics. HARPS has become the instrument of choice for determining stellar abundances and collecting the time series spectra required for asteroseismology. Combined with theoretical progress on modelling rotating stars, our understanding of the interiors of stars has increased dramatically. The observations of globular clusters have always been central to stellar evolution studies and Georges Meylan summarised what is known about cluster kinematics and dynamics. The line of instruments from CORAVEL (Danish 1.5-metre telescope) to CORALIE (Euler 1-metre telescope) and to HARPS at the 3.6-metre with ever increasing radial velocity accuracy was leading the way to resolved kinematics and dynamics in globular clusters.

Frank Eisenhauer summarised 28 years of observations of the Galactic centre from La Silla and Paranal, culminating in the spectacular observations of the effects of strong gravity close to the supermassive black hole at the centre of the Milky Way. La Silla telescopes were among the first to employ speckle imaging (for example, the SHARP camera) and adaptive-optics-assisted observations of the stellar population in the densest part of our Milky Way. Tracing the orbit of the star S2 around the black hole commenced at La Silla.

Cataclysmic variables and the current status of white dwarf observations were presented by Linda Schmidtobreick and Tom Marsh, respectively. La Silla telescopes have contributed to these fields via numerous Target of Opportunity (ToO) and monitoring programmes. UltraCAM is a visitor instrument which provides unique high-time-resolution capabilities helpful for many of the white dwarf studies. One of the primary goals of SOXS is the monitoring of variable sources. Pietro Schipani presented the concept and goals of SOXS. The wide-band spectroscopic coverage and the large allocation of observing time at the NTT will enable surveys of transient phenomena on an unprecedented scale. SOXS follows in the footsteps of the Public ESO Spectroscopic Survey of Transient Objects (PESSTO), which has provided new insights into supernovae and gamma-ray bursts (GRBs). PESSTO and its successor ePESSTO were presented by Rubina Kotak. PESSTO followed a long tradition of programmes studying supernovae at La Silla. Masimo Turatto was a key member of those projects and summarised the many results on supernovae obtained with La Silla telescopes. A special aspect he emphasised is the important role of such programmes in forming European collaborations.

SN 1987A has a special place in La Silla's history. The observations and unique contributions by the La Silla telescopes were summarised by Patrice Bouchet. The early indication of circumstellar material stemmed from NTT observations and was later confirmed by HST. The infrared observations of SN 1987A were led by ESO facilities and they provided important results, including monitoring the early dust formation and freeze-out at late times. An unbroken observational record of SN 1987A exists until today and continues with the inclusion of VLT and ALMA.

The Galactic bulge has been a favourite target for La Silla telescopes. Beatriz Barbuy reported on the latest results. The old population of the bulge has been confirmed and a clear signal of enrichment of alpha elements by core-collapse supernovae is found. The abundances in the bulge are comparable to those in the thick disc, while the oldest globular clusters are confined to the bar in the inner Galaxy.

Hosted telescopes

La Silla has hosted non-ESO ("national") telescopes for many years. Some of these operated on a mixed model with observing time available to the ESO community. The Danish 1.5-metre telescope began operating in 1978 and Michael Andersen gave an overview of its scientific achievements as well as future plans. This telescope was also one of the first on La Silla to use a CCD detector. This setup was used by a Danish team to discover the first distant supernovae, which opened up the possibility of observing the cosmic expansion rate beyond the local Universe. In addition, the telescope has also made important observations of GRBs and lensing of exoplanets. Today the Danish 1.5-metre is fully dedicated to photometry and is jointly operated by a Danish and Czech consortium. It is regularly used for exoplanet transit observations, and also discovered the rings around the asteroid Chariklo via occultations.

One of the first robotic telescopes was TAROT (Télescope à Action Rapide pour les Objets Transitoires — Rapid Action Telescope for Transient Objects), designed to hunt for GRBs; this project was presented by Michel Boër. The REM (Rapid Eye Mount) robotic telescope was installed in 2003 to follow GRBs photometrically in the infrared. Emilio Molinari presented the history and successes of this telescope. Today, REM focuses on time-domain astronomy (mostly follow-up of fast triggers like GRBs and kilonovae) but also exoplanet transits and space debris. The TRAnsiting Planets and PlanetesImals Small Telescope (TRAPPIST) is a robotic 60-cm telescope and was presented by Emanuel Jehin. TRAPPIST-South has now operated for 10 years and is also used for educational purposes in university courses. Its biggest success so far is the discovery of a planetary system consisting of seven transiting Earth-like planets around an ultra-cool dwarf (2MASS J23062928-0502285, now better known as TRAPPIST-1). This is one of the richest and best studied planetary systems so far.

After many years of time being offered to the ESO community on the MPG 2.2-metre telescope, the telescope has now become a hosted telescope on La Silla and is operated by the MPG. The exciting prospects of the BlackGEM telescope array were presented by Paul Groot. The three 60-cm telescopes are mainly set up to observe the electromagnetic counterparts of gravitational wave events. The installation is well under way and first light was obtained in January 2020. Another future telescope is the ESA TestBed Telescope (TBT), a 1-metre telescope to continuously monitor the sky for space debris and near-Earth objects. It will be a precursor to the ESA Near Earth Object Survey Telescope (NEOSTel) to survey the sky continuously in order to detect fast-moving objects.

The first La Silla telescope, the 1-metre photometric telescope, was installed in 1966 (even before the official inauguration of the observatory) and, as presented by Moni Bidin, since it ceased ESO operations it has been used by Bochum University and the Universidad Católica del Norte. A new high-resolution spectrograph (FIDEOS) built by the Pontificia Universidad Católica de Santiago was installed in 2016 and is used for exoplanet work. An important aspect of small (privately-run) telescopes is the training of astronomers at the start of their careers. Alessandro Ederoclite described the potential use of small telescopes in the future. Throughout its history, La Silla has often served as the first introduction to professional astronomy for early career researchers, and more recently this role has been boosted as the site of several astronomy training schools. Bruno Dias gave an account of the most recent school and Michel Dennefeld placed this into the wider context of the Network of European Observatories in the North (NEON) schools.

Future

The workshop ended with a general discussion of the future of La Silla. Andreas Kaufer gave an overview of the plans for the next few years to set the stage of the discussion. Central to these are the operation of the 3.6-metre telescope and the NTT, which will be equipped with new instruments that will be dedicated to specific science topics. Once the 3.6-metre telescope has been equipped with HARPS and NIRPS, it will become the primary facility for high-precision radial velocity studies in the optical and the near-infrared. SOXS on the NTT will focus mainly on the spectroscopy of transient objects and will be the primary spectroscopic follow-up facility for future surveys. A third component is the hosting of telescopes run by external consortia to enable access to the southern hemisphere at an excellent site.

During the discussions a number of points were made. La Silla telescopes already complement the current flagship facilities, VLT and ALMA, and will become workhorses for massive surveys of the brighter sky, targeting all objects that do not require 8-metre- or 40-metre-class telescopes. The time domain will become a major area for 4-metre-class telescopes in the future. Many science cases requiring long-term monitoring (for example, exoplanets, transient phenomena) will be best served with ESO’s 4-metre-class telescopes. The support role of some of these telescopes to complement missions such as PLATO was also stressed several times.

Demographics

The workshop was attended by 74 registered participants (see Figure 1), with only nine female participants (just under 12%). This was lower than the ratio of women to men in the Science Organising Committee (3:9). There were only five women among the 41 invited speakers (also 12%). Of the 18 contributed talks only 2 were given by female speakers. It should, however, be noted that more than half of the participating women were invited speakers. These numbers reflect in part the demographics during the early history of astronomy in Europe.

Summary

The La Silla Observatory has participated in most of the revolutions in astronomy over the past 50 years. The synergies with other observatories, in particular with space-based observations in the ultraviolet, in X-rays and in gamma rays, have been highly beneficial. The development of state-of-the-art instrumentation and the improvement in detector technologies reduced the need for larger telescopes for several decades. A further strength of La Silla programmes was (and still is) the large instrument complement and the possibility to execute long-term programmes — in some cases lasting decades. La Silla has been Europe’s flagship facility for three decades and has continued to produce exciting science results from surveys during the VLT era. In the future, it will focus its facilities even more on long-term and survey projects, which are impossible at larger telescopes given the demands on their time.

La Silla telescopes cover an important part of ESO’s integrated observing system as offered to its community. The La Silla observatory offers a prime site, significant instrumental capabilities and a versatile operations model. Fifty years after its inauguration the La Silla Observatory is still going strong and the promise of new scientific discoveries continues.

Acknowledgements

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Links

[1] The programme with links to the individual presentations: https://www.eso.org/sci/meetings/2019/lasilla2019/program.html