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Report on the ESO Summer School

La Silla Observing Summer School 2020

held at ESO La Silla, Chile, 3–14 February 2020

Emanuela Pompei[1]
Johanna Hartke[1]
Heidi Korhonen[1]
Chiara Mazzucchelli[1]
Camila Navarrete[1]
Anna F. Pala[1]
Luca Sbordone[1]
Linda Schmidtobreick[1]

[1] ESO

The La Silla Observing Summer School was originally conceived with the goal of providing hands-on training in the use of telescopes and astronomical instruments for senior masters and young doctoral students. The third La Silla Summer School ran over two weeks and was hosted by ESO's Office for Science and the La Silla Observatory. Twenty PhD and MSc students from several countries participated. They attended lectures on various observing modes and instrumentation but also on scientific presentations, time management, effective proposal writing, and career choices. For the hands-on part at the observatory, the students were supervised by seven ESO tutors. Four small research projects were offered, using three telescopes and four instruments. The students in each research group went through the full process of defining and discussing the observing strategies, conducting the observations, reducing and analysing the data and finally presenting the results to the scientific community at the ESO Vitacura offices. The next school is foreseen for the southern summer break of 2022.

Figure 1. The enthusiastic participants at the third La Silla Observing Summer School.

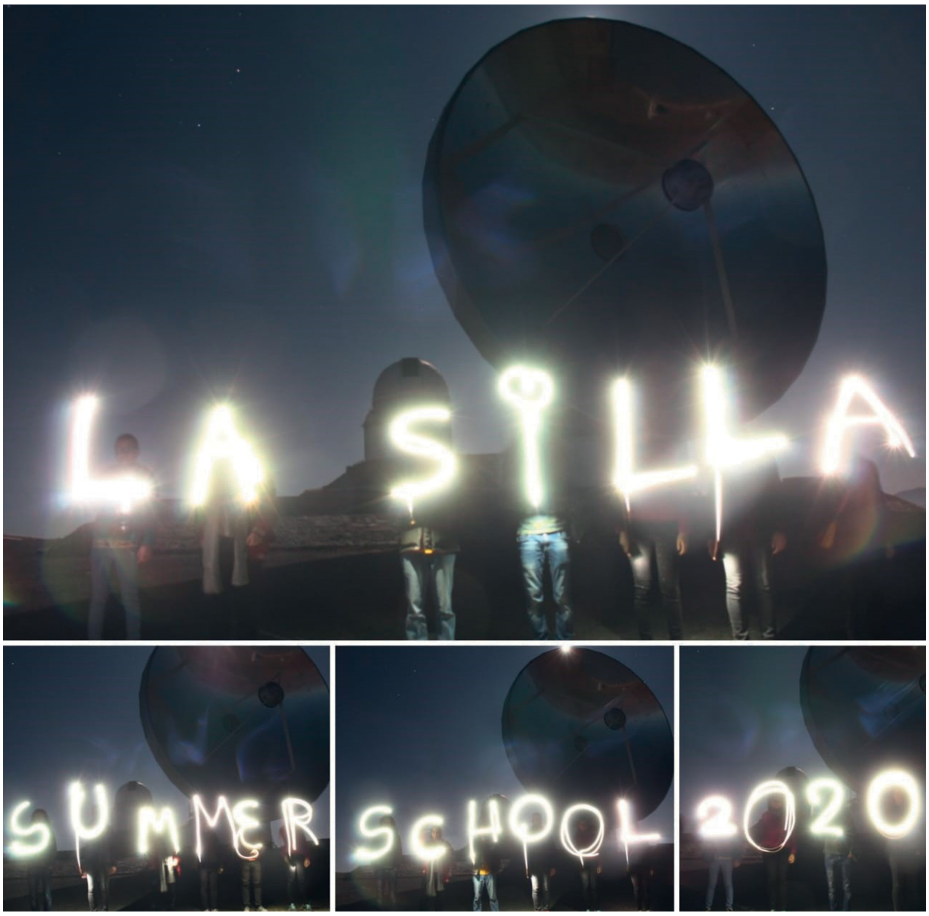

Figure 2. Happy students and tutors!

Introduction

Every two years, ESO hosts an observing school in La Silla during the summer break in the southern hemisphere, aimed at senior masters students and early doctorate students. The main goal of the school is to equip successful applicants with observational experience including, but not limited to, proposal preparation, observing strategy, data reduction, analysis and presentation of the results. This is becoming increasingly important, given the increasing use of remote observations, which denies many students the

Figure 3. Our time was divided between work and astro-tours.

possibility of having hands-on experience with large, modern observing facilities.

The previous versions of the school were organised primarily for students based in South America, given the relatively easy and cheap logistics which allowed us — with the generous contribution from OPTICON — to provide full support for accepted students, including travel costs. For this school, ESO provided paid lodging and transport. Students were housed in shared flats, which allowed the students to get to know each other in a relaxed environment.

During the first week, the students attended a series of lectures at the ESO premises in Vitacura. The students introduced themselves and shared their science interests and experience with their peers and the tutors. The participants then started to work in small groups on the specific science projects outlined below.

On Saturday 8 February, the students and tutors travelled to the La Silla Observatory; over the weekend they toured the site and familiarised themselves with the telescopes they were going to use. A special treat was a visit to the new BlackGEM[a] facility (see Figure 3). This time was also used to prepare observations, which began on the Danish 1.54-m telescope and the ESO New Technology Telescope (NTT) on 10 February, followed by the ESO 3.6-m telescope and the two telescopes above the following night. The instruments used for these observations were the Danish Faint Object Spectrograph and Camera (DFOSC; Andersen et al., 1995), ESO Faint Object Spectrograph and Camera v. 2 (EFOSC2; Buzzoni et al., 1984), Son of ISAAC instrument (SOFI; Moorwood, Cuby & Lidman, 1998), and High Accuracy Radial velocity Planet Searcher (HARPS; Mayor et al., 2003). The students returned to Santiago on 12 February, where they continued to analyse the data, discussed the results and prepared their presentations. On 14 February, the last day of the school, the students presented their results in Vitacura to an audience that included their colleagues, tutors, and ESO scientists. The successful conclusion of the school was then celebrated with a barbecue in the ESO grounds. The amount of work carried out over the two weeks was impressive and we were pleased to receive positive and useful feedback from the students.

The working groups

Four small research projects had been proposed by ESO staff astronomers and fellows, covering topics in stellar, Galactic and extragalactic astronomy. The students were divided into four groups: students with a background in extragalactic physics were assigned to stellar projects and vice versa, with the goal of encouraging them to explore outside their comfort zones and build strong collaborations. Care was also taken to evenly distribute expertise and seniority.

Characterising Nearby Galaxies with Optical Imaging

Tutor: Johanna Hartke
Students: Nicolas Rodriguez, Francesca Lucertini, Jon Joel Yael Galarza, Keila Y. Ertini, Paulina A. Miquelarena Hollger

The group observed nearby galaxies in isolation and in galaxy groups with the wide-field imager of the DFOSC at the Danish 1.54-m telescope[b]. The large field of view of the DFOSC, 13.7 × 13.7 arcminutes, and its pixel scale of 0.39 arcseconds, make it a perfect instrument for studying nearby galaxies. The aim of the project was to obtain photometry of these galaxies in different filters and to measure the

Figure 4. One of the highlights was a visit to one of the new BlackGEM telescopes.

Figure 5. The participants on one of the tours of the NTT.

Figure 6. The Hydra cluster with the brightest cluster galaxy NGC 3311 at its centre. The image was observed using the DFOSC at the Danish 1.54-m telescope.

galaxies' surface brightness profiles and colour profiles as a function of radius. The students carried out isophote fitting of all the galaxies and identified different structural components, such as bulges, discs, and halos. As a by-product, they produced beautiful three-colour images of their targets, such as the Hydra cluster with the brightest cluster galaxy NGC 3311 at its centre (see Figure 6).

Characterising nearby and distant galaxies with optical imaging and spectroscopy

Tutor: Chiara Mazzucchelli
Students: Silvina Cardenas, Giada Casali, Iskra Georgieva, Alonso Luna, Raphael A. P. Oliveira

The group used EFOSC2 to collect long-slit spectroscopy of galaxies in the local Universe. Their aim was to characterise their nuclear emission (star formation vs active galactic nuclei), by detecting and measuring several emission lines, for example, Hα, [NII], Hβ, and [OIII]. In order to do this, they relied on well-known diagnostics from the literature used to analyse nebular emission, for example, BPT — Baldwin, Phillips & Terlevich — diagrams (see Baldwin, Phillips & Terlevich, 1981). In addition, the students determined the redshifts of the sources from several emission lines, and these appeared to be consistent with values in the literature. They also observed a nearby Seyfert galaxy, MRK0841, and obtained a measurement of its central black hole mass, after fitting its broad Hα and narrow [NII] and Hα emission lines. Finally, the students also collected *JHK* imaging with SOFI of the highest-redshift quasar known, J1342+0928 at z = 7.5. These points were added to the variability curve built from literature measurements and showed that the luminosity of the quasar did not vary significantly on a timescale of ~ 1.5 years.

Stellar Astrophysics in Omega Centauri

Tutors: Camila Navarrete and Luca Sbordone
Students: Juanita Antilen, Ana Ines Ennis, Aishwarya Girdhar, Ana Carolina Posses, Luis Carlos Vasconcelos

This group's work consisted of identifying RR Lyrae pulsating variable stars in the globular cluster Omega Centauri and confirming them spectroscopically by detecting radial velocity variations, as well as analysing the chemical abundances of bright red giant branch (RGB) stars from two of the many stellar populations in the cluster. Gaia Data Release 2 (DR2, Gaia collaboration et al., 2018; Arenou et al., 2018) astrometry and photometry were used to clean up the Omega Cen colour-magnitude diagram (via proper-motion selection) and subsequently select stars for observation that were compatible with membership of the RR Lyrae population in the instability strip. Confirmed RR Lyrae members of the cluster were finally selected via a crossmatch with the catalogue of Navarrete et al. (2017).

Three of these were subsequently observed with EFOSC2 (Grism 14, spectral resolution R = 850) over two consecutive nights to confirm their pulsating nature. Their radial velocities were determined by cross-correlation. The radial velocity variations observed for all three targets were compatible with the expected pulsational phase. Using radial velocity lightcurve templates from the literature, the students derived the systemic velocity of the variables which was in good agreement with the mean radial velocity of the cluster, confirming their membership.

Two upper red giant branch (RGB) cluster member stars selected from the cleaned colour-magnitude diagram were also observed with HARPS to determine their chemical composition. The MyGIsFOS chemical analysis (Sbordone et al., 2014) revealed two very different objects, one in the lowermost ([Fe/H] = –1.98) and one in the upper ([Fe/H] = –1.35) part of the broad Omega Cen metallicity distribution, the latter object also being a rather chemically extreme second-generation star with strongly enhanced Na and Ba. Finally, the DFOSC at the Danish 1.5-m telescope was employed to obtain *B*, *V*, and *R* images of the entire Omega Cen cluster, from which a colour image of the object was derived.

In addition to the main science project, HARPS was also used to produce a very-high-resolution and high-S/N spectrum of Betelgeuse (Alpha Ori), which was undergoing the deepest photometric minimum ever observed at that time. The spectrum was immediately made public (Sbordone et al., 2020).

Spectroscopic identification of variable stars

Tutors: Ana F. Pala and Linda Schmidtobreick
Students: Avinash Chaturvedi, Lorenza Della Bruna, Eduardo Iani, Thais Pessi and Mattia Siressi

This science project aimed to provide the students with an understanding of stellar variability from both the spectroscopic and the photometric point of view. In particular, the group focused on the identification and study of cataclysmic variable (CV) candidates. These are compact interacting binaries hosting a white dwarf accreting from a main sequence star via an accretion disc. Candidates were selected because of their short variability timescales (of the order of minutes), allowing periodicity studies to be carried out and completed within the time window allocated for the observations.

From the catalogue presented in Pala et al. (2020), the students selected a total of 12 CV candidates for which they obtained identification spectra.

The ten faintest targets were observed with EFOSC2. From these spectra, the students confirmed that these systems are genuine CVs and classified them as low-, intermediate- and high-mass accreting systems (i.e., WZ Sge, SU UMa and U Gem CV sub-types) according to their spectral appearance. Interestingly, the students identified the presence of three CVs with nuclear evolved donors, which are the descendants of super-soft X-ray sources and are among the most promising supernova Ia progenitors in the single-degenerate scenario (Di Stefano, 2010).

The remaining two brightest targets, CoRoT 110741479 and V1129 Cen, were observed with HARPS and SOFI. Their spectra revealed that these systems are not CVs. In the case of CoRoT 110741479, the HARPS spectrum resembles that of an FU Ori-type young star, but more detailed studies are required in order to confirm this classification.

The SOFI spectrum of V1129 Cen acquired by the students represents the first near-infrared observation of this system and it was found to be dominated by a red star. Additional phase-resolved observations were carried out with HARPS. The detected radial velocity variation confirmed the multiple nature of the system, which previous work by Bruch (2017) had suggested was either a β Lyrae star (i.e., a close multiple stellar system) or a triple system consisting of an F star and a CV.

Finally, the students obtained time-resolved photometry with a two-minute cadence of the eclipsing CV RR Pic with DFOSC at the Danish 1.54-m Telescope. The observations delivered a 4-hour duration lightcurve of the system — thus covering the whole orbital period of 3.58 hours — and provided the students with an understanding of the relative orbital motions of the different components (the accretion disc, the donor star and the white dwarf) in a compact interacting binary.

Demographics

This year we decided to open the school to students worldwide and so did not offer travel support by default. We received approximately 100 applications evenly distributed between male and female applicants. Students applied from Chile, Argentina, Brazil, Venezuela, Ecuador, Colombia, France, Italy, Austria, Sweden, the United Kingdom, Iran, Ethiopia and Sudan. All applications were evaluated on an equal merit basis. Since travel support was unavoidably limited, a second selection was necessary to take into account whether the applicant was requesting travel support or not. The final selection resulted in 12 female and 8 male students, evenly distributed between senior masters and young doctorate students.

Acknowledgements

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Links

[1] https://www.eso.org/sci/meetings/2020/lasilla_school2020.html

Notes

[a] BlackGEM is a wide-field array of optical telescopes, jointly developed by Radboud University, the Netherlands Research School for Astronomy (NOVA), and the KU Leuven. Its scientific goals are to detect and characterise optical counterparts to gravitational wave detections.

[b] The Danish 1.54-m telescope saw first light in 1978 and is used today in a collaboration between the University of Copenhagen in Denmark and the Astronomical Institute of the Czech Academy of Sciences, Czech Republic. The telescope control system was upgraded in 2012 with funding from the Czech Academy of Sciences, making the Danish 1.54-m a reliable telescope that is very easy to use. The telescope can be fully controlled remotely and is often used from Europe by both the Danish and Czech teams. Currently the telescope has two photometric instruments: the Danish Faint Object Spectrograph and Camera (DFOSC) and the Lucky Imager. The DFOSC, which was used during this school, has a 2k deep-depletion E2V CCD that was installed in November 2018. It has a field of view of 13.7 × 13.7 arcminutes and a plate scale of 0.39 arcseconds per pixel, making it a perfect instrument for the study of extended objects. On the whole, the hands-on approach and excellent telescope control system make the Danish 1.54-m an ideal facility for teaching observations.