bases, which is why efforts like the one illustrated by Bruno Dias are important. He is trying to obtain Fe and Mg abundances using low-resolution spectroscopy, in order to expand the homogeneous metallicity sample. In the future this will enable the same method to be used to collect abundances for large samples of stars inside Galactic satellites.

Milky Way Halo + dwarf galaxies

Andreea Font recalled the lines of evidence that support the dual nature of the Halo, when they are compared to simulations: for instance the break in luminosity profile that separates the de Vaucouleurs profile of the *in situ* component from the power-law profile of the accreted component. Giuseppina Battaglia then expanded the view on dwarf galaxies, both in general terms and as possible contributors to the accreted component of the Milky Way Halo. One of the interesting points touched on by Giuseppina is the discovery of very metal-poor stars in dwarf galaxies; the current record is set at [Fe/H] ≈ –4, but even lower metallicity stars may be discovered, thus offering another way to constrain the properties of Pop III stars.

One issue with the comparison of present-day dwarf galaxies with possible progenitors, is that many of them orbit around massive hosts, so when simulating their evolution, care must be taken to explore the effects of tidal forces. One such study, which was applied to Sextans, was illustrated by Pascale Jablonka, who could reproduce the observed chemical and structural properties of the galaxy by dedicated soft particle hydrodynamic simulations which include detailed modelling of the gas physics and star formation.

Acknowledgements

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Links

[1] Cosmology Calculator: http://www.astro.ucla.edu/~wright/CosmoCalc.html

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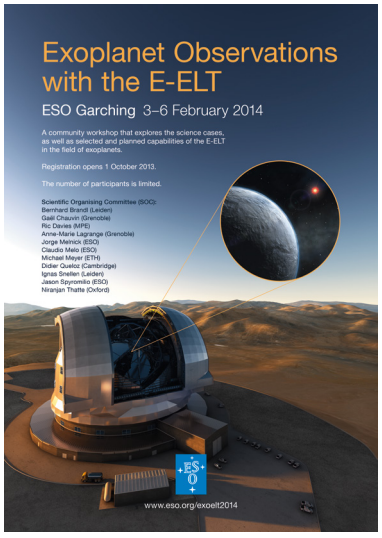
Report on the Workshop

Exoplanet Observations with the E-ELT

held at ESO Headquarters, Garching, Germany, 3–6 February 2014



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A brief summary of the presentations and discussions at the workshop on exoplanet science with extremely large telescopes is sketched. A broad range of topics covering the lifecycle of planets and the instrumentation landscape were presented.

Over 140 participants from the Member States of ESO and beyond attended the first ExoELT2014 workshop. The programme included significant time for discussions (45 minutes at the end of each morning and afternoon session and a whole session on the last day). As a result the programme was short on presentations (typically five per session) and long on debate and conversation. This report does not aim to summarise in detail the entire workshop as all the presentations are available on the workshop website[1]. A wiki page, linked from the conference programme[2], will be set up where we hope to continue the discussion that started at the meeting.

In such a rapidly changing field as exoplanet science, it would be folly to try to establish any ground truths. The workshop took place just after the Gemini

Planet Imager (GPI) instrument had gone to sky with some brilliant observations of the disc and planet systems β Pic and HR 4796 (Currie et al., 2013; Galicher et al., 2014), and the European Space Agency (ESA) had not quite announced, but everyone seemed to know, the news about the Planetary Transits and Oscillations of stars (PLATO) mission. By the time this report is in press, it is likely that more exciting news of exoplanet endeavour will have been announced.

Discs and protoplanets

The topic of the evolution of discs and the initial conditions for forming protoplanets opened the meeting. Planets are expected to form from the debris of protoplanetary discs. The ongoing and forthcoming observations with the Atacama Large Millimeter/submillimeter Array (ALMA) of these objects are likely to revolutionise our understanding of the field. Leonardo Testi opened the scientific part of the meeting with an overview, posing a number of questions related to: the grain growth process that is necessary to form rocky cores; the co-evolution of the gas and dust; and the dissipation of the disc.

The combination of ALMA and thermal infrared observations is necessary to examine the different regions of protoplanetary discs. Jonathan Marshall provided a nice validation of this, showing how Herschel observations help us to understand debris discs. Maria Rosa Zapatero Osorio's presentation on free-floating giant planets showed how they help to extend the Hertzsprung–Russell (HR) diagram and provide us with a substellar mass function as the number of detected objects increases. The discussion brought to the fore the need for *L*-band imaging to detect planets in the disc gaps. While the sensitivity of the James Webb Space Telescope (JWST) will be difficult to surpass, the angular resolution of the European Extremely Large Telescope (E-ELT) in the *L*-band does provide a powerful tool to probe the discs.

Surveys for exoplanets

The morning session on the second day focussed on the direct detection surveys. Christophe Lovis reviewed the field. With multiple surveys in various stages (e.g., HARPS very advanced, KEPLER finishing, GPI and VLT SPHERE starting, ESA Gaia starting, etc.) much, if not all, of the parameter space for discovery is being actively probed. The E-ELT is to focus on spectrophotometry during eclipse or transit, high-resolution spectroscopy and high-contrast imaging/spectroscopy.

Beth Biller reviewed the statistics of the populations of exoplanets from different surveys and provided constraints on the numbers of planets per star. The question of stellar noise and whether it was better to observe in the near-infrared was addressed by Andreas Quirrenbach, and we can expect to have data from the CARMENES spectrograph at Calar Alto soon. The MICADO camera on the E-ELT as a powerful direct detector of exoplanets, when augmented by a coronograph, was presented by Anthony Boccaletti.

Part of the discussion focussed on whether the E-ELT would be used for surveys to detect planets, what the objectives of such surveys would be and how would they be complemented by existing instrumentation. With the first light of the E-ELT planned for 2024, Raffaele Gratton provided an overview of the overlaps, both temporal and in terms of capabilities, of the wide gamut of missions dedicated to this field over the coming two decades. An interesting question of whether we would be focussing on young stars, providing us with better contrast capabilities and easier access to the habitable zone, was a recurring theme of the workshop.

Exoplanet transits

Transit spectroscopy was the main theme of the next session with an overview presented by Mercedes Lopez-Morales. This is also a very exciting and rapidly evolving field, with the recent detection using the CRIRES spectrograph of the orbital motion of HD 209458b through the CO lines being an ESO highlight (Snellen et al., 2014). The combination of data from multiple telescopes and broad wavelength coverage is providing direct constraints on the composition of the atmospheres of transiting planets with a number of detections of clouds or haze (featureless spectra). Enric Palle reminded the audience just how hard it is to do millimagnitude photometry, but also how crucial a very big telescope (in this case the 10.4-metre Gran Telescopio Canarias [GTC]) is for collecting the photons needed.

Xavier Bonfils provided a detailed explanation of all the challenges involved in precision differential spectroscopy (fibre bundle filling factors, slit *vs*. fibre precision, centring accuracy, etc.). The observations and techniques for mapping of clouds in exoplanetary atmospheres were discussed by Brice-Olivier Demory, with tantalising ideas about expanding the parameter space through polarimetry. Matteo Brogi presented the exciting results from the CRIRES observations of CO, resolving the planet motion. Transit spectroscopy with the E-ELT is gearing up to become one of the most exciting areas where the power of the telescope will be of great benefit.

Direct imaging and spectroscopy

Markus Janson took us to the planets that we can see. He reviewed the resolved imaging and spectroscopy results and discussed the hot/cold start scenarios for planet formation and the disruption of disc structures due to the presence of planets. The field of high-contrast imaging and spectroscopy is extremely active, and Sasha Hinkley brought this very much to the fore in his talk on lessons learnt from a variety of systems, and in particular the Palomar project 1640 on the sky measurements of the suppression of speckle noise and the importance of spectral resolution.

In addition to the aforementioned GPI data from Gemini, Keck adaptive optics imaging results at very small angular separation were also shown. Much of this work is being done at contrast ratios of $<$ a few 10^5 and angular separations of a significant fraction of an arcsecond. The E-ELT, by virtue of its smaller diffraction limit, should be able to push the inner working angle to lower values and

will need coronographic capabilities built into the instruments. Astrometric observations to constrain the orbits of larger, sub-stellar sized companions, and by extension the formation history of these systems, were presented by Christian Ginski.

Bernhard Brandl and Niranjan Thatte presented the capabilities of the E-ELT instruments METIS and HARMONI, respectively, and Markus Kasper showed the path that we will need to follow to reach the Planetary Camera Spectrograph instrument. Together with the presentations on MICADO (see above) and the discussions on the usage of multi-object instrumentation and high resolution spectroscopy, the totality of the instrument roadmap was extensively discussed at the workshop.

The last session at the workshop with presentations focused on the search for habitable planets. David Charbonneau gave the invited review and reminded the audience of the advances the field had made in the last year alone. A sobering thought when planning for instrumentation to go to sky in a decade from now! Ignas Snellen gave a taste of where the combination of high-resolution spectroscopy techniques with high-contrast imaging would lead us. Jay Farihi reminded us that what is left behind after planet formation will eventually fall back onto the star and can be detected by spectroscopy. Thus the meeting moved from the birth of the planets to the death of the material that made them.

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Links

[1] ExoELT2014 workshop website: http://www.eso.org/sci/meetings/2014/exoelt2014.html
[2] ExoELT2014 workshop programme: http://www.eso.org/sci/meetings/2014/exoelt2014/program.html

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Report on the ESO/RadioNet Workshop

3D2014: Gas and Stars in Galaxies: A Multi-wavelength 3D Perspective

held at ESO Headquarters, Garching, Germany, 10–14 March 2014

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This is the second ESO workshop devoted to the topic of 3D spectroscopy of galaxies; the last one took place in 2008. An overview of the workshop themes is presented and a discussion of the progress and open questions that have been resolved by new facilities and theoretical modelling since the last workshop.

With our current knowledge of both the standard model of particle physics and cosmology, combined with the successes of Lambda Cold Dark Matter (ΛCDM) cosmology, we now have a scientifically robust model of galaxy formation and evolution that can be tested with observations. The goal of this workshop was to gauge our progress in understanding the baryonic physics involved in galaxy formation and evolution, as it is the foundation for our ability to test the growth of galaxies and structures in the ΛCDM model. The workshop builds on the previous ESO 3D workshop, held in 2008 with the same title (see Lehnert et al. [2008] for a report). In our summary we have tried to be comprehensive, but not all contributions could be mentioned. There will be no published proceedings, but most of the presentations can be consulted via the workshop website[1].

Our ability to quantitatively test the ΛCDM model relies on our ability to exploit technology — using fast computers for large high-dynamic-range simulations, with advanced data visualisation techniques (contributions by Fluke, Ott, van der Hulst and Koribalski), robust and efficient algorithms, sensitive detectors and efficient instruments, and building large aperture space and ground-based telescopes (summarised in talks by Bershady, Braun and Emsellem). The meeting six years ago took place during, what was in many ways, the infancy of 3D technology, especially in the optical and near-infrared and in visualisation techniques. Also in the radio, the world is now a richer place with the advent of focal plane arrays for single-dish telescopes and phased array feeds on interferometers coming online soon. The capabilities of the Atacama Large Millimeter/submillimeter Array (ALMA) with its wide frequency coverage, both overall and in single observations, the increasing bandwidth of instruments like the Plateau de Bure interferometer and the broad wavelength coverage of current optical/near-infrared instruments, such as the *K*-band Multi-Object Spectrograph (KMOS) and the Multi-Unit Spectroscopic Explorer (MUSE) recently commissioned