Report on the

Chilean Exoplanet Meeting

held at ESO, Vitacura, Santiago, Chile, 4 June 2015

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The contribution of the Chilean scientific community to the field of exoplanetary research has been crucial in advancing our understanding of this relatively new discipline of astronomy. In order to highlight these achievements, present current areas of research and instrumentation development, and foster further collaborations, a one-day exoplanet focus meeting was organised at ESO Vitacura. A summary of the meeting is presented.

The meeting comprised talks spanning most fields of exoplanetary research, such as radial velocity and transit surveys, atmospheric studies, direct imaging and free-floating planets, as well as an historical overview of exoplanet research in Chile. Presentations of all the talks can be viewed online[1]. Furthermore, presentations on new instrumentation, such as the Spectro-Polarimetric High-contrast Exoplanet REsearch instrument (SPHERE) and the upgraded Very Large Telescope (VLT) spectrometer and imager for the mid-infrared (VISIR), or the Fibre Dual Echelle Optical Spectrograph (FIDEOS) destined for La Silla, could provide ideas for new channels of investigation. As an additional bonus, the contribution of the Atacama Large Millimeter/submillimeter Array (ALMA) to exoplanet studies was presented; in particular the role of debris discs in planetary formation and evolution was discussed. The meeting also benefited from an invited talk by Pedro Figueira from the University of Porto who presented a thorough history of exoplanet detection and characterisation.

A bit of history

The meeting began with an historical overview of exoplanet research, presented by Dante Minniti from Universidad Andrés Bello in Santiago. As he reminded the audience, exoplanet science in the Chilean community started as a concerted effort in 2003, with a summer school. This quickly brought fruits, with the first Chilean exoplanet discovered in 2004, the hot Jupiter around OGLE-TR-133. Many others followed, such as those made by the N2K consortium, the Magellan planet search and the ESO Large Programme 666. Following on, the efforts and contributions of the second generation of exoplanet scientists in Chile were highlighted, which included a variety of radial velocity search programmes and surveys, as well as transit searches, such as HAT-PI, spearheaded by Andrés Jordán at Universidad Católica. Finally, the outlook for the future of this science in Chile was highlighted, which was the perfect way to lead into presentations from the participants.

Radial velocity searches

James Jenkins highlighted three radial velocity (RV) search programmes currently ongoing at the Universidad de Chile. Firstly, the Calan–Hertfordshire Extrasolar Planet Search (CHEPS), which is a collaboration with the University of Hertfordshire (UK), aims to better characterise the Doppler signals of metal-rich stars. This search effort is intimately linked to ESO facilities, by following up the interesting targets with SPHERE. The other two searches, RAFT (Re-analysis of Archival FEROS Spectra) and CHIRON, headed by Maritza Soto and Matías Díaz respectively, were also highlighted, and then later developed by the corresponding principal investigators. The RAFT survey (see the article by Soto et al., p. 24) is a reanalysis of archival Fibre-fed Extended Range Echelle Spectrograph (FEROS) data, whereby an improvement to the barycentric velocity correction of the pipeline has yielded the detection of new planetary candidates, as well as the rejection of other previously confirmed planets (Soto et al., 2015). CHIRON is a high-resolution spectrograph on the 1.5-metre Small & Moderate Aperture Research Telescope System (SMARTS) at the Cerro Tololo InterAmerican Observatory (CTIO) and has been in use since 2014 in a campaign to find rocky exoplanets. A first discovery from this search effort was shown.

Two spectrographs

Besides the astrophysical contribution from the community, there is now a concerted effort from Chilean institutions, in particular the Centre of Astro-Engineering of Universidad Católica, in developing new instrumentation. Two of such projects were presented by Matías Jones.

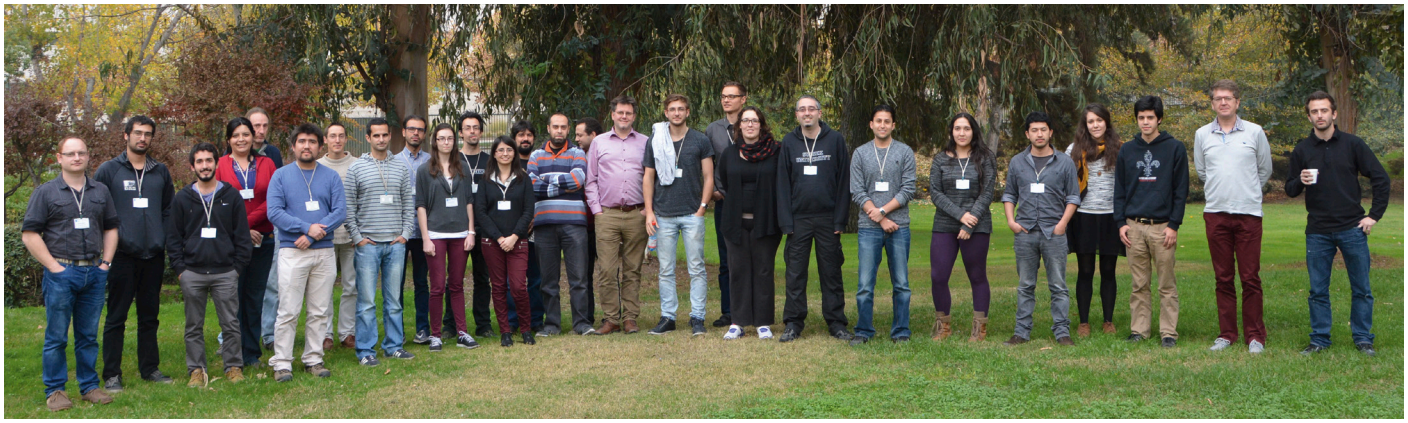


Figure 1. Participants at the Chile Exoplanet Meeting in the gardens at ESO Vitacura.

The almost completed FIDEOS is a stable, high-resolution spectrograph aimed at detecting exoplanets and brown dwarfs with high precision radial velocity measurements, as well as following up transiting planetary candidates. The secondary goals of the project include age determination of field stars in the Galaxy, RV of eclipsing binaries, studying circumstellar environments, monitoring massive star eruption phenomena, chemical abundances and stellar parameters, amongst others. FIDEOS has a resolution of 45 000, covering the spectral range of ~ 420–860 nm. It is a dual fibre-fed spectrograph for simultaneous observation of an astronomical object and the calibration lamp. An iodine cell mounted at the telescope–spectrograph interface provides a secondary alternative spectral calibration source. Additionally, the instrument is mounted on a fixed optical bench without any moving parts, whereby the CCD shutter and the enclosure are thermally controlled, ensuring opto-mechanical stability. The spectrograph is mounted on the Universidad Católica del Norte (UCN) 1-metre telescope at La Silla (Tala et al., 2014).

Details of a further spectrograph, TARdYS (TAO Aiuc high Resolution (d) *Y*-band Spectrograph), were also presented. This fully Chilean funded and designed project is planned for installation at the foreseen 6.5-metre optical–infrared telescope of the University of Tokyo Atacama Observatory (TAO) at an altitude of 5640 metres above sea level. This is an *R* ~ 60 000 echelle spectrograph with the aim of achieving high precision RV measurements, covering the spectral range of roughly 900–1100 nm.

Reflected light from 51 Peg b

ESO student Jorge Martins presented a technique that obtained a direct detection of reflected stellar light from the planet surrounding 51 Peg, using the High Accuracy Radial velocity Planet Searcher (HARPS) spectrograph (Martins et al., 2015). Utilising the cross correlation function method with a binary mask with 3600 lines, Martins and his collaborators were able to obtain the direct signal from the planet after the stellar signature had been removed. From the analysis of this reflected signal, the team was able to determine an inclination of ~ 80° for the orbit of this planet, which puts it agonisingly close to it being a transiting planet. Subsequently, this inclination yielded a value for the true mass of the planet of 0.46 M_J, making it an inflated hot Jupiter with a large albedo. These results were obtained from the fitted signal shown in Figure 2, which has a normalised amplitude of 6.0×10^{-5}, at a detection significance of 3.7σ.

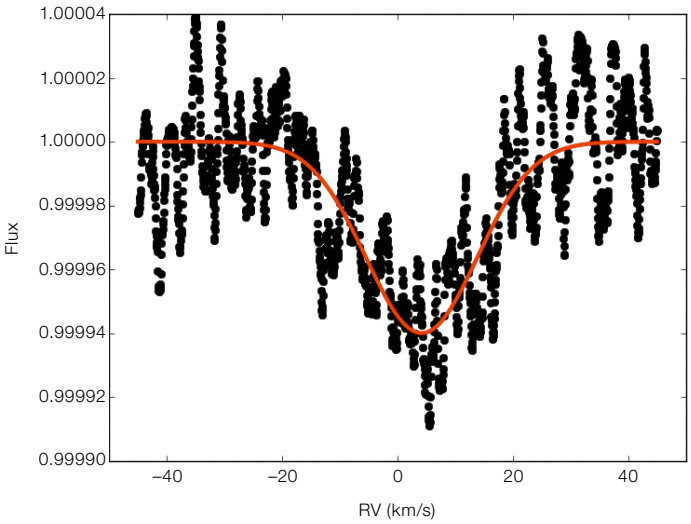


Figure 2. The reflected light signal from 51 Peg b is shown as a function of the radial velocity, including the Gaussian fit (red line). From Martins et al. (2015).

High-contrast imaging with SPHERE

High-contrast imaging represents the most direct method of detection and characterisation of extrasolar planets. With the advent of extreme adaptive optics systems implemented on a variety of large-class telescopes, astronomers have been able to directly detect and image a handful of exoplanets, such as those around HR8799 or β Pictoris. This technique requires extremely high angular resolution, as well as high contrast. Julien Milli, the instrument fellow for SPHERE recently commissioned on the VLT, presented some preliminary results from the commissioning data taken by the consortium. Benefiting from an extreme adaptive optics system and unique post-processing techniques, this instrument produces extremely stable, high Strehl ratio and diffraction-limited images.

One of the most recent results with SPHERE is the observation of the G9V star GJ758, located 16 parsecs away (Vigan et al., 2015). SPHERE confirms the presence of a sub-stellar companion, with an additional possible planetary candidate. Further campaigns will be required to confirm the nature of this new candidate and to determine whether it is bound to the system or not. As well as its high-contrast imaging capabilities, SPHERE will provide a wide range of spectroscopic and polarimetric modes of observation.

The new VISIR and exoplanets

As the only mid-infrared instrument mounted at a telescope in the southern hemisphere, VISIR has recently gone through an upgrade and is now fully operational at Unit Telescope 3 of the VLT (Käufl et al., 2015). Daniel Asmus, the instrument fellow for VISIR, highlighted the new possibilities for exoplanetary research using this newly upgraded instrument. Operating in the *N*- and *Q*-bands, it is able to take diffraction-limited images with resolution of 0.25–0.4 arcseconds. One of the new modes introduced in this instrument is the coronagraph with an annular groove phase mask, optimised at 12 μm and planned for full commissioning in July 2015. Medium resolution spectroscopy, burst mode imaging and sparse aperture masking are also soon to be commissioned/offered.

VISIR has already been used to study protoplanetary and debris discs. Future studies of transiting exoplanets in the mid-infrared with VISIR will be especially

interesting when observing occultations, as exoplanets are relatively bright in the mid-infrared compared to their host stars. However, some challenges still remain in the form of high background noise in this wavelength domain, as well as VISIR's relatively small field of view. There are currently some ongoing ESO programmes to investigate the feasibility of such observations with VISIR. The relative brightness of planets in this regime also opens up the possibility of directly imaging exoplanets with this excellent angular resolution instrument.

Besides the talks mentioned above, Elyar Sedaghati from ESO Santiago presented results on transmission spectroscopy of the exoplanet WASP-19b, performed with the VLT's FOcal Reducer/low dispersion Spectrograph 2 (FORS2) instrument, for the purpose of characterising its atmospheric properties (Sedaghati et al., 2015).

This observation was made possible through the exchange of the previously damaged longitudinal atmospheric dispersion corrector (LADC) prisms (Boffin et al., 2015). Bill Dent from ALMA gave an introduction to some of the capabilities of the now fully functional submillimetre interferometer; possible applications to study exoplanets, young exoplanetary systems and protoplanetary discs were highlighted. Mark Booth, from the Universidad Católica discussed the place of debris discs in planetary systems, as well as the consequences of interactions between young planets and their neighbouring environments. Finally, Holger Drass, from the same institute, presented some preliminary results from deep HAWK-I and KMOS observations of the Orion Nebula Cluster, where a second peak in the sub-stellar initial mass function points to the possible presence of free-floating planetary mass objects.

Acknowledgements

This one-day meeting was made possible through the support of the ESO Office for Science in Vitacura. Special thanks go to Claudio Melo, Paulina Jíron and María Eugenia Gomez for helping with organising various aspects of the meeting.

References

Boffin, H. M. J. et al. 2015, The Messenger, 159, 6
Käufl, H.-U. et al. 2015, The Messenger, 159, 15
Martins, J. et al. 2015, A&A, 576, A134
Sedaghati, E. et al. 2015, A&A, 576, L11
Soto, M. G., Jenkins, J. S. & Jones, M. I. 2015, MNRAS, 451, 3131
Tala, M. et al. 2014, Proc. SPIE, 914789
Vigan, A. et al. 2015, A&A, submitted

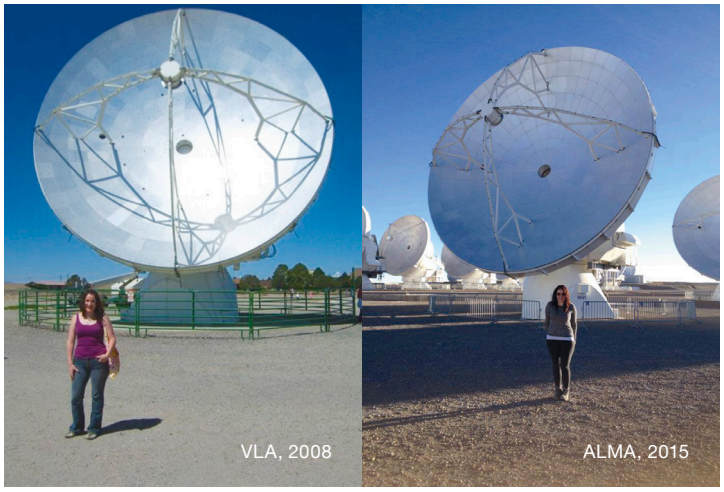
Links

[1] Introduction, programme, list of participants and the presentations can be found at: http://www.eso.org/sci/meetings/2015/Exoplanets2015.html

Fellows at ESO

Lizette Guzman-Ramirez

Ever since I can remember I have always been fascinated by the Moon, so I guess that was how my interest in astronomy started. I'm originally from a small town in the north of Mexico, called Saltillo. I lived there with my parents and sister until I was seventeen, when I moved to the centre of Mexico to do my undergraduate degree in physics. By the time I decided to do physics, I was already planning to be an astronomer, although I didn't know what being an astronomer really meant. During my study of physics I learnt many things, but almost nothing related to astronomy. Luckily I managed to get a grant for an astronomy summer school organised by the Centre for Radio Astronomy and Astrophysics (CRyA) of the Universidad National Autonoma de Mexico (UNAM). Those two weeks in the summer of 2004 were a turning point in my life as an astronomer — they convinced me that I wanted to be an astronomer and learn about the Universe.



Lizette Guzman-Ramirez

To receive a physics degree in Mexico you have to do a thesis on a research topic related to physics. To do this, I