



Figure 4 (above). Direct imaging detection of the planets around the G-type star GJ 758 announced at the meeting (SUBARU/HICIAO data, Thalmann et al., 2009).

The success and smooth organisation of this workshop would have not been possible without the help and support of Christina Stoffer and Jasmin Zanker-Smith, as well as the postdocs and students who served with enthusiasm and dedication on the Local Organising Committee (Joanna Brown, Greg Herczeg, Agata Karska, Pamela Klaassen, Luca Ricci, Paula Teixeira — see Figure 5). We also thank all our colleagues at the MPE for their patience and understanding during the invasion of their institute by over 200 conference participants.

References

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 Jørgensen, J. K. et al. 2007, ApJ, 656, 293
 Kwon, W. et al. 2009, ApJ, 696, 841
 Ricci, L. et al. 2010, A&A, in press, astro-ph: 0912.3356
 Thalmann, C. et al. 2009, ApJ, 707, L123

Links

¹ Workshop web page: <http://www.eso.org/sci/meetings/disks2009/index.html>

Figure 5 (below). Local organisers, from left to right: Joanna Brown, Greg Herczeg, Pamela Klaassen and Paula Teixeira enjoying themselves at the workshop dinner and Luca Ricci and Agata Karska setting up presentations for the speakers during the workshop breaks.



Report on the CAUP and ESO Workshop

Towards other Earths: Perspectives and Limitations in the ELT Era

held in Porto, Portugal, 19–23 October 2009

Nuno Santos¹
 Claudio Melo²
 Luca Pasquini²
 Andreas Glindeman²

¹ Centro de Astrofísica, Universidade do Porto, Portugal

² ESO

A short report on the workshop aimed at exploring the role of the Extremely Large Telescopes in finding and characterising Earth-like planets is presented.

The Centro de Astrofísica da Universidade do Porto hosted an ESO-sponsored conference, which had the main goal of understanding how Extremely Large telescopes (ELTs) will help in finding and characterising other Earth-like planets, as well the challenges that we have to overcome to achieve this goal.

In order to enable the discovery and characterisation of other Earths, a new generation of instruments and telescopes is now being conceived and built by different teams around the world. With the large diameter of their primary mirrors, the new generation of ELTs will play a crucial role in this research and the detection of Earth-mass planets is expected to be within reach.

In parallel, a new generation of instruments for current 8 to 10-metre-class facilities is being planned. The new cut-



The participants at the conference “Towards other Earths” in Porto.

ting-edge suite of instruments include high angular resolution adaptive optics (AO) imagers, micro-arcsecond astrometry with interferometers, and ultra-stable spectrographs at the cm/s precision level. Synergies of these facilities with space-based observatories will play a key role in the discovery of Earth-mass planets.

What are the requirements that this instrumentation will have to achieve for us to find other Earths? Do we know how to calibrate the instruments to achieve the required superb level of precision and stability? Equally important are the intrinsic limitations of the parent stars, caused by astrophysical phenomena such as stellar activity, granulation or oscillations. How is it possible to deal with and correct for these effects? What are the ultimate limitations of the different techniques for ground- or space-based facilities?

To address these issues, we proposed to ESO that a specific conference be organised to gather together the community of planetary astronomers and instrumentalists working in the field to: i) review the current status of the search for telluric exoplanets, and present our understanding about their formation; ii) discuss the implications of their main physical properties on the detectability limit with different techniques; and iii) draw a coherent picture of the technical and physical issues that we have to solve to succeed in the fabulous endeavour of finding and characterising other Earths.

The scientific programme of the conference started on Monday morning, following the welcome speeches by the organisers, the director of the Centro de Astrofísica da Universidade do Porto and the vice-rector of Porto University, a representative from ESO, and the presi-

dent of the Portuguese Fundação para a Ciência e a Tecnologia.

The scientific programme of talks was divided into three sessions. The first was dedicated to the presentation of the current results and status on prospects for Earth-mass/radius planet detection. The second session considered the astrophysical and technical challenges and solutions towards the detection of other Earths, and the third was entitled “Towards the characterisation of exo-Earths”.

In parallel with the talks, an excellent set of posters, often complementing the information given in the talks, was displayed and available for viewing for the whole week.

Session 1: Status and prospects

The first talks were dedicated to the results of different radial velocity surveys. We learned that HARPS is working at full throttle, with the announcement of 32 new planets (including some low-mass ones) from the HARPS guaranteed time observing (GTO) programme. A press conference (associated with an ESO press release, eso0939) was held, making a tremendous impact on the local and international media. According to the HARPS GTO team, it seems that these planets are just the tip of the iceberg, and that many more will be announced over the next couple of years. In one of the HARPS observing programmes, there is evidence that up to 60% of stars have planets with a mass below 50 times the mass of the Earth.

The derivation of precise radial velocities in the infrared was also a highlight of the first morning. We learned that it is now possible to achieve precisions of the

order of a few metres per second with CRILES, a result that opens up new perspectives for the detection and characterisation of planets around M dwarf stars and more active (younger) stars. Finally, the measurement of the Rossiter-McLaughlin effect during a planetary transit is now providing interesting and unexpected evidence that many short period planets have orbital planes that are misaligned with the stellar equator.

The conference proceeded with a series of talks on the results from transit surveys, both ground- and space-based. The way that these are providing crucial information about planetary interiors was also discussed. It was interesting to learn that, by coupling asteroseismology measurements with transit photometry, we can derive significantly more precise values for the planetary radius. Finally, we learned that in some particular cases the detection of transits from super-Earths is possible using ground-based instrumentation.

The direct imaging of other planets was then the focus of the conference, with some excellent talks describing the most recent results on this topic, and some of the difficulties and advantages of the technique. In particular, we saw that new data confirm some of the previously discovered planets detected in wide orbits, and the discussion is now turning to their formation process.

The first session concluded with a review about the results and prospects for the astrometric and microlensing detection methods. The importance of the astrometric method for the characterisation of exoplanets was outlined, in particular to derive the true masses of radial velocity systems. Finally, the formation and possible composition of other Earths was discussed. Earths and super-Earths should be common, but their composition and evolution is probably dependent on a number of conditions that are hard to predict.

Session 2: Detection challenges

The second session started with a presentation about the ELT instrumentation for Earth-like planet searches and char-

acterisation. We heard that the main purpose of the ELTs will not include the search for planets using astrometry, microlensing or photometric transit techniques (although follow-up using these methods is certainly envisaged). However, a lot is expected from radial velocity and direct imaging, and even the characterisation of their atmospheres is a goal.

Following the Tuesday afternoon social programme, which included a visit to the famous Porto wine cellars and a boat tour on the River Douro, the Wednesday sessions focused on the technical and astrophysical limitations to the detection of other planets using the radial velocity, photometric transit and astrometric techniques. Both the instrumental and astrophysical aspects are providing significant developments. Although stellar intrinsic phenomena and even the existence of multi-planet systems pose some difficulties to the detection of other Earths, a general consensus exists that it will be possible to detect Earth-type planets in the habitable zones of solar-type stars (spectral types G, K and M).

Small M dwarfs may be particularly good targets for transit searches, but new generations of stable spectrographs will also allow the discovery of “exo-Earths” orbiting K and M dwarfs.

Most of Thursday was dedicated to discussion of the challenges and progress achieved towards the direct detection of Earth-like planets with ELTs. We learned that although it will be a difficult task, a number of promising extreme AO instruments are being planned that will allow direct images of planets orbiting other solar-type stars to be made.

Session 3: Exo-Earth characterisation

The final session began late on Thursday, opening the window on an impressive number of results showing how the direct detection and characterisation of exo-atmospheres is a fast-growing field. It is already possible to identify molecules in exoplanet atmospheres, to detect day and night temperature gradients, and to find evidence for atmospheric escape

and variability. The advent of the ELTs will certainly open the way to new exciting science in this field, and may even allow the detection of biosignatures in the atmospheres of exo-Earths. The difficulty of modelling the atmospheres of exo-Earths was presented; however it was suggested that in this field observations will lead the theoretical findings.

Overall, the exceptional quality of the talks contributed to make this a great conference, where many different ideas were presented and discussed. We would thus like to deeply thank the scientific organising committee, the local organising committee and all the participants for making this a memorable event.

All the talks will be available (both in video and in pdf format) on the website¹ of the conference and a DVD will be sent to all the participants.

Links

¹ <http://www.astro.up.pt/toe2009>

Report on the ESO Workshop

Galaxy Clusters in the Early Universe

held at the Gran Hotel Pucón, Chile, 9–12 November 2009

Chris Lidman^{1,2}
Michael West¹

¹ ESO

² Anglo Australian Observatory, Epping, Australia

A workshop bringing together theoreticians and observational astronomers from different wavebands to discuss the current knowledge of galaxy clusters is briefly summarised.

Galaxy clusters are the most massive bound structures in the Universe. The most massive examples contain thousands of galaxies and are about a thousand times more massive than our own Milky Way. Since clusters can be detected from a time when the Universe was only a few billion years old all the way to present day, they serve as unique laboratories for studying environmental influences on galaxy formation and evolution. If we look back far enough we should be able to see clusters, and the galaxies within them, forming. Moreover, the number density of galaxy clusters is sensitive to cosmological parameters,

such as the amount of matter in the Universe, the equation of state of the mysterious dark energy and the primordial power spectrum of density fluctuations.

For these reasons, the search for distant galaxy clusters is currently a very active field, with the number of known distant clusters or proto-clusters increasing rapidly. The detection of distant clusters of galaxies is challenging because methods that have traditionally worked well — such as the detection of the X-ray emission from the hot intracluster gas or optical imaging to detect clusters as enhancements in the projected galaxy