FOURTH AUSTRALIAN EXOPLANET WORKSHOP

25-26 NOVEMBER 2014

PROGRAM

Version: 24 Nov 2014

Talks venue: Q501+Q502 (double room)
5th floor Phoenix Building
USQ TOOWOOMBA

TUESDAY 25 NOVEMBER 2014

09:00 Registration in the foyer beside lecture theatre Q501
09:25 Welcome and notices from the LOC and SOC

SESSION ONE 09:30-10:30 **SESSION CHAIR: STEPHEN MARSDEN**

Brad Carter, USQ brad.carter@usq.edu.au

Space Weather in Planetary Systems

Solar and stellar magnetic fields drive changing "space weather" environments whose planetary impacts are enhanced when the host star is active, when planets orbit closely, or a planet lacks a substantial magnetic field. An overview is presented of USQ research into space weather in planetary systems, including the current focus on observational studies of the magnetic fields of planet hosting stars, and the numerical modelling of stellar winds.

Matthew Mengel, USQ matthew.mengel@usq.edu.au

The Hot Jupiter of Tau Boo

The planet Tau Boo b is a hot Jupiter orbiting around 0.049 AU from its parent star. Investigations of the magnetic field of Tau Boo over several years show a rapid magnetic cycle and other interesting behaviours. Some results are presented and speculation made as to whether the presence of the planet influences the star's magnetic behaviour.

Belinda Nicholson, USQ belinda.nicholson@usq.edu.au

The Winds of Planet Hosting Stars

An important factor in planetary evolution and determining if a planet is habitable is the behaviour of the winds of the host star. Ongoing work is reconstructing the radial magnetic fields of a sample of planet hosting stars from spectropolarimetric observations, and using these magnetic field maps to inform a simulation of their winds using the Block Adaptive Tree Solar-wind Roe Upwind Scheme (BATS-R-US) code. This code was originally written for investigating the behaviour of the Solar wind, but can be re-configured for other systems. The resulting simulations give information about the velocity, pressure and density of the wind outward from the host star, and what influence the winds have on the space weather environment of the planet.

BREAK 10:30-11:00

TUESDAY 25 NOVEMBER 2014

SESSION TWO 11:00-12:00 **SESSION CHAIR: CAROLYN BROWN**

Jonti Horner, USQ jonathan.horner@usq.edu.au

Planetary architecture and periodic climate change

In the next decade, the first truly Earth-like exoplanets will be discovered, and their characterisation will play a vital role in determining which are chosen as targets for the search for life beyond the Solar system. One of the many variables that will be considered in that characterisation and selection process is the nature of the potential climatic variability of the exoEarths in question. In our own Solar system, the long-term variability of the Earth's climate is driven by several factors – including the modifying influence of life on our atmosphere, and the temporal evolution of Solar luminosity. The gravitational influence of the other planets in our Solar system add an extra complication – driving the Milankovitch cycles that are thought to have caused the on-going series of glacial and interglacial periods that have dominated Earth's climate for the past few million years.

James Gilmore, UNSW james.gilmore@unsw.edu.au

Solar System Architecture and Earth's Climate: Jupiter's Influence

Over the last three million years, Earth's climate has been dominated by glacial and interglacial periods, driven by long-term changes in Earth's orbital elements known as Milankovitch cycles. Here I study how Jupiter's orbit influences Earth's Milankovitch cycles and climate. The n-body integrator MERCURY, modified to include post-Newtonian effects, is used to compute the evolution of the Solar System under changes in Jupiter's orbit. I also solve the obliquity equations to form a complete picture of the Milankovitch cycles on Earth. Results indicate that small to moderate changes in Jupiter's orbit can have substantial effects on Earth's climate. By coupling the different architectures to models of Earth's paleoclimate, I highlight Jupiter's role in shaping Earth's ice ages. I will also discuss the implications of this work for exoplanet systems.

Charley Lineweaver, ANU charley.lineweaver@anu.edu.au

A Gaian Bottleneck?

Despite the abundant availability of the prerequisites and ingredients for life, the universe does not seem to be teeming with life (The Fermi Paradox). The most common explanation for this is a low probability for the emergence of life, notionally due to the intricacies of the molecular recipe. We call this the emergence-bottleneck hypothesis. Here we present an alternative explanation, the gaian-bottleneck hypothesis: initially habitable surface environments of rocky planets quickly become uninhabitable due to positive feedback mechanisms involving atmospheric volatiles, temperature and albedo. If life emerges on a planet, biotically mediated mechanisms can evolve to regulate atmospheric volatiles, temperature and albedo. However, the timescales required for the emergence of such gaian regulation may be much longer than the abiotic timescale for atmospheric evolution away from habitability. Such a gaian-bottleneck suggests that a rocky planet might need to be inhabited, to remain habitable.

LUNCH 12:00-13:00

TUESDAY 25 NOVEMBER 2014

SESSION THREE 13:00-14:00 **SESSION CHAIR: ROB WITTENMYER**

Matthew Davie, UNSW m.davie@student.unsw.edu.au

The spectral library of the Anglo-Australian Planet Search

The AAPS has been observing stars and finding planets since 1997. During this time the spectra of all these observations have been used only for the determination of radial velocities. These spectra were obtained though an Iodine cell to give precise wavelength determination. This talk will briefly discuss the reduction of these spectra, Iodine removal, and interesting opportunities with the resulting spectral library.

Joao Bento, Macquarie University joao.bento@mq.edu.au

Update on the status of the RHEA spectrograph

The detection of exoplanets using Radial Velocity (RV) measurements is commonly limited by the temperature and pressure stability of spectrographs and efficient fibre scrambling. Additionally, noise from stellar activity is becoming increasingly important, particularly in giant stars, where the amplitude of pulsations is comparable to RV signals from hot-Jupiters. Thus, long-baseline RV measurements are required to measure the intrinsic pulsations of the host star and de-correlate them to search for the planetary signals using asteroseismological analysis, which also provides an insight into the stellar structure. This is impractical using large telescopes, but possible to do on bright stars with 0.2-0.4m class telescopes, provided they can be fitted with cheap high-resolution spectrographs. In this talk I will report on the current status of development of the RHEA spectrograph, an inexpensive compact single-mode fibre-fed spectrograph being developed at Macquarie University currently serving as the basis for a series of spectrographs also being deployed on other amateur sized telescopes for exoplanet and asteroseismological studies.

Jeremy Bailey, UNSW j.bailey@unsw.edu.au

HIPPI - A high sensitivity polarimeter for exoplanet characterisation

HIPPI (High Precision Polarimetric Instrument) is a polarimeter built at UNSW for use on the Anglo-Australian Telescope. It is designed to measure polarisation at the parts per million level which should enable it to detect polarised scattered light from hot Jupiter type exoplanets. HIPPI has now had two successful runs on the telescope. I will describe the instrument and its performance and present preliminary results from our exoplanet observations.

BREAK 14:00-14:30

TUESDAY 25 NOVEMBER 2014

SESSION FOUR 14:30-15:30 **SESSION CHAIR: BELINDA NICHOLSON**

Lucyna Kedziora-Chudczer, UNSW lkedzior@unsw.edu.au

Examining atmospheres of the hottest "hot Jupiters"

Observations of transits and eclipses of extra-solar planets provided insights into the composition, structure and dynamics of their atmospheres. Challenges in obtaining multi-wavelength information for almost all but the very massive and highly irradiated "hot Jupiters" mean that these are the planets best studied so far. These hottest planets were predicted to host a strong thermal inversion ! zone due to the presence of gaseous molecules of TiO and VO in their atmospheres, but observations seem to contradict this expectation. I will focus on the effects observed in secondary eclipse spectra when the specific conditions such as pressure-temperature structure, metallicity and carbon abundance (C/O ratio) in the atmosphere are varied. I will present modelled spectra for some of the hottest "hot-Jupiters": WASP-19b, WASP-12b, WASP-33b and Corot-2b that were obtained by using the VSTAR radiative transfer code, compare them with published data and discuss possible reasons for the lack of inversion zones in their atmospheres.

Kimberly Bott, UNSW k.bott@student.unsw.edu.au

Precision polarimetric measurements of exoplanetary systems

Over the past ten years, the characterisation of exoplanets has become a predominant expansion of the field. The use of polarised light for exoplanetary characterisation, however, has been relatively overlooked outside of a few cases, in spite of being both complimentary to other characterisation methods and expansive in its capabilities. We present new high precision polarimetric measurements of exoplanetary systems both with and without previous claimed detections. The observations are from the HIPPI polarimeter (HIgh Precision Polarimetric Instrument) on the Anglo-Australian Telescope (AAT), and are combined with other characterisation work on the planetary systems.

Daniel Cotton, UNSW d.cotton@unsw.edu.au

Telluric Removal for Exoplanet Spectra

High resolution cross-correlation techniques represent one method for identifying molecular components of exoplanet atmospheres. Such techniques involve taking high resolution spectra of a star-exoplanet system and cross-correlating it with a template spectrum. The planet will have a large radial velocity amplitude, causing the planetary atmospheric absorption features to shift with orbital phase. This allows the cross-correlation peak to be searched for with radial velocity and systematic velocity. However, for this technique to work well, telluric absorption lines must be very carefully removed. It is particularly important that they be removed precisely when searching for an atmospheric constituent that is present in our own atmosphere. Here I will talk about our atmospheric fitting software ATMOF, and the advantages it offers in removing telluric features from our spectra. I will begin by looking at the improvement over traditional techniques with ATMOF by examining atmospheric spectra of solar system bodies, before going on to examine data for Wasp 43b.

BREAK 15:30-16:00

TUESDAY 25 NOVEMBER 2014

SESSION FIVE 16:00-16:40 **SESSION CHAIR: LUCYNA KEDZIORA-CHUDCZER**

Chris Tinney, UNSW c.tinney@unsw.edu.au

An update on the FunnelWeb and Veloce Projects

Daniel Bayliss, ANU daniel.bayliss@anu.edu.au

Photometric Follow-up of Transiting Planets

One of the advantages to finding transiting exoplanets is the detailed characterisation that can be performed on the systems. I will discuss two photometric follow-up programs that are aimed at measuring the precise radii and the temperature of exoplanets. These programs are undertaken using facilities at Siding Spring Observatory.

WORKSHOP DINNER
18:30 Free bus departs USQ Baker Street bus stop for restaurant:
Kajoku
430 Ruthven St
Toowoomba
ph 07 4564 9229
19:00 Dinner starts
22:00 Free bus departs restaurant for USQ Baker Street bus stop

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WEDNESDAY 26 NOVEMBER 2014

09:00 Information desk open at the foyer beside lecture theatre Q501
09:25 Notices from the LOC and SOC

SESSION SIX 09:30-10:30 **SESSION CHAIR: JONTY MARSHALL**

Anthony Cheetham, University of Sydney a.cheetham@physics.usyd.edu.au

Direct imaging of exoplanets in transition disks

Transition disks are thought to represent a short-lived phase in the evolution of circumstellar disks, an intermediate stage between gas rich protoplanetary disks and rocky debris disks. These objects present ideal laboratories to study planet formation. Several possible explanations exist to explain the origin of the annular disk gaps that define the class, including photoevaporation and dynamical interaction with a binary companion. One exciting hypothesis invokes the presence of giant planets that sweep up material from the disk as they form. In recent years, several companion candidates have been discovered. However, disk asymmetries and projection effects can make it difficult to decide which signals are indeed companions. In this talk I will present recent results from studies of these objects.

Nicolas Cuello, Centre de Recherche Astrophysique de Lyon nicolas.cuello@univ-lyon1.fr

Photophoresis in protoplanetary disks: a numerical approach

It is thought that rocky planets are formed in the inner regions of protoplanetary disks (PPD) about 1 - 10 AU from the star. However, it can be theoretically shown that when particles reach a size of about 1 meter they tend to be accreted very efficiently by the star. This is known as the radial-drift barrier. We explore the photophoresis in the inner regions of PPD as a possible mechanism for preventing the accretion of solids bodies onto the star. The photophoresis force has been included in our two-fluid (gas+dust) SPH code, which includes grain growth, in order to study its efficiency. I will show how this process shapes the inner rim of protoplanetary disks and its effects on grain growth.

Andrew Prentice, MOCA, Monash Univ.; Astrophysics Group USQ andrew.prentice@monash.edu

A concentric system of rings in the dust disc of HL Tauri with ALMA

This talk concerns the implications for theories of planet formation of the recent discovery by ALMA of a concentric system of rings in the dust disc of HL Tauri. A prediction is offered for the origin and structure of the asteroid Ceres

BREAK 10:30-11:00

WEDNESDAY 26 NOVEMBER 2014

SESSION SEVEN 11:00-12:00 **SESSION CHAIR: DAN BAYLISS**

Rob Wittenmyer, UNSW rob@unsw.edu.au

MINERVA: Small planets from small telescopes

I give an update on the LIEF-funded MINERVA project (MINiature Exoplanet Radial Velocity Array): a dedicated exoplanet observatory with the primary goal of discovering rocky, Earth-like planets orbiting in the habitable zone of bright, nearby stars. Small planets are extremely common, and it is likely that nearly every star in the sky hosts at least one rocky planet. We just need to look hard enough - but this requires vast amounts of telescope time. The way forward is to own the telescope. We have joined with Harvard, Caltech, Penn State, and Montana to build the 4-telescope MINERVA array, sited at Mt Hopkins in Arizona, USA. Full science operations will begin by 2015 March with all four telescopes and a stabilised spectrograph capable of high-precision Doppler velocity measurements. We will observe the 80 nearest, brightest, Sun-like stars every night for at least five years. Detailed simulations of the target list and survey strategy lead us to expect 12+/-3 new low-mass planets, with 3+/-1 in the habitable zone. Finally, I propose a complementary MINERVA-South facility to take advantage of the wealth of planet candidates which will come from K2, TESS, and AST-3.

Christoph Bergmann, University of Canterbury christoph.bergmann@pg.canterbury.ac.nz

Searching for Earth-mass planets around alpha Centauri

For the last five years we have been undertaking an extensive observational campaign that aims to detect terrestrial planets in our neighbouring star system alpha Centauri using the Doppler method. The most challenging problem we have encountered in reducing the observations is the spectral cross-contamination from the other star due to the small angular separation between the two components of the alpha Cen AB binary system. In order to overcome this complication we have accurately determined the amount of contamination for every observation by measuring the relative strengths of the H-alpha and NaD lines. We have also developed a modified version of a well established Doppler code that takes the contamination into account by modelling the observations using two stellar templates simultaneously. We present some promising initial results obtained with this new data reduction pipeline and comment on the detectability of Earth-mass planets in the alpha Centauri system. After correcting for the contamination we achieve radial velocity precision of typically 2.5 ms^{-1} for a given night of observations, which is a significant improvement of the radial velocity scatter compared to the uncorrected velocities, thus increasing the chances of detecting any potential terrestrial planets. Double-lined spectroscopic binaries present a similar case of composite spectra. Therefore, we have also applied this new Doppler code to several double-lined spectroscopic binary systems and have successfully recovered radial velocities for both components simultaneously.

Michael Albrow, University of Canterbury Michael.Albrow@canterbury.ac.nz

pyDIA: GPU-accelerated difference-imaging photometry

I will describe pyDIA, a new code for difference imaging and photometry. pyDIA is a flexible python package for building data pipelines. The difference-imaging part of the code implements the extended delta basis functions approach of Bramich et al. (2013) for kernel definition. This allows independent control of the degree of spatial variation for the differential PSF shape and photometric scaling. Embedded CUDA GPU code is used for the computationally intense tasks of determining the convolution kernel and PSF photometry.

LUNCH 12:00-13:00

WEDNESDAY 26 NOVEMBER 2014

SESSION EIGHT 13:00-14:00 **SESSION CHAIR: JONTI HORNER**

Daniel Huber, University of Sydney / SETI Institute dhuber@physics.usyd.edu.au

Exoplanet Characterization and Occurrence Rates in the Kepler Mission Closeout

The Kepler Mission has entered its closeout phase, which is aimed at producing planet-candidate catalogs using the full mission data and computing planet occurrence rates through a detailed characterization of the transit detection pipeline and the stellar parent sample. I will discuss recent Kepler exoplanet discoveries and present first results of ongoing efforts by the Kepler team to derive occurrence rates as a function of planet size and orbital period. In particular, I will highlight the importance of accurate stellar properties for deriving planet occurrence rates, and discuss the latest status of the Kepler star properties catalog. I will also give a brief outlook on future exoplanet science to be expected from Kepler\'s ecliptic plane follow-up mission, K2.

Timothy Bovaird, ANU timothy.bovaird@anu.edu.au

The expected detection rate of predicted planets in Kepler systems

Previous predictions for the periods of undetected exoplanets in multiple planet systems have resulted in the successful prediction of 7 new Earth-sized Kepler candidates. This equates to a detection rate of 5% - but what rate should be expected if the predictions are sound? For transiting exoplanets, the questions are will the planet transit, and will the transit result in a detectable signal? By identifying a subset of predictions with a high transit probability, we can reduce one of these factors and increase our detection rate. We expect these predictions will result in the detection of > 10 new Earth-sized planets in multiple planet Kepler systems.

Haiyang Wang, ANU haiyang.wang@anu.edu.au
Charles Lineweaver, ANU charley.lineweaver@anu.edu.au

Chemical Fractionation Patterns of a Terrestrial Planet and its Moon

Based on a detailed comparison of the best estimates of the bulk chemical composition of the Sun, Earth and Moon, one can identify the patterns of chemical fractionation that led to their current bulk chemistry. The dominant pattern is devolatilization. Elemental abundance as a function of condensation temperature shows that the Earth and Moon are devolatilized parts of the solar nebula. Using improved condensation temperatures, as well as core/mantle and crust/mantle partition coefficients we aim to improve the quantification of the depletion of siderophiles from the Moon as well as the depletion of incompatible lithophilic elements by the early heavy bombardment.

BREAK 14:00-14:30

WEDNESDAY 26 NOVEMBER 2014

SESSION NINE 14:30-15:30 **SESSION CHAIR: KIM BOTT**

Alexandra Greenbaum, Johns Hopkins University agreenba@pha.jhu.edu

Mind the Gap: Non-Redundant Masking on the Gemini Planet Imager

Duncan Wright, UNSW duncan.wright@unsw.edu.au

Improvements in techniques for hunting low-mass planets orbiting M Dwarfs

I will outline a new method developed for the reduction of high-resolution spectroscopic data and show its application to HERMES, HARPS and UCLES+CYCLOPS data. In addition I will show how this new technique allows a re-analysis of HARPS archival data and a deeper analysis of my own UCLES+CYCLOPS data in the search for low mass planets orbiting M Dwarf stars.

Chris Tinney, UNSW c.tinney@unsw.edu.au

The Luminosities of the Coldest Brown Dwarfs

In recent years, brown dwarfs have been extended to a new Y-dwarf class with effective temperatures colder than 500 K and masses in the range 5–30 Jupiter masses. They fill a crucial gap in observable atmospheric properties between the much colder gas-giant planets of our own solar system (at around 130 K) and both hotter T-type brown dwarfs and the hotter planets that can be imaged orbiting young nearby stars (both with effective temperatures of in the range 1500–1000 K). We report new distances for nine Y dwarfs and seven very late T dwarfs. These reveal that Y dwarfs do indeed represent a continuation of the T-dwarf sequence to both fainter luminosities and cooler temperatures. They also show that the coolest objects display a large range in absolute magnitude for a given photometric color. The latest atmospheric models show good agreement with the majority of these Y-dwarf absolute magnitudes. This is also the case for WISE0855-0714, the coldest and closest brown dwarf to the Sun, which shows evidence for water ice clouds. However, there are also some outstanding exceptions, which suggest either binarity or the presence of condensate clouds. The former is readily testable with current adaptive optics facilities. The latter would mean that the range of cloudiness in Y dwarfs is substantial with most hosting almost no clouds—while others have dense clouds, making them prime targets for future variability observations to study cloud dynamics.

BREAK 15:30-16:00

SESSION TEN: 16:00-17:00 **DISCUSSION & WORKSHOP CLOSE**

POST-WORKSHOP ACTIVITIES
WED 26 NOVEMBER
18:30 Arrive for Public Talk at H102 (Allison Dickson Lecture Theatre), USQ Toowoomba
19:00 Public Talk on 'Exoplanets & Life Elsewhere' by Dr Jonti Horner
(RSVPs: hes.engage@usq.edu.au or telephone 07 4631 2813)
THU 27 NOVEMBER
09:00 Free bus tour to Mt Kent Observatory, departs from USQ Baker Street bus stop
12:00 Bus departs from Mt Kent Observatory for USQ Baker Street bus stop
12:30 Bus returns to USQ
