OHP - 2015 colloquium

20 Years of Giant Exoplanets

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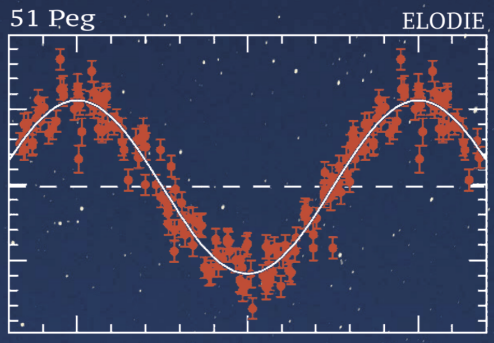

- Transiting giant exoplanets
- Jupiter-like planets from long-term RV surveys
- Directly imaged planets
- Atmosphere characterization
- Internal structure modeling
- Dynamics of systems: from observations to theory
- Formation and migration scenarios
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Abstracts Booklet

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Monday

Session 1

Results from Radial Velocities Surveys

Chair : D. Fischer

Radial Velocity Surveys

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Abstract

Radial velocity surveys were initiated more than 35 years ago. It is only 20 years ago that a first gaseous giant planet was discovered at OHP. This first detection by Doppler spectroscopy was followed by some 1000 additional detections based on the same indirect approach. This technique revealed the impressive diversity of planetary systems, multiplanetary systems, the existence of a rich subpopulation of Super-Earths, Rossiter-McLaughlin effect revealing unexpected orientation of orbital planes, resonnant orbits, ...Already large surveys allow to get some statistical distributions as function of host star metallicity, orbital periods and planetary masses. These distributions constrain the physics of planetary formation. Radial velocity measurements of transiting planets open the way to comparative planetology. ..... what could be the future of radial velocity spectroscopy ?

Keywords: Planetary systems, radial velocity surveys

*Speaker

ELODIE & SOPHIE spectrographs: 20 years of continuous improvements in radial velocities

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Abstract

From the first light of ELODIE spectrograph in 1993 to the recent upgrade of SOPHIE, radial-velocity precision was improved by an order of magnitude. The different steps of instrumental refinement are described and their impact on the detection and characterization of giant exoplanets are highlighted. Synergies of these two instruments with other detection technics like photometric transit, direct imaging and astrometry are presented with a special focus on the space missions GAIA, CHEOPS, TESS and PLATO

Keywords: Techniques: radial velocities, Planetary systems

*Speaker

20 Years of Precise Radial Velocities: Jupiter Analogs and Other Long-Period Giant Planets

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Abstract

The precise radial velocity survey at Keck Observatory began over 20 years ago. Its survey of thousands of stars now has the time baseline to be sensitive to planets with decade-long orbits, including Jupiter analogs. We present several newly-finished orbital solutions for long-period giant planets. Although hot Jupiters are generally "lonely" (i.e. they are not part of multiplanet systems), those that are not appear to often have giant companions at 5 AU or beyond. We present two of the highest period-ratios among planets in a two-planet system, and some of the longest orbital periods ever measured for exoplanets. Although many giant planets have highly eccentric orbits, many examples of circular orbits among long-period planets exist.

In many cases, combining Keck radial velocities from those from other long-term surveys at Lick Observatory, McDonald Observatory, the Anglo-Australian Observatory and, of course, OHP, produces superior orbital fits, constraining both period and eccentricity better than could be possible wiith any single set alone.

Keywords: giant exoplanets, long, period exoplanets, Jupiter analogs, Keck Observatory

*Speaker

15 years of giant exoplanets at McDonald Observatory: Survey Update

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[2]McDonald Observatory – United States

Abstract

I will present new results from the McDonald Observatory exoplanet survey. The survey has monitored the RVs of hundreds of nearby stars over 15 years, and is sensitive to true Jupiter analogs. We have recently discovered new Jupiter analogs around the solar-type stars HD 95872 and psi1 Draconis B. We have also discovered periodic RV signals for beta Virginis and HD 10086 that appear to be massive exoplanets, but are actually caused by long-period magnetic cycles. I will present preliminary estimates of the survey's completeness, and the resulting occurrence rates for Jupiter analogs.

Keywords: survey, McDonald Observatory, Radial Velocity, Jupiter analogs

*Speaker

Radial velocity search for long-period exoplanets and brown dwarfs with ELODIE and SOPHIE

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Abstract

Since end of 2006, the SOPHIE Exoplanets Consortium conducts a large program to search for exoplanets by radial velocity method. Our subprogram focuses on the follow-up of the drifts and long-period signals detected within the ELODIE historical program initiated on the 1.93-m telescope at Observatoire de Haute-Provence (OHP) in 1994. Since 2007, we have continued this program with the SOPHIE spectrograph with the objective to characterize orbital parameters of exoplanets similar to Jupiter and Saturn and brown dwarfs with orbital periods longer than 8-10 years. About 50 targets with a slow radial velocity drift were selected from the original ELODIE sample and are follow-up with SOPHIE. This nonsuch sample allows to extend the time base over 20 years to find sub-stellar companions beyond 5 UA. As part of this subprogram, we report the detection of new Jupiter-analogs and new brown dwarf companions and discuss their properties. Such targets are prime targets for high-angular resolution direct imaging.

We also discuss diagnostics to disentangle long-term radial velocity trend with stellar magnetic cycles. For this, we use the Ca II H & K lines, but we are currently extending this analysis using H-alpha lines. In parallel to this program, we follow-up with SOPHIE a sample of known transiting hot Jupiters from WASP, HAT, Kepler and CoRoT surveys in order to reveal additional long-period companion within the system. The orbital properties of hot Jupiters are the result of dynamical evolution that may involve interaction with massive external companions in the system. Detection of additional long-period companions is crucial for dynamical studies of these systems. We report preliminary results of this program.

Keywords: Exoplanets, Brown Dwarfs, Radial Velocities

*Speaker

Monday

Session 2

Radial Velocities and the Metallicity Correlation

Chair : A. Sozzetti

Reaching out: a Bayesian approach to detecting giant planets beyond the ice line.

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Abstract

With over 20 years of radial velocity observations under the belt, the architecture of extrasolar systems out to the ice line and beyond could in principle be probed. However, two factors act as the main limitations for this endeavour. Firstly, no single unmodified RV instrument has when uninterruptly observing for twenty years: ELODIE was replaced with SOPHIE in 2006, HIRES was upgraded in 2004, CORALIE was upgraded in 2007 and again in 2014. Even HARPS, which remained untouched for over ten years, has recently been upgraded. This implies that intrument offsets have to be dealt with correctly to avoid mistaking spurious signals with actual long-period giant planets. Secondly, many solar-type stars exhibit activity cycles or variations with typical timescales between a few years and a couple of decades. These cycles induce RV signals that can be mistaken with long-period planets. Morever, if these variations are not fully corrected, they can contaminate the RV time series at higher frequencies. In this talk we introduce a Bayesian data analysis technique designed to deal with these issues. This approach should provide the optimal detection limits for (giant) planets on long period orbits, while incorporating all available information, such as the correlation between activity proxies and the induced RV signal, and the information on instrument offsets coming from calibrations using a large set of stars. Furthermore, the results from these analyses can, in principle, also teach us about the RV spectrographs used. The analysis of three ELODIE+SOPHIE systems exhibiting RV variations in long time-scales will serve as case study for the application of this technique.

Keywords: radial velocities, statistical techniques, long, period planets, SOPHIE, ELODIE

*Speaker

Astrophysical limitation to the detection of giant planets

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Abstract

Due to their important mass, giant planets are the easiest type of planet to detect using the radial velocity (RV) technique. However in the case of stars more active than the Sun, or when searching for long-period giant planets like Jupiter, signals induced by the hosting star can prevent the detection of these massive objects.
From the Mount-Wilson survey, and more recently the results from the Kepler satellite, we know that stars much more active than the Sun are common in the Galaxy. Those stars are generally younger than the Sun and therefore rotate much faster, implying a stronger dynamo effect. This stronger effect results in large spotted areas on the stellar surface, which coupled with the rapid rotation induce RV variations that can exceed a hundred of meter-per-second. This RV signals induce by the star itself can prevent the detection of giant planets, even if they are orbiting close to their parent star. The common trend in RV survey is to reject those very active stars, as it will be difficult to find planets around them. However by using specific diagnostics, we can understand the signal induced by the star, and correct for it to a certain extend that enables the detection of these giant planets. It is extremely useful to study those systems to understand the formation scenarios of planetary systems.

Stellar activity of quiet stars similar to the Sun can also be a problem when we want to detect Jupiter-like planets, i.e. giant planets orbiting with several years of period. On those timescale, RV measurements are affected by stellar magnetic cycles. Indeed, it has been shown that during a magnetic cycle, stellar convection changes which induces a RV variation. For the Sun, the 11-year magnetic cycle is supposed to induce a 15 m/s amplitude signal, which would be extremely similar to the RV signal induced by Jupiter.
In conclusion stellar activity, on the short-term due to stellar rotation, or on the long-term due to magnetic cycles can prevent the detection of giant planets. In this talk, I propose to review our knowledge of stellar activity and present the different techniques to mitigate their impact on the detection of giant planets.

Keywords: stellar activity, giant planets, magnetic cycles, stellar rotation

*Speaker

The frequency of planets around metal-poor stars: first results from an intensive RV search.

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Abstract

The frequency of giant planets around main-sequence stars is highly dependent on one of the host stars properties: metallicity. The higher frequency of these planets around metal-rich stars was made clear since the first years of radial-velocity discoveries and explained in the context of planetary formation by the core-accretion mechanism. Yet, little is known about planet formation in low metallicity environments, and the formation of light planets (with a mass similar to Neptune or lighter) seems not to depend on the metal content of the host star.
To address this issue we started an ESO Large Program using the HARPS spectrograph and targeting quiet, low-metalicity stars without detected planets. Here we report the first results from this 10-year long study and the constraints it imposes on the frequency of planets around metal-poor stars.

Keywords: Planets, metallicity, RV

*Speaker
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The Planet-Metallicity Correlation for Hot Jupiters

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Abstract

Very soon after the discovery of the first few Hot Jupiter systems, it was noticed that the host stars tended to be preferentially metal-rich. This trend continued as more planets were discovered in subsequent years. Now, after many studies, it appears there is a robust correlation between planet frequency and host star metallicity. This correlation provides strong evidence for planetary formation via core-accretion. In this study I revisit the planet-metallicity correlation for a sub-set of exoplanets - namely giant planets in short period (< 10d) orbits. I use a sample free from significant selection bias and compare my results to the existing literature in order to help determine the orgin of the correlation.

Keywords: metallicity, hotjupiter, correlation, frequency

*Speaker

Monday

Session 3

Open Clusters and Giant Stars

Chair : M. Deleuil

Giant Planets in Open Clusters

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Abstract

Two decades after the discovery of 51 Peg b, more than 200 hot Jupiters have now been confirmed, but the details of their inward migration remain uncertain. While it is accepted that short period giant planets could not have formed in situ, several different mechanisms (e.g., Type II migration, planet-planet scattering, Kozai-Lidov cycles) may contribute to shrinking planetary orbits, and the relative importance of each is not well-constrained. Migration through the gas disk is expected to preserve circular, coplanar orbits and must occur quickly (within _˜10 Myr, before the gas dissipates), whereas multi-body processes should initially excite eccentricities and inclinations and may take hundreds of Myr. Subsequent evolution of the system (e.g., orbital circularization and inclination damping via tidal interaction with the host star) may obscure these differences, so observing hot Jupiters soon after migration occurs can observationally constrain the importance of each mechanism. Fortunately, the well-characterized stars in young and adolescent open clusters (with known ages and compositions) provide natural laboratories for such studies, and recent surveys have begun to take advantage of this opportunity. We present a review of the discoveries in this emerging realm of exoplanet science, discuss the constraints they provide for giant planet formation and migration, and reflect on the future direction of the field.

Keywords: open clusters, hot Jupiters, migration

*Speaker

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Occurrence rate of giant planets around giant stars with 3-4 solar masses

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[3]Tokyo Institute of Technology (TITECH) – Japan

Abstract

The occurrence rate of giant planets is known to depend on stellar mass and metalicity.An interesting feature is that only a few giant planets are found around giant stars with masses of more than 3 solar masses by the radial velocity (RV) method and the occurrence rate of giant planets in close-in orbits seems to be low. However, the lack of giant planets may be due to observational biases caused by a small number of sample stars and high detection limits in previous Doppler surveys of massive stars. Unfortunately, it is difficult to perform precise Doppler surveys of massive main-sequrence stars because the giant stars typically have fast rotations and a few atmospheric absorption lines. Only evolved stars that have higher surface activity and larger RV jitters than solar type stars are targets of the Doppler surveys. To address the stellar mass dependence of planetary systems and the rate of giant planets around massive stars, we have carried out a precise Doppler survey of giant stars with masses of 3-4 solar masses and metallicity of [Fe/H] = -0.1-0.3 since 2010. In our survey, we made precise RV measurements of sample stars using the Okayama Astrophysical Observatory (OAO) 188cm telescope and the HIgh Dispersion Echelle Spectrograph (HIDES) by a calibration technique with an Iodine absorption cell. Based on our survey over 3 years and results of other Doppler surveys, we estimated occurrence rates of giant planets around 3-4 solar masses stars and discuss relationships between the stellar mass and the occurrence rates.

Keywords: occurence rate, giant planet, intermediate mass giant stars

*Speaker

The Hunt for Planets in Open Clusters with HARPS and HARPS-N

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Abstract

Thousands of extrasolar planets have been discovered so far, and after the pioneer era, when the discovery of a single planet was a notable event, the interest is moving to the more complex work of planet and planetary system taxonomy, trying to put some order and eventually understand why they are so different from each others.
The characterization of planets is tied to the knowledge of its host host star. Nearly all planets known so far belong to isolated field stars, and their mass and radius are affected by large errors that transfer directly onto the precision of the planet parameters. On the contrary, distances, ages, mass and overall characteristics of stars in Open Clusters are much better measured than for field stars. OC stars are chemically homogeneous, so we can effectively investigate the effect of the presence of a planetary systems on the host star chemistry, e.g. if the observed trend of chemical elements with respect to their condensation temperature is effectively related to the presence planets.

Curiously, at the present time, only less than ten planets have been confirmed or validated around Main Sequence stars in OCs.
In this proposed talk I will give a short historical review on previous searches for exoplanets in OCs, then I will introduce our on-going survey aimed at detecting Neptune-mass planets around close, intermediate-age OC stars with HARPS (8 night/year) and HARPS-N (5 nights/semester, within the GAPS program). I will discuss our observational strategy and how we are dealing with activity, the main limiting factor in this kind of research. and the impact of the forth-coming K2 observations on our search. I will finally present our latest discoveries, including the first planetary multiple system around a OC star.

Keywords: Open Clusters, HARPS, HARPS, N

*Speaker
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Tuesday

Session 4

Results from Transit Surveys

Chair : F. Bouchy

Ground based surveys of Giant Planets: past successes and future challenges

Don Pollacco

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Abstract

Since the first transiting planet was found in 1998 ground based surveys have played a leading role in the discovery and characterisation of gas giants. These planets have some of the most accurately known physical parameters that have enabled comparison to theoretical models. While there are many outstanding issues, we have learnt much about this population. Here I will review the contribution these surveys have made to subject along with the potential contribution from the new generation of planet surveys currently being deployed. I will also discuss the future of ground based surveys in the era of TESS.

Structure and evolution of transiting giant planets: a Bayesian homogeneous determination of orbital and physical parameters.

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Abstract

We present a Bayesian homogeneous determination of orbital and physical parameters of a large sample of 211 giant transiting planets with masses between 0.1 and 25 Mjup and precision on mass estimates better than 30%. We analyze new high-precision radial velocities for forty-five of them with the HARPS-N@TNG spectrograph to improve and, in some cases, to revise the measure of their orbital eccentricity, and to search for long-period companions. Moreover, from updated determinations of orbital eccentricities we put constraints on the modified tidal quality factors of giant planets and their host stars. Our comprehensive study 1) allows for improved understanding of orbital evolution and migration scenarios for giant planets and, in general, the architecture of planetary systems with Jupiter-sized planets, and 2) provides the much needed benchmark statistics for thorough investigations of the diversity of giant planet densities and interior structures.

Keywords: radial velocity, orbital evolution, interior structures, Bayesian analysis

*Speaker

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The physical properties of giant transiting exoplanets within 400 days

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Abstract

At a time when small planets in the habitable zone are found, not all the questions about giant planets have been answered. For example, their formation, migration and evolution are far from being fully understood. In this context, the Kepler space mission is providing unprecedented constraints to theories by probing transiting giant planets in a wide range of orbital periods. In this talk, we will present the results of a 6-year spectroscopic survey with the SOPHIE spectrograph of the transiting giant-planet candidates detected by Kepler within 400 days of period. First, we will describe the giant-planet candidate sample from the Kepler catalog and our spectroscopic observations which allowed us to screen out more than half of the candidates as false positives. Then, we will present the occurrence rate of giant planets, based on our sample cleaned from fake transiting planets, and compare it with other surveys. Finally, we will discuss the physical properties of the giant transiting planets within 400 days of period and compare them with predictions from planet-synthesis models.

Keywords: transit, planet statistics, giant planets, spectroscopic observations

*Speaker

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Disentangling planetary and starspots features

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Abstract

We present an analytically-based method to disentangle the signature of a planet from that of starspots on the surface of a magnetically active star. The approach is based on a model developed by Montalto et al. (2014), which calculates the normalized photometry from a given coverage of starspots on a limb-darkened transited star. We complete it with the calculation of the time evolution of the spots, following the prescription of Kipping (2012). We include this model into a consistent Markov chain Monte Carlo software, developed at LAM for the combined fit of photometric and spectroscopic data of transiting planets.
Our code aims to be comparable in speed to a code for normal transit fit. We apply it to a canonical example of transiting planet around an active star, CoRoT-2b. We use the brightness variations in the whole light curve to explore the correction of the activity and further measure the transit depth.

Keywords: transits stellar activity

*Speaker

The legacy of the CoRoT mission

Roi Alonso

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Abstract

CoRoT (Convection, Rotation et Transits planètaires) was the first space mission with the search for exoplanets as one of its main goals. Launched in December 2006, and operating until November 2012, it observed 26 different fields close to the galactic plane, with durations ranging from a few days up to ~150 days. Light curves for about 160.000 stars are in the database, with the final legacy data release expected this year.
I will review the highlights of the mission, its main difficulties, challenges, and lessons learned, and the expected improvements of the legacy data release.

First K2 mutiplanetary system showing TTVs

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Abstract

In traditional transit timing variations (TTVs) analysis of multi-planetary systems, the individual TTVs are first derived from transit fitting and later modeled using n-body dynamic simulations to constrain planetary masses.
I will show that fitting simultaneously the transit light curves with the system dynamics (photo-dynamical model) increases the precision of the TTV measurements and helps constrain the system architecture. I will exemplify the advantages of applying this photo-dynamical model to a multi-planetary system found in K2 data very close to 3:2 mean motion resonance. In this case the period of the larger TTV variations (libration period) is much longer (more than 1.5 years) than the duration of the K2 observations (_˜80 days). However, our method allows to detect the short period TTVs produced by the orbital conjunctions between the planets that in turn permits to uniquely characterize the system. Therefore, our method can be used to constrain the masses of near-resonant systems even when the full libration curve is not observed and hence will help understanding evolution of these interesting systems.
Finally, I will summarize the results of our follow-up of K2 transit candidates with Sophie. We have developed a pipeline to obtain K2 light curves that we analyze with an adapted version of the CoRoT alarm pipeline. The best exoplanet candidates are then followed up with Sophie.

Keywords: multi, planetary systems, transit timing, K2 follow, up

*Speaker

Exploring Temperate Giants using Transit Timing Variations

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Abstract

The Kepler mission had a revolutionary span of continuous photometric monitoring and, for the first time, enabled the discovery and tracking of many giant planets with periods of tens to hundreds of days. We present new Spitzer measurements that extend the Kepler baseline, shore up dynamical interpretations, and reduce error bars in three scientifically compelling systems: Kepler 90, Kepler 297, and KOI 564. We describe the discovery of two non-transiting planets, characterization of mean-motion resonances, and additions to the mass-radius diagram in a valuable temperature regime. Observational projects directed towards the follow-up of long-period Kepler objects are well-poised to teach us about the formation and evolution of planets that halted their inward migration prior to becoming hot Jupiters like 51 Peg b.

Keywords: transiting giant exoplanets, dynamics of systems, link from observations to theory, formation and migration scenarios

*Speaker
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The Unique Links Between Transiting Hot Jupiters and Transiting Brown dwarfs

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Abstract

There are currently ten known transiting brown dwarfs, seven of which orbit single main-sequence stars. These systems give us one of the only ways in which we may directly measure the masses and radii brown dwarfs, which in turn provides strong constraints on theoretical models of brown dwarf interiors and atmospheres. In addition, the transiting brown dwarfs allow us to forge a link between our understanding of transiting hot Jupiters, and our understanding of the field brown dwarf population. This gives us a unique avenue to explore the role and interaction of surface gravity and stellar irradiation in the atmospheres of sub-stellar objects. Comparing the two types of objects also provides insight into the L/T transition in brown dwarfs, and atmospheric chemistry changes in hot Jupiters. I will discuss recent observational results, with a particular focus on the transiting brown dwarf KELT-1b, and suggest how more of these important systems may be discovered in the future.

Keywords: hot jupiters, brown dwarfs, transits, atmospheres

*Speaker

Tuesday

Session 5

Stellar Obliquities and the Origin of Hot Jupiters

Chair : P. Wheatley

Measurements of Stellar Obliquity: Probing the Dynamical History of Giant Exoplanets

Teruyuki Hirano*[1]

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Abstract

The origin of close-in giant planets is an enduring problem in the exoplanetary science. The key process is the planet "migration" from their birth-places. Many migration scenarios have been proposed and investigated both observationally and theoretically. One promising observational approach is to measure the obliquity of planet-hosting stars with respect to planetary orbits. This is because different migration scenarios predict different outcomes for the stellar obliquity, and with the growing number of systems characterized in term of stellar obliquity such as by the Rossiter-McLaughlin effect, our understanding on the dynamical history of giant exoplanets has made significant progress. There are two major ways of interpreting the presence of "misaligned" transiting systems. One is that they are formed by chaotic processes such as planet-planet scatterings or Kozai cycles, and this possibility is supported by the correlation between the obliquity and host stars' property (e.g., Winn et al. 2010, Albrecht et al. 2012). On the other hand, some authors ascribe the apparent spin-orbit misalignment around giant-planet systems to purely astrophysical origin and claim that close-in planets are formed by gravitational interactions between the planets and protoplanetary disk in the early stages of the systems (e.g., Rogers et al. 2012). This is supported by the general tendency of good spin-orbit alignment for multiple transiting systems (e.g., Sanchis-Ojeda et al. 2012, Hirano et al. 2012). Here I will present some of the key techniques to measure the stellar obliquity for transiting exoplanetary systems, and discuss the current observational status of obliquity measurements.

Keywords: planet migration, stellar obliquity, the Rossiter, McLaughlin effect

*Speaker

Long period planets in hot Jupiter systems

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Abstract

While hot Jupiters have for a long time been thought to be alone, recent studies have suggested the opposite (e.g. Knutson et al. 2014), finding that many hot Jupiters have distant companions. Among those companions, only a few are close enough to their parent star to have a full orbit observed.

It is commonly accepted that hot Jupiters have migrated to their current orbits from where they formed (Rafikov 2006). The two processes that can drive planetary migration involve either interactions with the gas disc or interactions with a third body (planetary or stellar). Understanding if additional planets are present in hot-Jupiter planetary systems and on what kind of orbits is key to determining the fraction of each migration mechanism.

Since 2008, we have conducted a long-term radial velocity survey of the WASP targets with a confirmed hot Jupiter, using the spectrograph CORALIE on the Euler Swiss telescope in La Silla. The aim of the survey was to find additional companions to these hot Jupiters that could have played a role in the migration process. I will present two additional planets with completed orbits that we have found in WASP hot-Jupiter systems.

The main difficulty when searching for long-period planets is to differentiate radial velocity variations due to the presence of a distant companion from variations due to the magnetic cycle of the star. The emission in the Ca H & K bands is a commonly used indicator to measure activity-related signals. Unfortunately it cannot be extracted from single CORALIE spectra. On the other hand, the emission in the Halpha band is located on the red part of the spectrum and benefits from a higher signal to noise in CORALIE measurements. This indicator is then easy to extract from our data. I will show how Halpha can be used to identify the periodic signals due to activity.

Keywords: hot Jupiter, multiple planetary system, stellar activity, radial velocities

*Speaker

Architectural and Chemical Insights into the Origin of Hot Jupiters

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Abstract

The origin of Jupiter-mass planets with orbital periods of only a few days is still uncertain. This problem has been with us for 20 years, long enough for significant progress to have been made, and also for a great deal of "lore" to have accumulated about the properties of these planets. Among this lore is the widespread belief that hot Jupiters are less likely be in multiple giant planet systems than longer-period giant planets. I will show that in this case the lore is not supported by the best data available today: hot Jupiters are not lonely. I will also show that stellar sodium abundance is inversely proportional to the probability that a star hosts a short-period giant planet. This observation is best explained by the effect of decreasing sodium abundance on protoplanetary disk structure and reveals that planet-disk interactions are critical for the existence of short-period giant planets. Collectively, these results support the importance of disk migration for the origin of short-period giant planets.

Keywords: planet formation: hot Jupiters

*Speaker

Tuesday

Session 6

Direct Imaging

Chair : I. Snellen

First and expected results of SPHERE on the detection/characterisation of giant planets

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Abstract

With the development of high contrast imaging techniques and instruments, vast efforts have been devoted during the past decades to detect and characterize lighter, cooler and closer companions to nearby stars, and ultimately image new planetary systems. Complementary to other planet-hunting techniques, this approach has opened a new astrophysical window to study the physical properties and the formation mechanisms of brown dwarfs and planets. In this talk, I will briefly describe the techniques and strategies used in high-contrast imaging and the main samples of nearby stars that are targeted in the context of the SPHERE GTO exploitation. I will summarize the main results obtained so far with SPHERE in terms of detection performances, characterization of giant planets, study of planetary system architectures, finally statistical information. Finally, I will conclude with the exciting perspectives offered for the coming years and the synergy with current and future missions and instruments devoted to exoplanetary science.

Keywords: exoplanets, imaging

*Speaker

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First Results in Exoplanet Characterization from the Gemini Planet Imager Exoplanet Survey

Marshall D. Perrin

Space Telescope Science institute

Abstract

The Gemini Planet Imager is a dedicated instrument for directly imaging and spectroscopically characterizing Jovian exoplanets around nearby young stars. After nearly a decade of development, GPI was commissioned at Gemini South starting in late 2013 and is now in full science operations including the conduct of a large multi-year exoplanet survey. I will briefly describe GPI's key enabling technologies and summarize several early results from GPI in characterizing the atmospheres of nearby exoplanets. In particular I will discuss our team's recent discovery and characterization of 51 Eridani b, a ~2 Jupiter mass planet with an atmosphere showing the strongest signature of methane absorption yet observed for an exoplanet. With a methane-dominated spectrum, low luminosity, and potentially low-entropy initial conditions, 51 Eri b is a bridge from previously-imaged wider-orbit, hotter, and more massive planets to Jupiter-like scales.

K-Stacker, a new way of detecting and characterizing exoplanets with high contrast imaging instruments

Hervé Le Coroller*†[1,2], Mathias Nowak‡[1,2], Luc Arnold[2], Thierry Fusco[1], Arthur Vigan[1], and Jean-François Sauvage[1]

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Abstract

This year, a second generation of coronagraphs dedicated to high-contrast direct imaging of exoplanets is starting operations. Among them, SPHERE, installed at the focus of the UT3 Very Large Telescope, reaches unprecedented contrast ratios up to 10–6 -10–7, using eXtreme Adaptive Optics and the Angular Differential Imaging (ADI) technics. In this paper, we present a new method called Keplerian-Stacker that improves the detection limit of high contrast instruments like SPHERE, by up to a factor of 10. It consists of observing a star on a long enough period to let a hy- pothetical planet around that star move along its orbit. Even if in each individual observation taken during one night, we do not detect anything, we show that it is possible, using an optimization algorithm, to re-center the images according to keplerian motions (ex: 10-100 images taken over a long period of typically 1-10 years) and detect planets otherwise unreachable. This method can be used in combination with the ADI technics (or possibly any other high contrast data reduction method) to improve the Signal to Noise Ratio in each individual image, and to further improve the global detection limit. It also directly provides orbital parameters of the detected planets, as a by-product of the optimization algorithm.

Keywords: Coronagraph, exoplanets, Adaptive Optics, AO, SPHERE, ELT

*Speaker

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Exploring Giant Exoplanets with Subaru Telescope: SEEDS and Future Direct Imaging Observations

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Abstract

Numerous giant planets have been identified after the discovery of exoplanet around 51 Peg, opening a new window to study the planet formation and evolution scenarios. The Subaru/SEEDS campaign has contributed to study giant exoplanets by surveying and characterizing the wide-orbit exoplanets around young stars, by using high-contrast direct imaging technique. Since 2009, we have observed about 400 stars, which have ages mainly ranging from _˜1 Myr to a few Gyr. Our targets consist of nearby field stars and stellar members of the Pleiades open cluster, moving groups, and star-forming regions. A fraction of our targets hosts protoplaneary or debris circumstellar disks. Our campaign observations have ended except for one-night remaining night and provided intriguing discoveries to date. Around the nearby G0-type star GJ 504, we have imaged a cold exoplanet with an inferred mass of 3–8.5 Jupiter masses. In addition, SEEDS discovered a substellar companion orbiting the B9-type star, Kap And. We have also carried out the statistical studies to place constraints on the population of substellar companions; the frequency of companions with 5–70 Jupiter masses and semimajor axes of 10–100 AU was estimated to be 1–3% depending on the adopted distribution function of substellar companions. Furthermore, stellar companions were imaged around stars that have exoplanets identified with indirect techniques. These may be the key presences to uncover the orbital evolution of inner giant exoplanets. Thus, the SEEDS findings help us reveal the properties of young wide-orbit giant planets and their origins. We are currently challenging to improve our high-contrast capability by developing extreme-AO based high-contrast instrument SCExAO and CHARIS. It is expected that these instruments enable us to explore the more inner regions (< a few tens of AU) in exoplanetary systems in near future. We here review the SEEDS achievements and briefly introduce our planning exoplanet observations.

Keywords: exoplanets, giant planets, Subaru Telescope, direct imaging, infrared radial velocity

*Speaker

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Wednesday

Session 7

Astrometry

Chair : I. Boisse

Gaia and the Dawn of the Astrometry Revolution

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Abstract

Astrometry as a technique has so far proved of limited utility when employed as either a follow-up tool or to independently search for planetary mass companions orbiting nearby stars. However, this is bound to change during the next decade (and maybe next year already!). I will outline the planet-finding capabilities of present and future astrometric observatories aiming at microarcsecond precision, with a particular focus on Gaia, now in its second year of routine science operations. I will then put astrometry in context, illustrating its potential for important contributions to (giant) exoplanets science, as a complement to other indirect and direct methods for the detection and characterization of planetary systems

Keywords: Planetary Systems, Astrometry, Numerical Methods, Statistical Methods

*Speaker

Astrometric detection of giant planets around nearby M dwarfs: the Gaia potential

Paolo Giacobbe*[1], Alessandro Sozzetti†[1], and Mario G. Lattanzi‡[1]

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Abstract

ESA's Cornerstone mission Gaia, launched DECEMBER 20, 2013, will carry out a magnitude limited (V $\leq$ 20), all-sky astrometric survey that is bound to revolutionize our understanding of countless aspects of astronomy and astrophysics within our Milky Way, and beyond (e.g., Perryman et al. 2001). The global impact of Gaia micro-arcsecond level (μas) astrometric measurements in the astrophysics of planetary systems has been addressed in the past (e.g., Lattanzi et al. 2000; Sozzetti et al. 2001, 2003; Casertano et al. 2008; Sozzetti 2011). However, those studies only provided general metrics for gauging detectability thresholds as a function of planetary properties (orbital elements, masses), using solar-like stars as the reference primaries. In addition, only brief mentions were made of the potentially huge levels of synergy between Gaia astrometry and other ongoing and planned exoplanet search and characterization programs. The approach adopted to carry out the analysis, particularly at the level of single- and multiple-planets orbital solutions, was still affected by some caveats and simplifying assumptions (e.g., only partial treatment or complete neglection of the problem of identifying adequate starting values for the non-linear fits). Finally, the Gaia astrometric performance, described in those works through a simple Gaussian single-measurement error model, has further evolved. A more realistic error model ought to be utilized.

We revisit the topics of planet detection and characterization with Gaia relaxing some of the above assumptions, and focusing on the sample of nearby low-mass M dwarf stars. The main thrust of this work is three-fold. First, we gauge the Gaia potential precision astrometry of exoplanets orbiting an actual sample of thousands of known dM stars (from Lépine 2005 and Lépine & Gaidos 2011). We then express Gaia sensitivity thresholds as a function of system parameters and in view of the latest mission profile, including the most up-to-date astrometric error model. The analysis of the simulations results will also provide insight on the capability of high precision astrometry to reconstruct the underlying orbital element distributions and occurrence rates of the planetary companions. These results will help in evaluating the expected Gaia recovery rate of actual planet populations around late-type stars. Second, we investigate some elements of the synergy between the Gaia data on nearby M dwarfs and other ground-based and space-borne programs for planet detection and characterization, with a particular focus on: a) the potential for Gaia to precisely determine the orbital inclination, which might indicate the existence of transiting long period planets; b) the ability of Gaia to accurately predict the ephemerides of (transiting and non-transiting) planets around M stars, and c) its potential to help in the precise determination of the

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emergent flux, for direct imaging and systematic spectroscopic characterization of their atmospheres with dedicated observatories from the ground and in space. Third, we test a Hybrid Markov Chain Monte Carlo Differential Evolution approach with the aim of tackling the challenge of combining astrometry and radial velocities of single planetary systems.

Keywords: astrometry, Gaia, giant planets, M dwarfs

Wednesday

Session 8

Atmospheric Studies (part 1)

Chair : D. Pollacco

Atmospheric characterization of extrasolar planets

I. Snellen

Leiden Observatory

Abstract

In this talk I will review the different methods and their results of atmospheric characterization, and provide a look into the future with JWST and ELTs.

Hot Exoplanet Atmospheres Resolved with Transit Spectroscopy

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Abstract

The field of exoplanet atmospheres is booming thanks to (low-resolution) space-borne spectrographs and high-resolution (narrow-ranged) NIR spectrographs on ground-based 8m-class telescopes. Atmospheres are important because they are our observing window on the physical, chemical, and evolutionary processes occurring on exoplanets. Transiting exoplanets are the best suitable targets for atmospheric studies. Observing a transit in different filters or with a spectrograph reveals the transmission spectrum of the planet atmosphere. More than one decade of such observations allowed the exploration of these remote words by detecting some constituents of their atmospheres, but revealing also the presence of scattering hazes and clouds in several exoplanets preventing the detection of major chemical constituents at low to medium resolution even from space.
Transit observations from the ground with stabilised high-resolution spectrograph, such HARPS, have key roles to play in this context. Observation of the hot-jupiter HD 189733b with HARPS allow the detection of sodium in the planet atmosphere. The high-resolution transmission spectra allowed to probe a new region high in the atmosphere and revealed rapid winds and a heating thermosphere. This new use of the famous planet hunter turned HARPS into a powerful exoplanet characterisation machine. It has the precision level of the Hubble Space Telescope, albeit at 20 higher resolution.

A survey of a large set of known hot transiting exoplanets with HARPS and later with ESPRESSO will allow the detection of key tracers of atmospheric physics, chemistry, and evolution, above the scattering haze layers known to dominate low-resolution visible spectra of exoplanets.
Such observation, in total sinergy with other technics, will firmly establish stabilised, high-resolution spectrographs on 4m telescopes as corner-stones for the characterisation of exoplanets. This is instrumental considering the upcoming surveys (NGTS,K2, CHEOPS, TESS, PLATO) that will deliver hundreds of exoplanets amenable to atmospheric characterisation.

Keywords: High Resolution Spectrograph, HARPS, ESPRESSO, Transit, Transmission Spectroscopy, Atmospheres, Hot, Jupiter, Temperature, Wind, Sodium, Optical, HD189733

*Speaker

The atmospheric properties of 51 Peg b

Jayne Birkby*[1,2,3], Matteo Brogi[2,4,5], Remco De Kok[2,6], Henriette Schwarz[2], and Ignas Snellen[2]

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[6]Institute for Space Research Netherlands (SRON) – Landleven 12, 9747AD Groningen, The Netherlands, Netherlands

Abstract

The atmospheres of non-transiting hot Jupiters have recently become available for detailed characterization via the use of high-resolution (R_˜100,000) spectrometry. I will present an analysis of multiple high-resolution datasets from CRIRES/VLT designed to determine the chemical composition of the atmosphere 51 Peg b and its overall structure. Signatures of both carbon monoxide and water are present, and I will demonstrate how this data can be used to determine carbon-to-oxygen ratios for hot giant planets. The C/O ratio has been proposed as a tracer of the planet formation mechanism and birth location in the protoplanetary disk, due to the different freeze-out temperatures of molecules in the gas. Determining C/O for hot giant planets may thus enable us to trace out their migration pathways.

Keywords: atmosphere characterization, giant planets, formation and migration scenarios

*Speaker

Exoplanet Reflections: the light from 51 Peg b

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Abstract

The direct detection of reflected light from an exoplanet is, even in the most favourable cases, a herculean task, close to the detection limit of current observing facilities. In this talk, we will show how using a technique that makes use of the Cross Correlation Function we were able to recover the minute reflected signal from 51 Peg b. We will present the methodology (see Martins et al. 2013, MNRAS, 436:1215), as well as how this result can be used to tentatively infer some of the planet's characteristics as detaily described in Martins et al.(2015, A&A, 576:A134)

Keywords: High resolution spectroscopy, Direct detection

*Speaker

Thursday

Session 9

Atmospheric Studies (part 2)

Chair : R. Alonso

USING THE CHROMATIC ROSSITER-MCLAUGHLIN EFFECT TO PROBE RAYLEIGH SCATTERING IN HD 189733b: GREAT PROSPECT FOR ESPRESSO

Emanuele Di Gloria*†[1], Ignas Snellen[2], and Simon Albrecht[3]

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[3]Aarhus University – Denmark

Abstract

We use the chromatic Rossiter-McLaughlin (RM) effect (Snellen 2004) to probe the Rayleigh scattering slope in HD189733b, using archival HARPS data of three transits of HD189733b. It shows that this method can be effectively used to measure broad-band transmission features: the amplitude of the RM effect depends on the effective size of the planet, and therefore in the case of an atmospheric contribution depends on the observed wavelength. This is extremely valuable specially in comparison with a succesful ground-based observational method that uses a differential technique based on high-dispersion spectroscopy, but that only preserves narrow features in transmission spectra, not allowing to probe broad-band features.
This method will be particularly interesting in conjuction with the new echelle spectrograph ESPRESSO, currently under construction for ESO's VLT, which will provide a gain in S/N of a factor _˜4 compared to HARPS. This will be of great value, taking into account the limited and uncertain future of the HST, and the fact that the future JWST will not cover this wavelength regime.

Keywords: HARPS, ESPRESSO, HD189733b, ROSSITER, MCLAUGHLIN, RAYLEIGH SCATTERING

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Spin measurement of the directly imaged sub-stellar companion, GQ Lupi b

Henriette Schwarz*[1], Matteo Brogi[2], Remco De Kok[1,3], Jayne Birkby[1,4,5], and Ignas Snellen[1]

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Abstract

Recently we measured for the first time the spin rotation of an extra-solar planet. The famous planet beta Pictoris b was found to spin much faster than any planet in our solar system, which is in line with the idea that massive planets spin more rapidly. Interestingly, field brown dwarfs do not seem to follow this relation, which may indicate that an object's spin is closely linked to its formation mechanism.

Here we present the spin measurement of the sub-stellar companion GQ Lupi b, which has an uncertain mass in the range separating extrasolar planets and brown dwarfs. The young T-Tauri system was observed for an hour with the CRIRES instrument at the VLT with a spectral resolving power of 100000, positioning the slit to both contain the host star and the companion separated from the host by 0.7 arcseconds. We have identified both CO and H2O in the planetary spectrum.

Keywords: exoplanets, GQ Lupi b, high dispersion spectroscopy, spin measurement

*Speaker

Exoplanet Atmospheres with the Extremely Large Telescopes

Ian Crossfield*[1]

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Abstract

The unprecedented size of the next generation of ground-based Extremely Large Telescopes (ELTs) make them unparalleled facilities for characterizing giant exoplanet atmospheres with high-resolution imaging and high-dispersion spectroscopy. I will give a comprehensive overview of the exciting new science goals that can be achieved with these colossal new observatories: (1) direct imaging, spectroscopy, and global weather maps of young, hot gas giants; (2) longitudinally-resolved molecular abundances, thermal structures, and global windspeeds of hot Jupiters; (3) direct albedo measurements and radiometric radii of old, cold Jovian analogues at < 2 AU; and (4) atmospheric measurements, RV masses, and the hunt for biosignature gases around small and/or potentially habitable planets.

Keywords: exoplanet, ELT, transit, direct imaging, extrasolar planet

*Speaker

HST hot-Jupiter transmission spectral survey: a cloud-free, cloudy and hazy atmospheres for WASP-17b, WASP-31b and WASP-6b

Nikolay Nikolov*†[1], David Sing , Gilda Ballester , and Hannah Wakeford

[1]University of Exeter – United Kingdom

Abstract

Over the past decade, observations of transits have revolutionized our understanding of exoplanet atmospheres thanks in large part to spectroscopy with the Hubble and Spitzer Space Telescopes. In this talk I will discuss the goals, overall methodology and some of the main results from a Large HST optical and near-IR spectral survey (P.I. David Sing) of eight hot Jupiters spanning a wide range of temperatures. I will particularly focus on the results for WASP-17b (in prep.), WASP-31b (Sing et al. 2015) and WASP-6b (Nikolov et al. 2015). We type each planet atmosphere by a comparative analysis with hot Jupiter models of cloudy, hazy and cloud-free atmospheres. Together with previous HST observations, this program is showing scattering by aerosols and absorption from water and alkali metals across the target range implying a significant diversity in exoplanet atmospheres.

Keywords: exoplanets:atmospheres

*Speaker

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The Transmission and Emission Spectra of the Massive, Extremely Close-in Hot Jupiter WASP-18b

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[2]University of Maryland Department of Astronomy – UMD-Department of Astronomy 1113 Physical Sciences Complex, Bldg. 415, United States

Abstract

We use observations with the near-infrared G141 grism on the Hubble Space Telescope's WFC3 instrument (1.1um – 1.7um) to measure the spectrum of the Hot Jupiter WASP-18b in both transmission (transit) and emission (secondary eclipse). The observations utilize the spatial scan mode of HST, a powerful observing strategy that reduces errors to very near the photon noise. Particularly when considered with data points acquired by others with Spitzer, these observations unveil, at least in the specific case of WASP-18b, insight on the possible presence of haze, clouds, and a temperature inversion. The planet is so massive (10.2 MJ) and in such an extremely small orbit (22.5 hours) that the shrinking of its orbit due to tides should be detectable on reasonable (few-year) timescales. This makes WASP-18b unique in that it is one of only a few – and the best of those few – planets that can provide an observational constraint on the tidal Q parameter. We present our analysis using the HST timing with previously published ephemerides.

Keywords: Hot Jupiter, Tides, Transit, Eclipse, Spectroscopy, Hubble, HST, Haze, Clouds, Inversion

*Speaker

Transmission spectroscopy of the inflated hot Jupiter WASP-52b

Louden Tom*[1] and Peter Wheatley

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Abstract

Transmission spectroscopy has revealed a fascinating range of albedos and spectral features in hot Jupiter atmospheres that are yet to be fully explained by models. WASP-52b is a member of the class of low density hot Jupiters with large scale heights, making it an ideal target for this technique.
We present new results from ground based observations of two transits of WASP-52b, operating in a low resolution mode that affords high sensitivity to the broad-band spectral features that can dominate the spectra of hot Jupiters, such as pressure broadened Sodium absorption and Rayleigh scattering.
WASP-52b orbits an active K class star which shows periodic brightness modulation. Unocculted starspots are capable of imprinting features into a transmission spectrum that can be falsely interpreted as Rayleigh scattering or molecule detections in the planetary atmosphere. Therefore, we carefully consider the effects of occulted and unocculted spots on our transmission spectrum and present an analysis of the long term activity patterns of the star.

Keywords: Atmospheres, transmission spectroscopy, ground based, stellar activity, starspots

*Speaker

VLT observations of giant exoplanet atmospheres: reliability and new results

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Abstract

Ground-based observatories are developing their role in the characterization of transiting giant planets. Through multi-wavelength observations of planetary transits and occultations, planetary atmospheres can be studied in transmission as well as emission.

In this context, it is important to assure the reproducibility and hence reliability of the observed features, which is intimately connected to the control and modelization of instrumental and atmospheric noise factors. We will present recent spectrally resolved observations of three transits of WASP-49b and two occultations of WASP-43b using the VLT instruments FORS2 and KMOS, respectively. We will focus on the do's and "don'ts" for the inference of reliable transmission and emission spectra, comment on the potential of KMOS for exoplanet science, and conclude by discussing the resulting scientific implications for our target planets.

Keywords: exoplanets, planetary atmospheres

*Speaker

Thursday

Session 10

Star-Planet Interactions

Chair : J. Wright

Star-planet interactions

Andrew Cameron

University of St-Andrews

Abstract

Close-orbiting planets are strongly influenced by tidal and radiative interactions with the host star, but to what extent is the host star itself influenced by the presence of a close-orbiting planet? In this talk I will review the evidence for tidal exchange of angular momentum between stars and close-in planets, and for energy release caused by a planetary magnetosphere passing rapidly through the outer corona or inner wind of its host star.

Evaporation of an ice giant

D. Ehrenreich

University of Geneva

Abstract

Exoplanets in extreme irradiation environments, close to their parent stars, could lose some fraction of their atmospheres because of the extreme irradiation. Atmospheric mass loss has been observed during the past 12 years for hot gas giants, as large (~10%) ultraviolet absorption signals during transits. Meanwhile, no confident detection have been obtained for lower-mass planets, such as ice giants, which are most likely to be significantly affected by atmospheric escape. In fact, hot rocky planets observed by Corot and Kepler might have lost all of their atmosphere, having begun as Neptune-like. The signature of this loss could be observed in the ultraviolet, when the planet and its escaping atmosphere transit the star, giving rise to deeper and longer transit signatures than in the optical. I will report on new Hubble observations of the Neptune-mass exoplanet GJ 436b, around which an extended atmosphere has been tentatively detected in 2014. The new data reveal that GJ 436b has huge transit depths (~56%) in the hydrogen Lyman-alpha line. The planet appears surrounded and trailed by an immense exospheric cloud of hydrogen, shaped as a giant comet bigger than the star, and far bigger than the envelopes observed on hot gas giants. I will discuss the implication of this new detection for the evolution of exoplanets, including gas giants, and their future atmospheric characterization.

The X-ray irradiation and evaporation of hot Jupiters

Wheatley Peter*[1]

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Abstract

The detection of atmospheric escape from giant exoplanets is one of the most remarkable discoveries of the past twenty years. The mass loss is believed to be driven by X-ray and extreme-ultraviolet irradiation, with the dynamics of the escaping material controlled by radiation pressure and charge exchange. Energetics and population statistics suggest that the evolution of close-in planets can be radically altered by atmospheric escape, with detected hot rocky planets likely to be the remnants of heavily eroded giants. In this talk I will present observations of X-ray irradiation of giant planets made simultaneously with HST measurements of the resulting mass loss that allow us to constrain the energetic efficiency atmospheric escape. I will also present preliminary results from a Large Program of X-ray observations with XMM-Newton.

Keywords: X, ray, evaporation, atmospheric escape

*Speaker

Energy-limited escape revisited: A transition from strong planetary winds to stable thermospheres

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[2]European Space and Technology Centre (ESA/ESTEC) – Keplerlaan 1 Postbus 299 2200 AG Noordwijk The Netherlands, Netherlands

Abstract

Hot Jupiters are thought to suffer from mass loss through planetary winds powered by strong high-energy irradiation. These photoevaporative winds may even affect planetary evolution. We carried out photoionization-hydrodynamics simulations of the thermospheres of hot gas planets in the solar neighborhood using our new interface between the PLUTO and CLOUDY codes (TPCI). These detailed simulations reveal efficient radiative cooling in the atmospheres of massive and compact Jovian planets, whose gravitational potential surpasses a critical limit. In contrast to widely-made assumptions, our modeling shows that planets like HAT-P-2 b host stable thermospheres in radiative equilibrium, whereas smaller gas giants, indeed, show considerable mass-loss rates. Therefore, the heating efficiency of the absorption of EUV radiation in the planetary thermospheres depends on the gravitational potential of the planet. We present a scaling law for the heating efficiencies that can be used in the well-known energy-limited escape formula and provides easily accessible estimates for the mass-loss rates for a wide range of irradiated planets from super-Earth type planets to the most massive hot Jupiters.
Among the 18 simulated systems, we further identify those with large in-transit Lyman alpha absorption that are likely detectable via transit spectroscopy.

Keywords: hydrodynamics, photoionization, atmospheres, evolution, stability

*Speaker

Thursday

Session 11

Dynamics

Chair : R. Dawson

The secrets revealed by multiplanet systems

R. Mardling

Institution Monash University

Abstract

The presence or absence of giants in multi-planet systems has a huge influence on their dynamics and evolution. I will review some of the highlights and surprises from our 20 years of studying exoplanets, and present some exciting new results for obtaining accurate planet masses and orbital parameters from transit timing variations for systems in, near and far from resonance.

Dissipation in resonant planetary systems: implications of observed orbital configurations

Jean-Baptiste Delisle*[1], Jacques Laskar[2], and Alexandre Correia[3]

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[2]IMCCE (IMCCE) – CNRS : UMR8028 – 77 Av Denfert-Rochereau, France
[3]Universidade de Aveiro – Campus Universitário de Santiago 3810-193 Aveiro, Portugal

Abstract

Using an analytical model, we study the dynamical evolution of two planets in mean-motion resonance undergoing dissipation (tidal effect, disk-driven migration). This model allows to understand some properties of Kepler multi-planetary systems statistics (Delisle et al, 2012, 2014, Delisle & Laskar 2014). Indeed, close-in planetary systems detected by the Kepler mission present an excess of period ratios that are just slightly larger than some first order resonant values (2/1, 3/2). This feature occurs naturally when resonant couples undergo dissipation, such as tidal effect, that damps the eccentricities. We also apply our model to individual exoplanetary systems, and look how the current configuration of the planets constrains the dissipative forces they underwent in the past. This allows to put constraints on the nature (gaseous or rocky) of the planets (Delisle et al, 2014) since the tidal dissipation highly depends on their internal structure. This may also be used to constrain some properties of the proto-planetary disk where the planets formed and migrated (Delisle et al, 2015). Refs.:
Delisle, Laskar, Correia, Boué, 2012, A&A, 546, A71
Delisle, Laskar, Correia, 2014, A&A, 566, A137
Delisle, Laskar, 2014, A&A, 570, L7
Delisle, Correia, Laskar, 2015, accepted to A&A (arxiv: 1506.03750)

Keywords: dynamics, multiplanetary systems, resonance, dissipation, migration

*Speaker

When to eat your brown dwarf: at breakfast, lunch or dinner?

Tristan Guillot*[1], Leila Sadeghi Ardestani[2], Doug Lin[3], and Pierre Morel[1]

[1]Laboratoire Lagrange, CNRS, Observatoire de la Cote d'Azur – Université de Nice-Sophia Antipolis, Observatoire de la Cote d'Azur (OCA) – France
[2]IPM – Iran
[3]Lick Observatory – United States

Abstract

It is found that brown dwarfs (and by extension massive giant planets) are much more rare in close orbit around G dwarfs than around F dwarfs, a sign that they have been eaten by G dwarfs. The explanation can be found in the interplay between tidal interactions between stars and their companion coupled to the fact that G dwarfs have a much stronger magnetic braking and are therefore able to extract angular momentum much more efficiently. Also, dissipation in G dwarfs is possible by exciting inertial gravity waves and dissipating them at the radiative center, which is not possible in F dwarfs which have a convective center. However, theory predicts that all this takes time and would occur only after a few billion years of evolution: G dwarfs would eat their brown dwarfs at lunch or even dinner. This is partially contradicted by observations. The strong dichotomy between G and F dwarfs seems to imply that G dwarfs should eat their close-in brown dwarfs at breakfast. The problem will be reviewed and possible solutions discussed.

Keywords: exoplanets, stars, brown dwarfs, tidal interactions, magnetic fields

*Speaker

Friday

Session 12

Internal Structure

Chair : D. Fabrycky

The giant challenges in our understanding of giant planets internal structure

N. Nettelmann

University of Rostock

Abstract

The internal structures of giant planets (GPs) including their composition provide important clues on the formation of planetary systems, and on how atmospheres and planetary magnetic dynamos work. In this talk we will use the solar system GPs, for which a wealth of observational constraints are available, to discuss general challenges in our understanding of GP internal structure. In particular, we will see that our view of GPs depends on model assumptions despite the progress in extrasolar GP mass, radius, and atmosphere composition determinations, or new data from high-pressure lab experiments and computer simulations. As one of the crucial challenges we will identify the development of self-consistent models for GPs, such that reliable estimates of their composition may eventually become possible.

Inner structure determination of transiting close-in planets

Alexandre Correia*[1,2]

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[2]Institut de Mécanique Céleste et de Calcul des Ephémérides (IMCCE) – Observatoire de Paris – 77 av Denfert-Rochereau 75014 Paris, France

Abstract

Planets orbiting very close to their host stars have been found, some of them on the verge of tidal disruption. The ellipsoidal shape of these planets can significantly differ from a sphere, which modifies the transit light curves. Here we present an easy method for taking the effect of the tidal bulge into account in the transit photometric observations. We show that the differences in the light curve are greater than previously thought. When detectable, these differences provide an estimation of the fluid Love number, which is invaluable information on the internal structure of close-in planets. We also derive a simple analytical expression to correct the bulk density of these bodies, that can be 20% smaller than current estimates obtained assuming a spherical radius.

Keywords: planetary systems, planetary interiors, transiting planets

*Speaker

Understanding tidal dissipation in gaseous giant planets: towards global modelling from their core to their surface

Mathieu Guenel*[1] and Stephane Mathis[1]

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Abstract

Tidal dissipation in planetary and stellar interiors is one of the key mechanisms driving the evolution of planetary systems, especially for planets orbiting close to their host star. It strongly depends on the internal structure and rheology/friction mechanisms in the involved bodies. Here, we focus on the tidal response of Jupiter and Saturn-like gaseous giant planets using a simplified bi-layer model consisting of a rocky/icy core surrounded by a deep fluid convective envelope. For these planets, we compare the frequency-averaged amplitudes of the viscoelastic dissipation in the central solid region and of the damping of inertial waves by turbulent friction in fluid layers, as a function of the core size and mass. We find that the two dissipation mechanisms could generally have the same strength. This demonstrates that tidal dissipation in giant planets must be examined from their centre to their surface taking into account mechanisms occurring both in solid and fluid parts of the giant gaseous planets. These conclusions will be discussed in the context of exoplanetary systems and of recent observational constraints obtained in the Solar system for Jupiter and Saturn thanks to high precision astrometry.

Keywords: star, planet interactions, tides, hydrodynamics, waves, dynamical evolution

*Speaker

Scaling laws to quantify tidal dissipation in star-planet systems

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Abstract

Planetary systems evolve over secular time scales. One of the key mechanisms that drive this evolution is tidal dissipation. Submitted to a tidal perturbation, stellar and planetary fluid layers do not behave like rocky ones. They are the place of resonant gravito-inertial waves. Therefore, tidal dissipation in fluid bodies strongly depends on the excitation frequency while this dependence is smooth in solids ones. Thus, the impact of the internal structure of celestial bodies must be taken into account when studying tidal dynamics. The purpose of our talk is to present a local model of tidal gravito-inertial waves allowing us to quantify the internal dissipation due to viscous friction and thermal diffusion analytically, and to study the properties of the resonant frequency spectrum of the dissipated energy. We derive from this model scaling laws characterizing tidal dissipation as a function of fluid parameters and discuss them in the context of star-planet systems.

Keywords: hydrodynamics, waves, turbulence, planet star interactions

*Speaker
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Friday

Session 13

Formation and Migration

Chair : S. Udry

Giant planet formation and migration scenarios

Rebekah Dawson*[1]

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Abstract

Discoveries of giant planets so different from those in our Solar System have called in question conventional theories for how planetary systems form and evolve. I will review recent progress in our understanding of the physical processes that drive the formation and assembly of giant planetary systems and result in the surprising variety of orbital properties we observe today. I will focus on the formation and migration of giant planets, including the origin of hot Jupiters, giant planets on elliptical and tilted orbits, and systems of giant planets in mean motion resonances. I will conclude with pathways forward toward a blueprint for how systems of giant planets form and evolve.

Keywords: formation, migration

*Speaker

The effects of birth environment on planetary systems

Melvyn Davies*[1]

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Abstract

Stellar clusters are common and virtually all stars form in some type of cluster or association. I will discuss how the birth environment of a star can affect the planetary system it hosts. Close encounters with other stars may help explain the myriad of surprising exoplanet systems which have been observed including massive planets on relative tight, eccentric orbits, planets on wider orbits, and hot Jupiters. Encounters with passing stars may destabilize any existing planetary system, leading to planet-planet scattering or collisions between planets. Some planets may be ejected leaving others on more bound, and more eccentric orbits. Planets are rarely ejected immediately after a single strong scattering event with another planet. Rather, they are placed on progressively wider orbits until they are unbound. Planets on such wider orbits may be visible in direct imaging surveys. Their observation (or their absence) will therefore place limits on the frequency of unstable planetary systems. Single, planet-hosting stars may also exchange into stellar binaries. The stellar companion, which will have a random orientation to the plane of the planetary system, may then induce Kozai oscillations within the planetary system potentially leading to orbit crossing, strong scattering and planetary ejection, leaving the remaining planets on more bound and eccentric orbits. In extreme cases, this process may produce hot Jupiters as massive planets are placed on extremely eccentric orbits which can then circularize via tidal interactions with the host star. I will quantify the frequency of both close encounters with single stars and exchange encounters with binaries for a variety of birth environments.

Keywords: Planetary dynamics: stellar clusters: hot Jupiters: wide orbits

*Speaker

Formation of planetesimals from millimeter sized grains

Daniel Carrera*[1], Anders Johansen[1], and Anders Johansen[1]

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Abstract

Giant planets are often thought to form by gas accretion onto a _˜10 earth-mass embryo. Recent models suggest that this embryo forms through the accretion of "pebbles" onto a Ceres-mass planetesimal. However, understanding the origin of the planetesimal remains a challenge, as coagulation models cannot produce objects larger than _˜1 mm. In this work we investigate the formation of planetesimals from mm-sized grains. We used a hydrodynamic code to model the interaction between solids and gas in the disk. We found that mm-sized grains form dense particle clouds through a process known as the streaming instability. We also found that the collision speeds between grains are low enough to allow grain growth on short timescales. We suggest that coagulation and gas dynamics act together to form a particle cloud dense enough for planetesimals to form by gravitational instability, which in turn allows giant planet cores to form.

Keywords: giant planet formation, planet formation, planetesimals, computer simulations, models, core accretion

*Speaker

Posters

Magnetic Fields and Circumstellar Environment around Planet-Hosting Stars

Julian Alvarado-Gomez*[1], Gaitee Hussain[1], Jason Grunhut[1], Cohen Ofer[2], Jeremy Drake[2], and Cecilia Garraffo[2]

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[2]Harvard-Smithsonian Center for Astrophysics (CFA) – 60 Garden Street, Cambridge, MA 02138, United States

Abstract

Recent developments in instrumentation and observational techniques have opened a new window for stellar magnetic field studies. In particular Zeeman Doppler imaging (ZDI) techniques are now routinely used to recover the large scale magnetic field topologies of stars different from the Sun, including several planet-hosting stars.

These stellar magnetic fields in turn intimately affect the environment around late-type stars. This is observed in the form of transient events such as flares and coronal mass ejections, and the development of stellar winds and astrospheres. These elements can have a strong impact in the evolution of planetary systems via star-planet interactions and erosion of exoplanetary atmospheres driven by the stellar wind. In this context, the initial results from ZDI data-driven, detailed modelling of the coronal conditions and circumstellar environment around three planet hosting stars will be presented. In particular, the predicted mass loss rates for these systems and their impact on the orbiting exoplanets will be discussed.

Keywords: coronae: magnetic field: late, type: planet, hosting stars: mass loss: winds: circumstellar environment

*Speaker

Line Profile Variations of Solar Analog Stars: Chromospheric Indexes vs. Li Abundance. The Exoplanets Environment - Extending the sample.

Eliana Maritza Amazo-Gomez* , Julian Alvarado-Gomez†[1], Thomas Preibisch , and Klaus Strassmeier[2]

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[2]Leibniz-Institute für Astrophysik Potsdam (AIP) – Germany

Abstract

PolarBase contains stellar spectropolarimetric data collected with the NARVAL and ESPaDOnS instruments, (Petit et al. 2014). Their respective spectral resolutions are 65.000 and 68.000, in spectropolarimetric mode. As the first part of this work, we use the NARVAL spectropolarimetric repositories. We selected spectra from a sample of cool stars with effective Temperature (T_eff) ranging between 4900 to 6000 K. This sample contains stellar systems with and without reported exoplanets. We exploit the full wavelength range from 380 to 900 nm in order to obtain chromospheric indexes such as the Ca ii H&K S-Index, and a Ca ii IRT and Halpha index. We calibrated our measurements using the Mount Wilson S-Index values. Furthermore, we employ lithium (Li) abundance measurements from the literature (Gonzalez, et al. 2010, Delgado Mena, et al. 2014, Israelian, et al. 2004), investigating in this way a possible correlation between the chromospheric activity measurements and the Li abundance in 52 selected cool stars.

Keywords: Cool stars, Chromospheric Index, Li, abundance, Exoplanets

*Speaker

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Planets in the K2 Mission Data

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Abstract

The NASA Kepler mission has been enormously successful in detecting exoplanets, from giants down to superearths. After reaction wheel failure ended the original mission, the spacecraft has been repurposed as K2, and now surveys fields near the ecliptic for continuous 80 day observation campaigns. This provides the opportunity to detect new planetary candidates, several of which have already become apparent. Here we will describe a custom detrending algorithm designed to reduce instrumental systematics associated with the new mission concept, such as aperture losses arising from significant pointing drift. We will also describe the search of these lightcurves for new planetary candidates, and describe some of the discovered systems. These include EPIC201505350, a star hosting two neptune sized gas giants orbiting very close to a 3:2 mean motion resonance.

Keywords: K2, Kepler

*Speaker

POSTER 4

K2 planet detection pipeline

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[2]IA (CAUP) – CAUP, Rua das Estrelas 4150-762 Porto, Portugal

Abstract

The Kepler satellite has lead to the detection of thousands of planet candidates and a better understanding of planetary systems. Unfortunately, the mission ended before planed due to the failure of 2 out of 4 reaction wheels that controlled the pointing stability. A cleaver observing strategy (Howell et al 2014) allowed continuing operations surveying 4 fields a year during 80 days each. The lower pointing accuracy combined with differences in pixel sensitivity results in a loss of precision of the light curves and requires special reduction.
I will present a pipeline (Barros et al. in prep) developed by our group to obtain precise light curves from the K2 data. The pipeline is based on the CoRoT imagette pipeline (Barros et al 2014) and to correct for the flux dependence with position we use a procedure similar to Vanderburg & Johnson 2014. These light curves are then searched for planetary transits using an adapted version of the CoRoT alarm pipeline.

Keywords: K2, transit surveys, transit detection

*Speaker

Giant Planets Around M-Dwarfs: HATS-6b

Daniel Bayliss*[1]

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Abstract

We present the discovery by the HATSouth survey of HATS-6b, an giant planet transiting an M-dwarf. HATS-6b has a period of 3.3 days, a mass of 0.3 Mjup, and a radius of 1.0 Rjup. HATS-6 is one of the lowest mass stars known to host a close-in gas giant planet, and its transits are among the deepest of any known transiting planet system. Despite the host star being optically faint, it is expected to have the highest K-band S/N transmission spectrum among known gas giant planets with Teq $<$ 750 K. HATSouth is the first wide-field transit survey to probe significant numbers of M-dwarfs, and will provide an insight into the formation and properties of giant planets orbiting low mass stars.

Keywords: transit, mdwarf, hatsouth

*Speaker

Transiting Super-Neptunes: HATS-7b and HATS-8b

Daniel Bayliss*[1]

[1]Université de Genève – 24 rue du Général-Dufour CH - 1211 Genève 4, Switzerland

Abstract

We present the discovery of two Super-Netune transiting exoplanets: HATS-7b and HATS-8b. Both planets have masses just over 0.1Mjup, putting them in a transition regime between planets with and without significant amounts of H and He. While only a few planets in this regime have precisely determined masses and radii, we already see evidence for a huge diversity in densities. We will discuss whether these Super-Neptunes have properties significantly different to the well-studied population of hot-Jupiters have have been discovered and characterised over the past two decades. We will also outline the prospects for atmospheric characterisation for these systems.

Keywords: transit, superneptunes, density, hatsouth

*Speaker

Regaining the FORS: Optical ground-based transmission spectroscopy with VLT+FORS2

Henri Boffin*[1]

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Abstract

Since a few years, the study of exoplanets has evolved from being purely discovery and exploratory in nature to being quite quantitative. In particular, transmission spectroscopy now allows the study of exoplanetary atmospheres. Such studies rely heavily on space-based or large ground-based facilities, as one needs to perform time-resolved, high signal-to-noise spectroscopy. The very recent exchange of the prisms of the FORS2 atmospheric diffraction corrector on ESO's Very Large Telescope should allow us to reach higher data quality than was possible before. With FORS2, we have obtained the first optical ground-based transmission spectrum of WASP-19b, with a 20 nm resolution in the 550–830 nm range. This data set represents the highest resolution transmission spectrum for this planet obtained to date. We detect large deviations from planetary atmospheric models in the transmission spectrum redward of 790 nm, indicating the presence of additional sources of opacity not included in the current atmospheric models for WASP-19b, or additional, unexplored sources of systematics. Nonetheless, this work shows the new potential of FORS2 to study the atmospheres of exoplanets in greater detail than has been possible so far.

Keywords: instrumentation, transiting planets

*Speaker

Putting exoplanets in the stellar context: the case of tau Bootis

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Abstract

We observed the
tau Boo system with the HARPS-N spectrograph to test a new observational strategy aimed at jointly studying asteroseismology, the planetary orbit, and star-planet magnetic interaction. Methods. We collected high-cadence observations on 11 nearly consecutive nights and for each night averaged the raw FITS files using a dedicated software. In this way we obtained spectra with a high signal-to-noise ratio, used to study the variation of the Ca ii H&K lines and to have radial velocity values free from stellar oscillations, without losing the oscillations information. We developed a dedicated software to build a new custom mask that we used to refine the radial velocity determination with the HARPS-N pipeline and perform the spectroscopic analysis.We updated the planetary ephemeris and showed the acceleration caused by the stellar binary companion. Our results on the stellar activity variation suggest the presence of a high-latitude plage during the time span of our observations. The correlation between the chromospheric activity and the planetary orbital phase remains unclear. Solar-like oscillations are detected in the radial velocity time series: we estimated asteroseismic quantities and found that they agree well with theoretical predictions. Our stellar model yields an age of 0.9 ± 0.5 Gyr for
tau Boo and further constrains the value of the stellar mass to 1.38 ± 0.05 M.

Keywords: hot jupiter, tau bootis, asteroseismology

*Speaker

The Range of Chemistry for Exoplanet Interiors

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Abstract

Accurate characterization of exoplanets and exoplanetary systems requires accurate and precise characterization of the stars around which they live. High resolution spectroscopy has traditionally provided high precision for a small time investment but accuracy has been more problematic, especially for surface gravity. Techniques such as asteroseismology provide great accuracy but generally require too much telescope time for large stellar samples. I have developed an improved spectroscopic analysis procedure which yields gravities consistent with asteroseismology for F, G, and K stars and have now used this to analyze 3400 spectra of 2000 stars from the California Planet Search taken since 2005. In addition to accurate gravities, we get precise temperatures, metallicities, and abundances for 15 elements which could yield new insights into the initial conditions for the planets some of these systems host. I will present these results and discuss some of the abundance correlations and their implications for planet compositions.

Keywords: Abundances, Planet Interiors, Stellar Parameters, log g, gravity

*Speaker

Pre-history of planet detections - Focus on transits 1627 -1991

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Abstract

The discovery of 51 Peg b has been a wonderful scientific discovery, answering a multi-secular question and opening a extended new domain of astronomical research. We want to recall some old studies, some of them quite forgotten, which have used the same methods that those for planet detection, emphasizing transit method. In addition to an overview of planet search pre-history, some searchs for unknown planets in the Solar System since the seventeenth century will be evoked, as well as the search for exoplanet transits during the nineteenth and the twentieth century. The conclusion will be back to the future.

Keywords: Transit, History

*Speaker
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The SOPHIE radial velocity survey for giant exoplanets

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Abstract

Since its installation in 2006, a radial velocity survey of giant planets is conducted with SOPHIE at the 193-cm OHP telescope. The observable sample includes more than 2000 Solar-type stars in a limited volume. Its main goals are the search and characterization of new giant exoplanets around bright stars - some of them possibly transiting, identifying favorable hosts for low-mass planets search, and establishing refined statistics of the populations and properties of systems including giant planets. The latest results of this survey will be presented.

Keywords: radial velocities

*Speaker

POSTER 12

CfA Follow-up Observations of Transiting-Planet Candidates from Photometric Surveys

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Abstract

Starting in 1999 we have used the facilities of the Harvard-Smithsonian Center for Astrophysics for follow-up observations of transiting-planet candidates identified by wide-angle ground-based photometric surveys, initially for the NASA Ames Research Center Vulcan camera, and then the Trans-Atlantic Exoplanet Survey (TrES), the H*ungarian*-made *Automated Telescope Network* (HATNet) Exoplanet Survey, the Kilodegree Extremely Little Telescope (KELT), and the Qatar Exoplanet Survey (QES). Spectroscopic observations were obtained with the CfA Digital Speedometers (DS) on three different telescopes until 2009, and then with the Tillinghast Reflector Echelle Spectrograph (TRES) at the Fred Lawrence Whipple Observatory (FLWO), primarily for the identification of astrophysical false positives and the determination of improved host-star parameters, and more recently for the determination of orbital solutions and planetary masses. A total of more than 3,000 candidates were provided by the five surveys, and altogether more than 10,000 spectra were obtained, divided almost equally between the Digital Speedometers and TRES. These observations have so far contributed to the published confirmation and characterization of 64 giant exoplanets, an overall yield of about 2 percent. In addition, the KeplerCam CCD camera on the 1.4-m reflector at the FLWO has been used to provide high-quality light curves for the published analysis of many of these transiting planets.

On the detectability of quasi-circular co-orbital planets. Application to the radial velocity technique.

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Abstract

Several celestial bodies in co-orbital configurations exist in the Solar System. However, co-orbital exoplanets are yet to be discovered. This lack may result from a degeneracy between the signal induced by co-orbital planets and other orbital configurations. Here we determine a criterion for the detectability of quasi-circular co-orbital planets and develop a demodulation method to bring out their signature from the observational data. We show that the precision required to identify a pair of co-orbital planets depends only on the libration amplitude and on the planet's mass ratio. We apply our method to synthetic radial velocity data, and show that for tadpole orbits we are able to determine the inclination of the system to the line-of-sight. Our method is also valid for planets detected through the transits or astrometry techniques.

Keywords: detection, dynamical evolution and stability, coorbitals

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POSTER 14

An observation of KELT-1b Transit

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Abstract

We present a KELT1b transit with data of OGS Telescope in Tenerife Observatory from 22 July 2015. We have calculated the best fit of its light curve with a Transit Analysis Package (TAP) programme to compare with physical parameters already published. This software utilizes Markov Chain Monte Carlo MCMC) techniques to fit transit light curves using the Mandel & Agol (2002) model. In addition we have calculated the central transit time and its uncertainties using a residual-permutation method. Finally we show a technique to study atmospheres of giants exoplanets and this one will be my future work in my Phd.

Transmission photometry to probe the atmosphere of giant exoplanets

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Abstract

I will review the most relevant results obtained so far in the investigation of the atmosphere of transiting giant exoplanets with the
transmission-photometry technique. I will stress the advantages and the limits of this technique. I will then focus on the monitoring of planetary-transit events with multi-band imaging instruments, which are able to perform simultaneous observations through different pass-band filters.

Keywords: planetary systems, stars: fundamental parameters, techniques: photometric

*Speaker

Hot Jupiters and Super-Earths

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Abstract

There are as yet no detections of super-Earths in systems containing hot Jupiters, despite low-mass planets being otherwise extremely common. We propose that the lack of close-in super-Earths in hot Jupiter systems is a signature of the migration history of the hot Jupiters and helps to discriminate between different mechanisms of migration. We present N-body simulations of dynamical migration scenarios where proto-hot Jupiters are excited to high eccentricities prior to tidal circularisation and orbital decay. We show that in this scenario, the eccentric giant planet typically destroys planets in the inner system, in agreement with the observed lack of close super-Earth companions to hot Jupiters. We explore the effects of varying the configuration of the outer system forcing the proto-hot Jupiter's eccentricity, such as scenarios leading to planet–planet scattering or Kozai perturbations.

Keywords: Hot Jupiters, Super Earths, dynamics, multiplicity

*Speaker

Radial Velocity Eclipse Mapping of Exoplanets

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Abstract

Planetary rotation rates and obliquities provide information regarding the history of planet formation, but have not yet been measured for evolved extrasolar planets. We investigate the theoretical and observational perspective of the Rossiter-McLaughlin effect during secondary eclipse (RMse) ingress and egress for transiting exoplanets (Nikolov & Sainsbury-Martinez 2015, ApJ, 808, 57). Near secondary eclipse, when the planet passes behind the parent star, the star sequentially obscures light from the approaching and receding parts of the rotating planetary surface. The temporal block of light emerging from the approaching (blue-shifted) or receding (red-shifted) parts of the planet causes a temporal distortion in the planet's spectral line profiles resulting in an anomaly in the planet's radial velocity curve. We demonstrate that the shape and the ratio of the ingress-to-egress radial velocity amplitudes depends on the planetary rotational rate, axial tilt and impact factor (i.e. sky-projected planet spin-orbital alignment). In addition, line asymmetries originating from different layers in the atmosphere of the planet could provide information regarding zonal atmospheric winds and constraints on the hot spot shape for giant irradiated exoplanets. The effect is expected to be most-pronounced at near-infrared wavelengths, where the planet-to-star contrasts are large. We create synthetic near-infrared, high-dispersion spectroscopic data and demonstrate how the sky-projected spin axis orientation and equatorial velocity of the planet can be estimated. We conclude that the RMse effect could be a powerful method to measure exoplanet spins.

Keywords: exoplanets:atmospheres:rotation

*Speaker

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Exploring the impact of stellar activity on high-precision photometric transit observations

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Abstract

Stellar activity features (such as spots/plages) can create complications in determining planetary parameters through spectroscopic and photometric observations. The overlap of a transiting planet and a stellar spot/plages can produce anomalies in the transit light-curves that may lead to inaccurate estimation of the transit duration, depth and timing. We found that spot anomalies can lead to the transit duration be 4%, overestimated or underestimated, which can affect the planet orbital inclination estimation. Depending on the size and distribution of spots, anomalies can also produce transit timing variations (TTV) with significant amplitudes. For instance, TTVs with signal amplitudes of 200 seconds can be produced when the spot is completely dark and as large as the largest Sun spot. Transmission spectroscopy, which is based on the measurements of the variations of planet-to-star radius ratio as a function of wavelength, is a powerful technique to study the atmospheric properties of transiting planets. Results of our simulations indicate that transit anomalies can lead to a significant underestimation or overestimation of the planet-to-star radius ratio as a function of wavelength. At short wavelengths, the effect can reach to difference of up to 10% in the planet-to-star radius ratio, mimicking the signature of Rayleigh scattering in the planetary atmosphere.

Keywords: Transiting planet, stellar activity

*Speaker

System 83 Leo – two planets' orbit of one star: mapping possibilities for the system.

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Abstract

Our focus is on binary stellar systems that host extrasolar planets which orbit one of the stars (S-type) (Dvorak, 1986). We have investigated the motion of planets in the case of the three-body problem (acc. to Plávalová and Solovaya, 2013). We can completely solve the three body problem given the initial conditions of; (1) a planet in a binary system revolves around one of the components (parent star); (2) the distance between the star's components is greater than that between the parent star and the orbiting planet (ratio of the semi-major axes is a small parameter); and (3) the mass of the planet is less than the mass of either star, but is not negligible. The solution of the system was obtained and qualitative analysis of the motion was made. We have applied this theory to system 83 Leo (ADS8162), whose B-component has two orbiting planets, calculating their unknown angular orbital elements; inclination and ascending node. Using this new data, we have determined if this system could be stable via numerical calculation. We have discussed the possible construction of systems like this one.

Keywords: binary system, extrasolar planet, celestial mechanics, 83 Leo

*Speaker

Finding Planets Orbiting Bright Stars with SuperWASP-South

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Abstract

The brightest planet host star currently known in the southern hemisphere is WASP-18 (V=9.3). There are 13 planet host stars in the northern hemisphere brighter than WASP-18. This dearth of bright planet hosts in the southern hemisphere is the motivation behind modifying the southern installation of the highly successful Wide Angles Search for Planets (WASP) to observe brighter stars. The brightness of these targets makes them very favourable to detailed investigation, having lead to robust and fascinating discoveries. Likewise, the bright targets we expect to find, combined with the availability of the VLT and soon E-ELT, will provide us with more details about the diversity and similarities between planetary systems. The new, upgraded WASP-South instrument has now been running for nearly 3 years. In this time we have collected data on stars with visual magnitudes ranging from just brighter than 6 to around 12 across nearly half of the sky. We have re-optimised the reduction pipeline for the new data and will present first results from our new observing strategy; a quantitative assessment of the performance of the new instrument and new discoveries made in our search for rarer, bright objects.

Keywords: Exoplanets, WASP, South

*Speaker

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Long Period Planets from the California Planet Survey

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Abstract

We present several long-period giant planet systems, including Jupiter analogs, based on long-term monitoring by the California Planet Survey at Keck Observatory, and literature velocities. Two of our systems have some of the largest period ratios yet measured - such systems provide important constraints on Kozai-based theories of the origin of hot Jupiters.

Keywords: long period planets, hot Juptiers

*Speaker