STARS2016:
Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

11 – 16 September 2016
Low Wood Bay Hotel, Lake District, UK

Contents

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Introduction

Scientific Rationale

A complex relationship exists between rotation, binarity, pulsation, magnetism and chemical peculiarity in upper main sequence stars. In the region of the HR diagram where the classical instability strip crosses the main sequence, one finds the delta Scuti and gamma Doradus stars, alongside the strongly magnetic roAp stars. Pulsational variability is also observed in evolved stars such as the RR Lyrae and Cepheid stars, as well as the subdwarf and white dwarf stars. Beyond the classical instability strip lie also the slowly pulsating B stars and the beta Cephei variables. Many of the stars in the upper main sequence show chemical peculiarities in their atmospheres which are thought to result from chemical stratification aided by a combination of slow rotation, binarity, and strong magnetic fields; all theories which can be tested with time-resolved photometric and spectroscopic observations. In the era of high-quality and statistically significant samples in Astronomy, we are beginning to understand not only the physical processes that occur in these stars, but also how they interact.

This conference will provide an opportunity for the latest results to be discussed by leading scientists at the forefront of their respective fields. The SOC welcomes applications for contributed talks and posters, and the research talk programme will cover a wide range of topics related to upper part of the HR diagram including rotation, pulsation and asteroseismology, binarity, activity and magnetism, chemical peculiarity and a balanced programme between observational and theoretical work.

Sponsors

We gratefully acknowledge the financial support from the Stellar Astrophysics Centre at Aarhus University, the UK Royal Astronomical Society, the Jeremiah Horrocks Institute and the School of Physical Sciences and Computing at the University of Central Lancashire.

STELLAR ASTROPHYSICS CENTRE

uclan University of Central Lancashire | Jeremiah Horrocks Institute for Mathematics, Physics and Astronomy

Conference Venue

The conference is being held at the **Low Wood Bay Hotel**, which is located in the beautiful Lake District national park in the north-west of England. This area is protected as an area of outstanding natural beauty. The venue is positioned on the shores of Lake Windermere, which is approximately 17 km long and only 2 km across at its widest point, making it England's largest lake. Its name comes from the Scandinavian for 'lake of a man called Vinandr'. The Lake District, and in particular the area around Windermere, is a popular location for tourists from the UK and from overseas.

The talks and the posters will be presented in the **Coniston and Ullswater meeting rooms** in the upstairs conference centre of the Low Wood Bay Hotel.

If you need any help or have questions, then the registration desk will be occupied be Liz Roberts, Monday to Friday from 8:30 onwards, which is located just outside the meeting room in the Low Wood Bay hotel. You can also contact the LOC at any time using the conference email: `stars2016@uclan.ac.uk`

Conference Social Programme

Welcome Drinks

Welcome drinks and nibbles will be served in the **Club Lounge** in the Low Wood Bay Hotel on Sunday 11th September at **19:00**.

Conference Dinner

The conference dinner will be held on Thursday 15th September at **19:00** in the **Low Wood Bay Hotel restaurant**.

Excursion

The conference excursion will take place on Wednesday 14th September between 14:00 and 18:00, but the end time is open ended and delegates are not required to return to the Low Wood Bay Hotel in the evening. The cost of the excursion has been included for those who have paid for the registration fee for the whole week. A coach will leave from outside the front of the Low Wood Bay Hotel at 14:00 and take delegates to **Holehird Botanical Gardens**, at which a guided tour of the home of the Lakeland Horticultural Society has been arranged. After the tour, which will last approximately 90 min, delegates will meet back at the coach and will be taken into the town of **Bowness-on-Windermere**. A short walk lasting approximately 30 min along the waterfront is possible, but delegates are also free to explore the town, take in the sights and attractions and find a new and exciting place for their evening meal.

The 'World of Beatrix Potter Attraction' is located in Bowness-on-Windermere, and it will be possible for delegates to visit the attraction if they wish, but this cost is extra and is **not** included in the registration fee. The attraction has its last admission at 17:30, with the building closing at 18.30. More details can be found on their website: `http://www.hop-skip-jump.com`.

Local Travel

The Low Wood Bay Hotel is located about half way between the small towns of Windermere and Ambleside on the A591 main road. The **505**, **555** and **599** bus services run regularly between the two towns and there is a bus stop directly outside the front entrance to the Low Wood Bay hotel. The journey from Windermere train station to the conference venue takes approximately 10 minutes by bus and so travel by taxi is also possible (and relatively inexpensive).

An excerpt of a map of all bus routes in the local area of Windermere is shown below. Delegates should be advised that the bus stop outside the Low Wood Bay Hotel may not always listed as a major bus stop on bus timetables. Please note that this bus service may only accept British sterling (£) coins as payment.

Information for Communicants

Talks

All talks are requested in PDF or Microsoft Powerpoint and to be uploaded to the conference laptop in the coffee or lunch break preceding the session in which they will be presented. If you wish to use other software (e.g. Keynote) or use your own laptop, then please bring all necessary adaptors/connectors as these will not be provided.

There are three different types of oral presentation:

- Special Invited Review (25+5 min)
- Invited Talk (25+5 min)
- Contributed Talk (15+5 min)

Posters

Posters should be in **portrait** orientation, with an upper limit in size of **A0** (85 by 120 cm). Posters will be attached to boards by pins, which are provided by the LOC, and are located at the back of the meeting room.

There is a dedicated poster session on Tuesday afternoon included in the programme, which will include a 1-min presentation of each poster between 15:10 – 15:30. Authors of posters who wish to take part in this are requested to send a single landscape slide (in PDF format) to `stars2016@uclan.ac.uk` no later than 14:00 (i.e. the end of the lunch break) on Tuesday 13th September. After the 1-min presentations, there will be time for delegates to view and discuss posters with authors.

Scientific Organising Committee

Co-Chairs

Victoria Antoci
AARHUS UNIVERSITY

Daniel Holdsworth
UNIVERSITY OF CENTRAL LANCASHIRE

Committee

Jørgen Christensen-Dalsgaard
AARHUS UNIVERSITY

Margarida Cunha
INSTITUTE OF ASTROPHYSICS AND SPACE SCIENCES

Gerald Handler
COPERNICUS ASTRONOMICAL CENTER

Peter Martinez
UNIVERSITY OF CAPE TOWN

Gautier Mathys
JAO/ESO

Simon Murphy
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Hiromoto Shibahashi
UNIVERSITY OF TOKYO

Sylvie Vauclair
INSTITUT DE RECHERCHE EN ASTROPHYSIQUE ET PLANÉTOLOGIE

Local Organising Committee

Co-Chairs

Dominic Bowman
UNIVERSITY OF CENTRAL LANCASHIRE

Daniel Holdsworth
UNIVERSITY OF CENTRAL LANCASHIRE

Committee

Liz Roberts
UNIVERSITY OF CENTRAL LANCASHIRE

Emma Woodward-Kelly
UNIVERSITY OF CENTRAL LANCASHIRE

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Delegate List

Victoria Antoci
SAC, Aarhus University

Thomas Barclay
NASA Ames Research Center

Gordon Bromage
University of Central Lancashire

Dominic Bowman
University of Central Lancashire

Emily Brunsden
University of York

Michel Breger
University of Texas at Austin

Jørgen Christensen-Dalsgaard
SAC, Aarhus University

Mark Cropper
MSSL-UCL

Christopher Corbally
Vatican Observatory

Margarida Cunha
Institute of Astrophysics and Space Sciences

Laurent Eyer
University of Geneva

Stewart Eyres
University of Central Lancashire

Yves Fremat
Royal Observatory of Belgium

Douglas Gough
University of Cambridge

Paul Greer
The Open University

Ghina Halabi
University of Cambridge

JJ Hermes
University of North Carolina

Martin Hall
University of Central Lancashire

Daniel Holdsworth
University of Central Lancashire

Gerald Handler
Nicolaus Copernicus Astronomical Center

Swetlana Hubrig
Leibniz Institute for Astrophysics

Andreas Irrgang
Dr. Karl Remeis-Observatory

Miroslav Jagelka
Masaryk University

Jeremy Jones
Georgia State University

Simon Jeffery
Armagh Observatory

Filiz Kahraman Alicavus
Canakkale Onsekiz Mart University

Donald Kurtz
University of Central Lancashire

Oleg Kochukhov
Uppsala University

John Landstreet
University of Western Ontario &
Armagh Observatory

Gautier Mathys
ALMA/ESO

Joanna Molenda-Zakowicz
University of Wrocław

Jaymie Matthews
University of British Columbia

Nami Mowlavi
Université de Genéve

Thebe Medupe
North West University

Simon Murphy
University of Sydney

Ewa Niemczura
University of Wrocław

Rhita-Maria Ouazzani
SAC, Aarhus University

Margit Paparo
Konkoly Observatory MTA CSFK

Péter Pápics
KU Leuven

Javier Pascual-Granado
Instituto de Astrofísica de Andalucía

Cristina Popescu
University of Central Lancashire

Andrzej Pigulski
University of Wrocław

Paola Quitral-Manosalva
Universidade do Porto

Jonathan Riley
East Lancs NHS Trust

Ian Roxburgh
Queen Mary University of London

Tamara Rogers
Newcastle University

Frédéric Royer
Observatoire de Paris

Hideyuki Saio
Tohoku University

James Silvester
Uppsala University

Valentina Schmid
KU Leuven

Sergio Simon-Diaz
Instituto de Astrofisica de Canarias

Markus Schoeller
ESO

Barry Smalley
Keele University

Evgenii Semenko
Special Astrophysical Observatory

Juan Carlos Suárez
University of Granada

Hiromoto Shibahashi
University of Tokyo

Robert Szabo
MTA CSFK Konkoly Observatory

James Sikora
Queen's University

Masahide Takada-Hidai
Tokai University

Masao Takata
University of Tokyo

Gerard Vauclair
IRAP

Sylvie Vauclair
IRAP

Derek Ward-Thompson
University of Central Lancashire

Tao Wu
Yunnan Observatories Chinese Academy of Sciences

Ilya Yakunin
Special Astrophysical Observatory

Konstanze Zwintz
University of Innsbruck Institute for Astro- and Particle Physics

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Timetable

Sunday 11th September	
18:00 – 19:00	**Registration**
19:00 - 21:00	**Welcome Drinks Reception** Club Lounge, Low Wood Bay Hotel

Monday 12th September	
08:30 – 09:00	**Registration**
09:00 – 09:10	**Stewart Eyres** (University of Central Lancashire) Welcome address
Session 0: Chair:	**Special Reviews** *Jørgen Christensen-Dalsgaard*
09:10 – 09:40	**Derek Ward-Thompson** (University of Central Lancashire) The life and times of Donald Wayne Kurtz (*Special Invited Review*)
09:40 – 10:10	**Michel Breger** (University of Texas at Austin) The many faces of Donald Wayne Kurtz (*Special Invited Review*)
10:10 – 10:40	**Thebe Medupe** (North West University) Don Kurtz, the South African connection (*Special Invited Review*)
10:40 – 10:50	**Extra Time**
10:50 - 11:20	**Coffee Break**
Session 1 Chair:	**Ground and Space Projects** *Gerald Handler*
11:20 – 11:50	**Tom Barclay** (NASA Ames Research Center) Kepler/K2 Overview (*Invited Talk*)
11:50 – 12:10	**Robert Szabo** (Konkoly Observatory) The Kepler/K2 RR Lyrae survey
12:10 – 12:30	**Ewa Niemczura** (University of Wrocław) Spectroscopic survey of A- and F-type stars in the original Kepler field-of-view
12:30 - 14:00	**Lunch**
Session 2 Chair:	**The Chemically Peculiar Stars** *Daniel Holdsworth*
14:00 – 14:30	**John Landstreet** (University of Western Ontario) The chemically peculiar A and B stars (*Invited Talk*)
14:30 – 14:50	**Gautier Mathys** (Joint ALMA Observatory & ESO) How slowly do Ap stars rotate?
14:50 – 15:10	**Miroslav Jagelka** (Masaryk University) Global characteristics of photometric light curves of magnetic chemically peculiar stars
15:10 – 15:30	**Evgenii Semenko** (Special Astrophysical Observatory) Spectroscopy of magnetic chemically peculiar stars in binary and multiple systems
15:30 - 16:00	**Coffee Break**

Monday 12th September (*continued*)	
16:00 – 16:20	**Sylvie Vauclair** (IRAP) Unexpected consequences of chemical peculiarities inside stars: instabilities induced by heavy element accumulation
16:20 – 16:40	**James Silvester** (Uppsala University) Magnetic field and abundance mapping of chemically peculiar stars
16:40 – 17:00	**James Sikora** (Queen's University) Understanding the fossil magnetic fields of Ap/Bp stars: conclusions from a volume-limited survey
	End of working day

	Tuesday 13th September
Session 3	**Activity, Rotation and Binarity**
Chair:	*Victoria Antoci*
09:00 – 09:30	**Rhita-Maria Ouazzani** (Aarhus University) On the arduous task of modelling rotating A-type stars and their pulsations (*Invited Talk*)
09:30 – 09:50	**Masao Takata** (University of Tokyo) Inference for the internal rotation profile of stars based on dipolar modes of oscillations
09:50 – 10:10	**Frédéric Royer** (Observatoire de Paris) Normal fast rotating A- and B-type stars seen pole-on
10:10 – 10:30	**Ghina Halabi** (University of Cambridge) Two-Dimensional Stellar Evolution: 2DStars
10:30 - 11:00	**Coffee Break**
11:00 – 11:30	**Tamara Rogers** (Newcastle University) Internal gravity waves in massive main sequence stars (*Invited Talk*)
11:30 – 11:50	**Joanna Molenda-Zakowicz** (University of Wrocław) Activity indicators and the atmospheric parameters of the Kepler targets
11:50 – 12:10	**Markus Schoeller** (ESO) The central role of low-resolution FORS 1/2 spectropolarimetric observations for the investigation of magnetic fields in massive pulsating stars
12:10 - 14:00	**Lunch**
Session 1	**Ground and Space Projects**
Chair:	*Simon Murphy*
14:00 – 14:30	**Andrzej Pigulski** (University of Wrocław) Science with nano-satellites: BRITE-Constellation (*Invited Talk*)
14:30 – 14:50	**Daniel Holdsworth** (University of Central Lancashire) Asteroseismology with SuperWASP
14:50 – 15:10	**Paul Greer** (The Open University) Characteristics of a new Blazhko effect population in the SuperWASP archive
15:10 – 15:30	**1-min poster slide presentations**
Chair:	*Dominic Bowman*
15:30 - 16:00	**Coffee Break**
16:00 – 17:00	**Poster Session**
	End of working day

Wednesday 14th September	
Session 4	**Insights from Asteroseismology**
Chair:	*Sylvie Vauclair*
09:00 – 09:30	**Péter Pápics** (KU Leuven) Rotation and mixing in SPB stars – Where are we now? (*Invited Talk*)
09:30 – 09:50	**Sergio Simon-Diaz** (Instituto de Astrofísica de Canarias) New insights about stellar oscillations in O stars and B supergiants with NOT, HERMES and SONG spectroscopic observations
09:50 – 10:10	**Andreas Irrgang** (Dr. Karl Remeis-Observatory) The slowly pulsating B-star 18 Peg: A testbed for upper main sequence stellar evolution
10:10 – 10:30	**Swetlana Hubrig** (Leibniz-Institut fuer Astrophysik) Pulsations challenging the detection of magnetic fields in upper main sequence stars
10:30 - 11:00	**Coffee Break**
11:00 – 11:30	**JJ Hermes** (University of North Carolina) Watching stellar evolution all the way to the closing credits (*Invited Talk*)
11:30 – 11:50	**Victoria Antoci** (Aarhus University) Mysteriously oscillating stars – Eliminating the impossible to find the improbable
11:50 – 12:10	**Dominic Bowman** (University of Central Lancashire) Amplitude modulation in delta Scuti stars: statistics from an ensemble of Kepler targets
12:10 - 13:00	**Lunch**
	End of working day

	Afternoon Excursion
14:00 - 18:00	**Holehird Gardens and Bowness-on-Windermere**

Thursday 15th September	
Session 2 Chair:	**The Chemically Peculiar Stars** *Gautier Mathys*
09:00 – 09:30	**Jaymie Matthews** (University of British Columbia) A roAp by any other name would cast a spell as sweet (*Invited Talk*)
09:30 – 10:00	**Douglas Gough** (University of Cambridge) Ap stars: the phenomenon of rapid oscillation (*Invited Talk*)
10:00 – 10:20	**C. Simon Jeffery** (Armagh Observatory) Pulsation in the chemically peculiar hot star zoo
10:20 - 10:50	**Coffee Break**
10:50 – 11:10	**Margarida Cunha** (Instituto de Astrofísica e Ciências do Espaço) Revisiting the Instability Strip for rapidly oscillating Ap stars
11:10 – 11:30	**Hideyuki Saio** (Tohoku University) Models for the amplitude-phase modulation of the peculiar roAp star HD 24355
11:30 – 11:50	**Paola Quitral-Manosalva** (Universidade do Porto) A theoretical tool for the study of radial velocities in the atmospheres of roAp stars
11:50 – 12:10	**Oleg Kochukhov** (Uppsala University) Doppler imaging of stellar non-radial pulsations
12:10 – 12:30	**David Mkrtichian** (National Astronomical Research Institute of Thailand) Acoustic tomography of gamma Equulei: discovery of acoustic separation of the first and the second ions in the stratified clouds of rare-earth elements
12:30 - 14:00	**Lunch**
Session 4 Chair:	**Insights from Asteroseismology** *Hiromoto Shibahashi*
14:00 – 14:30	**Konstanze Zwintz** (University of Innsbruck) Tracing the early lives of stars with asteroseismology (*Invited Talk*)
14:30 – 14:50	**Nami Mowlavi** (University of Geneva) The roles of rotation and pulsation in the new B- and A-type periodic variable stars in NGC 3766
14:50 – 15:10	**Masahide Takada-Hidai** (Tokai University) A spectroscopic analysis of KIC 11145123
15:10 – 15:30	**Javier Pascual-Granado** (Instituto de Astrofísica de Andalucía) Unbiased estimation of a multifrequency solution in delta Scuti stars
15:30 - 16:00	**Coffee Break**

	Thursday 15th September (*continued*)
16:00 – 16:20	**Juan Carlos Suárez** (Universidad de Granada) The impact of gap-filling methods for the determination of periodicities in the oscillation spectra of A-F stars
16:20 – 16:40	**Valentina Schmid** (KU Leuven) Modelling the binary F-type g-mode pulsator KIC 10080943
16:40 – 17:00	**Mark Cropper** (MSSL-UCL) Convection without the mixing length parameter
	End of working day

19:00 -	**Conference Dinner** Low Wood Bay Hotel Restaurant

	Friday 16th September
Session 3	**Activity, Rotation and Binarity**
Chair:	*Margarida Cunha*
09:00 – 09:30	**Barry Smalley** (Keele University) Binarity, pulsations and peculiarities (*Invited Talk*)
09:30 – 09:50	**Hiromoto Shibahashi** (University of Tokyo) The Blazhko RR Lyrae variables and phase modulation in binary systems
09:50 – 10:10	**Simon Murphy** (University of Sydney) Kepler's non-eclipsing binary population for delta Scuti stars
10:10 - 10:40	**Coffee Break**
Session 1	**Ground and Space Projects**
Chair:	*Margarida Cunha*
10:40 – 11:10	**Laurent Eyer** (University of Geneva) Gaia (*Invited Talk*)
11:10 – 11:30	**Discussion**
Session 0	**Special Reviews**
Chair:	*Jørgen Christensen-Dalsgaard*
11:30 – 12:00	**Daniel Holdsworth** (University of Central Lancashire) Closing Remarks
12:00 - 13:00	**Lunch**
	End of conference

STARS2016:

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Talks

STARS2016:

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Monday

12th September

The life and times of Donald Wayne Kurtz

Derek Ward-Thompson[1]

[1]*Jeremiah Horrocks Institute, University of Central Lancashire, Preston PR1 2HE, UK*

Abstract

I will give a brief overview of Don's life, and some of its significant milestones. I will discuss Don the person, as well as Don the scientist, based upon a decade and a half of friendship as a fellow astronomer, colleague and co-worker.

The many faces of Donald Wayne Kurtz: Don's career in Texas (1970 - 1976)

MICHEL BREGER[1]

[1]*University of Texas*

Abstract

The talk covers the beginning of Don's remarkable research activities while he was a graduate student at the University of Texas. I review his investigation of the chemical peculiarities in short-period pulsating stars and show why his scientific results still matter after four decades.

Don Kurtz, the South African connection

THEBE MEDUPE[1]

[1]*North West University*

Abstract

Donald Wayne Kurtz's contribution to South African astronomy can be divided into two parts. The first one was simply through his excellence in astronomy research. He was part of the two main leading astronomy groups (University of Cape Town and SAAO) in South Africa during the 1970s, 1980s and 1990s. It was during this time that he discovered the rapidly oscillating Ap stars, and made important contributions in other areas of stellar pulsation research. It is no wonder that by the time he left South Africa in the late 1990s, Don Kurtz had received the highest rating (A) in the South African science system. His second most important contribution was in the teaching of Astronomy. His passion for sharing his knowledge of Astronomy was unparalleled, and is a legacy that has inspired his former students (some of whom are astronomers in South Africa). I must mention that Don is still involved in South African Astronomy through his annual lectures at the South African National Astrophysics and Space Science Programme. He continues his research collaborations with former students. This talk presents in detail the scientific and educational achievements of this fine scientist and great educator while he was in South Africa.

Kepler/K2 Overview

THOMAS BARCLAY[1]

[1]*NASA Ames Research Center*

Abstract

By repurposing the Kepler spacecraft, K2 expands upon Kepler's groundbreaking discoveries in the fields of exoplanets and astrophysics, substantially increasing the scientific return from the spacecraft. With approximately two years of fuel remaining, the K2 mission provides a wide variety of new and exciting science opportunities. K2 points in the ecliptic, sequentially observing fields as it orbits the Sun. This observing strategy regularly brings new, well-characterised fields into view, enabling observations of scientifically important objects across a wide range of galactic latitudes in both the northern and southern sky. The K2 mission performs a series of long, ecliptic-pointed campaigns to conduct new research in exoplanets, star clusters, young stars, stellar activity, variable stars, stellar structure and evolution, galaxies, supernovae, and solar system objects. With a demonstrated 6-hour photometric precision of 30-40 ppm, the K2 mission provides simultaneous observation of thousands of objects at a precision within 20% of Kepler's. K2 offers a unique exoplanet discovery space, filling the gap in duration and sensitivity between the Kepler and TESS missions, and has already provided high-value transiting exoplanet targets for Hubble and JWST transit spectroscopy. K2 observes new types of science targets inaccessible to Kepler and with higher photometric precision and fainter magnitude limits than TESS. Additionally, K2 is enabling unique opportunities such as the Campaign 9 microlensing experiment and a dedicated supernova campaign.

The Kepler/K2 RR Lyrae survey

ROBERT SZABO[1], KATRIEN KOLENBERG[2]

[1]*Konkoly Observatory, MTA CSFK*
[2]*KU Leuven, Belgium*

Abstract

The Kepler Mission induced a revolution in both exoplanetary science and in stellar astrophysics. It also shed new light on seemingly simple classical pulsating stars, like RR Lyrae variables. We have learnt that besides the large amplitude radial pulsation, various dynamical phenomena are happening in many of these objects. These include extra periodicities, possible nonradial modes, period doubling, various resonances and other dynamical phenomena. Based on the new results, even a new explanation for the century-old mystery, the Blazhko-modulation has been proposed. Following the success of Kepler, we have initiated a large survey with K2, to observe thousands of RR Lyrae stars along the ecliptic. The high photometric precision and the 80–90-day continuous coverage will allow us to investigate the light variation of these galactic structure tracer variable stars with an unprecedented detail. The survey will help us to conduct a thorough statistical study of RR Lyrae pulsation including old and recently discovered dynamical phenomena. In this talk we describe the survey, present the first results, and discuss the prospects in the light of what the combination of the survey and LSST (and also Gaia) will have to offer in the context of galactic structure studies.

Spectroscopic survey of A- and F-type stars in the original Kepler field-of-view

Ewa Niemczura[1], Magdalena Polinska[2], Barry Smalley[3], Simon Murphy[4], Tomasz Rozanski[1]

[1]*University of Wrocław*
[2]*University of Poznan*
[3]*Keele University*
[4]*University of Sydney*

Abstract

The NASA space mission Kepler was launched in 2009. The Kepler photometric time series of a remarkable precision are excellent database for studying pulsation variability of stars across the HR diagram. To perform the successful asteroseismic study, the precise pulsation frequencies, mode identification, atmospheric parameters (effective temperature, surface gravity, microturbulence, macroturbulence, chemical abundances) and rotational velocity are necessary ingredients. The best way to obtain information about atmospheric parameters is the investigation of high-resolution, high signal-to-noise spectra. For this reason, the ground based spectroscopic observations of hundreds of stars in the primary Kepler field were obtained. In particular, high- and medium-resolution spectra have been collected and analysed for a substantial number of A and F-type stars. Their atmospheric parameters obtained in such investigations are of great importance for seismic modelling of delta Scuti, gamma Doradus, and gamma Dor/delta Sct hybrid stars which occupy this region of the HR diagram. Additionally, the spectroscopic analysis of large samples of A and F stars helps in finding answers to many questions concerning A and F stars and their atmospheres in general, like what is the dependence of microturbulent and macroturbulent velocities on effective temperature and other atmospheric parameters.

The chemically peculiar A and B stars

JOHN LANDSTREET[1]

[1]*University of Western Ontario, Canada*

Abstract

Among the intermediate mass (about 1.7 to 8 solar masses) main sequence stars, we find an astonishing variety of atmospheric chemical compositions, from approximately solar chemistry to huge over- and under-abundances of many elements. We also find magnetic fields in some of these stars, and a range of rotation periods from near break-up to a century or more. This variety provides us with tools to detect and study many physical processes in these stars. New developments in observational instrumentation and data treatment have allowed us to study a far wider variety of stars in detail than was possible even 20 years ago. In this talk I will survey some of the larger questions from this field on which people are working at present.

A major area of interest is to determine observationally how various phenomena depend on stellar age before and during the main sequence, and to use the results to guide theory. We are trying to learn how slow rotation, magnetic fields and and chemical peculiarities develop during the pre-main sequence, and how they then evolve. Studies are also beginning to reveal how these phenomena persist into the red giant stage. Another area of great interest is to link theoretical work on the interior stellar physics that may lead to the observed surface peculiarities, to the increasingly detailed interior structure studies from asteroseismolgy. Still another developing field is to connect the widespread phenomenon of binarity with peculiarity; for example, many stars now single may be the results of mergers earlier in their lives, and this could have had very important consequences. These and similar problems provide a rich field for studies of stellar physics.

How slowly do Ap stars rotate?

GAUTIER MATHYS[1]

[1] *Joint ALMA Observatory & European Southern Observatory*

Abstract

There are at present 36 stars known to have rotation periods longer than 1 month – more than twice as many as were known 15 years ago, and indicative of the existence of a sizeable population of super-slow rotators among Ap stars. We show that several of those stars must have periods of the order of 300 years, and that some may even reach 1000 years. This implies that the rotation periods of Ap stars span 5 to 6 orders of magnitude. It makes the Ap stars unique among main sequence stars, and raises the question of how stars within a limited range of masses ($\sim 1.8 - 3.0$ $M_\odot$) can achieve such differentiation of their rotation rates at the pre-main sequence stage. Further improvement of our knowledge of the properties of the super-slowly rotating Ap stars is one of the keys to answering it. Here we present recent results in the study of the periods of some of those stars.

Global characteristics of photometric light curves of magnetic chemically peculiar stars

MIROSLAV JAGELKA[1], ZDENĚK MIKULÁŠEK[1]

[1]*Masaryk University, Brno*

Abstract

The shape of light curves of magnetic chemically peculiar (mCP) stars is a result of uneven flux distribution caused by uneven distribution of chemical elements on their surface, concentrated in vast spots. The incidence of spots is believed to follow the geometry of the stellar global magnetic field. Therefore, we are trying to find some basic patterns which should modulate the shape of these light curves. We applied a simple model function to a data set of 316 mCP stars photometric measurements in filter V. Using this model we can describe the shapes of light curves in a sense of single-waved, double-waved and symmetric or asymmetric character. The analysis shows that the asymmetry appears in nearly half of the cases, and symmetric light curves have a higher tendency to be single-waved rather then double-waved.

Spectroscopy of magnetic chemically peculiar stars in binary and multiple systems

Evgenii Semenko[1]

[1]*Special Astrophysical Observatory, Nizhnii Arkhyz, Russia*

Abstract

The study of magnetic chemically peculiar stars is one of the largest observing programs carried out on the Russian 6-m telescope of SAO in the North Caucasus. Multiplicity is common in the world of non-magnetic and chemically normal hot stars. Peculiar stars show the lack of incidence of magnetic components in close short-periodic binary systems. Using the results of own observations we present the cases of interesting wide binary and multiple systems with the strongly magnetic members.

Unexpected consequences of chemical peculiarities inside stars: instabilities induced by heavy element accumulation

SYLVIE VAUCLAIR[1]

[1]*IRAP, Toulouse University*

Abstract

Whereas the so-called “chemically peculiar stars” seemed to be very exotic objects, other main sequence stars, referred to as “normal”, were thought to be more simple and well known ones. Recent studies show however that the difference between “peculiar’’ and “normal” stars is not as sharp as previously thought, and that all these objects still hide some surprises. Chemical segregation occurs inside most main sequence stars. Even if the effects are not always visible in the spectra, the resulting local accumulation can have important consequences for the opacities and the stellar models. Moreover, such chemical variations can lead to hydrodynamic instabilities which were not previously taken into account, neither for “peculiar’’ stars, nor for “normal’’ stars. I will give a summary of these effects and show results of recent studies.

Magnetic field and abundance mapping of chemically peculiar stars

JAMES SILVESTER[1]

[1]*Uppsala University*

Abstract

Magnetic chemically peculiar A and B type stars (Ap/Bp) exhibit strong globally organised magnetic fields, this is combined with strong chemical abundance non-uniformities within the atmosphere. The presence of the magnetic field influences energy and mass transport within the atmosphere of a star, this is thought to cause these observed chemical non-uniformities. With recent spectropolarimetric observations and by using magnetic Doppler imaging (MDI) techniques, we are starting to obtain detailed maps of the magnetic surface structure of a selection of Ap stars and are beginning to investigate correlations between the magnetic field structure and the chemical abundance structures in the photospheres of Ap/Bp stars. In this talk I will present some of the very latest mapping results for Ap stars and discuss their implications and future work.

Understanding the fossil magnetic fields of Ap/Bp stars: conclusions from a volume-limited survey

JAMES SIKORA[1], GREGG WADE[2]

[1]*Queen's University*
[2]*Royal Military College of Canada*

Abstract

Over the past decade, a surprising property of Ap/Bp stars has been reported: essentially no stars hosting fields with dipolar strengths < 300 G have been found. Presently, it is unclear whether or not this so called "magnetic desert" truly exists or if it is rather an artefact of the biases inherent to most published surveys – these surveys have typically focused on the brightest, most slowly rotating stars hosting relatively strong fields. Expanding on measurements obtained using the previous generation of high resolution spectropolarimeters (MuSiCoS), we have carried out an extensive spectropolarimetric survey of all identified magnetic Ap/Bp stars within 100 pc of the Sun. All of these stars have precise Hipparcos parallaxes and proper motions. This sample is compared in detail with the analogous sample of (presumably) non-magnetic A- and B-type stars in the same volume. In this talk, we will present the conclusions drawn from our homogeneous analysis of the physical, kinematic, magnetic, rotational and chemical properties of this essentially complete sample and discuss the implications within the context of previous studies.

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

Tuesday

13th September

On the arduous task of modelling rotating A-type stars and their pulsations

Rhita-Maria Ouazzani[1]

[1]*SAC, Aarhus University, Ny Munkegade 120, 8000 Aarhus C, Denmark*

Abstract

Rapid stellar rotation introduces a number of phenomena that considerably complicate the modelling of stars and the interpretation of their pulsations. On the one hand, centrifugal acceleration reduces local gravity, mimicking a lower mass, and distorts the propagation cavity of pulsation modes. On the other hand, rotation induces dynamical processes such as meridional circulation, shear and baroclinic instabilities, and modifies the dynamics of pulsation modes. In this review, I will present the state of the art of the modelling of A-type stars structure and pulsations.

Inference for the internal rotation profile of stars based on dipolar modes of oscillations

MASAO TAKATA[1]

[1]*University of Tokyo*

Abstract

One of the hottest topics in asteroseismology is to extract information about the structure of the internal rotation from the oscillation frequencies. In many of the rotation problems, nonradial eigenmodes of stellar oscillations with the dipolar horizontal pattern play an essential role. It is known that the governing equation of the dipolar modes can be particularly simplified, without neglecting the perturbation to the gravitational potential. The most important point is that the displacement of the mass element in the formulation of the general nonradial modes should be replaced by the 'reduced displacement', which means the difference between the displacement of the mass element and that of the center of mass of the corresponding concentric mass.

This study first demonstrates that the rotation inversion of the dipolar modes can be formulated in the simplified framework based on the reduced displacement. Based on this formulation, the logic that concludes the faster rotating envelope than the core in an A-type main sequence star, KIC 11145123, is established (cf. Kurtz et al. 2014). It is then shown, in the case of subgiants and red giants, that asymptotic inversion is possible to constrain the ratio between the core and envelope rotation rates without any evolutionary models (cf. Goupil et al. 2013; Deheuvels et al. 2015).

Normal fast rotating A- and B-type stars seen pole-on

FRÉDÉRICK ROYER[1], YVES FRÉMAT[2], RICHARD MONIER[3], MARWAN GEBRAN[4], JUAN ZOREC[5]

[1]*GEPI - Observatoire de Paris*
[2]*Observatoire Royal de Belgique*
[3]*Université de Nice Sophia Antipolis*
[4]*Notre Dame University-Louaize*
[5]*Institut d'Astrophysique de Paris*

Abstract

Single, non chemically peculiar A- and B-type stars are expected to be fast rotators on average. Whereas it is reflected in the rotational equatorial velocity distributions of mid- to late A-type stars, those for normal late B to early A-type do show the presence of slowly rotating objects (Royer et al. 2007, Zorec & Royer 2012). Recently, Royer et al. (2014) performed a detailed study of the properties of a sub-sample of 47 low $v \sin i$ (< 65 km s^{-1}) A0–A1 stars from Royer et al. (2007). They found that a large part of the sample is in fact composed of previously unidentified spectroscopic binaries and chemically peculiar stars. One third of the sample is however still composed of low $v \sin i$ normal stars. A similar ratio is found in the preliminary analysis of the late B counterpart, gathering 49 low $v \sin i$ B8-B9.5 stars.

These confirmed normal objects are investigated with very high quality spectroscopic data (signal-to-noise ratios higher than $\sim$400), using the instruments SOPHIE (OHP/T193) and HERMES (La Palma/Mercator), in order to detect gravity darkening signatures. Modelling the spectral line profiles affected by gravity darkening, using the calculation code FASTROT (Frémat et al. 2005), enables us to disentangle the equatorial velocity v and the inclination angle i. Our preliminary results on the early A-type and late B-star samples show the presence of fast pole-on rotator candidates. Objects such as HD47863 and HD85504 bear gravity darkening signatures more pronounced than the ones detected in Vega (Takeda et al. 2008, Hill et al. 2010, Monnier et al. 2012) and rotate at velocities close to breakup. Eventually, on a statistical basis, the inclination values for the full sample of confirmed normal stars will also enable us to verify how valid the assumption of random orientation of the rotational axes is for this specific sample.

Two-Dimensional Stellar Evolution: 2DStars

Ghina Halabi[1], Robert Izzard[1], Christopher Tout[1], Robert Cannon[2], Adam Jermyn[1], Jordi José[3], Mounib El Eid[4]

[1]*Institute of Astronomy, University of Cambridge, UK*
[2]*Textensor Limited, Edinburgh, UK*
[3]*Universitat Politecnica de Catalunya, Barcelona*
[4]*American University of Beirut, Beirut, Lebanon*

Abstract

Many stars are known to be rapid rotators, both at the surface and in their interiors. This rapid rotation causes aspherical distortion and surface temperature variations. It also drastically alters their chemistry, magnetic fields and future evolution. Thus, they can only be modelled properly in multi-dimensions. I will introduce 2DStars which is a general-use 2D, adaptable to 3D, stellar evolution code that is currently being developed at IoA. 2DStars will incorporate essential physics like rotation, magnetic fields, mixing, tides and mass transfer.

In addition to modelling rotating stars, possible applications of the code encompass a variety of multi-dimensional phenomena in stellar evolution like accretion and mass transfer in close binary systems, where an accretion disc forms by Roche-Lobe overflow from the giant companion star. Our recent results on the synthesis of C-rich dust in CO nova outbursts may thus benefit from 2D stellar evolution models that can provide important feedback on the accretion process on white dwarfs.

Internal gravity waves in massive main sequence stars

TAMARA ROGERS[1]

[1]*Newcastle University, UK*

Abstract

Internal Gravity Waves (IGW) can lead to angular momentum transport and chemical mixing in stellar interiors. In this talk I will present numerical simulations of these waves in massive stars and discuss how they might contribute to the understanding of a variety of observational mysteries.

Activity indicators and the atmospheric parameters of the Kepler targets

JOANNA MOLENDA-ZAKOWICZ[1], ANTONIO FRASCA[2], PETER DE CAT[3], GIOVANNI CATANZARO[2], JIAN NING FU[4], AN BING REN[4]

[1]*University of Wrocław*
[2]*INAF-OACt, Catania, Italy*
[3]*Royal observatory of Belgium, Brussel, Belgium*
[4]*Beijing Normal University, Beijing, China*

Abstract

For 51 385 stars of spectral types ranging from B to M located in the Kepler field of view, we derived the atmospheric parameters ($T_{\rm eff}$, $\log\, g$ and [Fe/H]) and the radial velocities (RV). Our results have been based on the low-resolution spectroscopic observations obtained with the LAMOST facility in the framework of the LAMOST-Kepler project. The accuracy of the parameters derived from the LAMOST data are typically $10 - 15$ km s^{-1} in RV, about 3.5 % in $T_{\rm eff}$, 0.3 dex in $\log\, g$, and 0.2 dex in [Fe/H]. We notice a systematic difference of about 0.2 dex between spectroscopic and photometric metallicities which is consistent with earlier findings based on smaller data samples. The analysis of H alpha and Ca II-IRT fluxes which allowed us to detect 442 chromospherically active stars, one of which is a likely accreting object. Then, we made use of the precise rotation periods from the Kepler photometry and we studied the dependency of the chromospheric fluxes on the rotation rate for a quite large sample of field stars. Finally, we report on detection of stars variable in RV, stars with very high projected rotational velocity ($v\, \sin\, i > 150$ km s^{-1}), and emission-line objects.

The central role of low-resolution FORS 1/2 spectropolarimetric observations for the investigation of magnetic fields in massive pulsating stars

MARKUS SCHOELLER[1]

[1]*European Southern Observatory*

Abstract

The spectropolarimetric mode of the ESO FOcal Reducer and low dispersion Spectrograph (FORS) has made it possible to probe for the first time the presence of magnetic fields in massive pulsating O-type stars, beta Cephei variables, and slowly pulsating B (SPB) stars. In particular, we were able to show that beta Cep and SPB stars can no longer be considered as classes of non-magnetic pulsators. In our talk, we will present the most recent results of magnetic field measurements and discuss the advantage of using FORS to progress with stellar magnetism studies.

Science with nano-satellites: BRITE-Constellation

Andrzej Pigulski[1]

[1] *University of Wrocław*

Abstract

Starting from 2013 a constellation of five cube BRIght Target Explorer (BRITE) satellites provides precise two-band photometry of the brightest stars in the sky. BRITE-Constellation is one of the first space projects using nano-satellites to provide scientifically useful data. I will present the main characteristics of this ongoing project, its scientific goals and sample results.

Asteroseismology with SuperWASP

DANIEL HOLDSWORTH[1]

[1]*University of Central Lancashire*

Abstract

SuperWASP is one of the largest ground-based surveys for transiting exoplanets. To date, it has observed over 31 million stars. Such a extensive database of time resolved photometry holds the potential for extensive searches of stellar variability, and provide solid candidates for the upcoming TESS mission. Previous work by e.g. Smalley et al (2011), Holdsworth et al (2014), Paunzen et al (2015) have shown that the WASP archive provides a wealth of pulsationally variable stars. In this talk I will provide an overview of the SuperWASP project, present some of the published results from the survey, and some of the on-going work to identify key targets for the TESS mission.

Characteristics of a new Blazhko effect population in the SuperWASP archive

Paul Greer[1], S. G. Payne[1], A.J. Norton[1], R.G. West[2]

[1]*The Open University*
[2]*University of Warwick*

Abstract

Despite being discovered one hundred years ago, the physical cause of the modulation of the pulsations of RR Lyrae stars, known as the Blazhko effect, remains a mystery. A large isotropic population is required to perform a statistical analysis of the common pulsation characteristics of those stars in order to better understand this effect. The archive from the all sky SuperWASP survey provides just such a population of thousands of pulsating variables, many of which we have already classified as RR Lyrae objects. A new population of a few hundred potential Blazhko effect RRab objects has been discovered through analysis of the frequency spectra created using SuperWASP data and the CLEAN algorithm. These objects have been cross referenced against known RRab objects in GCVS and M. Skarka's list of known Blazhko objects; the vast majority are previously unknown Blazhko stars, and most are previously unclassified as RRab. These objects have also been compared to a SuperWASP population identified by quantifying the increase in scatter at the peak of their light curves, due to the Blazhko effect. This presentation will exhibit light curves and power spectra from a selection of objects typical of this new Blazhko effect catalogue, and discuss preliminary findings of their common pulsation attributes and correlations between parameters.

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

Wednesday

14th September

Rotation and mixing in SPB stars – Where are we now?

PÉTER PÁPICS[1]

[1]*Institute of Astronomy, KU Leuven, Belgium*

Abstract

Slowly pulsating B (SPB) stars are main sequence stars with a mass between $2.5\ \mathrm{M}_\odot$ and $8\ \mathrm{M}_\odot$ that show non-radial heat-driven gravity-mode oscillations (see, e.g., Aerts et al. 2010, Chapter 2). Although it has been a quarter century since their discovery by Waelkens (1991), the first actual seismic modelling based on the high-order g modes was only achieved recently for KIC 10526294 by Pápics et al. (2014). Even though these objects are not massive stars according to the classical definition, they share the same internal structure by having a convective core and a radiative envelope. This means that SPB stars are ideal asteroseismic probes of ill-understood internal mixing processes that have a significant influence on the lifetime of the metal factories of the Universe, such as core overshooting, diffusive mixing, or internal differential rotation. Therefore these stars hold the key to the precise calibration of stellar structure and evolution models of massive stars.

We start this talk by giving a short historical overview of the highlights of the ground-based days and the pre-*Kepler* space-based era of SPB studies. Then we move on to the state-of-the-art in-depth investigations of KIC 10526294 (Pápics et al. 2014, Moravveji et al. 2015, and Triana et al. 2015) and KIC 7760680 (Pápics et al. 2015 and Moravveji et al. 2016) to illustrate how the unambiguous detection and forward modelling of gravity mode period series (of the same degree ℓ with consecutive radial order n) enabled the authors to put stringent constraints on the value of the core overshoot (reaching a $\sim 5\ \%$ precision – an order of magnitude better than ever before), the amount of diffusive mixing, and the internal rotation profile. Following this we present five new SPB stars (one of which shows Be signatures) from the nominal *Kepler* field that exhibit long series of gravity modes. In comparison with the two KIC stars that are being presented first, the rotation rates of these SPBs are faster, with $v \sin i$ values up to 240 $\mathrm{km\,s^{-1}}$, which is clearly traceable in the observed period spacings. In-depth modelling of these stars will provide significant input (in terms of rotation and mixing properties) to a new generation of stellar structure models of massive stars, while some interesting conclusions can already be drawn from the shape of the detected period spacing patterns combined with fundamental parameters from high-resolution spectroscopy.

New insights about stellar oscillations in O stars and B supergiants with NOT, HERMES and SONG spectroscopic observations

Sergio Simon-Diaz[1]

[1]*Instituto de Astrofísica de Canarias*

Abstract

Motivated by the characterisation of the macroturbulent broadening in the whole OB star domain, and the investigation of its postulated pulsational origin, we have compiled during the last six years a unique high-resolution spectroscopic dataset comprising more than 5000 spectra of about 500 Galactic O4–B9 stars (including dwarfs, giants and supergiants). Completely fulfilling its original aims, the database has also become a pot-of-gold to provide empirical information about spectroscopic variability (likely pulsational) phenomena in O stars and B supergiants. In this talk I will highlight the more important results obtained up-to-date from the exploitation of this unique spectroscopic dataset.

The slowly pulsating B-star 18 Peg: A testbed for upper main sequence stellar evolution

ANDREAS IRRGANG[1], APURVA DESHPANDE[2], SABINE MOEHLER[3], MARKUS MUGRAUER[4], DAVID JANOUSCH[5]

[1]*Dr. Karl Remeis-Observatory*
[2]*Imperial College London*
[3]*European Southern Observatory*
[4]*Astrophysikalisches Institut und Universitäts-Sternwarte Jena*
[5]*Sternwarte Dieterskirchen*

Abstract

The predicted width of the upper main sequence in stellar evolution models depends on the empirical calibration of the convective overshooting parameter. Despite decades of discussions, its precise value is still unknown and further observational constraints are required to gauge it. In this contribution, we would like to report on our discovery of a new benchmark object (Irrgang et al. 2016, A&A, in press): Based on a photometric and preliminary asteroseismic analysis, we showed that the mid B-type giant 18 Peg is one of the most evolved members of the rare class of slowly pulsating B-stars and, thus, bears tremendous potential to derive a tight lower limit for the width of the upper main sequence. In addition, 18 Peg turned out to be part of a single-lined spectroscopic binary system with an eccentric orbit that is greater than six years. Further spectroscopic and photometric monitoring and a sophisticated asteroseismic investigation are required to exploit the full potential of this star as a benchmark object for stellar evolution theory.

Pulsations challenging the detection of magnetic fields in upper main sequence stars

Swetlana Hubrig[1]

[1]*Leibniz-Institut fuer Astrophysik, Potsdam*

Abstract

Substantiated by results from photometric monitoring, we can expect that a large fraction of massive stars show photometric variability, due to either beta Cephei- or SPB-like pulsations, stochastic p-modes or convectively driven internal gravity waves. Due to the strong and rapid changes of line profile positions and profile shapes in the spectra of massive pulsating stars, high-resolution spectropolarimetric observations frequently fail to show credible magnetic field measurements. We discuss the recent discoveries of magnetic fields in such stars including the recent results obtained within the BOB (B-field in massive stars) collaboration and current attempts to take into account the impact of pulsations on the field measurements.

Watching stellar evolution all the way to the closing credits

JJ HERMES[1]

[1]*University of North Carolina, USA*

Abstract

Fast-forwarding through some juicy action sequences along the upper main sequence, I will jump straight to the stellar denouement and connect observations of white dwarf stars to questions of rotation, pulsation and chemical peculiarities. Kepler and especially K2 are revolutionising our empirical constraints on these final stages of all low- and intermediate-mass main sequence stars. Attention will be paid especially to the extremely low-mass (He-core) white dwarfs, the endpoints of close binary evolution.

Mysteriously oscillating stars – eliminating the impossible to find the improbable

Victoria Antoci[1], Peter Nemeth[2], John Telting[3], Jason Rowe[3], Rhita-Maria Ouazzani[1]

[1] *Stellar Astrophysics Centre, Aarhus University*
[2] *Friedrich-Alexander-Universität, Erlangen-Nürnberg*
[3] *Nordic Optical Telescope*
[4] *Universite de Montreal*

Abstract

Here I present a sample of suspected A and F type main sequence pulsators observed by Kepler that show frequency patterns consistent with gravity modes. The periods spacings, however, do not match the expected values for main sequence stars but rather those of compact objects. Beyond the problem of explaining the short period spacings, the pulsation periods, which are too short for gamma Dor stars, only partly overlap with known examples of sdB pulsators. Recent theoretical predictions of mode instability in compact stars suggest the gravity modes in pre-extremely-low-mass white dwarfs could be consistent with our observations. Nevertheless, at this stage it is impossible to rule out pressure modes as detected in delta Sct stars, although their appearance would be very different to any known member of this group. Preliminary results of ALFOSC data obtained at NOT for about 65 % of our stars show no evidence of an sdB companion in the blue part of the spectrum. Additionally, we have high-resolution spectra for two of our targets, for which we find a low $v \sin i$ and an abundance pattern similar to that of the chemically peculiar star rho Puppis.

Amplitude modulation in delta Scuti stars: statistics from an ensemble of Kepler targets

DOMINIC BOWMAN[1], DONALD W. KURTZ[1], MICHEL BREGER[2], SIMON J. MURPHY[3], DANIEL L. HOLDSWORTH[1]

[1]*Jeremiah Horrocks Institute, University of Central Lancashire, Preston, UK*
[2]*Department of Astronomy, University of Texas, Austin, USA*
[3]*Sydney Institute for Astronomy, University of Sydney, Australia*

Abstract

Kepler data provide unprecedented views of light variability in pulsating stars. Intermediate-mass pulsators, such as delta Scuti stars, lie in a transition region between radiative cores and thick convective envelopes in low-mass stars, and large convective cores and thin convective envelopes in high-mass stars. Mode coupling and non-linearity are predicted in delta Scuti stars, which give rise to variable pulsation amplitudes. The delta Scuti star KIC 7106205 was shown to have a single amplitude-modulated pulsation mode that decreased in amplitude by more than a factor of 20 over 6 yr, whilst all other pulsation modes remained constant in amplitude and phase (Bowman et al. 2015).

A thorough and statistical search for amplitude modulation in approximately 1000 delta Scuti stars that were continuously observed by Kepler for 4 yr has been carried out. We present these results and demonstrate that diverse pulsational behaviour, in particular amplitude modulation, is common among delta Scuti stars with the majority of these stars exhibiting at least one pulsation mode that varies significantly in amplitude over 4 yr (Bowman et al. 2016). We construct models and use case studies to distinguish among different scenarios: beating of close-frequency pulsation modes; pure amplitude modulation; mode coupling and non-linearity.

Our study shows that time spans of years and decades are important for delta Scuti stars and that amplitude modulation is not restricted to a small region of the HR diagram. The study of approximately 1000 delta Scuti stars using the Kepler data set by Bowman et al. (2016) will be useful for studying similar stars with K2 and TESS, as the 4-yr time span will not be surpassed for some time.

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

Thursday

15th September

A roAp by any other name would cast a spell as sweet: A love-hate sonnet to pulsation, peculiarity and magnetism

Jaymie Matthews[1]

[1] *Department of Physics & Astronomy, University of British Columbia, Canada*

Abstract

Some say it as an acronym. Is it pronounced “rope”, as in “Give me enough roAp and I’ll hang myself”? Or “rho-app”, as in “I wish there were an app to model this roAp”? I prefer to enunciate the letters: r-o-A-p, as in a text message: “OMG, roAp, WTF!?!” The full name is “rapidly oscillating Ap”, which if Dante were alive and an astronomer, he might describe as the nine syllables of Hell. Why?

At first, the roAp stars seemed like a perfect match for the aspiring asteroseismologist before the advent of space photometry. The matchmaker was Don Kurtz, who introduced us in 1978 to the first high-overtone p-mode pulsator known after our Sun. The new class of chemically peculiar pulsators featured (a) small amplitudes, but big enough to be detected from the ground, (b) frequency patterns whose spacings could be fitted with asymptotic theory, and (c) non-radial mode geometries perturbed by the stars’ magnetic fields.

The 1987 thesis of a student besotted with roAp stars called them “ideal laboratories to probe atmospheres and internal magnetic fields and to locate A-Fp stars in the theoretical HR Diagram.” That young roAp-starstruck romantic was me. Three decades later, I’ve become more pragmatic – almost cynical – in my relationship with roAp variables, evolving from adoration to cautious friendship. We’ve learned much from studies of this class, but one lesson is “Life is complicated, and so is the connection between the p-mode frequencies and magnetic fields of roAps.” Often, the 60 known roAps seem a blessing, but equally often, a curse worthy of Dante.

In 30 minutes, I’ll recap almost 40 years of roAp history, from the initial skeptical reaction to Kurtz’s non-differential photometry, to the findings from space-based missions like MOST, Kepler, K2 and BRITE Constellation, and the models which try to connect them.

Ap stars: the phenomenon of rapid oscillation

Douglas Gough[1]

[1]*University of Cambridge*

Abstract

In 1981 Don Kurtz's discovery of rapidly oscillating (ro) Ap stars was announced. The stars appear to have two large antipodal spots, and are oscillating at high frequency with intensity amplitudes of the order of one per cent in predominantly dipole and perhaps axisymmetric quadrupole configurations whose axes are aligned with the spots. The presumption was that the spots are produced by a large-scale intense primordial magnetic field, which is quite plausible in young upper main sequence stars, although at the time a correspondence between the spots in those stars and a magnetic field had not been observationally established. In time it was established that associated with the spots are severe overabundances of chemical elements such as Europium, Neodymium and Praseodymium in their upper atmospheres. It was evident that in order to understand the roAp-star phenomenon the following questions needed to be addressed: Are the spots produced by magnetic suppression of convection, as in the Sun, and, if so, is the field intensity great enough? And what causes the chemical anomalies? With regard to the oscillations, what drives them and why are their frequencies so high? The frequencies correspond to those of very-high-order acoustic modes. Why are the amplitudes so small (if one is likening the stars to classical variables), and why are the amplitudes so large (if the oscillations were to be intrinsically stable and excited stochastically, as in the Sun)? Why are only dipole, and perhaps quadrupole, modes present, and why are they aligned with the spots? Does the magnetic field play an important direct role in the oscillation dynamics, or is it important only for producing the spots? In the three-and-a-half decades since the initial studies, we have gone a long way towards providing, or postulating, answers to those questions. And, not surprisingly, those answers raise further issues which I am sure will lead us to a deeper understanding not only of those stars, but to stellar evolution in general.

Pulsation in the chemically peculiar hot star zoo

C. SIMON JEFFERY[1]

[1]*Armagh Observatory*

Abstract

The discovery of radial pulsation in the extreme helium star V652 Her precipitated interest in the stability of low-mass early type stars. It was followed by discoveries of strange mode pulsations in the luminous extreme helium stars, and non-radial pulsations in very hot white dwarfs, the GW Vir variables. A decade later, sdB star pulsations were discovered, and recently, pulsations have been found in extremely-low mass white dwarf progenitors. In nearly all cases, driving is due to the kappa mechanism, and in many it is due to highly-ionised iron-group elements. Pulsation is also more likely when the hydrogen abundance is reduced. Meanwhile, a few hot subdwarfs, with reduced hydrogen and extremely peculiar surface chemistries including 4 dex enhancements of zirconium, yttrium, strontium, germanium and lead have been discovered. At least one of these, LS IV-14 116, is pulsating – but theory cannot explain it. This talk will explore recent work on the pulsations of helium-enriched low-mass stars. It is also intended to report the discovery of a remarkable new pulsating star, providing work is complete by the date of the meeting.

Revisiting the Instability Strip for rapidly oscillating Ap stars

MARGARIDA CUNHA[1], LUIS BALONA[2], DANIEL HOLDSWORTH[3], GUNTER HOUDEK[4], KARRINE PERRAUT[5], BARRY SMALLEY[6]

[1]*Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto*
[2]*South African Astronomical Observatory*
[3]*University of Central Lancashire*
[4]*Stellar Astrophysics Centre, Aarhus University*
[5]*IPAG, University of Grenoble*
[6]*Keele University*

Abstract

Chemically peculiar stars are stage to a wide variety of physical phenomena. Progress in the understanding of these objects, through the study of their oscillations, can help us characterize these physical phenomena and better understand the way they are coupled in stars.

More than 60 Ap stars are today known to exhibit high frequency oscillations. Despite this, the mechanism responsible for driving these oscillations is still under debate. Currently, the most widely accepted theory states that oscillations in this class of pulsators are excited by the opacity mechanism acting on the hydrogen ionization region, in an envelope where convection has been suppressed by a strong magnetic field. Nevertheless, this theory has been challenged in a number of ways, particularly for its difficulty in reproducing the observed red edge and the very high frequencies observed in some of the well studied pulsators.

In this study we revisit the theoretical instability strip proposed by Cunha (2002) and compare the results with the observations for over 60 roAp stars, including 5 stars with exquisite luminosity and effective temperature determinations, derived from a combination of interferometry, parallax, and bolometric flux. The main differences with respect to the previous theoretical work is the exploitation of a larger parameter space and different input physics for the non-adiabatic models.

The results show that there is an overall consistency between the position of the known roAp stars in the HR diagram and the predicted Instability strip. However, hints of disagreement are seen when comparing the range of frequencies excited in stellar models and those observed in some stars. This, in turn, points towards the need to re-think the excitation mechanism at work, at least in a sub-group of roAp stars.

Models for the amplitude-phase modulation of the peculiar roAp star HD 24355

HIDEYUKI SAIO[1]

[1]*Tohoku University, Japan*

Abstract

HD24355 is a peculiar roAp star in various respects. The effective temperature $T_{\mathrm{eff}} = 8200 \pm 200$ is one of the highest among the roAp stars. HD 24355 pulsates in a single mode with a frequency of 244.3 d^{-1} (6.4 min), which is one of the highest frequencies, and highly super-critical. The pulsation amplitude and phase of a roAp star generally modulates as a function of rotation phase, because the pulsation axis is inclined to the rotation axis (oblique pulsator). The amplitude modulation produces rotational side-lobes in the Fourier spectrum for a light curve. The Fourier spectrum of HD 24355 shows four main side-lobes (characteristic of a quadrupole mode) and additional nine side-lobes, indicating the angular distribution of the pulsation to be strongly deformed from a quadrupole mode.

Furthermore, HD 24355 shows very small phase modulation, indicating again a strong deformation of the amplitude and phase distribution on the stellar surface. Such a deformation is caused by a coupling between magnetic field and acoustic pulsation. I will talk about models for such magnetic deformations which cause the peculiar amplitude-phase modulation of HD 24355.

A theoretical tool for the study of radial velocities in the atmospheres of roAp stars

Paola Quitral-Manosalva[1], Margarida S. Cunha[2]

[1]*Universidade do Porto*
[2]*Institute of Astrophysics and Space Sciences of Portugal*

Abstract

Studies of high-resolution spectroscopy of rapidly oscillating Ap (roAp) stars show that the pulsations in these stars have a complex behavior in the atmospheric region, which results from their magnetoacoustic nature. Aiming at a better understanding of these pulsations, we developed a theoretical tool for the computation of the integrated radial velocities in roAp stars, as a function of depth. In the computation, we consider that the star is permeated by a dipolar magnetic field. The displacement at each latitude and depth is obtained with the MAPPA code (Cunha 2006) and we verify that the solutions for the outer atmosphere tend to the decoupled acoustic and magnetic analytic solutions valid for an isothermal atmosphere (Sousa & Cunha 2011). We explore the amplitude and phase behaviour derived from the theoretical radial velocities, for different mode degrees and different inclinations of the observer.

Doppler imaging of stellar non-radial pulsations

OLEG KOCHUKHOV[1]

[1]*Uppsala University*

Abstract

Doppler imaging is powerful technique of producing maps of unresolved stellar surfaces from time series of high-resolution spectroscopic data. This indirect surface imaging methodology is often applied to study magnetic fields and spots on the surfaces of active stars. In this presentation I discuss the extension of Doppler imaging to mapping surface velocity variation due to stellar non-radial pulsations. I present application of pulsational Doppler imaging to rapidly oscillating Ap stars, showing how it allowed to directly observe distortions of non-radial pulsations by the global magnetic field and enabled a decisive test of the predictions of magneto-acoustic pulsation theories.

Acoustic tomography of gamma Equulei: discovery of acoustic separation of the first and the second ions in the stratified clouds of rare-earth elements

DAVID MKRTICHIAN[1], A. HATZES[2]

[1]*National Astronomical Research Institute of Thailand*
[2]*Thuringen Landessternwarte, Tautenburg*

Abstract

We present the results of a radial velocity (RV) time series of the roAp star γ Equ spanning 4 days. We discover four new oscillation modes. The frequencies of these new modes, along with previously known ones, exhibit a well-defined large spacing of 62.8 μHz that are well structured in the echelle-diagram.

Lines of chemical elements that are differently stratified in the atmosphere are used to find the amplitude-phase cross sections and we derive the phase versus geometrical scale height. We find that the amplitude of the pulsations slowly decreases with the height from about $60 - 75$ m s^{-1} to almost zero velocity from the levels above the continuum to the lower atmosphere. In the outer atmosphere, where $\log \tau < -3$ the amplitude then slowly rises from a zero to a value of $\sim$180 m s^{-1}. Above these layers, in the narrow interval of $\log \tau = -3.5$ to -4.0, the amplitude dramatically increases from 180 to 2350 m s^{-1}. We discover that the RV pulsation amplitude has an inflection point near $\log \tau = -4.0$. Above this height over the corresponding optical depth interval $\log \tau = -4.0$ to -5.15, the RV amplitude decreases rapidly to a value of a few hundreds of m s^{-1}.

Remarkably, the amplitude inflection point is located exactly in the stratified Nd and Pr cloud and divides the cloud into two ionisation zones. Below the inflection point the rare earth elements (REE) of Nd, Pr, and Tb are singly ionised and above this inflection point the rare-earth elements are doubly ionised. We discuss possible reasons of existence of the inflection point and the ionic separation for the rare-earth elements.

Tracing the early lives of stars with asteroseismology

KONSTANZE ZWINTZ[1]

[1] *University of Innsbruck*

Abstract

The earliest phases in the lives of stars define their future fate. In the dusty, circumstellar disks that appear at star formation planetary systems like our own solar system are formed, thus connecting the origin of planets closely to the early evolution of the central stellar object. Therefore, understanding the physical processes that occur in these early stages is essential. Although we have a general concept of how stars are formed and evolve, our current knowledge of early stellar evolution is limited.

Pre-main sequence stars can become vibrationally unstable during their evolution to the zero-age main sequence. As they gain their energy from gravitational contraction and have not started nuclear fusion in their cores yet, their inner structures are significantly different to those of (post-) main sequence stars.

The field of pre-main sequence asteroseismology has progressed significantly since the start in the 1990s. I will review the development of this research area and show latest results.

The roles of rotation and pulsation in the new B- and A-type periodic variable stars in NGC 3766

Nami Mowlavi[1], Sophie Saesen[1], Thierry Semaan[1], Patrick Eggenberger[1], Fabio Barblan[1], Laurent Eyer[1], Sylvia Ekström[1], Cyril Georgy[1]

[1]*University of Geneva, Switzerland*

Abstract

We report on new findings about the new B-type periodic variable stars that were discovered in 2013 in the open cluster NGC 3766 (Mowlavi et al. 2013). The understanding of the nature of the new variables was challenging because of their position in the color-magnitude diagram of the cluster, between classical Slowly Pulsating B-type (SPB) and delta Scuti stars, and because of their periods, typically between 0.1 and 0.5 days. Both these observational properties challenged model predictions of pulsating stars that were available at the time of their discovery as well as other causes of variability.

Spectra taken with ESO's Very Large Telescope of all the new variables as well as of all SPB stars and of a subset of non-periodic stars in the magnitude range of interest contributed to a decisive understanding of the roles of rotation and pulsation in these new periodic variables. They revealed that the majority of them not identified as binaries are fast rotating. In addition, a new unexpected property was discovered, that strongly points to a pulsation origin of the variability, opening the door to potentially new perspectives in the study of pulsation in fast-rotating stars.

We present in this contribution those new findings, argue about the pulsation origin of the new periodic variability, and discuss the potential impact of the discoveries for asteroseismology and stellar models of fast-rotating stars.

A spectroscopic analysis of KIC 11145123

Masahide Takada-Hidai[1], Donald Kurtz[2], Hiromoto Shibahashi[3], Simon Murphy[4]

[1]*Tokai University*
[2]*University of Central Lancashire*
[3]*University of Tokyo*
[4]*University of Sydney*

Abstract

KIC 11145123 is a main sequence A star and has been discovered to show both delta Sct p-mode and gamma Dor g-mode pulsations, which gives the first robust determination of the rotation of the deep core and surface of a main sequence star. Its rotation is the nearly rigid rotation with a period near 100 days, so that it is very important to clarify what a strong angular momentum transfer mechanism operates (Kurtz et al. 2014, MNRAS, 444, 102). Among A stars, there are slow rotators such as magnetic Ap stars and non-magnetic Am stars. However, no known Ap star shows such low overtone p modes and g modes as detected in KIC 11145123. Other possibility is that this star may be Am star. To clarify the characteristics of this star, we carried out spectroscopic analyses of the atmospheric parameters and abundances, based on the spectroscopic data observed with HDS on the Subaru telescope. Fe I and Fe II lines are used to determine atmospheric parameters of $T_{\rm eff}$, $\log g$, microturbulence, Fe abundance, and $v \sin i$. The results confirm that the star is a main sequence A star with considerably low metallicity and slow rotation. Abundances of 20 elements including Fe are obtained to clarify a chemical signature, which suggests that the star may be normal star rather than CP stars. We will present the results and discussion in details.

The impact of gap-filling methods for the determination of periodicities in the oscillation spectra of A-F stars

Juan Carlos Suárez[1], Javier Pascual Granado[2], Rafael Garrido[2]

[1]*Universidad de Granada*
[2]*Instituto de Astrofísica de Andalucía-CSIC*

Abstract

We have shown that gap filling of stellar pulsations light curves has a key importance in the harmonic analysis of stellar oscillations, particularly in the use of Lomb-Scargle periodograms. Recently, we have found that pre-whitening procedures applied to a sample of light curves of delta Scuti stars observed by the CoRoT mission yield quite different results when the time series gaps are filled with (a) linear interpolation, (b) ARMA interpolation (using MIARMA algorithm), and (c) or leaving the gaps on the light curve. Surprisingly, the solutions differ significantly after the very first iterations of the frequency detection process.

Here we have considered those results to discuss the impact of the different gap-filling methods on the search for quasi-periodicities. In particular we focus on the determination of the large separation, which it have recently demonstrated to be a powerful tool (like for solar-like stars) to constrain the modelling of A-F stars. We discuss the impact of determining other periodicities, e.g., those related with rotation.

Unbiased estimation of a multifrequency solution in delta Scuti stars

Javier Pascual-Granado[1], Rafael Garrido[1], Juan Carlos Suárez[2]

[1]*Instituto de Astrofísica de Andalucía - CSIC*
[2]*University of Granada*

Abstract

Stellar rotation studies through asteroseismology require an unbiased estimation of the frequencies describing the luminosity variations. Even in ultra-precise satellite missions with a high duty-cycle bad data appears systematically in the light curves of pulsating stars due to instrumental or environmental events which lead to a biased frequency spectrum. To deal with bad data the usual treatment consists in performing an iterative prewhitening procedure for each frequency component detected in order to remove the contribution of the spectral window, or removing bad data and then filling the resulting gaps with an efficient interpolation method.

As far as we know no study of the impact of the different bad data treatments have been done before. Using a sample of delta Scuti stars we present here a comparison study between the frequency solutions given by an algorithm based on a prewhitening cascade (SigSpec) and two different approaches for correcting bad data: a simplistic but computationally efficient approach based on polynomial interpolation, and a more sophisticated but information preserving approach based on interpolation with ARMA models.

We show that, surprisingly, the solutions differ significantly after the very first iterations of the frequency detection process. This proves how crucial is using a consistent approach for bad data treatment even when the duty-cycle is high in order to obtain an unbiased estimation of the frequency solution and therefore a physically consistent model of rotating stars.

In consequence, any systematic study which is aimed to find frequency patterns in the power spectra of pulsating stars might be biased by an inadequate treatment of bad data.

Modelling the binary F-type g-mode pulsator KIC 10080943

VALENTINA S. SCHMID[1]

[1]*KU Leuven, Institute for Astronomy*

Abstract

Pulsating binary stars are ideal targets for testing the theory of stellar structure and evolution. Fundamental parameters can be derived from binary modelling to high precision and provide crucial constraints for seismic modelling. High-order gravity modes are sensitive to the conditions near the convective core and therefore allow for a determination of parameters describing interior physics, especially the convective-core overshooting parameter. KIC 10080943 is a binary system, which contains two gravity and pressure hybrid pulsators. A detailed observational study has provided fundamental and seismic parameters for both components.

In our study, we have used the stellar evolution code MESA and the seismic code GYRE, to compare theoretical properties to the observed mean period spacing and position in the Hertzsprung-Russell diagram. Additional constraints imposed by the binarity, are the mass ratio, equal age and composition.

We present here the first consistent seismic modelling of a binary F-type g-mode pulsator. Our best models have masses below the values estimated from binarity, which is a consequence of the low observed mean g-mode period spacing. We find that strength of overshooting and turbulent diffusion can be well constrained by the equal-age requirement for the two stars. However, we find no significant difference for different shapes of the overshooting. Furthermore, when we aim to explain the morphology of the period spacing pattern, we lose the agreement with the binary parameters. Our models present a fruitful starting point for more detailed studies, which also take the tidal interactions into account.

Convection without the mixing length parameter

MARK CROPPER[1], STEFANO PASETTO[1]

[1]*MSSL - UCL*

Abstract

For the last half century, stellar convection theory has depended on a scaling relation between the mean free path of a convective element and the pressure gradient, mediated by a parameter called the mixing length. This assumption is used to close the set of fluid flow equations. This scaling relation is not derived from within the physical formulation, and requires calibration by measurements of the Sun or through model-fitting of the isochrones in globular clusters. Its universality is unknown, and this parameterisation is one of the significant uncertainties in stellar evolution. We present here a new treatment of convection (Pasetto et al 2014, 2016) in which derives a closed form of the fluid equations self-consistently, eliminating the mixing length. We apply this formulation to the Sun and a set of standard stellar evolution models, and show that that matches current best knowledge. The formulation will inform and benefit from confrontation with stellar seismological data, and will be important for improving the accuracy and reliability of stellar models, especially in the Gaia era.

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

Friday

16th September

Binarity, pulsations and peculiarities

BARRY SMALLEY[1]

[1]*Keele University*

Abstract

Among the stars of the upper main sequence binary is common. Wide binary systems live their lives like single stars, but in close systems their mutual gravity influences the component stars' structure and evolution. In this talk a short review of binarity amongst the early-type stars will be presented, including the incidence of binary systems within the chemically peculiar stars. The role of binarity on pulsations and peculiarity will outlined, concentrating on the metallic-lined (Am) stars. The talk will conclude with a look to the future.

The Blazhko RR Lyrae variables and phase modulation in binary systems

Hiromoto Shibahashi[1]

[1] *University of Tokyo*

Abstract

The Blazhko phenomenon is the quasi-periodic amplitude and phase modulation seen in a fairly large fraction of RR Lyrae variables. The uninterrupted photometry with high precision from space missions revolutionised observations of these stars and revealed (i) a two-cycle amplitude modulation of the light curve, – the period doubling, (ii) a 2:9 resonance between a low-order mode and a high-order mode, and (iii) a presence of high-order multiplets. Nevertheless the Blazhko phenomenon still remains as a long-lived enigma to be explained. Frequency fine structures can also be seen in pulsating stars in binary systems. By carefully investigating the multiplets seen in RR Lyrae stars, I demonstrate that some of stars classified as Blazhko variables can be explained as binary systems and also show that some stars classified as binary systems are actually not binaries.

Kepler's non-eclipsing binary population for delta Scuti stars

SIMON MURPHY[1], HIROMOTO SHIBAHASHI[2], TIMOTHY BEDDING[1], DONALD KURTZ[3]

[1]*University of Sydney*
[2]*University of Tokyo*
[3]*University of Central Lancashire*

Abstract

I will present the latest results on Kepler's non-eclipsing binaries from the Phase Modulation method. The companions detected with this method include planets, brown dwarfs, main sequence stars with masses between 0.1 and 2.5 $M_\odot$, and possible compact objects such as neutron stars and black holes. Statistically robust distributions of the orbital parameters are discussed, exploring such phenomena as the circularisation of orbits as a function of orbital period. I will compare the binaries to those found by the RV method and show that the methods are complementary, each detecting binaries in different parameter spaces. I will comment on the precision available and the implications for planet occurrence around A stars.

Gaia

Laurent Eyer[1]

[1]*University of Geneva*

Abstract

The first Gaia data release is planned for September 14, 2016. It should contain positions for more than 1 billion stars brighter than 20.7 mag in G band, a 5-parameter astrometric solution (positions, proper-motions and parallaxes) based on the Tycho-2 catalogue and Gaia data for 2 million stars and 3200 variable stars. The content of the release will be presented in some detail together with a special focus on time sampling properties and the released data on 3200 Cepheid and RR Lyrae stars.

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

Posters

List of posters

A1 **Swetlana Hubrig** (*Leibniz-Institut fuer Astrophysik Potsdam*)
Pulsations versus magnetic field in the atmosphere of the strongly magnetic Bp star HD 96446

A2 **Christopher J. Corbally** (*Vatican Observatory*)
Investigating pulsating lambda Boötis stars

A3 **Santosh Joshi** (*ARIES, Manora Peak, Nainital*)
The Nainital-Cape survey: a project initiated by Don Kurtz et al. at ARIES Nainital

A4 **Ilya Yakunin** (*Special Astrophysical Observatory*)
Magnetic field of CP stars in Ori OB1 association

A5 **Yves Fremat** (*Royal observatory of Belgium*)
Gravity darkening in stars with surface differential rotation

A6 **Paulina Sowicka** (*Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences*)
Detection of rapid differential rotation in the Gamma Doradus star KIC 8197761

A7 **Margit Paparo** (*Konkoly Observatory, MTA CSFK*)
Characterisation of echelle ridges in fast rotating Delta Scuti stars: eigenmodes or rotationally split modes

A8 **Filiz Kahraman Alicavus** (*University of Canakkale Onsekiz Mart*)
Comparison of delta Scuti and gamma Doradus stars

A9 **Filiz Kahraman Alicavus** (*University of Canakkale Onsekiz Mart*)
Delta Scuti components in eclipsing binary systems

A10 **Jeremy Jones** (*Georgia State University*)
The ages of A stars: interferometric observations of our brightest neighbours

A11 **Tao Wu** (*Yunnan Observatories*)
An independent seismic analysis of stellar fundamental parameters and interiors: KIC 6225718

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

Poster abstracts

1

Pulsations versus magnetic field in the atmosphere of the strongly magnetic Bp star HD 96446

SWETLANA HUBRIG[1]

[1]*Leibniz-Institut fuer Astrophysik Potsdam*

Abstract

HD 96446 (=V430 Car) is a well-known magnetic B2p He-strong photometric variable with beta Cephei-like pulsations with a period of 2.23 h and a strong magnetic field of kG order. In our poster, we present new magnetic field measurements taking into account the pulsational variability. Since pulsating early-B type stars with very strong magnetic fields are rather rare, we gathered an intensive time series of high S/N high-resolution spectra of this star with the CORALIE echelle spectrograph attached to the 1.2-m Euler telescope on La Silla (Chile) to search for the rotation period and to study the pulsation pattern in more detail.

2

Investigating pulsating lambda Boötis stars

Christopher J. Corbally[1], Simon J. Murphy[2], Richard O. Gray[3]

[1]*Vatican Observatory*
[2]*University of Sydney, Australia*
[3]*Appalachian State University, Boone NC, USA*

Abstract

Lambda Boo stars are in a rare A-type spectral class, whose mechanism remains a puzzle after their isolation as peculiar over 70 years ago. They have a selective deficiency of the refractory elements while showing solar-abundance of the volatile elements (C, N, O, S). The origin of this pattern seems to be in the accretion of material onto the star's surface from either the interstellar medium or a circumstellar disk, but the alternative that the star is metal-weak throughout needs to be definitively addressed. Since many late-A type lambda Boo stars pulsate, asteroseismology can help distinguish between the two compositional profiles. It may also provide helpful information about their ages.

A recent re-evaluation of 212 objects, recorded in the literature as lambda Boo candidates, led to 67 being considered by Murphy et al. (2015) to be genuine members of the class. While pulsation data for these is incomplete, there is a ready goldmine of such data in the Kepler field stars, among which 132 have been classified from LAMOST spectra with the expert computer classification program MKCLASS as lambda Boo candidates (Gray et al. 2015). We are also conducting a spectroscopic survey of known metal poor stars to find additional lambda Boo candidates, for which asteroseismic data will be accessible from the upcoming TESS mission.

This poster reports on our project to obtain new, high-quality spectra of lambda Boo candidates that may pulsate. These data will confirm their status as lambda Boo stars and provide the initial parameters of effective temperature, gravity, and overall metallicity. The asteroseismic analysis of their pulsations will follow later.

3

The Nainital-Cape survey: a project initiated by Don Kurtz et al. at ARIES Nainital

SANTOSH JOSHI[1], THE NAINITAL-CAPE SURVEY TEAM[1]

[1]*ARIES, Manora Peak, Nainital*

Abstract

The Nainital-Cape Survey is a dedicated survey programme initiated in 1999 by Don Kurtz and Peter Martinez in the coordination of the astronomers from ARIES Nainital and ISRO Bangalore with aims to search for new roAp stars and pulsating Am stars in the northern and southern hemisphere, and perform asteroseismic studies to understand their internal structure and evolution. The candidate stars were selected on the basis of having Strömgren photometric indices similar to those of known pulsating chemically peculiar (CP) stars, and the survey was conducted using high-speed photometry. Over the last 17 years a total of 337 candidate pulsating CP stars were observed for the Nainital-Cape survey, making it one of the longest ground-based surveys for pulsation in CP stars in terms of time span and sample size. Under this survey, we discovered the rapid pulsation in an Ap star HD12098 while delta Scuti pulsations were detected in seven Am stars. As a part of establishing the detection limits in the Nainital-Cape survey, we investigated the scintillation noise level at the two observing sites used in this survey, Sutherland and Nainital, by comparing the combined frequency spectra of stars observed from each location. Our analysis shows that both the sites permit the detection of variations of the order of 0.6 mmag in the frequency range $1-4$ mHz. Sutherland is on average marginally better. A major credit of the success of this survey goes to Prof. Don Kurtz who initiated the first such survey in India, particularly at ARIES Nainital.

4

Magnetic field of CP stars in Ori OB1 association

Ilya Yakunin[1], I. Romanyuk[1], E. Semenko[1], D. Kudryavtsev[1]

[1]*Special Astrophysical Observatory*

Abstract

We present the results of magnetic field measurements for 8 CP stars in Ori OB1 association, obtained with Main Stellar Spectrograph of 6-m telescope of Special Astrophysical Observatory. All of them are belong to He-weak subclass of chemical peculiarity. Rotation periods of the stars are estimated using longitudinal field variations. For several stars, magnetic field variations and rotation periods differ considerably from the ones known in literature.

5

Gravity darkening in stars with surface differential rotation

YVES FREMAT[1], J. ZOREC[2], A. DOMICIANO DE SOUZA[3], F. ROYER[4]

[1]*Royal observatory of Belgium*
[2]*Sorbonne Universités, UPMC Université Paris 06 et CNRS UMR 7095, Institut d'Astrophysique de Paris, F-75014 Paris, France*
[3]*4 Laboratoire Lagrange, Université Côte d'Azur, Observatoire de la Côte d'Azur, Bd. de l'Observatoire, CS 34229, 06304 Nice Cedex 4, France*
[4]*GEPI, Observatoire de Paris, PSL Research University, CNRS UMR 8111, Université Paris Diderot, Sorbonne Paris Cité, 5 place Jules Janssen, 92190 Meudon, France*

Abstract

A model is proposed to determine consistently the latitudinal dependence of the effective temperature in a star with surface differential rapid rotation. The effects introduced by the differential rotation on spectral lines are tested using a Maunder's rotation law. We note that the usually employed gravity-darkening exponent is a function of the stellar aspect angle which thus has only a relative efficiency to describe rotational properties of stars.

6

Detection of rapid differential rotation in the Gamma Doradus star KIC 8197761

Paulina Sowicka[1], G. Handler[1], B. Debski[2], D. Jones[3], M. Van de Sande[4], P. I. Papics[4]

[1]*Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences*
[2]*Astronomical Observatory of the Jagiellonian University*
[3]*Instituto de Astrofisica de Canarias*
[4]*Instituut voor Sterrenkunde, KU Leuven*

Abstract

A search for planetary transits among stars in the lower part of the classical instability strip in short-cadence Kepler data revealed KIC 8197761 as the best candidate. The detected periodic dimming with a period of 9.87 d and an amplitude of about 6 mmag are however due to grazing transits of an M dwarf star. Our analysis of the gamma Doradus pulsation implies an internal rotation period of 300 d, whereas the measured $v \sin i$ is consistent with the hypothesis of the envelope rotation period – 30 times faster than in the stellar interior – being synchronised with the binary orbit.

7

Characterisation of echelle ridges in fast rotating delta Scuti stars: eigenmodes or rotationally split modes

MARGIT PAPARO[1], JOZSEF M. BENKO[1], DANIEL REESE[2]

[1]*Konkoly Observatory, MTA CSFK*
[2]*LESIA Paris Observatory*

Abstract

Unexpected regularity of echelle ridges were published for fast rotating delta Scuti stars (Paparo et al. 2016a,b). A subset of those sample stars were investigated for the origin of individual echelle ridges. The subset contains those delta Scuti stars in which the dominant spacing proved to be the large separation according to the relation of Suarez et al. (2014). In these cases the echelle ridges are expected to have modes of consecutive radial order with the same ℓ value and rotational split frequencies in separated echelle ridges. Compared the shift of the echelle ridges and the estimated rotational velocity we derived which ridges contain the eigenmodes or the rotationally split frequencies. We present the quantum numbers (ℓ and m) for test case(s).

8

Comparison of delta Scuti and gamma Doradus stars

Filiz Kahraman Alicavus[1], Ewa Niemczura[2], Esin Soydugan[3], Peter De Cat[4], Magdalena Polinska[5], Krzysztof G. Helminiak[6], Patricia Lampens[4], Joanna Molenda-Zakowicz[2], *et al.*

[1]*University of Canakkale Onsekiz Mart*
[2]*University of Wroclaw*
[3]*University of Canakkale Onsekiz Mart*
[4]*Royal Observatory of Belgium*
[5]*University of Adam Mickiewicz*
[6]*National Astronomical Observatory of Japan*

Abstract

Delta Scuti and gamma Doradus stars are remarkable pulsating variables for asteroseismology. The space telescopes discoveries increased their numbers significantly and many problems have been revealed about these stars. In particular, what are the exact locations of the delta Scuti and gamma Doradus instability strips? How strong is the relation between rotational velocity and pulsation period and amplitude? These are some of the most important questions to be answered. For this reason, we performed detailed spectroscopic studies of a sample of delta Scuti and gamma Doradus stars. The atmospheric parameters (effective temperature, surface gravity, microturbulent velocity) and projected rotational velocities were obtained by using exactly the same methods for all stars. The atmospheric chemical abundances of the analysed stars were derived by using the spectrum synthesis method. Finally, the relations between pulsation period, amplitude and atmospheric parameters, rotation velocity and metallicity were examined. Additionally, the chemical abundance patterns of both types of pulsating stars were compared with each other and with non-pulsating stars. In this poster, the results of this investigation are shown.

9

Delta Scuti components in eclipsing binary systems

Filiz Kahraman Alicavus[1], Esin Soydugan[1], Jiri Kubat[2]

[1]*University of Canakkale Onsekiz Mart*
[2]*Astronomicky ustav, Akademie ved Ceske republiky*

Abstract

The eclipsing binary systems with a delta Scuti component are notable objects, which exhibit both binarity and pulsation nature. These systems offer us an opportunity to obtain accurate fundamental parameters (mass, radius) of pulsating components by modelling the light curves in addition to the pulsation properties. Therefore, we collected eclipsing binary stars with a delta Scuti component to examine the basic properties of them. In this study, we present the revised catalog of this type of objects. As a result, we gathered fundamental parameters (e.g., masses, radii, effective temperatures, surface gravities, projected rotational velocities of pulsating components) of 98 eclipsing binary stars with a delta Scuti component. The effective temperature and surface gravity ranges of the stars were found approximately between $6750 - 9700$ K and $3.4 - 4.4$ dex, respectively. The projected rotational velocities were obtained from 12 to $130\ \mathrm{km\,s^{-1}}$ which is lower than the single delta Scuti stars'. Relations between the pulsation quantities and gathered parameters were checked and significant relations between pulsation periods and effective temperatures, radii, filling factors of pulsating delta Scuti components were found.

10

The ages of A stars: interferometric observations of our brightest neighbours

Jeremy Jones[1], Russel White[1], Tabetha Boyajian[2], Gail Schaefer[1], Ellyn Baines[3], Michael Ireland[4], Samuel Quinn[1]

[1]*Georgia State University*
[2]*Louisiana State University*
[3]*US Naval Research Laboratory*
[4]*Australian National University*

Abstract

The age of a star is one of its most fundamental parameters. Accurate ages of disk and/or planet hosting systems are essential for understanding their evolution, and accurate ages of stars which host directly-imaged planets are necessary for estimating the masses of such companions. With accurate ages, it is possible to test models of certain chemical peculiarities such as whether λ Boötis stars are accreting gas, and thus are young, or whether they are experiencing mass loss, and thus are old.

The rapid rotation of stars in the upper main sequence introduces two major difficulties to determining their ages. First, the gravity darkening induced by rapid rotation affects the observed properties of a star (e.g., flux, temperature, etc.) making them be dependent on the star's inclination. Secondly, this rotation changes how the star evolves both chemically and structurally and so must be accounted for when choosing evolution models for comparison. Observations from optical interferometry can address this first concern and modern evolutionary models which account for rapid rotation can address the second concern. When used in conjunction, these can yield accurate age estimates for early-type main sequence stars. Using observations from the CHARA Array interferometer and the MESA evolutionary models, we estimate the ages and masses of seven members of the coeval Ursa Major moving group leading to an age estimate for the group of 414 ± 23 Myr. We also estimate the age of the directly-imaged planet host star κ Andromedae finding it to be 47^{+27}_{-40} Myr implying that the companion is in fact a low-mass brown dwarf with a mass of 22^{+8}_{-9} $\mathrm{M_{Jup}}$. Finally, we present new observations and preliminary age and mass estimates for five stars with the λ Boötis chemical peculiarity and for six members of the Hyades open cluster.

11

An independent seismic analysis of stellar fundamental parameters and interiors: KIC 6225718

TAO WU[1]

[1]*Yunnan Observatories, Chinese Academy of Sciences*

Abstract

Asteroseismology is a powerful tool to probing stellar interiors. In order to do so, making comparisons between theoretical models and observations are usually used. To obtain the best fitting model, the "target-box" method, which uses non-seismic observations (such as effective temperature, luminosity, metal abundance) to select the initial sample and to further decide the best fitting model, is a usually used method. Thanks to the space-based missions, such as CoRoT, Kepler, and K2, more and more ultra-precise and long-time time series have been obtained. Based on those high-precision observations, seismic materials (such as oscillation frequencies and their derivations) can be independently used to analyse pulsation targets, such as solar-like oscillations, red giants. In the process of deciding the best fitting model, non-seismic observations are not used as constrains. They are only used as references, when analyse stellar fundamental parameters and stellar interiors. In the poster, we will show the analysis of solar-like oscillator KIC 6225718.

STARS2016:

Understanding the roles of rotation, pulsation and chemical peculiarities in the upper main sequence

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