20th
Stellar Pulsation
Conference Series

Impact of new instrumentation & new insights in stellar pulsations

5-9 September 2011
Granada

CSIC

Abstracts book

Monday

Session I: the poor agreement between observed & predicted frequencies

SESSION Ia	*9h-12h55*	*Chair: L. A. Balona*	
Welcome		J.C. Suárez	20′
Stellar pulsations and stellar evolution: conflict, cohabitation, or symbiosis?		A. Weiss	45′
3D Simulation of the Interaction of Radial Pulsation and Convection		C. Geroux	20′
Physics of the solar twin: the example of 18 Sco		M. Bazot	20′
Vibrational Instability of metal-poor low-mass main-sequence stars		T. Sonoi	20′
Coffee Break (30′)			
Non-radial pulsation and magnetic fields of OB stars		N.P. Sudnik	20′
Pulsations in hot massive stars		C. Lovekin	20′
On the origin of the dense frequency spectra of space observed intermediate mass pulsating stars		J. Pascual-Granado	20′
The photometric & spectroscopic behavior of classical pulsators in the instability strip		E. Poretti	20′

SESSION Ib	*15h-18h15*	*Chair: A. Weiss*	
Open questions in seismology of rapidly rotating stars		F. Lignières	45′
Pulsations of rapidly rotating evolved stars		R. Ouazzani	20′
Traditional approximation for low-frequency modes in rotating stars		H. Shibahashi	20′
Coffee Break (30′)			
Modeling stellar convection & pulsation in multidimiensions using ANTARES code		H.J. Muthsam	20′
Regular modes in rapidly-rotating stars		M. Pasek	20′
Periodicities in the frequency spectra of delta Scuti stars		A. García Hernández	20′
Oscillation spectra and fast rotation		F. Peña	20′

Tuesday

Session II: Giant stars

SESSION IIa	*9h-12h35*	*Chair: H. Shibahashi*	
Asteroseismology of red giants		J. De Ridder	45′
Mean large frequency separations of read giants: By how much do estimates vary depending on the selected frequency range?		S. Hekker	20′
Some thoughts about the Blazhko effect for RR Lyrae variable pulsations		A. Cox	20′
Period doubling in Kepler Blazhko RR Lyrae stars		R. Szabo	20′
Coffee Break (30′)			
First detection of period doubling in a BL Herculis type star. Observations & theoretical models		R. Smolec	20′
The projection factor of Cepheids		N. Nardetto	20′
New links between pulsation and stellar history		N. Evans	20′
Evidence of pulsation-driven mass loss from delta Cephei		M. Marengo	20′

SESSION IIb	*15-18h15*	*Chair: H. Evans*	
Multiperiodic oscillations in Cepheids & RR Lyr-type stars		P. Moskalik	45′
RR Lyrae studies with Kepler		K. Kolenberg	20′
The ancient population of M32: RR Lyr variable stars revisited		G. Fiorentino	20′
The nature variability in M supergiants: the forgotten type C semiregulars		D. Turner	20′
Coffee Break (30′)			
Pulsational light variability in post-AGB stars in the Milky Way Galaxy & the Large Magellanic Cloud		B. Hrivnak	20′
A testimator approach to detecting heteroskedasticity in the Cepheid PL relation		S. Kanbur	20′
Synthetic Cepheid Period-Luminosity Relations in the IRAC Bands		C.C. Ngeow	20′

Wednesday

Session III: new instrumentation from the ground & space

SESSION III	*9h-13h40*	*Chair: E. Poretti*	
New ground-based observational methods and instrumentation for asteroseismology		P. J. Amado	45′
Impact of high precision photometry in space		E. Michel	45′
VOTA: A virtual Observatory tool for asteroseismology		E. Solano	20′
Coffee Break (30′)			
Long-baseline interferometric observations of Cepheids		P. Kervella	20′
Life after Kepler		A. Kaiser	20′
Programs & perspectives of visible long baseline interferometry: VEGA/CHARA		D. Mourard	20′
Spectro-inteferometry studies of velocity-related phenomena at the surface of stars: pulsation & rotation		A. Mérand	20′
The Vista variables in the Via Lactea ESO public Survey: Current status and First results		M. Catelan	20′
Solar-like stars observed by Kepler: an incredible adventure		R. García	20′
First evidence for solar-like oscillations in a Delta Scuti star		V. Antoci	20′

Free afternoon / Night Alhambra Visit (22h30)

Thursday

Session IV: Mode identification
Session V: oscillations vs. activity plus planet transits

SESSION IV	*9h-13h00*	*Chair: F. Lignières*	
Identification of pulsation modes in main sequence pulsators: uncertainties and limits		A. Pamyatnykh	45′
Uncovering hidden modes in RR Lyrae stars		L. Molnár	20′
Complex asteroseismology of the slowly pulsating B-type star HD74560		P. Walczak	20′
Coffee Break (30′)			
First evidence of pulsations in Vega: Results of today's most extensive spectroscopic research		T. Böhm	20′
Theoretical properties of regular spacing in the oscillation spectra of delta Scuti stars		J.C. Suárez	20′
Theoretical approach to mode identification		J. Guzik	45′
Diagnostic tools for solar-like stars		I. Roxburgh	20′
Towards a precise asteroseismology of solar-like stars		A. Grigahcène	20′

SESSION V	*15h-18h25*	*Chair: K. Zwintz*	
Current state of the modeling of photospheric activity		A. F. Lanza	45′
Pulsating stars harboring planets		A. Moya	45′
Succesful asteroseismology for a better characterization of the exoplanet HAT-P-7		M. Oshagh	20′
Coffee Break (30′)			
The new Kepler picture of variability amongst A and F stars		K. Uytterhoeven	20′
Stellar activity cycles and contribution of the deep layers knowledge		S. Mathur	45′
Conference Dinner (21h00)			

Friday

Session VI: Early type stars. Oscillations vs other agents (mainly regular/ rotational variations of B stars)

SESSION VI	*9h-13h30*	*Chair: K. Uytterhoeven*	
The Be stars puzzle		L. Balona	45′
Be stars: rapidly rotating pulsators		T. Rivinius	45′
A pulsational study of a sample of CoRoT faint Be stars		T. Semaan	20′
Coffee Break (30′)			
Mode identification of subdwarf B stars with Kepler data		M. Reed	20′
Pulsating pre-main sequence stars in NGC 2264 discovered by the MOST and CoRoT satellites		K. Zwintz	20′
Constraints on Pasta structure of neutron stars		H. Sotani	20′
Whole Earth Telescope observations of EC14012-1446: Convection in DA white dwarfs		J.L. Provencal	20′
Asteroseismology of a V777 Her pulsator observed by Kepler		R. Østensen	20′
Conclusions		J. A. Guzik	30′

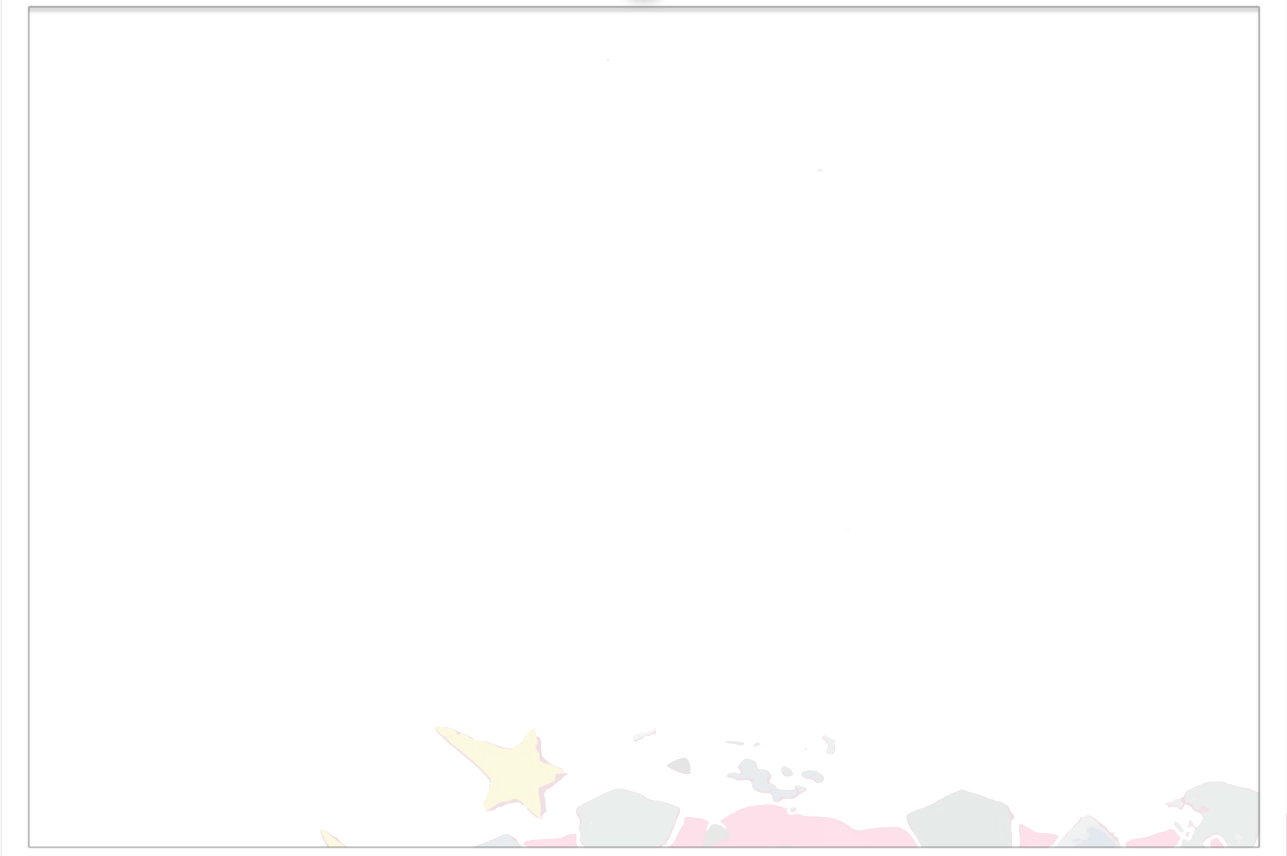
Oral Abstracts

SESSION I: THE POOR AGREEMENT BETWEEN OBSERVED & PREDICTED FREQUENCIES

Stellar pulsations and stellar evolution: conflict, cohabitation, or symbiosis?

Invited Speaker: A. Weiss

While the analysis of stellar pulsations allows the determination of current properties of a star, stellar evolution models connect it with its previous history. In many cases results from both methods do not agree. I will review some classical and current cases, where conflicts have either led to an improvement of the theory of evolution, or where they remain unsolved. I will then point out some well-known problems of stellar physics, for which it is hoped that seismology - or in general the analysis of stellar pulsations - will help to resolve them, but will also critically point to the limits of this symbiosis.



3D Simulation of the Interaction of Radial Pulsation and Convection

Chris Geroux and Robert Deupree

The nonlinear hydrodynamic computation of classical variable stars such as RR Lyrae and Delta Cephei stars was one of early great triumphs of (then) high performance computing in astrophysics. One of the last remaining obstacles in this area is the interaction of convection and stellar pulsation. We have developed a code which can perform these simulations in 1D, 2D, and 3D, with an algorithm which uses the interior mass as the radial independent variable in all cases. We use large eddy simulations to model the convective flow. Previous 2D calculations showed how convection quenched pulsation at the red edge of the RR Lyrae gap,

and we build on these by extending nonlinear hydrodynamic calculations to 3D. A comparison between our 1D and 2D simulations shows that convection reduces the growth rate of pulsation in an RR Lyrae model just blue ward of the red edge of the instability strip. Results and comparisons of our multidimensional simulations will be presented.

Physics of the solar twin: the example of 18 Sco

Michaël Bazot

Solar twins are nowadays a growing center of interest. They are defined as being spectroscopically identical to the Sun. There is actually an on-going race between spectroscopic surveys to find the "best" solar twin. However, the progresses in high-precision in spectroscopy and interferometry also allows us to study the seismic characteristics of some solar twins and to measure their radiuses. I present in this talk the results obtained for the brightest of them all: 18 Sco.

Vibrational Instability of Metal-Poor Low-Mass Main-Sequence Stars

Takafumi Sonoi & Hiromoto Shibahashi

We carry out the fully nonadiabatic analysis of the vibrational instability in metal-poor low-mass main-sequence stars. Since the outer convection zone of these stars is very limited only to the very outer layer, the uncertainty in the treatment of convection does not affect the result seriously.
We find that low-degree low-order g-modes become unstable due to the epsilon-mechanism of the helium 3 burning in the pp-chain. The decrease in metallicity leads to decrease in opacity and hence increase in luminosity of a star. This makes the star compact and results in decrease in the density contrast, which is more favorable to the epsilon-mechanism instability.
We find also instability for p-modes and high order g-modes of metal-poor low-mass stars. Since the effective temperature and the luminosity of metal- poor stars are significantly higher than those of population I stars, the stars showing delta Scuti-type and/or gamma Doradus-type pulsation are substantially less massive than in the case of population I stars. We demonstrate that those modes are unstable for about 1Msun stars in the metal-poor case.

Non-radial pulsation and magnetic fields of OB stars

N.P. Sudnik, A.F. Kholtygin

We report the results of our studying the fast line profile variability (LPV) in spectra of bright OB stars. Spectral and spectropolarimetric observations of 12 OB stars were made during last ten years in a framework of a program of searching the regular and stochastic LPV in spectra of OB stars and their magnetic fields. The spectra were obtained with using the 6-m telescope of Special Astronomical Observatory (SAO, Russia) and 1.8-m telescope of Bohyunsan Optical Astronomy Observatory (Korea). For all studied stars we detected the regular LPV connected with the non-radial pulsation (NRP) and induced by the rotation of the large-scale structures in the wind. We propose that the NRP are a trigger of the formation of the large-scale structures in the stellar wind. The regularization of these structures by the moderate magnetic field is investigated. The results of searching the polarimetric line profile variability (pLPV) in the spectra of OB stars are also reported. We find that pattern of LPV can differ for left and right polarized components of stellar radiation.

Pulsations in hot massive stars

C.C Lovekin, J.A. Guzik & A.N. Cox

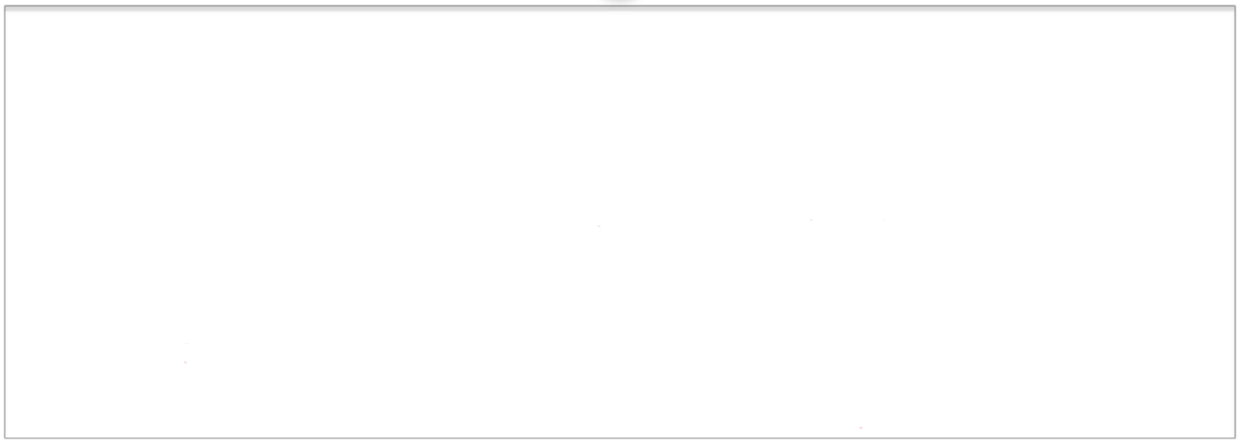
Massive stars are known to pulsate at many stages of evolution. Most spectacular are the Luminous blue variables (LBVs), in which pulsation is one possible origin for the S-Dor type outbursts. In this work, we study the radial pulsations of stars with initial masses of 20, 40, 60 and 85 solar masses using both linear and non-linear pulsation codes. The pulsations can then interact with time-dependent convection, which increases the luminosity until the Eddington limit is exceeded locally, potentially driving mass loss and S-Dor outbursts. We consider models at various stages of evolution and metallicity, covering the observed properties of the majority of the observed LBV and LBV candidates. Preliminary results characterizing the pulsations as functions of Y and Z are presented.

On the origin of the wealthy frequency spectra of space observed intermediate mass pulsating stars

J. Pascual-Granado, A. Grigahcène, D. Díaz-Fraile, M. Gruberbauer, R. Garrido, P. Amado, J. C. Suárez

Several hypotheses have been advanced to explain the wealthy spectra of space observed intermediate mass pulsating stars. Among which we can find the rotational splitting, stochastic excitation or detection of

coloured noise due to superficial granulation.
An overview of the problem requires a coherent analysis of a large number of stars looking for correlations between the observed frequency spectra and the position on the HR diagram, which hence, means stage of evolution of the stars.



The photometric and spectroscopic behaviour of classical pulsators in the instability strip

Poretti, E., Mantegazza, L., Rainer, M., er al.

The phenomenologic knowledge of variable stars located in the instability strip has been largely increased by the space photometric observations and the ground-based spectroscopic ones. We have to explain
A) the large number of photometric frequencies detected in low-amplitude Delta Sct stars and the spectroscopic confirmation that high-degree modes are excited; B) the very limited pulsational content of high amplitude Delta Sct stars with respect to the low-amplitude ones and the importance of linear combinations; C) the photometric modulation of the large amplitude radial modes observed in high-amplitude Delta Sct stars;
D) the insights in the Blazhko effect provided by the extensive CoRoT and Kepler timeseries; E) the pulsational content of the very few Cepheids observed by CoRoT and Kepler.
The recent results obtained on these classes of variables will be compared and discussed.

Open questions in seismology of rapidly rotating stars

Invited Speaker: F. Lignières

Interpreting the frequency spectrum of rapidly rotating stars is a long standing unsolved problem of stellar seismology. The quality of the spatial data together with the advances in modelling the effects of rotation bring fresh perspectives towards a successful comparison between theory and observation. I shall summarize recent progresses in modelling the effects of rapid rotation on stellar oscillation modes using non-perturbative models. However, many open questions that arise from either observation or theory still need to be addressed to access the information content of the detected modes. I shall review and discuss some of these open questions.

Pulsations of rapidly rotating evolved stars

Ouazzani, R-M., Marques, J.P., Dupret, M-A.

A new two dimensional non-perturbative code to compute accurate oscillation modes of rapidly rotating stars is presented. The 2D calculations fully take into account the centrifugal distorsion of the star while the non perturbative method includes the full influence of the Coriolis acceleration. This 2D non- perturbative code is used to study pulsational spectra of highly distorted evolved models of star. 2D models of stars are obtained by a self consistent method which distorts spherical stellar models a posteriori. The spherical models to be distorted take into account effects of rotation on stellar evolution as it is understood nowadays. One is also able to compute gravito- acoustic modes for the first time in rapidly rotating stars. We will present the dynamics of these modes, and how they can give access to the rotation profile in the stellar interior.

Traditional approximation for low-frequency modes in rotating stars

Hiromoto Shibahashi & Hiroyuki Ishimatsu

Traditional approximation, in which the Coriolis force associated with radial motion and the radial component of the Coriolis force associated with horizontal motion is reasonably good for very low frequency modes, in which the horizontal motion dominates the oscillation. In this approximation, the angular dependence of eigenfunction is expressed in terms of the Hough functions, and the radial dependence is expressed in a form similar to the case of non-rotating stars. By solving numerically the equations governing the low-frequency modes, we demonstrate that the temperature perturbation near the surface is large enough to produce detectably large luminosity variation while the kinetic energy of modes is confined mainly near the stellar core. We discuss the possibility of manifestations of these modes in real stars.

Modelling stellar convection and pulsation in multidimensions using the ANTARES code

Herbert J. Muthsam, Eva Mundprecht

The ANTARES code (ANTARES = A Numerical Tool for Astrophysical RESearch; Muthsam et al., NewAst 15, 460 (2010)) has been extended beyond solar research so as to allow, among others, simulations of the convection- pulsation interaction in multidimensions (presently multi = 2) using realistic microphysics and opacities, radiative transfer and a stretched, optionally refined grid, the gridpoints being allowed to move in the radial direction. We report on our simulations of Cepheid and RR Lyr models. In particular, we concentrate on the H+HeI and the HeII convection zones of a Cepheid with M = 5M_sun, L = 921 L_sun, log

g = 1.96 and its atmospheric structures. We furthermore discuss the requirements and prospects for corresponding 3D work.

Regular modes in rapidly rotating stars

Mickael Pasek, François Lignières, Bertrand Georgeot, Daniel R. Reese

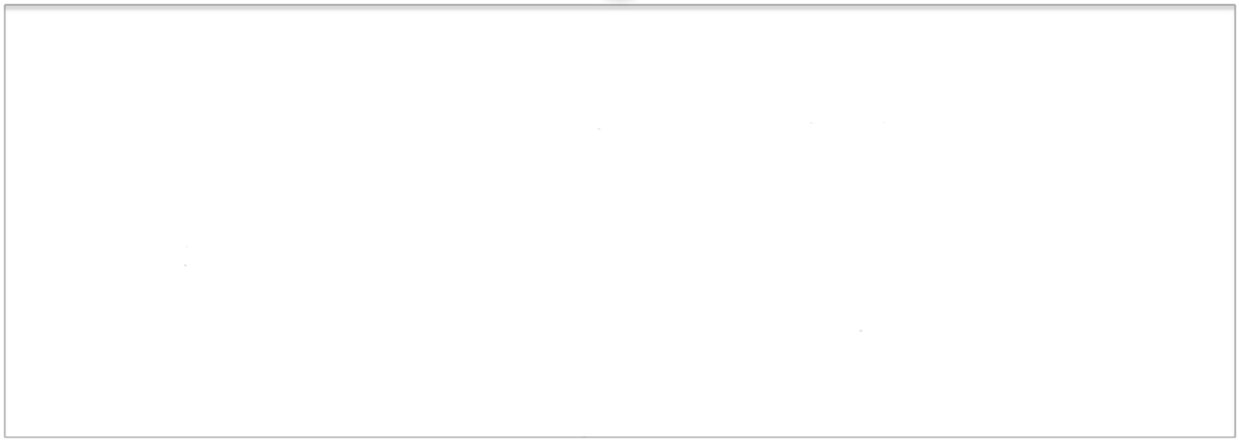
Rapid rotation prevents reliable mode identification in most intermediate to massive pulsating stars. In this talk we will show how a new set of asymptotic methods for pressure modes predicts regular frequency spacings in the spectrum of rapidly rotating stars. We give a semi-analytical formula for these spacings that is in good agreement with numerically computed high frequency modes. This should help to extract from the spectra some information on the structure of rapidly rotating stars.

Periodicities in delta Scuti frequency spectra along the HR diagram.

Antonio García Hernández, Javier Pascual Granado, Ahmed Grigahcène, A. Moya, , S. Martín-Ruiz, J. Gutiérrez-Soto, J.C. Suárez, R. Garrido

Delta Scuti pulsating stars are challenging but interesting targets. They constitute good laboratories for stellar physics theories (such as convection) mainly for the complexity of their structure as reflected in their complex frequency spectra. Any classical asteroseismic study of these stars by individual frequency fitting does not give accurate results and the analysis is not too much useful. Hence, more observables are needed to help in their study.
Some authors have claimed to find periodicities in the frequency spectra of a couple of stars observed from

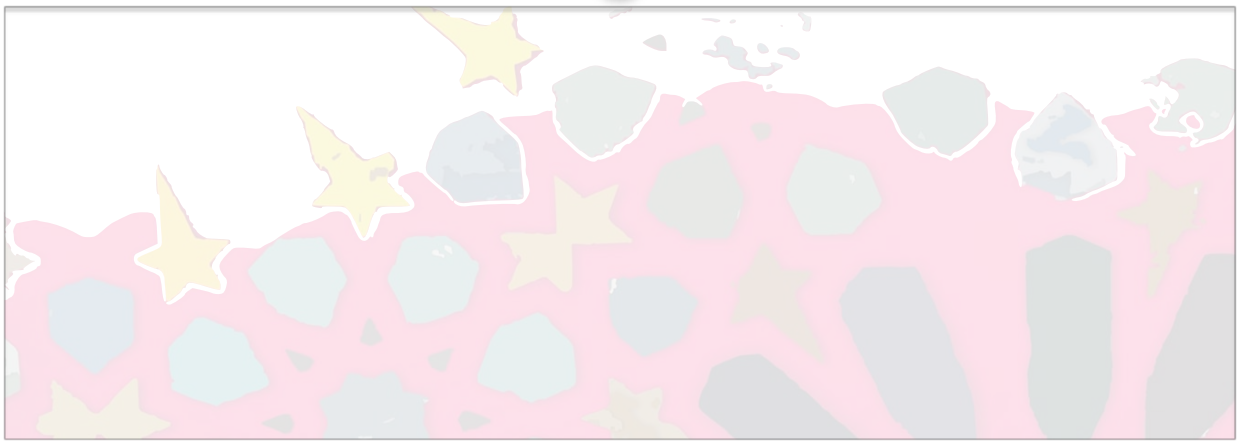
the ground (FG-Vir, Breger et al. 1999; CD-24 7599, Handler et al. 1997). Using CoRoT observations, we have definitely confirmed the presence of such regularities in the frequency spectra of HD 174936 (García Hernández et al 2009) and HD 174966 (presented at the 2nd CoRoT symposium). However, the first question to be addressed at this level is: are these stars peculiar cases? The large sample of delta Scuti stars observed by Kepler offers us the possibility of carrying out an statistical analysis and of studying the behaviour of such structure along the HR diagram. In this talk, we will present the very preliminary results of our work.



Oscillation spectra at fast rotation

Fernando Peña, Robert Deupree

Interpreting the oscillation power spectra from fast rotating stars is a difficult task. Mode splitting provides information about the interior angular momentum distribution but large splitting due moderate and fast rotation makes mode identification difficult on the echelle diagram, as different modes overlap. Besides, from the theoretical point of view, labeling the modes at fast rotation becomes difficult as the wave pattern deviates significantly from the well understood non-rotating patterns, making hard to assign standard benchmarks that keep mode identification consistent at different speeds. We have computed pulsation frequencies for low to mid order p-modes for 2D models of rapidly rotating stars. Tracking down the evolution of the particular mode frequency as a function of rotational velocity from nearly break-up speeds to zero velocity allow us to label the modes at fast rotation, and potentiality one can use this connection as a discriminant for mode identification. We also address the question of how reliable is to obtain the large separation from the observed spectra, and what happens to the small separation as a function of rotation.

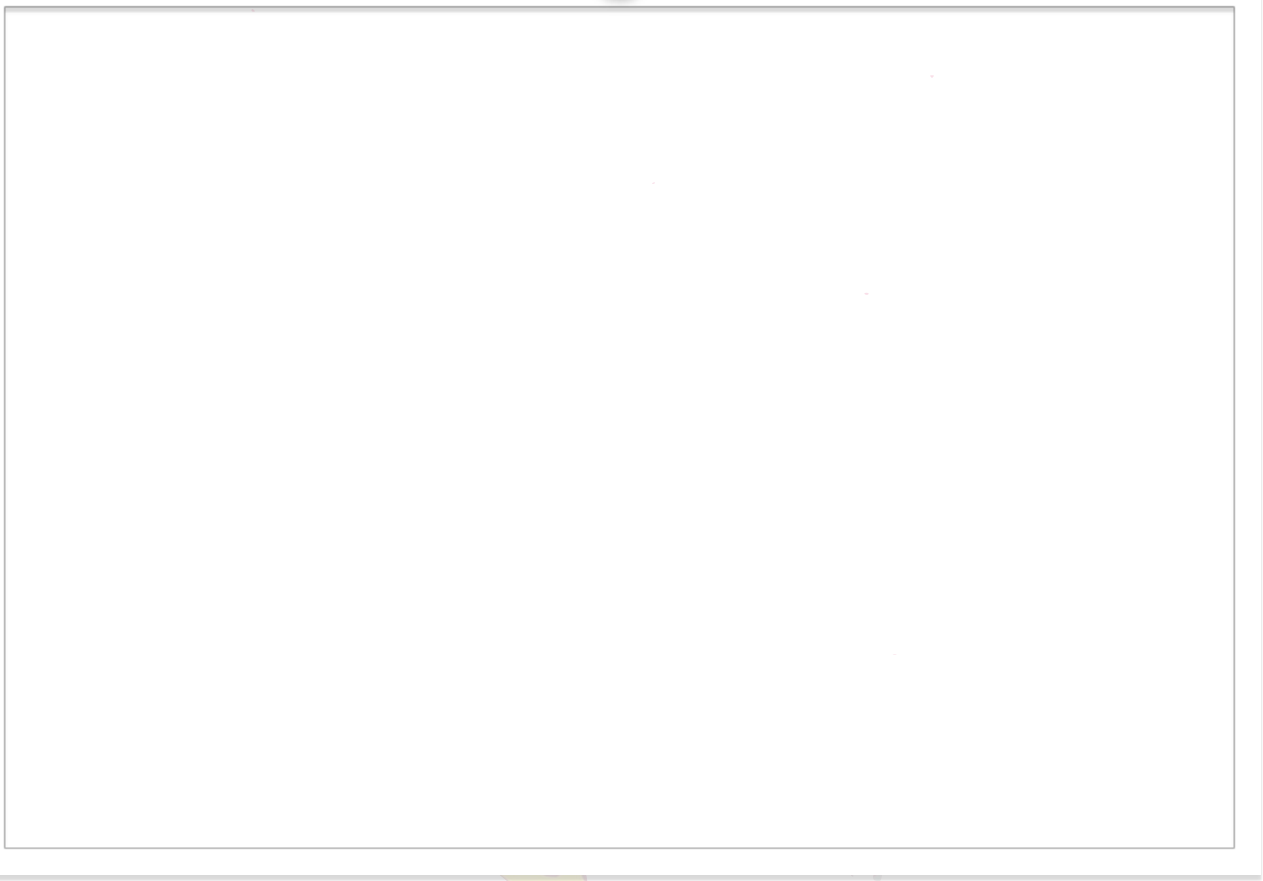


SESSION II: GIANT STARS

Asteroseismology of red giants

Invited Speaker: J. De Ridder

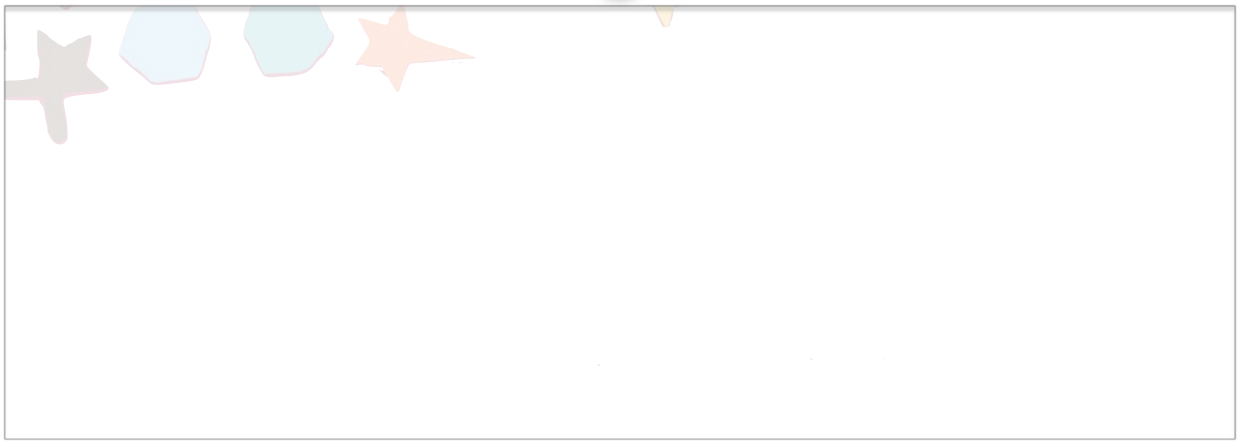
The satellites CoRoT and Kepler are delivering amazing time series with unprecedented precision. Although this is having a profound impact on almost all subfields of asteroseismology, a few research fields really stand out. Red giant seismology is one of those. In only a few years, our understanding of red giant oscillations has exponentially grown. We review the current status of red giant seismology, what we have learned from the space missions, how it affected our view on red giant evolution, what the open questions are, and we describe the road ahead.



Mean large frequency separations of red giants: By how much do estimates vary depending on the selected frequency range?

S. Hekker, S. Basu, Y. Elsworth, W.J. Chaplin

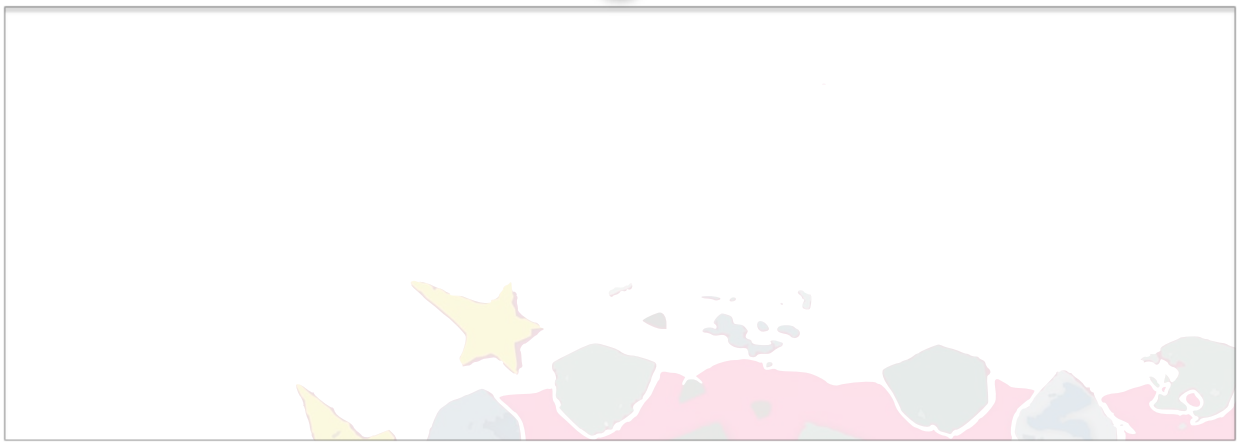
The mean large separation is one of the important observables that allows asteroseismology to provide basic stellar properties like mass and radius. It is therefore important to know how robust its determination is. First results from Kepler showed indications that the mean large frequency separations in red giants are not as sensitive to the frequency range over which they are computed as the mean large separations obtained for the Sun or main- sequence stars. Here we use YREC models of stars of different masses, metallicity and evolutionary phase to verify this result. The models indeed show a similar trend as the data, which could reveal interesting differences in the internal structures of giants and main-sequence stars.



Some Thoughts about the Blashko Effect for RR Lyrae Variable pulsations

Arthur Cox

The amplitude variations in a few RR Lyrae stars seem possible as the beating of the main pulsation mode (a radial variation) and a nonradial l=1 mode of high radial order with a period very close to the main mode. My report of this beating has been given at the Victoria (1992) and Santa Fe (2009) pulsation star conferences, with the first of these suggesting the radial (l=0) and the l=1 g4 modes occuring and the radial and the g12 modes not actually predicted to be both self excited. Recent studies show that a nonradial mode might depend on the interior structure, both based on the material opacity an its dependence on temperature and density. Current linear theory for pulsation calculations using my much improved pulsation code show that two beating modes (one radial and another nonradial) may exist for an explanation of those few pulsating RR Lyrae, amplitude varying variable stars.

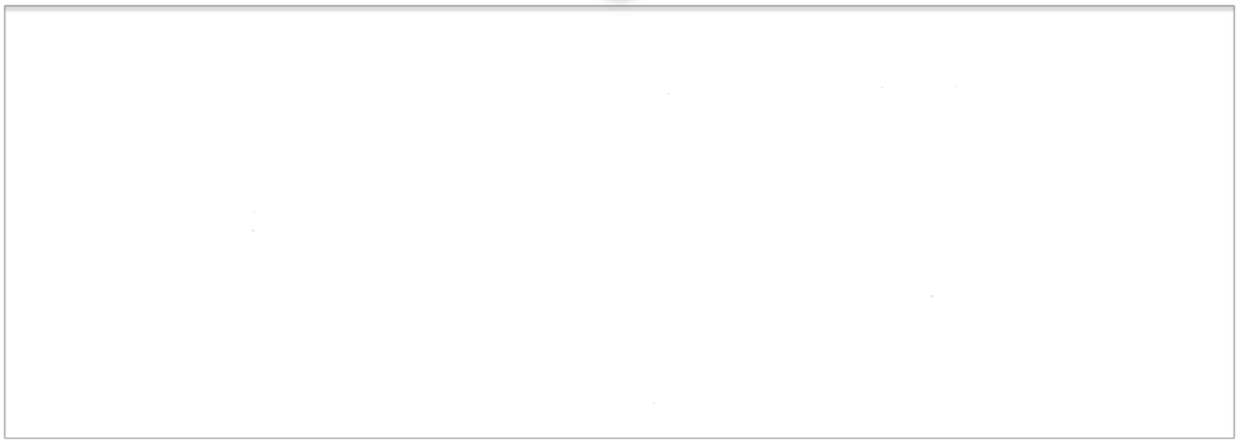


Period doubling in Kepler Blazhko RR Lyrae stars

R. Szabo, Z. Kollath, L. Molnar, K. Kolenberg, D.W. Kurtz, S.T. Bryson, J.M. Benko, J. Christensen-Dalsgaard, H. Kjeldsen, W.J. Borucki, D. Koch, J.D. Twicken, M. Chadid, M. Di Criscienzo, Y.-B. Jeon, P. Moskalik, J.M. Nemec, J. Nuspl

The physical origin of the conspicuous amplitude and phase modulation of the RR Lyrae pulsation - known

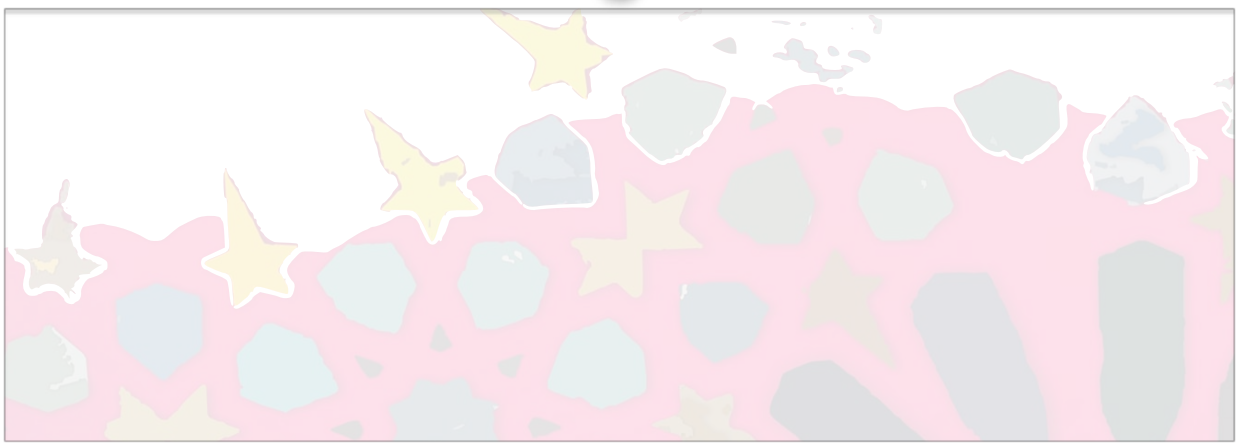
as the Blazhko effect - is still a mystery after more than 100 years of its discovery. With the help of the Kepler space telescope we have revealed a new and unexpected phenomenon: period doubling in RR Lyr - the eponym and prototype of its class - as well as in other Kepler Blazkho RR Lyrae stars.
We have found that period doubling is directly connected to the Blazhko modulation.
Furthermore, with hydrodynamical model calculations we have succeeded in reproducing the period doubling and proved that the root cause of this effect is a high order resonance (9:2) between the fundamental mode and the 9th radial overtone, which is a strange mode. I will discuss the implications of these recent findings on our understanding of the century-old Blazkho problem.



First detection of period doubling in a BL Herculis type star. Observations and theoretical models.

Smolec, R., Soszynski, I., Moskalik, P., Udalski, A., Szymanski, M.K., Kubiak, M., Pietrzynski, G., Wyrzykowski, L. et al.

We report on the discovery of the first BL Herculis star showing the regular alternations of the light curve shape - the period doubling phenomenon. The star was found in the Galactic bulge in the OGLE-III survey data. Existence of such variables was predicted nearly twenty years ago by Buchler & Moskalik, who found the period doubling effect in their radiative hydrodynamic models of BL Her stars. In this contribution we discuss the observations and present the new set of the nonlinear convective hydromodels. The models confirm that the 3:2 resonance between the fundamental mode and the first overtone is responsible for the period doubling effect. Comparison of the computed and observed light curves, together with the predictions of the stellar evolution theory allows us to constrain the parameters of the star.



The projection factor of Cepheids

Nardetto N., Storm J., Gieren W., Fokin A.

The projection factor used in the Baade-Wesselink methods of determining the distance of Cepheids makes the link between the stellar physics and the cosmological distance scale. A coherent picture of this physical quantity is now provided based on high resolution spectroscopy and hydrodynamical modelling. Recent observations of 36 LMC Cepheids bring new constrains on the projection factor and new insights on the universality of the period- luminosity relation.

New Links between Pulsation and Stellar History

Nancy Remage Evans

New instrumentation is providing new insights into intermediate mass pulsating Cepheids, particularly about their formation and history. Three aspects of this are discussed, using space (Hubble and Chandra) and ground (Automatic Spectroscopic Telescope AST) studies. First, we are conducting a survey of Cepheids with the Hubble Space Telescope Wide Field Camera 3 (WFC3) to identify possible resolved companions, for example Eta Aql. X-ray observations (Chandra and XMM-Newton) can confirm whether possible low mass companions are young enough to be physical companions of Cepheids, hence providing constraints on star formation. In a related study of intermediate mass stars, Chandra X-ray observations of late B stars in Tr 14 and Tr 16 have been used to determine the fraction which have low mass companions (which are X-ray active in contrast to the late B stars which are X-ray quiet). Finally, the Tennessee State Automatic Spectroscopic Telescope has obtained velocities of a number of Cepheids. As an example, the orbit of V350 Sgr has been redetermined, providing a new level of accuracy to the orbital velocity amplitude, used in mass determination.

Evidence of Pulsation-Driven Mass Loss from delta Cephei

Marengo, M., Evans, N. R., Barmby, P., Matthews, L. D., Bono, G., Welch, D. L., Romaniello, M., Huelsman, D., Su, K., Fazio, G.

We present the first direct detection of mass loss from a Classical Cepheid star: the class namesake delta Cephei. Using the Spitzer Space Telescope, we have detected an infrared nebula shaped as a bow shock, aligned with the space velocity of the star with respect to the local ISM. The mass loss rate associated with this nebula is in the range 5E-9 to 6E-8 Mo/yr, which has important implications for the still unresolved “Cepheids mass loss discrepancy”. The low dust content we have measured in this wind suggests a different driving mechanism than the dust-driven outflow commonly associated with evolved stars, favoring pulsation-driven mass loss triggered by the shocks crossing the Cepheid atmosphere. Observations of other 28 Cepheids, as part of the same Spitzer program, show further evidence of Cepheids mass loss, in at least 25% of our targets.

Multiperiodic oscillations in Cepheids and RR Lyr-type stars

Invited Speaker : Pawel Moskalik

Majority of classical Cepheids and RR Lyrae-type stars are considered to be simple monoperiodic pulsators. But this is not always the case. I will review different types of multiperiodicity observed in Cepheids and in RR Lyr variables, including Blazhko effect and various types of multimode oscillations. My presentation will concentrate on the recent developments in the field.

RR Lyrae studies with Kepler

Katrien Kolenberg & KASC WG13

To date, about 40 known RR Lyrae stars are located in the Kepler field. The outstandingly high-precision data of these stars are investigated within the RR Lyrae working group as part of the Kepler Asteroseismic Science Consortium (KASC). In this talk I present some of the most interesting results obtained with Kepler data of RR Lyrae stars, and their implications for our understanding of RR Lyrae stars and the still mysterious Blazhko effect.

The ancient population of M 32: RR Lyr Variable stars revisited

Fiorentino, G.

Using archival ACS/WFC images in F606W and F814W filter taken over 16 days of a resolved stellar field in Local Group dwarf elliptical galaxy M 32 we have made an accurate Colour-Magnitude Diagram and a careful search for RR Lyr variable stars. We identified 280 RR Lyr over our field of view, and the spatial distribution shows a steeply rising number density towards the centre of M 32 that matches the surface brightness profile. These new observations clearly confirm the tentative result of Fiorentino et al. (2010), on a much smaller field of view, associating an ancient population of RR Lyr variable stars to M 32.

The Nature of the Variability in M Supergiants: The Forgotten Type C Semiregulars

David G. Turner, Kathleen E. Moncrieff, C. Ian Short, Robert F. Wing, Arne A. Henden

SRC variables constitute the forgotten class of red semiregulars. Sufficiently luminous and well behaved in terms of a period-luminosity relation to be more valuable than Cepheids as extragalactic distance indicators, most are considered to be pulsating, yet that has never been demonstrated formally and the possibility of variability induced by giant convection cells has also been raised. They are the immediate predecessors of Type II supernovae according to stellar evolutionary models, so recent changes in the angular diameter of Betelgeuse naturally raise suspicions about its long-term survival. Here we investigate the nature of the variability in M supergiants using new and archival spectroscopic and spectrophotometric observations of the stars in conjunction with archival data on their brightness variations, and describe some of the more intriguing characteristics of the SRC class: irregular fading episodes that may result from dust ejection, fairly regular variability but with changing mean brightness, and temperature-dependent light amplitudes. The class is one of the more intriguing and exciting groups of pulsating stars, and the secrets of their variability are just beginning to be uncovered.

Pulsational Light Variability in Post-AGB Stars in the Milky Way Galaxy and the Large Magellanic Cloud

Bruce J. Hrivnak, Wen Lu, Kristie A. Shaw

We recently published the results of a long-term (14 year) photometric monitoring program of 12 carbon-rich post-AGB stars in the Milky Way Galaxy (Hrivnak et al. 2010, ApJ, 709, 1042). These objects appear to be the direct precursors of planetary nebulae and are classified as proto-planetary nebulae (PPNe). They all vary in brightness and the carbon-rich PPNe in the spectral range G8 – F3 have pulsation periods in the range of 155 to 35 days, with the cooler possessing the longer periods. In fact, we found a tight inverse linear correlation between the period of pulsation and the effective temperature of the star over this temperature range, with a slope of -0.047 days/K. In the present study, we have extended the results in several ways: by including several more years of data for the carbon-rich MWG PPNe, through a comparison with oxygen-rich PPNe in the MWG, and through a comparison with carbon-rich PPNe in the Magellanic Clouds. The oxygen- rich objects show some clear differences from the carbon-rich ones in their period-temperature relationship. These observations should provide good comparisons for pulsational models for post-AGB stars, and together should allow us to determine the masses and luminosities for these objects. This research has been sponsored by the National Science Foundation and by the Indiana Space Grant Consortium.

A Testimator approach to detecting heteroskedasticity in the Cepheid PL relation

A. Nanthakumar, S. Kanbur, C. Ngeow, A. Marsh

We develop the method of testimation to check for heteroskedasticity in the context of varying dispersion in the Cepheid Period-Luminosity (PL) relation. We apply this method and an adaptation of the Schwarzschild Information Criterion to check for varying dispersion in the LMC PL relation using OGLE III data. For the V band data, both methods report strong statistical evidence of a change in the variance of the PL relation at periods around 10 days and 2.5 days. At both these periods, previous work has suggested nonlinearities in the slope of the PL relation. We discuss possible implications and applications of our work.

Synthetic Cepheid Period-Luminosity Relations in the IRAC Bands

Chow-Choong Ngeow, Marcella Marconi, Ilaria Musella, Michele Cignoni & Shashi Kanbur

The mid-infrared period-luminosity (P-L) relations for Cepheids will be important in the JWST era, as it holds the promise of deriving the Hubble constant within 2% accuracy. In this work, we present the synthetic P-L relations, derived from a series of stellar pulsatin models with varying helium and metallicity abundance, in the Spitzer IRAC bands. Selected synthetic P-L relations were compared to the empirical IRAC band P-L relations derived from the Galactic and Magellanic Cloud Cepheids. Possible metallicity dependency on these synthetic IRAC band P-L relations is also investigated, as it is expected that the mid-infrared P-L should be insensitive to metallicity. Howerver, our results revealed that the IRAC band P-L relations may not

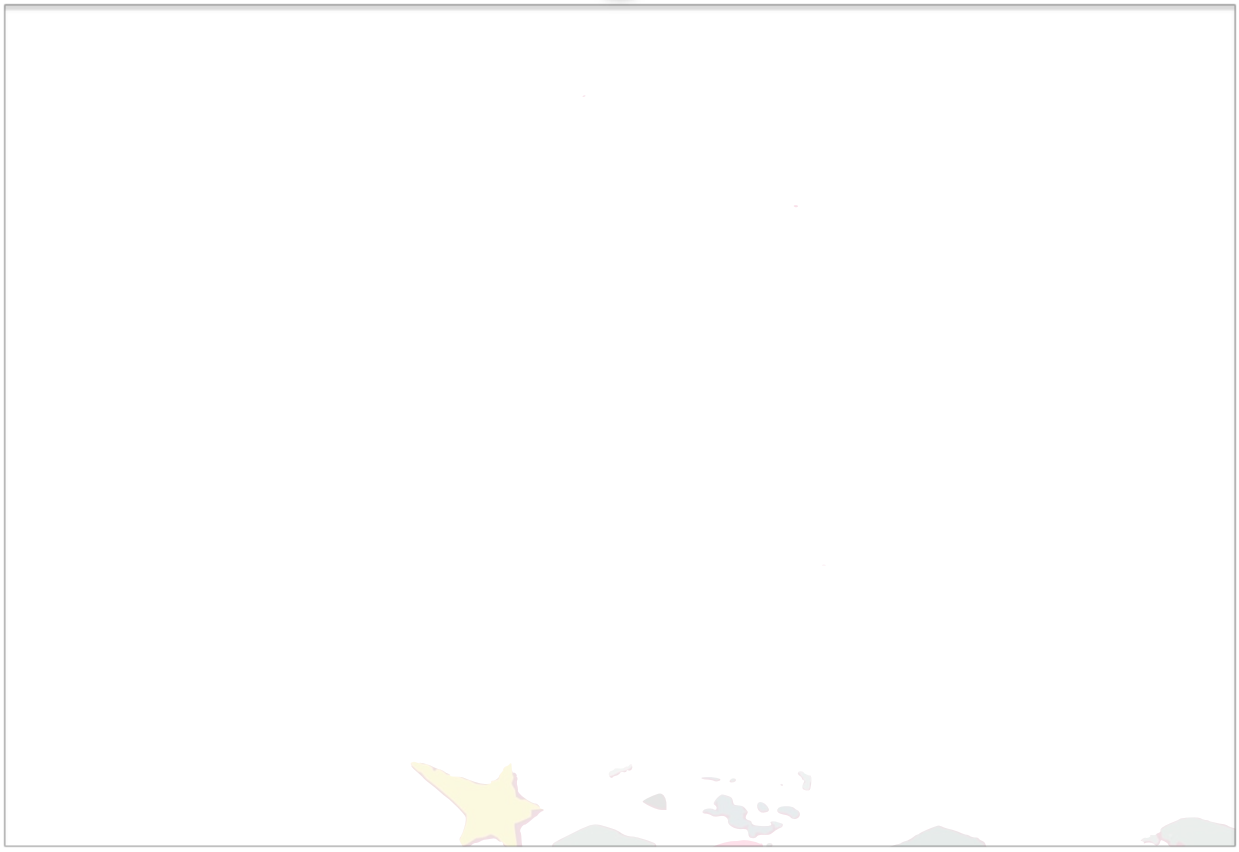
be totally independent of metallcity.

SESSION III: NEW INSTRUMENTATION FROM THE GROUND & SPACE

New ground-based observational methods and instrumentation for asteroseismology

Invited Speaker: P. Amado

Space instrumentation like SOHO, MOST, CoRoT & Kepler have been and are being built to attain very high precision of the data to be used for asteroseismic analysis. However, there still is a very strong need for providing any additional information, specially on mode identification. With this contribution I will review the efforts been put on new ground-based instrumentation and the methodology that can be used to achieve this aim.



Impact of high precision photometry in space

Invited Speaker: E. Michel

Impact of high precision photometry in space For several decades already, our community is working at developing stellar seismology as a way to reach a new insight on stars and address problems hitherto out of reach. In this framework, space photometry projects have been dedicated great efforts and have raised great expectations. In the light of recent results, I will show that this approach is keeping its promises beyond expectations, confirming space photometry monitoring as a relevant approach in our present and future strategy.

VOTA: A Virtual Observatory tool for asteroseismology

E. Solano, C. Rodrigo, J.C. Suárez, A. Moya, A. García Hernández

VOTA (Virtual Observatory Tool for Asteroseismology) is a tool designed to easily handle stellar and seismic models and analyze their properties. At present, VOTA is working with a database that contains approximately 500000 models representative of intermediate-mass stars (delta Scuti and gamma Dor stars). The models have been computed using the CESAM, FILOU and GRACO codes.
In this talk we will describe the main functionalities of VOTA as well as its application to the study of the regular spacings found in the oscillation spectra of delta Scuti stars.

Long-baseline interferometric observations of Cepheids

Pierre Kervella, Antoine Mérand, Alexandre Gallenne

Although the period-luminosity relation was discovered 100 years ago, Cepheids are still surprising stars in many respects. The recent availability of optical/infrared long-baseline interferometers with hectometric baselines allows us to measure their changing angular diameters with sub-percent accuracy. Through a variant of the classical Baade-Wesselink method, interferometric measurements, complemented by spectroscopy, give us their distance and radius from the comparison of their angular size and radius variation amplitudes. This elegant and accurate method, although quasi- geometrical, presents some particular difficulties that I will briefly discuss. The combination of spectroscopic and photometric measurements with interferometric measurements also provides important information on, e.g. the effective temperature as a function of phase, presence of stellar companions,... I will present the status and preliminary results of our ongoing Cepheid observing program using the CHARA and VLTI interferometers.

Life after Kepler: BRITE-Constellation

W. Weiss, A. Kaiser & BRITE-Constellation Team

The NASA mission Kepler is producing photometric data of unprecedented quality and quantity since it's launch in March 2009. Light curves from the brighter target stars look synthetic with no noise added. The question arises immediately: Is there a future for space photometry after Kepler?
The answer to this question is a clear "yes'' and supported by BRITE- Constellation, a project developed since 2003 by researchers at Austrian, Canadian and Polish academic institutions, and by PLATO, a M2 mission currently under considerations by ESA. BRITE-Constellation presently consists of UniBRITE and BRITE-Austria, which are two 20 cm cube nanosatellites, and of two similar pairs of nanosatellites provided by Canada and Poland. Each BRITE will fly a 30 mm aperture telescope with a CCD camera equipped with either a red (550 to 700 nm) or a blue (390 to 460 nm) filter, to perform high-precision and two-color photometry of the brightest stars (up to V=4) in the sky for up to several years. A "U" filter, instead of the red filter is presently investigated for the second Polish BRITE satellite. Fainter stars will be observed simultaneously with reduced accuracy in an on- board photometric mode. Depending on the orbit and the position of the BRITE targets the photometry can be obtained contiguously during many orbits for many months, with gaps during individual orbits, or only for certain periods of the year.
The primary science goals are studies of massive and luminous stars in our neighborhood, representing objects which dominate the ecology of our Universe, and of evolved stars (giants) to probe the future development of our Sun. The 24-degree wide field cameras will also obtain data from other scientifically interesting stars to investigate their stellar structure and evolution.
The mission characteristics are: - Two- (three-)color photometry - 1 minute data cadence - All sky access - Main targets are m(V)$\leq$4, which allows for high temporal and/or spectral resolution even for telescopes in the 2-m class.
All of this is enabled by innovative technology currently developed by the Space Flight Laboratory, Univ.

Toronto, Canada, in collaboration with Austria and Poland. A launch of the first pair of (Austrian) BRITE's is envisioned for Q4 of 2011, followed in 2012 by the second pairs of Polish and Canadian origin.

Programs and perspectives of visible long baseline interferometry: VEGA/CHARA

Mourard Denis, Nardetto, Nicolas, Ligi, Roxanne, Perraut, Karine

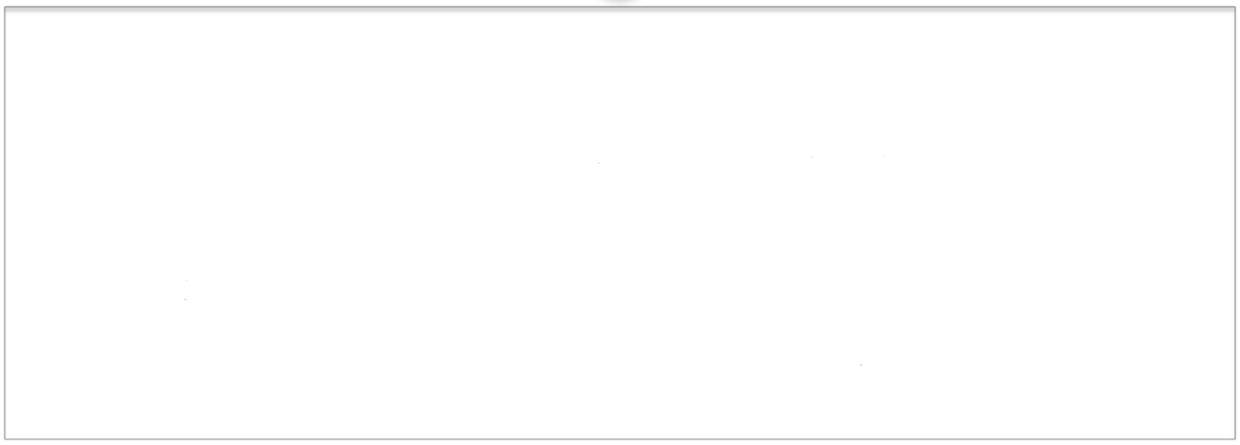
VEGA/CHARA is a visible spectro-interferometer installed on the CHARA Array at Mount Wilson Observatory. Combining high spectral resolution (6000 or 30000) and high angular resolution (0.3mas), VEGA/CHARA opens a wide class of astrophysical topics in the stellar physics domain. Circumstellar environments and fundamental parameters with a high precision could be studied. We will present a review of recent results and discuss the programs currently engaged in the field of pulsating stars and more generally for the fundamental stellar parameters.

Spectro-interferometry studies of velocity-related phenomena at the surface of stars: pulsation and rotation.

A. Mérand, F. Patru, J. Aufdenberg et al.

I illustrate here two applications of spectro-interferometry to the study of velocity fields at the surface of stars: pulsation and rotation. Stellar pulsation has been resolved spectroscopically for a long time, and interferometry has resolved stellar diameters variations due to pulsation. Combining the two provides unique insights to the study of Cepheids, in particular regarding the structure of the photosphere (by 'looking' at the

limb) or investigating the infamous projection factor which biases distances measured by Baade- Wesselink method. On the other hand, resolving the surface velocity field of rotating stars offers a unique opportunity to study differential rotation in other cases than for the Sun.
I will present the model we have implemented recently, as well as two applications to VLTI/AMBER Data: the pulsation of Cepheids and the rotation of A-type main sequence stars. In both cases, the insights the application of spectro-interferometry provide are unique.



The Vista Variables in the Via Lactea ESO Public Survey: Current Status and First Results

M. Catelan

The Vista Variables in the Via Lactea (VVV) is a public IR variability survey of the Milky Way bulge and an adjacent section of the mid-plane, using ESO's 4.1m VISTA telescope. It will take 1929 hours, over a timespan of about 5 years, covering ~10^9 point sources within an area of 520 sq. deg, including 33 known globular clusters and ~350 open clusters. Here I provide a description of the project's current status, as well as some first results.

Solar-like stars observed by Kepler: an incredible adventure

R. García on behalf of the WG#1 Team

The NASA Kepler mission, in flight since March 2009, is producing an enormous number of high-quality continuous light curves. Now, and for the first time ever, we are able to do “ensemble asteroseismology”, i.e.,

to do the asteroseismic analysis with a statistically significant sub-sample of solar-like stars covering a wide range of stellar characteristics. During the first year of scientific operations, the Kepler WG#1 team decided to run a survey. About 2000 stars were observed, and more than 500 showed pulsations due to acoustic modes. In the present talk we will review the most recent studies done within the Team and the best results will be highlighted.

First evidence for solar-like oscillations in a Delta Scuti star

V. Antoci, G. Handler, T.L. Campante, A. O. Thygesen, A. Moya, T. Kallinger, D. Stello, A. Grigahcène, H. Kjeldsen, et al.

Theoretical predictions suggest that solar-like oscillations should exist in delta Scuti stars. Up to now no such oscillations have been observed, seriously questioning our understanding of the physics occurring in the outer layers of these stars. Using ultra-precise data from the Kepler mission, we show here the first evidence of these predicted pulsations. Our interpretation is supported by the striking similarities between the observed signal at high frequencies and the properties of stochastically excited pulsation, i.e. 1) overtones of high radial order with a rough equidistant spacing, 2) evidence for short mode lifetimes, 3) correct estimate for the frequency of maximum power for the observed large separation, 4) amplitudes comparable to predictions, and 5) statistical evidence for the stochastic nature of the signal.

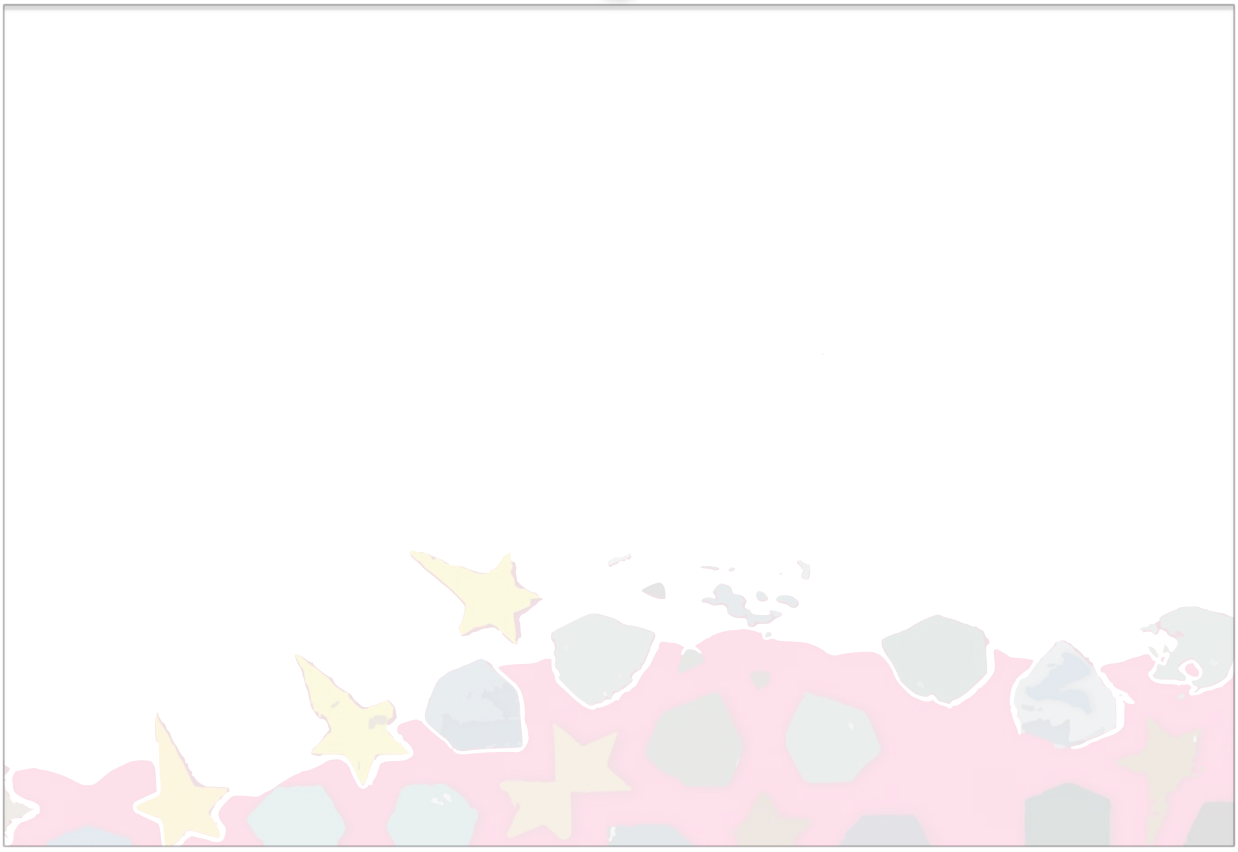
SESSION IV: MODE IDENTIFICATION

Identification of pulsation modes in main sequence pulsators: uncertainties and limits

Invited Speaker: A. A. Pamyatnykh and J. Daszynska-Daszkiewicz

Studying pulsating stars in the era of the space photometric missions is one of the most developing branch of astrophysics. The unprecedented large number of pulsational frequencies gives a hope to construct detailed seismic models of stars and to obtain stringent constraints on input physics. However, to explore these data, the unequivocal identification of mode geometry is required. This is often not an easy task if equidistant patterns are missing in the oscillation frequency spectra. We review the most important effects that may affect mode identification in main sequence pulsators, i.e. convection, rotation and model atmospheres.

In particular, we will focus on diagnostic properties of photometric diagrams. As for rotation, we will consider modes coupled by rotation as well as slow modes that have pulsational frequencies of order of rotational frequency. The last subject we would like to discuss is how should we deal with such rich oscillation spectra as derived from the CoRoT and Kepler data. For most of these frequencies, mode identification will not be possible, in particular for those of the high spherical degree. Are such frequency peaks still useful for asteroseismic modelling? What can we expect from the forthcoming BRITE missions that will observe bright pulsators at least in two colours?



Uncovering hidden modes in RR Lyrae stars

László Molnár

The Kepler space telescope revealed new, unexpected phenomena in RR Lyrae stars: period doubling and the possible presence of additional modes. Identifying these modes is complicated because they blend in the rich features of the Fourier-spectrum. Our hydrodynamical calculations uncovered that a 'hidden' mode, the 9th overtone is involved in the period doubling phenomenon. The period of the overtone changes by up to 10 per cent compared to the linear value, indicating a very significant nonlinear period shift caused by its resonance with the fundamental mode.
The observations also revealed weak peaks that may correspond to the first or second overtones. These additional modes are often coupled with period doubling. We investigated the possibilities and occurrences of mutual resonances between the fundamental mode and multiple overtones in our models. These theoretical findings can help interpreting the origin and nature of the 'hidden' modes found in the high quality light curves of space observatories.

Complex asteroseismology of the Slowly Pulsating B-type star HD 74560

Walczak, P., Szewczuk W., Daszynska-Daszkiewicz, J.

Results of complex seismic modeling of the βCephei stars have shown some disagreements between models and observations. The problems emerged with finding models reproducing simultaneously observed frequencies and corresponding values of the empirical f-parameters defined by the ratio of the bolometric flux perturbation to the radial displacement at the photospheric level. The aim of these studies is to check whether similar problems appear for the less massive B-type pulsators, i.e., the Slowly Pulsating B-type stars. We choose the star HD 74560, which pulsates in five frequencies, detected in photometric observations. We present identification of the mode degree, l, for all these frequencies. For two frequencies, found also in spectroscopic data, we are able to derived the empirical values of the nonadiabatic parameter f and compare them with theoretical counterparts. We test effects of the chemical composition and opacity data. Our results show that properties of seismic models of the SPB star HD 74560 differ significantly from those of the β Cephei stars.

First evidence of pulsations in Vega? Results of today's most extensive spectroscopic search

Torsten Böhm

The impact of rapid rotation on stellar evolution theory remains poorly understood as of today. Vega is a special object in this context as spectroscopic and interferometric studies have shown that it is a rapid rotator seen nearly pole one, this rare orientation being particularly interesting for seismic studies. Vega was monitored in quasi-continuous high-resolution echelle spectroscopy. In three distinct observing runs, a total of 4478 spectra were obtained with Espadons/CFHT and NARVAL/TBL, at resolutions above R=65000. This data set should represent the most extensive high S/N, high resolution quasi-continuous survey obtained on Vega as of today. Least square deconvolved spectra (LSD) were obtained for each spectrum representing the photospheric absorption profile potentially deformed by the presence of pulsations. After precise radial velocity corrections, residual velocities were analyzed and periodic faint amplitude variations, potentially indicative of stellar pulsations, detected. In a subsequent step, LSD profile variations were searched for in a bidimensional analysis night by night.

Theoretical properties of regular spacings in the oscillation spectra of delta Scuti stars

J.C. Suárez, A. Moya, A. García Hernández, R. Garrido, E. Solano, C. Rodrigo

In this work we study theoretically the properties of the regular spacings found in the oscillation spectra of delta Scuti stars. The strategy followed consists in searching for possible relations between the quasi-periodicities found by García Hernández et al. (2009) in a delta Scuti star observed by CoRoT, with combination of frequencies. We find a relation between these two observables. In this talk I will give details about this relation, its properties and its possible consequences. (Note: This work is currently in process of publication and hence they are under embargo. By the time of the conference, we hope they will have already become public).

Theoretical approach to mode identification

Invited Speaker: J. A. Guzik

Mode identification in pulsating stars is challenging because the modes that are predicted to be excited and visible are not all observed, and because sometimes modes that are not expected are observed. In principle, finding rotationally split multiplets can assist mode identification, but often not all of the components are observed, and rapid and differential rotation complicates the interpretation. Other challenges include distinguishing modes from star spots, identifying frequencies that are linear combinations of other (perhaps invisible) intrinsic modes, mode coupling, and unexpected and sometimes variable mode amplitudes. For brighter stars and modes with high signal-to- noise, spectroscopic and photometric techniques based on theoretical expectations have had some success in separating ℓ=0, 1 and 2 modes and in identifying the azimuthal orders. For solar-like oscillations the patterns of small and large frequency separations can guide mode identifications.

We will review theoretical expectations for pulsation mode driving and damping, focusing on main-sequence variables, and compare with observational examples. We will see whether we can gain some insight into mode selection and amplitudes by examining the energy partition between various processes in these stars (radiation, thermal energy, rotation, convection, pulsation, winds, etc.) and among the possible oscillation modes, and possibly compare the forces that contribute to driving and damping (radiation, gravity, convection). We hope to motivate discussion on the next steps to progress in understanding the reasons for the observed patterns of modes.

Diagnostic tools for solar-like stars

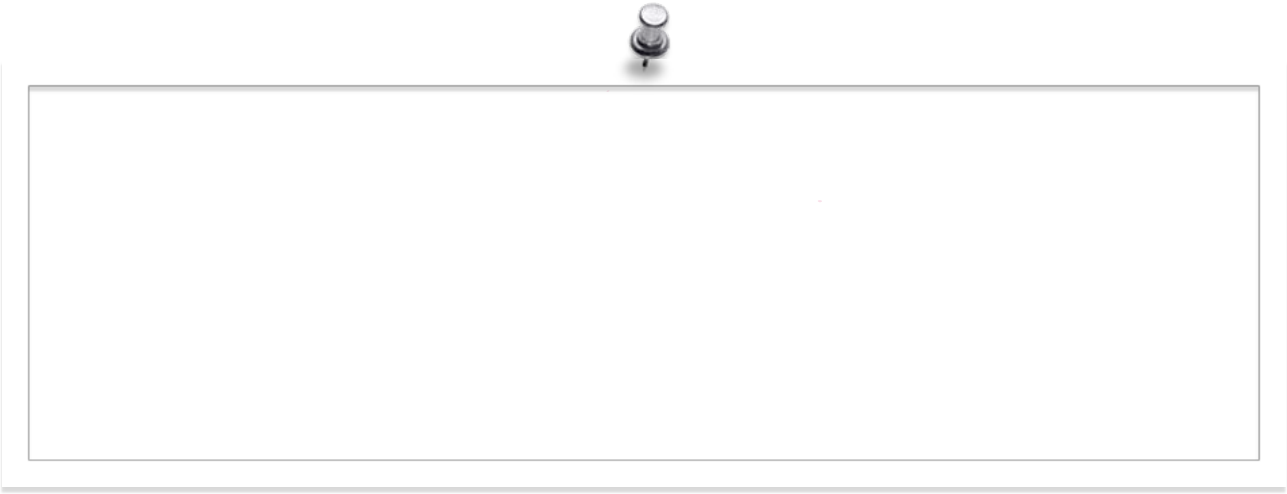
Ian Roxburgh

We present a range of diagnostic tools for inferring the structure of solar-like stars given high precision frequency sets; these include model-filtering, the ratio of separations, inversions, and the location of regions of sharp changes in acoustic variables. These are applied to some CoRoT stars.

Towards a precise asterseismology of solar-like stars

A. Grigahcène, M.-A. Dupret, S. G. Sousa, M. J. P. F. G. Monteiro and R.Scuflaire

Two conditions are necessary for a precise probing of the physics of the stellar interior with asteroseismology. The first is related to the quality of the collected data. A major improvement has been achieved thanks to space missions, gathering unprecedented high-quality data. The second condition, no less important than the previous one, is the improvement of theoretical models able to reflect the complex physics at work in the stars, allowing for a precise interpretation of the observations. Solar like-stars have extensive convective envelopes, responsible for the excitation of their oscillations modes which occurs mostly near the top of the envelope. However, adiabatic models of the oscillations have shown their limits for a precise fitting of individual oscillation frequencies. That is known as the problem of the near-surface effects on the mode physics. Here, we present a theoretical study to address the adequacy of Time- Dependent-Convection non-adiabatic models to better reproduce the observed individual frequencies of oscillation. Thereby the number of acceptable model solutions are significantly reduced and more precise constraints can be imposed on those models. The results obtained for specific stars match very well both the global and the seismic observables. These indicate that the accuracy of the model fitting based on seismic data is greatly improved when a more complete description of the interaction convection-pulsation is taken into account.

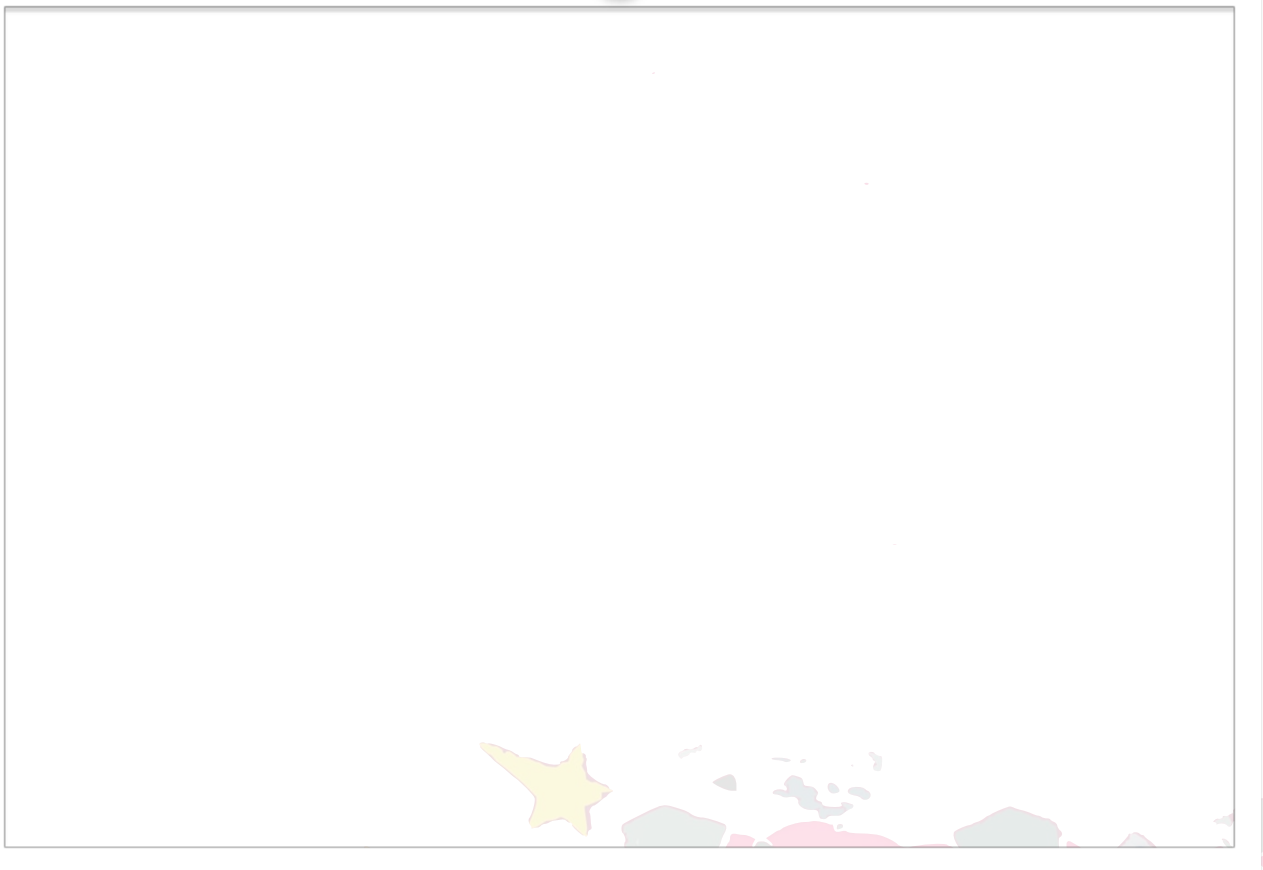


SESSION V: MODE OSCILLATIONS VS. ACTIVITY PLUS PLANET TRANSITS

Current state of the modeling of photospheric activity

Invited Speaker: A. F. Lanza

I shall briefly review the current state of the modeling of photospheric activity based on the high-precision optical light curves obtained with MOST, CoRoT, and Kepler. These models can be used to search for active longitudes where activity is preferentially concentrated, measure stellar differential rotation and look for short-term activity cycles as, e.g., in the case of CoRoT-2. In the case of a late-type star accompanied by a transiting hot Jupiter, the small light modulations observed during transits when a dark spot is occulted by the disc of the planet are also briefly considered. They can be used to derive information on individual active regions as well as on the stellar rotation and the projected spin-orbit misalignment of the system.



Pulsating stars harboring planets

Invited Speaker: A. Moya

Asteroseismology and exoplanetary sciences have well known synergies that opened scientific interesting fields and space missions opportunities. These collaborations have already achieved some results; there are a number of research groups working actively in the characterization of exoplanets using asteroseismology; the future of these collaborations is exciting if Plato is finally accepted. In this review I will summarize the past and present of this research field, and some guidelines for the next future.

Successful asteroseismology for a better characterisation of the exoplanet HAT-P-7

M. Oshagh, A. Grigahcène, T. L. Campante, M.-A. Dupret, M. J. P. F. G. Monteiro and N. C.Santos

It is well known that asteroseismology is the unique technique permitting the study of the internal structure of pulsating stars using their pulsational frequencies, which is per se very important. It acquires an additional value when the star turns out to be a planet host. In this case, the astroseismic study output may be a very important input for the study of the planetary system.
With this in mind, we use the large time-span of the Kepler public data obtained for the star system HAT-P-7, first to perform an asteroseismic study of the pulsating star using Time-Dependent-Convection models. Secondly, we make a revision of the planet properties in the light of the astroseismic study.

The new Kepler picture of variability amongst A and F type stars

K. Uytterhoeven, A. Moya, A. Grigahcène, J.A. Guzik, J. Gutierrez-Soto, B. Smalley, G. Handler, L.A. Balona, E. Niemczura, L. Fo

The Kepler spacecraft is providing photometric time series with micromagnitude precision for thousands of variable stars. The continuous time-series of unprecedented timespan open up the opportunity to study the pulsational variability in much more detail than was previously possible from the ground. We present a first general characterization of the variability of A-F type stars as observed in the Kepler light curves of a sample of 750 candidate A-F type stars, and investigate the relation between gamma Doradus, delta Scuti, and hybrid stars. Our results suggest a revision of the current observational instability strips of delta Scuti and gamma Doradus stars, and imply an investigation of pulsation mechanisms to supplement the kappa mechanism and convective blocking effect to drive hybrid pulsations.

Stellar activity cycles and contribution of the deep layers knowledge

Invited Speaker: S. Mathur

It is believed that magnetic activity on the Sun and solar-type stars are tightly related to the dynamo process driven by the interaction between rotation, convection, and magnetic field. However, the detailed mechanisms of this process are still incompletely understood. Many questions remain unanswered, e.g.: why some stars are more active than others?; why some stars have a flat activity?; why is there a Maunder minimum?; are all the cycles regular?

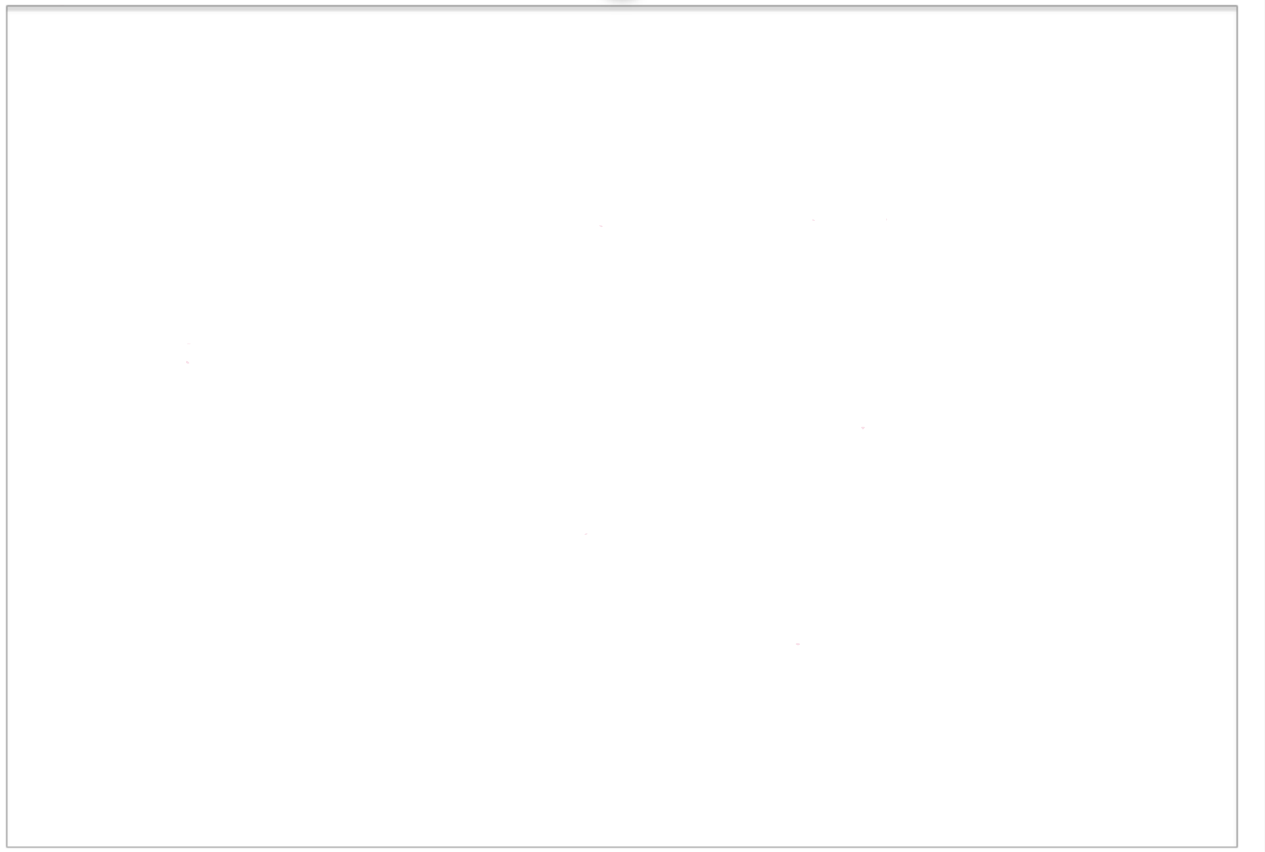
A large number of proxies are typically used to study the magnetic activity of stars, such as optical, UV or X-ray emission from magnetically heated gas but also starspots or flares, and other phenomena that are associated with magnetic fields in the Sun.

Many surveys have been carried out to measure UV, X-ray and CaHK in the stellar atmosphere. The common point between all of them is that they depend on the surface activity and possibly on the inclination angle of the star and the position of the active latitudes. Aside that, it also seems that though no surface magnetic activity is observed (such as a Maunder minimum) a possible cycle could still be running underneath the photosphere. It is well agreed now that to better constrain the dynamo models and the processes driving the magnetic activity of a star, it is crucial to have some information on the structure of the star and its internal rotation.

Over the past decade, asteroseismology has emerged as a powerful unique tool allowing us to directly probe the stellar interior (such as the depth of the convective zone, the presence of a differential rotation in latitude or in radius). Recently, it was shown that asteroseismology can also be used to study stellar activity, making it an even more powerful tool. Aside that, it seems that short cycle are not so uncommon, which should allow us to detect many of them with missions such as CoRoT, Kepler, and the future PLATO mission if it is accepted by ESA.

We will review some of the latest results obtained with spectroscopic measurements. We will show how

asteroseismology can help us to better understand the complex processes involving the interaction between rotation, convection, and magnetic field. We will illustrate how the CoRoT and Kepler missions are revolutionizing our knowledge on stellar activity. A new window is being opened over our understanding of the magnetic variability of stars.



SESSION VI: EARLY TYPE STARS. OSCILLATIONS VS OTHER AGENTS (MAINLY REGULAR/ROTATIONAL VARIATIONS OF B STARS)

The Be stars puzzle

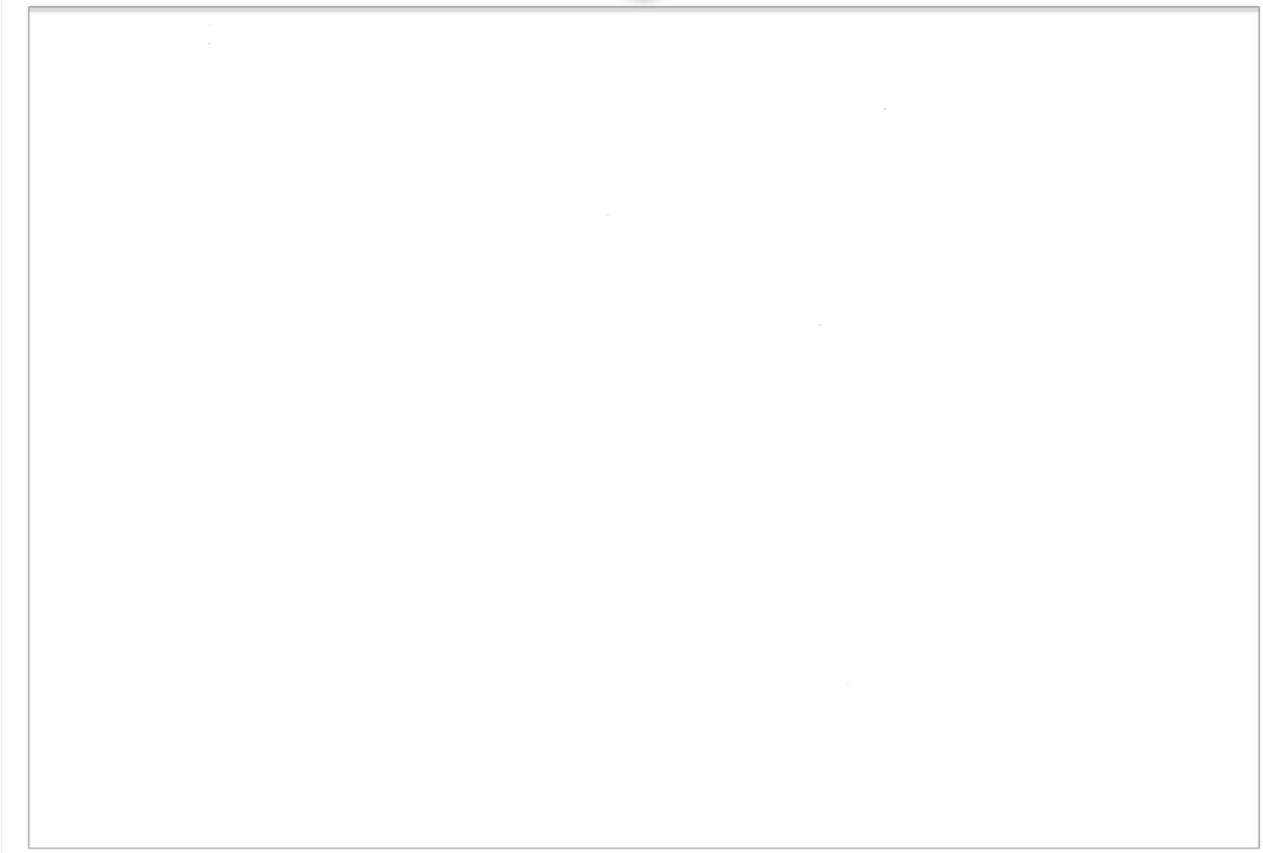
Invited Speaker: L. A. Balona

One of the most important unsolved problems in astrophysics is the mechanism which leads to episodic mass loss in Be stars. Periodic line profile variations have generally been interpreted as nonradial pulsation (NRP). Photometric observations, especially from space, have shown complex light variations that seem to support NRP. Thus the idea has arisen that the mass loss might be due to acceleration of material by pulsational driving in a star rotating close to the critical limit. This mechanism will only work if all Be stars, without exception, are close to critical rotation. Support for this idea is the contention that the derived values of projected rotational velocity are too low because the effect of gravity darkening has not been correctly taken into account. With this problem resolved, it has often been claimed that the Be star puzzle is now understood. We argue that this is far from the truth. We show that the effect of gravity darkening has precisely the opposite effect. The rotational velocities of the hottest Be stars (which constitute the majority of these stars) are so far below critical that no amount of gravity darkening will allow all of them to rotate near the critical velocity. Moreover, recent space observations show, without much doubt, that the periodic variations are transient and are coupled with formation of line emission. We present a simple picture of the Be stars which does not involve any re-interpretation of the projected rotational velocities and explains all major phenomena associated with these stars.

Be stars: rapidly rotating pulsators

Invited Speaker: Th. Rivinius

I will show that for Be stars as a class a) The periodic phenomena observed on timescales of hours to days, line profile as well as light variations, are due to non-radial pulsation. b) There is no observational evidence for Be stars to host magnetic fields or otherwise corotating surface structures, such as spots (and theoretical support for those is strongly contested at best). Stars showing these phenomena exist, but are distictively different from Be stars and cannot be mistaken for them. c) Be stars are rapidly rotating objects. Though the value of the lower threshold is subject to debate, not a single Be star was ever shown to have really low equatorial rotation velocity. Instead all so far proposed candidates for this can be disproven on a closer look. For each claim it will be discussed why it applies to all or at least the overwhelming majority of stars studied in sufficient detail, as well as individual potential exceptions to the scheme.

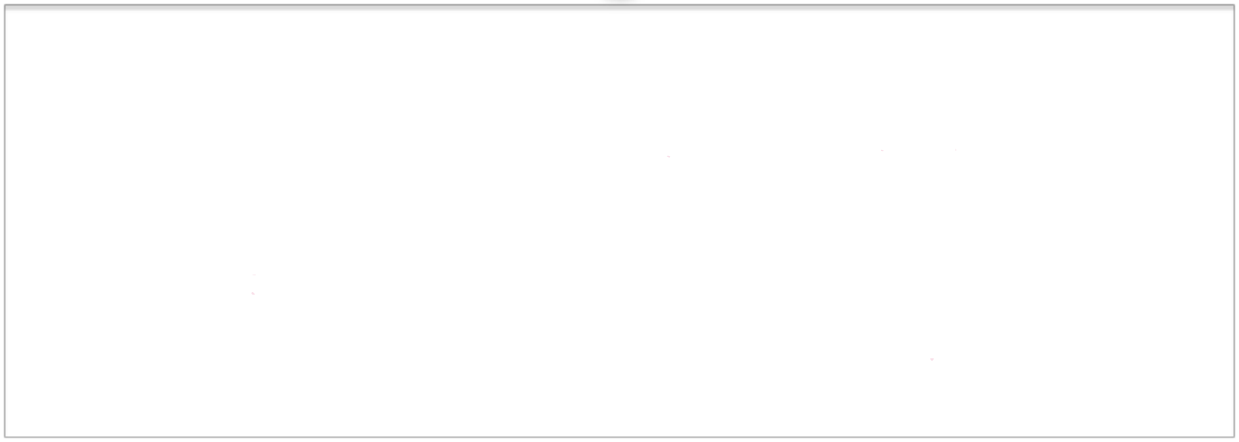


A pulsational study of a sample of CoRoT faint Be stars

Thierry Semaan, Juan Gutiérrez-Soto et al.

We present an intensive study of a sample of 10 Be stars in the first exoplanetary fields of the CoRoT mission (IR1, LRC1, LRA1) that aims to understand the short-term variability in Be stars. We take advantage of both spectroscopic and photometric data: VLT-Giraffe spectra to derive the fundamental parameters, and light curves from COROT to search for low- amplitude frequencies. This allowed us to locate these stars in the HR diagram and compare the position to the instability strips of other pulsating B stars. In addition, we have performed a careful study of the frequencies and amplitudes and their variations with time for all the stars and in particular for those with outbursts.
From VLT-GIRAFFE observations, we determined the stellar parameters by fitting the observed spectra with non-LTE models of stellar atmospheres. If needed, the observed spectra were corrected from the veiling effect due to the circumstellar environment, and the derived apparent parameters for the effects induced by fast rotation. We estimated the rotational frequency of Be stars using the corrected fundamental parameters.

Regarding the COROT light curves, we analyze them (frequencies and variation-amplitudes), compare the main frequencies to the rotational frequency and investigate the behavior of frequencies spectrum at the epochs of outbursts.
This is the first time that such a study has been performed. Many interesting and not-expected results have been found, as for example the presence of high frequencies in a late-type Be star or the similar behavior of the amplitude variations at the epoch of the outburst for several Be stars.



Mode identification for subdwarf B stars using period spacings in Kepler data

Mike Reed

During the Kepler satellite's first year of operation, its short cadence observations were obtained in a survey mode where targets received one month of nearly continuous observations. 48 subdwarf B stars were observed of which 14 were found to be pulsators, with only one of these having predominantly short periods. The other 13 were mostly long-period (g-mode) pulsators. With Kepler's exquisite duty cycle and data quality, an average of 23 periods per star were detected with ranges from 6 to 44. As the g-mode pulsations are high-overtone (typically n>10), asymptotic period relations could apply and so we searched for evenly spaced periods. We found these for l=1 and 2 modes in all but one of the Kepler stars and that one outlier has a very complex temporal spectrum caused by a close companion. We were able to associate 222 of 317 measured periods with l=1 and 2 modes. Those results should provide tight constraints on pulsation models. However, they also offer a surprise as current structure models predict significant mode trapping, which is inconsistent with the period spacings we have found.

Pulsating pre-main sequence stars in NGC 2264 discovered by the MOST and CoRoT satellites

Konstanze Zwintz, Luca Fossati, Tanya Ryabchikova, Thomas G. Barnes

Using dedicated MOST and CoRoT high precision photometric time series observations of the very young open cluster NGC 2264 several pulsating stars have been discovered. As the cluster age is ~3 million years, all members with spectral types later than A0 have not started hydrogen burning in their cores yet, i.e., are in their pre-main sequence (PMS) evolutionary stage. As the eigenfrequency spectra of PMS stars differ from those of their evolved (post-) main sequence analogs, asteroseismology provides us with an independent method to constrain the evolutionary phase of a given star.
Recently obtained high resolution spectroscopy for the pulsators in NGC2264, allowed us to confirm for the first time the existence of gamma Doradus pulsation among PMS members of the cluster. The spectroscopically derived parameters were also used to investigate the stars' location in the cluster HR-diagram and hence to constrain their membership to the cluster. We will present the latest results of this work.

Constraints on Pasta Structure of Neutron Stars

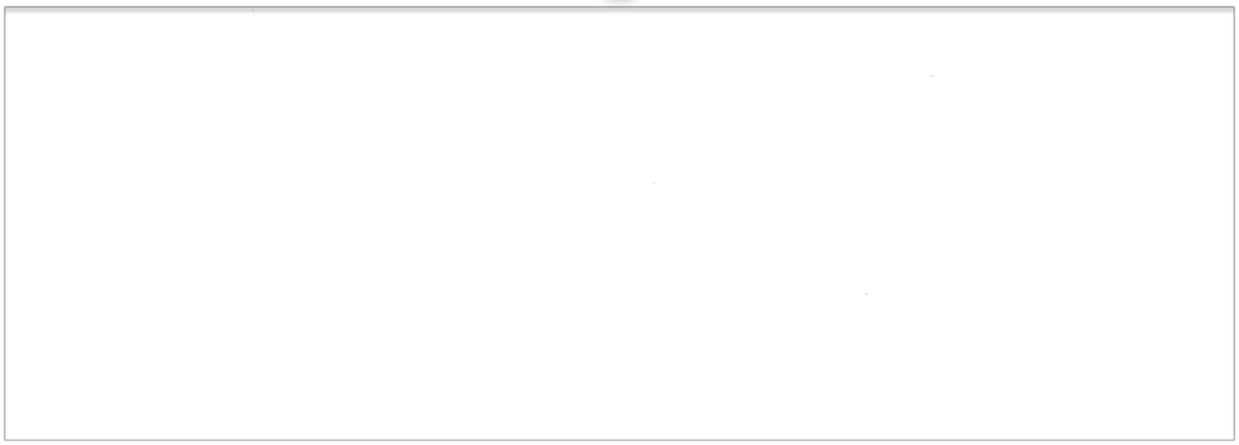
Hajime SOTANI

We show that the shear modes in the neutron star crust are quite sensitive to the existence of nonuniform nuclear structures, so-called ``pasta". Due to the existence of pasta phase, the frequencies of shear modes are reduced, where the dependence of fundamental frequency is different from that of overtones. Since the torsional shear frequencies depend strongly on the structure of pasta phase, through the observations of stellar oscillations, one can probe the pasta structure in the crust, although that is quite difficult via the other observations. Additionally, considering the effect of pasta phase, we show the possibility to explain the observed frequencies in the SGR 1806-20 with using only crust torsional shear modes.

Whole Earth Telescope Observations of EC14012-1446: Convection in DA White Dwarfs

Provencal, J. L., M. Montgomery, A. Kanaan, and the WET Team

We will present 309 hrs of high speed photometry targeting the pulsating DA white dwarf EC14012-1446. Our goals are to determine an asteroseismological mode identification and 2) to use that information to extract empirical measurements of the physical properties of EC14012-1446's convection zone. The data were acquired with the Whole Earth Telescope (WET) during the 2008 international observing run (XCOV26). The Fourier transform has dominate peaks at 1633.9, 1887.4, and 2504.9 microhz. We find a total of 13 independent frequencies distributed in 8 modes as well as numerous combination frequencies. Our analysis, for which we include archival data from 2004-2007, reveals that the identified frequencies are consistent with a series of consecutive l=1 modes with an average period spacing of 41 s. Building on these results, we present nonlinear fits to SOAR lightcurves on EC14012-1446, determine its convective parameters, and explore our current understanding of convection across the DA instability strip.



Asteroseismology of a V777 Her pulsator observed by Kepler

Roy Østensen et al.

We present an asteroseismic analysis of a pulating DB white dwarf in the Kepler field. The 1-month light curve from the Kepler spacecraft reveals a sequence of five independent pulsation modes, of which three are split into triplets with a spacing indicating a rotation period of 1.2 days. The five modes have periods ranging from 197 to 376 seconds and can be identified as a sequence of l=1 modes with a mean spacing of 36.75 seconds. We make a first attempt at exploring the interior structure of this pulsator by fitting the period sequence to a state-of-the-art grid of white dwarf models.

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1 - A. Arellano Ferro, R. Figuera Jaimes, D.M. Bramich, Sunetra Giridhar

New Blazhko variables in the globular cluster NGC 5024 (M53)

We report the discovery of amplitude and phase modulations typical of the Blazhko effect in 14 RRc and 3 RRab type RR Lyrae stars in NGC 5024 (M53). Six other RRc border-line cases are identified.
This brings the confirmed Blazhko variables in this cluster to 15 RRc and 5 RRab, that represent 43\% and 17\% of the total population of RRc and RRab stars in the cluster respectively. This makes this cluster the one with the largest presently known population of Blazhko RRc stars. The overall Blazhko variables among
the RR Lyrae population in this cluster is 31\%. The modulation periods were estimated and found to be contained between 20 and 200 days. The amplitudes of the modulations range between 0.01 and 0.10 mag.
Among the RRab stars the Blazhko variables tend to have larger amplitudes and shorted pulsational periods. The Blazhko stars in NGC~5024 are found, in
average, less bright than stable RR Lyrae stars of similar colour by ~ 0.1 mag and tend to show a larger concentration in the inter-mode region of the Horizontal Branch.
A correlation was found between the main pulsation frequency f_0 and the modulation frequency f_m in Blazhko RRab stars, a relationship previously sketched by Blazhko RRab stars in the globular cluster M5. No correlation is found for RRc stars with modulation periods longer than 20 days.

2 - A. Frasca, H.-E. Froehlich, J. Molenda-Zakowicz, A. Bonanno, G. Catanzaro, K. Biazzo

Magnetic activity and differential rotation in very young stars in the Kepler field of view

The case of KIC 8429280 present a spectroscopic and photometric analysis of young active stars in the field of view of the Kepler space telescope. These stars were initially selected in the RasTyc sample of coronal stellar sources, obtained from the cross-correlation of the RASS (ROSAT All-Sky Survey) and the Tycho catalogs. The stars were then chosen on the basis of follow-up high-resolution spectroscopy performed with different echelle spectrographs, namely SARG@TNG, FRESCO@OAC, and FOCES@CAHA.
We discuss the case of KIC 8429280, discovered as a very young, active and fast-rotating star in this spectroscopic survey. Ground based data, such as high-resolution spectroscopy and multicolor broad-band photometry, have been used to derive the basic stellar parameters and the spectral subtraction technique has been adopted to emphasize the strong chromospheric emission in the cores of hydrogen H-alpha and H-beta and CaII HK and IRT lines. A robust spot model has been employed to fit the high-precision Kepler photometry spanning 138 nearly consecutive days. Model selection and parameter estimation has been done in a Bayesian manner using a Markov chain Monte Carlo method.
KIC 8429280 is a cool (K2V) star with a young age, based on its lithium content, which has overcome the T Tau phase and is spinning up approaching the ZAMS on its radiative track. The high level of chromospheric activity is witnessed by the strong radiative losses in the chromospheric lines present in the SARG spectra.
The analysis of the Kepler data suggests the presence of at least seven enduring spots in its photosphere which is differentially rotating with a Sun-like law (equator faster than poles) but with a much higher rotational shear. The high equator-to-pole differential rotation of 0.27 rad/day is shortly discussed in the context of recent models of differentially rotating stars.

3 - A. Kaiser, W. Weiss

Automatic stellar characterization of large sets of low resolution spectroscopic observations - a bayesian approach

The CoRoT exo data archive contains light curves of several thousands of stars including a large sample of d Scuti stars. One crucial aspect in the analysis and modeling process is the stellar parameter determination. For the IRa01, LRa01 and LRa02 multi-fiber low resolution classification spectra obtained at the AAO by Guenther et al. are available and can be used for this purpose. We show that by using a large grid of synthetic spectra and employing an automated bayesian fitting procedure it is possible to estimate Teff, logg and Fe/H in a statistically sound way including error estimation. We present preliminary results for the CoRoT d Scuti and g Dor - d Sct hybrid stars and show the reliability of the method by applying it to the Elodie stellar spectral library.

4 - Á. Sódor

Recent and past changes in the Blazhko modulation of RR Geminorum

RR Gem is one of those few Blazhko stars that have long-term photometric observations available from many past decades. Particularly, the maximum brightness observations on RR Gem span more than a century. The O-C variations, the archive photographic and photoelectric light curves and two seasons of multicolour CCD observations from 2004 and 2005 has already been analyzed and published (Sódor, Jurcsik and Szeidl, 2007, A&A, 469, 1033). In 2011, we continued the multicolour CCD observations of the target, obtaining full coverage of the pulsation in many different Blazhko phases. These data enable us to detect slight but definite changes in the modulation and in the underlying physical properties of the star since 2004-05, utilising the Inverse Photometric Baade--Wesselink Method. The amplitude and shape of the mean pulsation light curve also changed slightly. In this presentation, I summarize our results on the long-term changes in the modulation and pulsation of RR Gem during the past decades.

5 - C. Perini and M. Chadid

First detection of strong cycle to cycle changes of the Blazhko modulation

For the first time, we detect significant cycle-to-cycle changes in the Blazhko modulation of CoRoT ID star 105288363, which appear to be analogous to those predicted by Stothers - owing to the suppression of turbulent convection - to explain this phenomenon. We discuss the clear correlations between the phase and the amplitude of the bump, and the skewness and acuteness of the light curve during different Blazhko cycles. We find that these quantities are strongly anticorrelated with the fundamental pulsation period. This provides a strong support to the slow convective cycle model suggested by Stothers. We also detect a long-term modulation period in the maximum brightness spectrum. A more extended coverage of the long-term modulation is required to constrain its period. Seventh-order side peaks of the pulsation multiplet structure are also visible with the left-side peak amplitudes being higher than those of the right. This has never previously been detected. Future theoretical investigations are required to understand on a quantitative basis the complex behavior of the Blazhko effect. In particular, we still lack firm constraints of the physical mechanisms driving both phase and amplitude modulations during consecutive Blazhko cycles and their correlation, if any, with the long-term modulation.

6 - C.-C. Ngeow, R. Szabo, L. Szabados, A. Henden, M. Groenewegen & the Kepler Cepheid Working Group

Ground-Based BVRI Follow-Up Observations of Two Cepheid Candidates in Kepler's Field

Kepler space telescope is a NASA mission to search for Earth-size and larger planets around other stars, by observing continuously the stars in a dedicated patch of the sky. As a result, the almost un-interrupted observation can also be used for stellar variability and asteroseismological study. However, Kepler's observations were carried out with a single broad-band filter, and ground-based follow-up observation is needed to complement Kepler's light curves to fully characterized the properties of the target stars. Here we present our effort on the ground-based optical (BVRI) follow-up observations for two Cepheid candidates in Kepler's field. Together with Kepler's light curves, the ground-based follow-up observation ruled out V2279 Cyg being a Cepheid, and V1154 Cyg remained the only Cepheid in the Kepler's field.
CCN thanks the funding from National Science Council (of Taiwan) under the contract NSC 98-2112-M-008-013-MY3. Funding for Kepler mission is provided by NASA's Science Mission Directorate.

7 - C. Rodríguez López, J. MacDonald and A. Moya

Pulsations in M dwarf stars

We present the results of the first theoretical non-radial non-adiabatic pulsational study of M dwarf stellar models with masses in the range 0.1 to 0.5 M⊙. We find the fundamental radial mode to be unstable due to an epsilon mechanism, caused by deuterium burning for the young 0.1 and 0.2 M⊙ models, by non-equilibrium He3 burning for the 0.2 and 0.25 M⊙ models of 10^4 Myr, and by a flux blocking mechanism for the partially convective 0.4 and 0.5 M⊙ models once they reach the age of 500 Myr. The periods of the overstable modes excited by the D-burning are in the range 4.2 to 5.2 h for the 0.1 M⊙ models and is of order 8.4 h for the 0.2 M⊙ models. The periods of the modes excited by He3 burning and flux blocking are in the range 23 to 40 min. The more massive and oldest models are more promising for the observational detection of pulsations, as their ratio of instability e-folding time to age is more favourable.

8 - D. Bramich, A. Arellano Ferro, S. Giridhar, R. Figuera Jaimes

Exploring the variable stars in NGC6981 and NGC5024: RR Lyraes and SX Phe

We present results from multi-night photometric campaigns targeting the globular clusters NGC6981 and NGC5024. We employed the latest techniques in difference image analysis to extract equisitely precise lightcurves of the RR Lyrae pulsators, and we detect 11 and 2 new RR Lyrae in NGC6981 and NGC5024 respectively. Fourier lightcurve decomposition of the RR Lyraes has been performed allowing us to estimate the physical properties of these stars using well established empirical relations and which further allow us to estimate the properties of the parent cluster. Consequently we estimate metallicities of -1.48+-0.03 and -1.93+-0.07 for NGC6981 and NGC5024 respectively, along with distances of ~16.7 kpc and ~17 kpc respectively.
We also detect 3 SX Phe pulsators in NGC6981 where previously none have been found, and we detect 13 new SX Phe in NGC5024. We identify the pulsation modes of these new discoveries in most cases, and we discuss the period-luminosity relation for the SX Phe stars in NGC5024, comparing it with theoretical predictions and previous empirical determinations for other clusters.

9 - D. Citro, J. Bennett, C. Ngeow, S. Kanbur

Random Phase Corrections to the IRAC bands PL relation using SAGE data for the LMC/SMC

Recent work has shown the importance of the Cepheid PL relation at mind-infrared wavelengths in developing a more accurate value of Hubble's constant. Examples are the work of Ngeow and Kanbur (2008, 2010a) who used random phase observations by the SAGE program on the Spitzer satellite to contruct the first ever Cepheid PL relation in the Magellanic Clouds at these wavelengths.
Here we use recently released time information from the SAGE archive together with a random phase correction method to refine the mean light mid-infrared PL relation developed earlier. We discuss possible applications and future prospects.

10 - D. G. Turner, D. J. Majaess, and D. J. Lane

Recent Observations of HDE 344787, the Smallest Amplitude Classical Cepheid

A summary is presented of ongoing and archival photometric and radial velocity observations of the 9th magnitude F9 Ib supergiant HDE 344787 made over the last 120 years, with emphasis on recent trends. HDE 344787 is a double-mode Cepheid variable, period = 5.4/3.8 days, of extremely small amplitude, < 0.01 magnitude, with a rapidly-increasing period and sinusoidal light variations of decreasing amplitude that may result in non-variable status within the next half century. The star displays all of the characteristics of a Cepheid undergoing a first crossing of the instability strip, and about to depart the cool edge for first crossers. Its existence helps to redefine the observational characteristics normally attributed to Cepheid pulsation.

11 - D.Mozdzierski, A.Pigulski, G.Kopacki, M.Steslicki, Z.Kolaczkowski,

Variability survey in the young open cluster NGC 457

We present the results of the 2010/11 CCD photometric survey in the field of the young open cluster NGC 457. The data were obtained during 24 observing nights with a 60-cm reflecting telescope in Bialkow Observatory, University of Wroclaw. The multicolour BVI photometry is used to construct colour-magnitude diagram and derive cluster parameters. The results of the variability survey, focused on pulsating B-type stars (Beta Cephei, SPB) and bright eclipsing binaries, are discussed in terms of predictions of the theory. Some objects, interesting from the point of view of asteroseismology, are also indicated.

12 - E. Brunsden, K. R. Pollard, P. L. Cottrell, D. J. Wright, P. De Cat

Spectroscopic Pulsations of Gamma Doradus Stars

Gravity modes of pulsation in Gamma Doradus stars probe deep into stellar interiors. We wish to further our understanding of these modes under the influence of stellar rotation. We present the spectroscopic mode identification of four frequencies found in the slow-rotating star HD135825. Furthermore, we present the frequencies found in a fast-rotating Gamma Doradus star HD12901. This star is of particular interest for further astroseismic modelling due to the prevalence of (1,1) modes. We make a preliminary comparison of spectroscopic detection of pulsations in slow and rapid rotating stars.

13 - E. Guggenberger, K. Kolenberg and R. Szabo

The changing Blazhko effect of KIC6186029: a comparison with other cases of non-repetitive Blazhko cycles

The high quality of satellite data together with the possibility to observe a star continuously for hundreds of days have made it possible to study the long-term stability of the Blazhko effect of RR Lyrae stars in detail. A preliminary analysis of the RR Lyrae star KIC6186029, observed by the Kepler space telescope, is presented. KIC6186029 is of type RRab (fundamental mode pulsation) and exhibits a strong Blazhko variation. Special attention is paid to the non-repetitive nature of the Blazhko effect which will be discussed in detail. The results on KIC6186029 are compared with other known cases of changing Blazhko modulations, such as the CoRoT star 105288363 and other well-studied RR Lyrae stars for which long-term observations are available.

14 - E. Kanev

Radii of LMC & SMC Cepheids

We collected published long sets of precise observations of radial velocity as well as photometric data (magnitude V and colour index B-V) for LMC and SMC Cepheids . We used these data to estimate the radii of such Cepheids using our modification of the Balona's method. The period-raduis relation for these Cepheids was compared with such relation for Galactic Cepheids. Properties of these relations are discussed.

15 - Earl Bellinger, Shashi Kanbur, C. Ngeow

New insights into the mean light Cepheid PL relation through the use of multiphase relations

The Cepheid PL relation is of fundamental importance in the extra-galactic distance scale. Usually this relation is considered at mean light. We show, using OGLE III data, how a deeper understanding of the metallicity dependence of the mean light Cepheid PL relation can be gained by considering how this relation varies as a function of pulsation phase in the LMC and SMC. We also consider the Wesenheit function and show that it too is highly dynamic and nonlinear for many pulsation phases. We discuss possible implications for Cepheid modeling and the extra-galactic distance scale.

16 - Emese Plachy, Zoltán Kolláth, László Molnár

Detection of chaos in RR Lyrae models

The period doubling phenomenon was recently discovered in RR Lyrae stars with the Kepler space telescope and has been theoretically explained by hydrodynamical calculations. However, peculiar solutions of the Florida-Budapest turbulent convective hydrodynamical code suggest that bifurcation cascade may evolve to chaos in these dynamical systems.
We show that chaotic behaviour may be recovered from the radius variations of the model using the global flow reconstruction method. The fractal (Lyapunov) dimension of the underlying dynamical attractor is calculated to be ~2.2. Compared to the radius, the luminosity variations proved to be less suitable for such investigations due to their complexity. That suggest that even the continuous Kepler data would require transformation before conducting a similar analysis.

17 - Ewa Niemczura, Marek Steslicki et al.

Spectroscopic observations of B-A-F stars from the Kepler field

The Kepler space mission is providing continuous and high-precision photometry of thousands of stars. Such data are essential for asteroseismic studies. However, the Kepler data do not provide information on the stellar physical parameters, which are also crucial for successful seismic modelling. Therefore, additional ground-based data are needed. We report spectroscopic observations of B, A and F stars from the Kepler field. For these stars, by using the LTE and NLTE methods we are obtaining effective temperatures, surface gravities, projected rotational velocities and abundances of chemical elements. These determinations are fundamental for seismic modelling of these objects.

18 - Fehmi Ekmekçi, Lale Çelik, H. Volkan Şenavci

RR Lyrae type stars, ST Boo and RR Leo: 2007 observations and the preliminary results of the frequency analysis

We present BVR light curves of ST Boo and RR Leo pulsating stars obtained between March and September 2007 at the Ankara University Observatory (AUG) and at the TÜBİTAK National Observatory (TUG). Although these observational data are insufficient to obtain the reliable results on the frequency analysis of ST Boo and RR Leo

stars, in this study we tried to investigate the pulsational phenomena of these two stars, as an overview, using the Period04 software package. As preliminary results, we present the possible frequencies for ST Boo and RR Leo.

19 - G. Kopacki, A. Pigulski

Period-Luminosity Relation for SX Phoenicis stars from Galactic Globular Clusters

We have compiled a list of known SX Phoenicis stars in Galactic globular clusters in order to study period-luminosity relation for this type of variable. We find about 250 stars of this type located in 30 globular clusters with the suitable photometric data. The absolute magnitudes of the studied stars were derived using metallicity-luminosity calibration for RR Lyrae stars. We show that large photometric amplitude is a poor discriminant of the radial pulsation mode in SX Phoenicis stars. We also discuss the difficulties in defining strict period-luminosity
relation arising from the contamination by non-radial modes in SX Phoenicis stars and the lack of unique method of mode identification. As a solution, we propose using only the confirmed double-mode radial pulsators.

20 - G. Kopacki, A. Pigulski

Variable Stars in the Globular Cluster M79

We present results obtained from the analysis of the VI photometry of the poorly studied globular cluster M79. Stellar variability survey performed with the image subtraction method yielded ten new pulsating stars: six of RR Lyrae type, three SX Phoenicis stars and even one W Virginis star. Using all ten RR Lyrae stars known in the cluster we find that M79 is Oosterhoff type II globular cluster. We discuss properties of RR Lyrae stars in M79 using colour-magnitude and period-amplitude diagrams.

21 - Gergely Hajdu, Béla Szeidl & Johanna Jurcsik

A comprehensive investigation of the period changes of RR Lyrae stars in Messier 3

Period change studies of RR Lyrae variables have the potential of measuring the rate of stellar evolution. Globular clusters with large numbers of RR Lyrae stars are ideal targets for such studies. The photometric measurements spanning more than 100 years were analysed for the three most studied clusters(o Cen, M5 and M3) by our group. Our recent study of period changes of RR Lyrae stars in M3 clearly shows striking differences in period change behaviour as compared with that of the other clusters.

22 - Hajime Sotani, Nobutoshi Yasutake, Toshiki Maruyama, and Toshitaka Tatsumi

Signatures of hadron-quark mixed phase in gravitational waves

We calculate stellar oscillations including the hadron-quark mixed phase considering the finite size effects. We find that it is possible to distinguish whether the density discontinuity exists or not in the stars, even if one will observe the gravitational waves of the fundamental mode. Additionally, the normalized eigenfrequencies of pressure modes depend strongly on the stellar mass and on the adopted equation of state. Especially, in spite of the fact that the radius of the neutron star with $1.4M_ \odot$, which is standard mass, is almost independent from the equation of state with quark matter, the frequencies of pressure modes depend on the adopted equation of state. Thus, via observing the many kinds of gravitational waves, it will be possible to make a restriction on the equation of state.

23 - Hilding Neilson

Constructing a Cepheid period p-factor relation from static stellar atmospheres

The Baade-Wesselink method has been shown to be a robust method for measuring the distances to Cepheids in our galaxy and in the Magellanic Clouds. However, one of the greatest uncertainties is the connection between the observed radial velocity and the pulsation velocity, called the projection factor (p-factor). Recently, Nardetto et al. showed that the p-factor is a function of pulsation period with a small value of the slope. On the other hand, measurements using the Infrared Surface Brightness method suggest that the slope of the period p-factor relation is significantly steeper. In this work, we compute spherically symmetric static model stellar atmospheres to better understand the role of geometry in constraining the p-factor as well as compute a period p-factor relation for a grid of model atmospheres.

24 - A. Moya, I. Baraffe and D. Barrado

Theoretical study of non-radial pulsations in brown dwrafs

Understanding the structure and early evolution of brown dwarfs is a challenge that we have only been able to undertake in recent years. Improvement of the physics of these objects combined with new observational techniques provide the opportunity of achieving this goal. Palla \& Baraffe (2005) found that brown dwarfs, during the deuterium burning phase, can excite fundamental radial modes via the ϵ-mechanism. Asteroseismology can thus be used to test and improve our knowledge of the internal structure of these objects. The discovery of pure radial oscillations and their interpretation as intrinsic stellar pulsations is not an easy task. The presence of non-radial oscillations in these objects would facilitate this discovery. Their existence introduce in the light curves genuine features which can hardly stem from other sources of variability. We have searched for theoretical radial and non-radial excited modes in brown dwarfs using state-of-the-art numerical codes: 1) the Lyon stellar evolution code and 2) the non-radial, non-adiabatic pulsational code GraCo. We have found that non-radial modes with frequencies similar to the fundamental radial mode (several hours) are excited due to the ϵ-mechanism. The less massive and yougest models are more promising for the observational detection of pulsations, as their ratio of instability e-folding time to age is more favourable. Models for which the e-folding time is of the order of the age of the model make the observational detection of pulsations a challenge, unless the initial amplitudes of the modes are large.

25 - J. H. Peña, L. Fox Machado, H. Garcia, A. Renteria, S. Skinner, A. Espinosa

Membership determination of the variable stars in the direction of the open cluster NGC 6811 through Stromgren photoelectric photometry

Very recently, Luo et al. (2009) carried out a search for variable stars in the direction of NGC 6811 with CCD photometry in B, and V bands. They detected a total of sixteen variable stars. Among these variables, twelve were catalogued as Delta Scuti stars, while no variability type was assigned to the remaining stars. They claim that the twelve Delta Scuti stars are all very likely members of the cluster which makes this cluster an interesting target for asteroseismological studies. Moreover, NGC 6811 has been selected as a asteroseismic target of the Kepler space mission (Borucki et al. 1997). Therefore, deriving accurate physical parameters for the pulsating star members is very important.
The study of open clusters and their short period variable stars is fundamental in stellar evolution. Because the cluster members are formed in almost the same physical conditions, they share similar stellar properties such age and chemical composition. The assumption of common age, metallicity and distance impose strong constraints when modeling an ensemble of short period pulsators belonging to open clusters (e.g. Fox Machado et al. 2001, 2006). Thus, observational studies involving variable stars in open clusters attract more and more attention (e.g. Fox Machado et al. 2002, Li et al., 2002 and 2004).
A series of Papers (see Peña et al., 1994, 1998, 2003, 2007) study the physical nature of the short period variable stars in open clusters by means of Stromgren photometry since, once their membership to the cluster has been established, their physical quantities can be unambiguously derived. In particular, the determination of physical parameters of cluster member stars from uvby-beta photometry can be done through a comparison with theoretical models.
From uvby-beta photometry of the open clusters NGC 6811 (75 stars), we are able to determine membership of the stars to the cluster, and fix the age and reddening. We present the study of these variables

26 - J. Molenda-Zakowicz, E. Niemczura, K. Brogaard, F. Grundahl, and T. Arentoft

Spectroscopic Study of two Open Clusters in the Kepler Field of View: NGC 6811 and NGC 6866

Stars in open clusters are thought to have formed from the same cloud of interstellar gas and dust and therefore, share the same space velocity, distance, and chemical composition. This offers a unique opportunity to model the structure and evolution of pulsating stars which have different mass and evolutionary status but the same age, and metal abundance.
Thanks to the NASA space telescope Kepler, which delivers photometric data of the precision of several parts per million, we are now able to model the structure of pulsating stars with the precision only recently available for stars other than the Sun. The asteroseismic methods, though, to be efficient, require precise determination of the effective temperature, the surface gravity, and the metalicity of the stars, as well as the information about their projected rotational velocity.
We provide the atmospheric parameters, the projected rotational velocity, and the radial velocity for 15 solar-like stars in the field of the open cluster NGC 6811, and for 13, in NGC 6866. Both clusters were observed spectroscopically with the FIES instrument at the Nordic Optical Telescope in two observing seasons: 2007 and 2008. The parameters derived in our study will be used as the

input information for computing asteroseismic models of the stars and will be helpful for the interpretation of the frequency spectra computed from the Kepler data while the radial velocities will help detecting new spectroscopic binaries and discuss the membership of the stars to the cluster.

27 - J. Molenda-Zakowicz, K. Uytterhoeven, M. Steslicki, D. Drobek and the PE-16 group

Standard Photometry of Kepler Asteroseismic Targets

The Kepler space mission, successfully launched in March 2009, is providing continuous, high-precision simultaneous photometry of thousands of stars in the Kepler field. Since the Kepler data do not contain color information, ground-based follow-up observations are necessary to obtain physical parameters and reddening of the targets, because only using these values can we achieve successful asteroseismic modeling.
In this poster, we present the first results of the multi-colour photometric observations of selected Kepler asteroseismic targets acquired at three observatories: BUSCA at the 2.2m telescope at the Calar Alto Observatory, CAMELOT at the IAC-80 telescope on Tenerife, and WFC at the INT on La Palma.
The Stromgren uvby-Hbeta and Johnson UBV magnitudes measured at those sites will be used for deriving the atmospheric parameters of the targets, and will provide the input parameters for future seismic modeling of the stars.

28 - J. Vandenbroere, J.F. Le Borgne, A. Klotz, E. Poretti et al.

Evolutionary changes in the periods of RR Lyrae stars

RR Lyr stars are observed since more than one century. We present updated results on the evolutionary changes of their periods, extending the results presented and discussed in Le Borgne (2007). At this purpose we used the maxima of RR Lyrae stars continuously inserted into the GEOS database. Indeed, the number of maxima increases rapidly since in 2007, both in number and in accuracy. The contribution of the automatic telescopes TAROT was of crucial importance to achieve this goal in a few years. The much larger statistical basis allowed us to obtain a new picture of the period changes.

29 - Javier Fernández Fernández, Dean-Yi Chou, Li-Han Wang,Ming-Tsung Sun, Antonio Jimenez, Aleksander Serebryanskiy

Mode Properties of Delta Scuti V830 Her and HD163032 with the Taiwan Automated Telescope Network

The Taiwan Automated Telescope (TAT) network is a global ground-based fully-automated telescope network, dedicated to multicolor observations of stellar pulsations. So far three telescopes have been installed: at Teide Observatory (Tenerife, Spain), at Maidanak Observatory (Uzbekistan), and at Gaomeigu Observatory (Yunnan, China). Here we present results of mode detection on low amplitude delta Scuti stars V830 Her and HD 163032 using white-light data taken with the TAT at Teide in 2008-2010 and at Maidanak in 2009-2010, totally 21260 exposures. Nine pulsation modes are convincingly detected for V830 and three modes for HD 163032. The temporal variations of mode parameters are discussed.

30 - John Telting, Raquel Oreiro, Roy Ostensen, Mike Reed, Laurel Farris, Conny Aerts, Simon O'Toole, et al.

Orbits of hot subdwarf binaries in the Kepler field

We present results from an ongoing spectroscopic survey for binarity in a sample of the 15 pulsating and a few non-pulsating sdB stars observed with the Kepler spacecraft. We find clear evidence for binarity in several of the pulsators, some of which were not previously known to be binaries. For a few of the targets we have not found significant velocity variations (~5km/s upper limit). We also present radial-velocity curves of some of the non-pulsating systems from the sample.

31 - Jurcsik, J., Sódor, Á., Szeidl, B. et al.

Is period doubling indeed the clue to understanding the Blazhko effect?

The photometric data of the Konkoly Blazhko Survey (30 stars with periods shorter than 0.5 d and 120 variables in the 0.55-0.60 d period regime) indicate that half-integer pulsation frequencies appear quite rarely in RR Lyrae stars. The data enable us to detect these components with 1-2 mmag amplitudes if present for most of the stars. The temporal appearance of period doubling and the very few number of true detections in the sample are discussed.

32 - K. Kinemuchi, S. Howell, M. Still, R. Szabo

Selecting New Pulsating Stars from the Kepler Full Frame Image Variability Catalog

Kepler, NASA's discovery mission to find Earth-sized planets within the habitable zone of nearby stars, provides an unique and powerful resource to perform serendipitous time-domain astrophysics. There are 10^7 sources brighter than Kp=21 confusion limit of Kepler. Due to telemetry restrictions, only 170,000 targets are observed each quarter, of which 96% are reserved for the exoplanet program. Finding new targets from the ground is limited by depth, time, and field of view constraints. An alternative method for identifying targets of high potential astrophysical interest is to extract variables from the Kepler Full Frame Images (FFIs). These images are taken principally for engineering purposes at one month intervals with 30-minutes exposure times. Here we describe a "short" catalog created from eight FFIs obtained over a 34 hour interval during the spacecraft commissioning phase. Many of these objects will be pulsators, rotators, eruptive, or eclipsing stars, as well as other exotic variable stars exhibiting large brightness changes. This FFI catalog will increase the number of known variable stars in the Kepler field and provide new targets for astrophysical studies. This variable star catalog will provide an excellent stepping stone for Kepler astrophysics projects through the Kepler Asteroseismic Science Consortium (KASC), the Guest Observer Program, or Guest Observer Director's Discretionary Time. Kepler was selected as the 10th mission of the Discovery Program. Funding for this mission is provided by NASA, Science Mission Directorate.

33 - K. Uytterhoeven, P. Palle, F. Grundahl, and the SONG team

The SONG Project and the prototype node at Tenerife

SONG (Stellar Observations Network Group) is a global network of 1-m class robotic telescopes that is under development. The SONG prototype will shortly be operational at Observatorio del Teide, Tenerife, and first light is expected before December 2011. The main scientific goals of the SONG project are asteroseismology of bright stars and follow-up and characterization of exo-planets by means of precise measurements of stellar surface motions and brightness variations. In this poster we present the Tenerife SONG node and its instruments.

34 - Ennio Poretti, Rainer, M., Mathias, Ph., Amado, P., et al.

The spectroscopic observations of CoRoT asteroseismic targets

CoRoT photometric measurements of asteroseismic targets need for ground-based spectroscopic observations. In addition to spectroscopic monitoring from Observatoire Haute Provence (SOPHIE instrument), Calar Alto Observatory (FOCES instrument), and Canary Island (HERMES instrument) a large number of observations has been performed with the high-resolution echelle spectrograph HARPS attached to the 3.6m-telescope in the ESO-LaSilla Observatory.
Two Large Programmes have been accepted by ESO: the LP 182.D-0356 consisted in 45 nights of observations from December 2008 to December 2009, while the current LP 185.D-0056 started on June 2010 and will end in January 2013.
More than 2000 spectra of several CoRoT targets have been obtained in the EGGS mode (R = 80,000) with high values of signal-to-noise ratio (around 150-200). The spectra have been reduced in an homogeneous way with a semi-automatic pipeline developed at INAF-OAB. Subtle instrumental effects were detected. The calibrated and normalized HARPS spectra were subsequently delivered to the PIs of the specific targets (Delta Sct, Gamma Dor, Be, SPB, Beta Cep, rotational, red giant variables).
The high-quality spectra allowed us to identify high-degree modes in Delta Sct stars, the single velocity field in the atmosphere of the Beta Cep star HD 180642, the variations in the line intensities of the Be variables, the radial velocity curves and the physical parameters of several CoRoT targets.

35 - L. ÇELİK, F. EKMEKÇİ, J. NEMEC, K. KOLENBERG, J. BENKÖ, R. SZABO, D. KURTZ, K. KINEMUCHI, H. V. ŞENAVCI

How to "correctly" stitch together data of a Blazhko star?

One of the most challenging difficulties on performing the frequency analysis of a Blazhko star is stitching together the Kepler data from different seasons. In this study, we discuss the preliminary steps about stitching, detrending and especially the rescaling process using the data of the long term Blazhko stars. We also discuss about a possible automated routine concerning the rescaling process of such complicated dataset. We illustrate

the process on Kepler data of a Blazhko star with a strongly variable Blazhko cycle, and present some first results of our analysis.

36 - M. E. Escobar, S. Théado, N. Dolez, S. Vauclair, J. Ballot, S. Charpinet, G. Vauclair, L. Gizon

Detailed asteroseismic modelling of the CoRoT main target HD52265

We present the results of a detailed modelling of the main target HD52265, observed by CoRoT during 117 days between November 2008 and March 2009. This star is the only main target with an exoplanet detected. We computed evolutionary tracks using the Toulouse-Geneva Evolution Code (TGEC) for a range of masses between 1.15 and 1.30 solar masses, with four different sets of initial chemical composition: two diferent metallicity values and two different initial helium abundances. We calculated adiabatic mode frequencies using the PULSE code and found the models which best represent the observational frequency separations and echelle diagrams. Applying a chi square statistical test, and taking into account the log g-log teff -metallicity from spectroscopic observations, we are able to choose, between all these models, the model which better fits globally the observations for each set of initial chemical composition. We also check the importance of including or not the radiative accelerations on metals in the computation of atomic diffusion for these models.

37 - M. Reed, S. O'Toole, J. Bean, R. Ostensen

Time-resolved spectroscopy and multicolor photometry of pulsating subdwarf B stars

Observational mode constraints have mostly been lacking for short period pulsating sdB stars, yet such identifications are vital to constrain models. Two methods, time-resolved spectroscopy and multicolor photometry have been employed separately with mixed results for short-period pulsating sdB stars. Time-resolved spectroscopy has successfully measured radial velocity, temperature, and gravity variations in six pulsators, yet interpreting results is far from straightforward. Multicolor photometry requires extremely high precision to discern between low-degree modes, yet has been used effectively to eliminate high-degree modes. Combining RV and multicolor measurements has also been shown as an effective means of constraining mode identifications. I will present results for the subdwarf B pulsators Feige 48 and EC01541-1409 using both time-resolved spectroscopy and multicolor photometry and attempts to constrain their pulsation modes using the atmospheric codes BRUCE and KYLIE.

38 - Marek Skarka

Physical parameters of RR Lyrae type stars DH Peg and UY Cam

Light curve analysis of two short periodic RRc type stars is presented. Both stars are hot low mass with pulsating period only a bit longer than 6 hours. Using Fourier decomposition and empirical relations the basic physical parameters, like metallicity, effective temperature, absolute magnitude, luminosity and mass have been estimated, as well as the distance and new ephemeris have been determined.

39 - Medupe

A formula for mode-identification

Medupe, Christensen-Dalsgaard & Phorah (2009) presented a formula for calculating relative surface flux fluctuations for plane-parallel atmosphere. They indicated that it could be used for mode-indentification in A stars. In this paper we present a modified form of this formula to include non-radial oscillations and show how it can be applied to multi-colour photometry to determine the l-value.

40 - Michalska, G., Kolaczkowski, Z., Leiton, R., Szewczyk, O., Kinemuchi, K.

Variable Stars in the Open Cluster NGC 6611

Variable stars in young open cluster allow to study many interesting astrophysical problems related to stellar structure and evolution of the stars. The cluster members, depending on their masses, are at different evolutionary stages. All of them, however, were formed in approximately the same chemical environment, have nearly the same age and distance. This allows to put much better constrains on the parameters of individual stars. Here we present the results of the search for variable stars in a very young open cluster NGC 6611.

41 - Mikolaj JERZYKIEWICZ

Baade-Wesselink Radius and Distance of V1154 Cygni

A derivation of the radius and distance of the cepheid V1154 Cyg by means of Baade-Wesselink method will be presented and discussed.

42 - Nuspl, J., Bíró, I.B.

Pulsating stars in eclipsing binaries - signal disentangling and mode identification

Eclipsing binaries with pulsating component(s) are considered as a remedy for many problems of asteroseismology. Although ground based observations have been collected from nearly one hundred members of this class, the data analysis still struggles with quite similar problems as in other cases of ground-based measurements. CoRoT and mainly Kepler measurements have changed the playground. Kepler SC data provide us with equidistant (1 min) and well sampled LC functions in nearly pure mathematical sense. Hence, we can focus on the yet non-trivial question of deconvolution of these signals.
The frequency spectra are crowded due to modulations and one has to separate the physically relevant signals from the many artificial ones. Herein we demonstrate a procedure of filtering in the Fourier space, by which the clean light curve component due to eclipses can be separated from the pulsation one and the significant frequencies can be identified. Furthermore, using these frequencies, our dynamical eclipse mapping method to reconstruct the pulsation modes is applied and some results and problems connected with this technique are discussed.

43 - Ocando, S., Martín-Ruiz, S., Rodríguez E.

Delta Scuti and Gamma Doradus Variables in Open Clusters.

Variable stars in open clusters are an important tool to test stellar structure and evolution models because parameters such as distance, age, reddening and initial chemical abundance can be assumed to be the same for all the stars in the cluster and can be known accurately.
In this work we performed an extensive literature research of the current knowledge of Delta Scuti and Gamma Doradus variables in open clusters aiming to search for possible correlations between the pulsational properties of the variables and the physical parameters of the host clusters.

44 - P. De Cat, D.J. Wright, K.R. Pollard, F. Maisonneuve, P. Kilmartin, D. Laneye

Spectral disentangling and pulsational analysis of the double-lined binary HD147787

HD 147787 (HIP 80645, iota Tra; SpT F4IV; V = 5.3 mag) is a double-lined spectroscopic binary with a poorly known eccentric orbit of about 40 days for which one asymmetric profile was observed for the primary by De Cat et al. (2006, A&A 449, 281). Both components are slow rotators (vsini ~ 8 and 25 km/s for the primary and secondary component, respectively). HD 147787 is listed as a candidate gamma Doradus star because two g-mode type pulsation periods were observed in photometry (Aerts et al., 1998, A&A, 337, 790). This object was selected as one of the targets for a spectroscopic multi-site campaign with observations in 2007 and 2008 from three southern sites covering all longitudes: Mount John University Observatory (HERCULES; Mount John, New Zealand), South African Astronomical Observatory (GIRAFFE; Sutherland, South Africa) and the European Southern Observatory (HARPS; La Silla, Chile). In this poster, we present the results of spectral disentangling and of the subsequent pulsational analysis of both components.

45 - P. Lenz, W. Dziembowski, A. A. Pamyatnykh

KIC 9700322 revisited: Testing the binary star hypothesis

For the Kepler Delta Scuti star KIC 9700322 rotational brightness variation and amplitude modulation of the two dominant pulsation modes was observed. We examine whether these features can be caused by tidally induced distortion in a detached non-eclipsing binary system. Our results indicate that this hypothesis is unlikely in the case of KIC 9700322.

46 - P. Moskalik, R. Smolec, K. Kolenberg, J. Nemec, A. Kunder, M. Chadid, G. Kopacki, R. Szabo + WG13 + selected KASC/Kepler Team

Discovery of Peculiar Double-Mode Pulsations and Period Doubling in Kepler c-type RR Lyrae stars

We present an analysis of the Kepler photometry of first overtone RR Lyrae-type stars (RRc stars). Only four RRc variables are known in the Kepler field, and all of them display remarkably similar frequency spectra. In each case we detect a higher-frequency low-amplitude secondary mode. The period ratio of the secondary and of the primary (radial) modes, P2/P1, falls in a narrow range of 0.614-0.632. Such a period ratio cannot be explained in terms of two radial pulsations. We

briefly summarize the occurrence of this peculiar period ratio in other RR Lyrae-type stars and classical Cepheids and argue for the existence of a new class of double mode variables.
In addition to the secondary frequency f2, we also detect its subharmonics (half-integer frequencies) at ~ 1/2 f2 and ~ 3/2 f2. The presence of subharmonics is a characteristic signature of a period-doubling of the secondary oscillation. While the primary radial mode has almost constant amplitude, the amplitudes of the secondary mode and its subharmonics display very large, irregular variations with a time scale of several days.

47 - P. A. Bradley, J.A. Guzik, and L.F. Miles

Analysis of Gamma Doradus and Delta Scuti Stars from the KEPLER Satellite

The KEPLER satellite observed over 100 faint stars that were part of our guest observer proposals in quarter 6 and 7 in 2010. There were over 100 stars selected with the following criteria. First, they were in or near the instability strips (8300 K > Teff > 6200 K and 3.6 < log g < 4.7). The KEPLER magnitude was < 16 and the contamination factor was < 10-3. None of these stars had been looked at for pulsations before. The goal was to extend the search for “hybrid” delta Scuti-gamma Doradus pulsators to fainter magnitudes. So far, many of these stars were non-variable (to the noise level), but there are twelve Gamma Doradus candidates, 2 delta Scuti candidates, one eclipsing binary, and several stars with light variations consistent with spots or rotation. We will present results of our pulsation analysis of these stars and which (if any) of these stars are also “hybrid” delta Scuti-gamma Doradus pulsators. These observations show that the KEPLER satellite is able to detect pulsations in stars of 14th and 15th magnitude. We will comment on how capable KEPLER is at detecting low amplitude pulsations and “hybrid” stars

48 - P. R. Wood, D. Kamath, H. Van Winckel, E. van Aarle

Variability properties of Magellanic Cloud post-AGB candidates

Post-AGB candidates have been selected in the SMC and LMC using data from the Spitzer Space Telescope surveys SAGE and SAGE-SMC. The main criterion for a post-AGB star is that it should have a mid-infrared excess. Spectra have been obtained for more than two thousand post-AGB candidates. The variability properties of these candidates as obtained from the MACHO and OGLE surveys are discussed. Among the variable types seen are RV Tauris stars, Be stars, AGB stars and stars with long-term trends in magnitude.

49 - Pierre Kervella, Antoine Mérand, Denis Mourard, Nicolas Nardetto

High accuracy interferometric radii of asteroseismic targets: a powerful constraint for stellar models

Long baseline interferometry at optical and infrared wavelengths now provides angular diameter measurements of nearby stars with sub-percent accuracy, creating a novel and powerful constraint for stellar models. Combining such measurements with accurate parallaxes from Hipparcos, we measured the linear radius of a number of nearby stars with available asteroseismic frequencies: HD 49933, Procyon, Alpha Cen A & B, Eta Ser, Epsilon Oph,… The radius is a strong constraint for evolutionary stellar models, particularly as a complement to asteroseismic frequencies. I will present examples of recent interferometric measurements, and the resulting stellar models constrained with spectrophotometry, linear radius, and asteroseismic frequencies.

50 - Pierre-Olivier Quirion & Jean Dupuis

Multicolour Photometry; Mixing FUSE Observations with Data from the CFHT

The potential for sdB multicolour photometry to do mode identification has been demonstrated in Randall et al. (2005), and it has been applied successfully in visible light to Balloon 090100001. We are developing tools to extend the multicolour identification technique to ultra-violet observations and especially to data obtained by the FUSE satellite. Here, we identify the angular order of the main pulsating modes in FEIGE 48 by combining optical and UV observations.

51 - R. Samadi, K. Belkacem, M.J- Goupil, H.-G. Ludwig, E. Caffau, F. Baudi, C. Barban

Amplitudes of solar-like oscillations in red giants

Solar-like oscillations are now detected by CoRoT and kepler in numerous red giant stars. The quality of the present data permit to accurately measure their amplitudes. We present here a comparison between observed and theoretical mode amplitudes. We find that the theoretical amplitudes under-estimate systematicaly the observations.

This discrepancy is shown to be related to the adiabatic treatment of the oscillations.

52 - S.Joshi, Y. C. Joshi, B. Kumar, L.A. Balona

Search for Photometric Pulsational Variability in Open Star Cluster NGC6866

The variable stars, particularly pulsating one are the kind of objects for which the quantitative measurements of the internal structure parameters have been derived from their variable nature. A survey project to search for the photometric variability in young and intermediate age open star cluster, is being run at ARIES Nainital. Under this survey, we have detected photometric variability in 32 stars of open cluster NGC6866. Out of these 32 variables, 15 stars are classified as pulsating variables which are important objects for the further asteroseismic study. In order to study the physical properties of the programme cluster, UBV RI photometry of the cluster on a good photometric is also carried out. The physical parameters of the cluster are derived from these observational data.

53 - S. Martin-Ruiz, L. Fox Machado, L. Parrao, M. Alvarez, F. Aceituno, A. Sota, V. Casanova, V. Costa, E. Rodríguez, M. Fernández, et al.

Is V994 Herculis really a quadruple system of two eclipsing binaries?

We present a large set of Stromgren photometric measurements collected between the years 2006 and 2008 with the aim of discovering the true nature of the V994 Herculis. In agreement with Lee et al. 2008, this object is a multiple system binary composed of the two pairs of double-lined detached eclipsing binaries. Both systems have the orbital periods around 2.083 d and 1.420 d and the their components are very similar in temperatures with B-A spectral types. In addition to the light minima corresponding to the two systems, Other eclipses of the 0.02 and 0.03 magnitudes of depth in the Stromgren v-filter have been detected. Thanks to the high precision of these observations, we have discovered the existence of two new components in this very complex quadruple system. Also in this study, we have determined the orbital parameters of the known both systems using the uvby photometry and new high resolution spectra.

54 - S. Prins, G. Raskin, H. Van Winckel, J. Perez Padilla,W. Pessemier, J. Morren,F. Merges, R.H. Ostensen, J. Vandersteen,C. Aerts

MAIA, a fast Three-Channel Imager for Asteroseismology

MAIA – Mercator Advanced Imager for Asteroseismology – is a photometric instrument currently being built for the 1.2-meter Mercator Telescope (La Palma, Spain), that focuses on asteroseismological studies of hot subdwarf stars.
In order to achieve the required precision on the pulsation amplitude ratios, the photometric variations must be sampled simultaneously in multiple wavelengths bands and at high speed.
MAIA will observe a large field (9.4 x 14 arcmin) simultaneously in three colour bands, approximately corresponding to the SDSS u, g, r+i photometric bands. Large frame-transfer CCDs originally designed for ESA's canceled Eddington space mission are used in order to reduce the dead-time due to readout and to guarantee sufficient numbers of reference objects in the same field of view as the science target. ESA (European Space Agency) made these detectors available to the Instituut voor Sterrenkunde, Katholieke Universiteit Leuven (Belgium) by means of a loan agreement on the condition that the devices be used for science related to asteroseismology.

55 - S. Théado & S. Vauclair

Iron accumulation, thermohaline convection and stellar oscillations.

Iron accumulations induced by radiative diffusion are often invoked in A and B type stars to recouncile seismic observations with theoretical frequency spectra deduced from stellar models. In all the computations done up to now in this context the question of the stability of the iron accumulation profiles introduced in the models is not adressed. However iron rich regions overlying metal poor layers may lead to an unstable mu-stratification in the star (with dln mu/dr > 0), this situation is unstable against a double diffusive instability : the thermohaline convection. This process results in a partial mixing of the stellar material which proceeds until a stable situation is restored. In this poster, we study the effects of such a process on iron accumulations occuring in the oscillation driving region and we discuss its consequences for the stellar oscillations.

56 - Sachkov M.

Long term spectroscopic study of pulsations in the roAp star gamma Equ

Nineteen time series of high-resolution, high S/N and high time resolution spectra were obtained in the period from 2003 to 2010 with the NES spectrograph of the SAO-RAS 6 m telescope.
RV data have allowed to identify 14 frequencies including the new frequency f3=1.364954 mHz that is very close to the known frequencies f1=1.364594 mHz and f2 =1.365411 mHz. Observed amplitude modulation in Equ and, possibly, in some other slowly rotating roAp stars can be explained by the existence of such closely spaced frequencies.

57 - Shashi Kanbur, Lucas Macri, Chow Ngeow, Mike Smitka, Frank Ripple

Near Infrared Observations of Cepheids in the Large Magellanic Cloud

We have carried out a multiyear campaign of near infrared JHK observations of Cepheids in the Large Magellanic Cloud. Two of our main goals were to definitively characterize the Cepheid PL relation at these wavelengths and test these relations for linearity/nonlinearity.
Our dataset comprises observations of nearly 1000 OGLE II Cepheids using the CTIO 1.5m telescope and the CPAPIR camera. Here we present preliminary results: light curves, period-luminosity and period-color relations and color-magnitude diagrams. This dataset should be invaluable in understanding the Cepheid PL relation at these wavelengths and in constraining theoretical models.

58 - Siobahn Morgan

Cepheid Instability Strip "First-time Crossers"

Recently there was a proposal that Polaris was a first-time crosser of the Cepheid Instability Strip – on its way to ascending the Red Giant Branch. In addition to Polaris, several other stars have also been proposed as "first-time crossers", based upon features such as a rapid change in pulsation period, as well as observed or derived physical characteristics. Extensive grids of linear non-adiabatic pulsation models have been produced and compared to the observational data and evolutionary models to help resolve this issue. Possible "first-time crossers" are also identified in various large scale surveys, which are currently available on-line.

59 - Smolec, R., Houdek, G., Gough, D.O.

Nonlocal model for the turbulent fluxes due to thermal convection in rectilinear shearing flow

We revisit a phenomenological description of turbulent thermal convection along the lines proposed originally by Gough (1965, 1977) in which eddies grow solely by extracting potential energy from the unstably stratified mean state and are subsequently destroyed by internal shear instability. This work is part of an ongoing investigation for finding a procedure to calculate the turbulent fluxes of heat and momentum in the presence of a shearing background flow in stars. In order to test and calibrate the formalism it is prudent first to compare its predictions with existing results from what we hope are more reliable investigations, such as experiments or numerical simulations. Here we compare the functional forms of the mean temperature profile and the distortion of an imposed horizontal shearing flow that is induced by the Reynolds stress implied by our theory with that of direct numerical simulations of Rayleigh-Benard convection in air. In this contribution we present our latest results from a nonlocal generalization of our earlier local model (Smolec, Houdek & Gough 2011).

60 - Steven Reyner, Shashi Kanbur, Choong Ngeow

The approximation of RR Lyrae and eclipsing binary light curves using cubic polynomials

We describe the method of cubic polynomials in approximating the light curves of RR Lyrae stars and eclipsing binaries. We describe some advnatges of this method over existing techniques and apply the method to HST RR LYrae data in the halo of M31. We show that this method eliminates virtually all ringing effects and, at least for RRc stars, all the parameters of the fit can be related to pulsation physics. We find a number of additional periodicities not found in the data previously: we report 23 RRc stars, 29 RRab stars and 3 multiperiodic stars. We also discuss the use of this method to detect eclipsing binaries.

61 - Szewczuk W., Walczak P., Daszynska-Daszkiewicz J.

Constraints on model atmospheres from complex asteroseismology of the β Cephei stars

There are several factors which determine theoretical values of the photometric amplitudes and phases of pulsating stars. Besides the mode geometry, these are inputs from theory of stellar pulsation and atmospheres. Therefore application

of these observables goes beyond mode identification.
Using the method termed complex asteroseismology we derive constraints on model atmospheres, in particular on the NLTE effects. This kind of seismic modelling consists in fitting simultaneously pulsational frequencies and the corresponding values of the nonadiabatic complex parameter f. To this end, we choose four β Cephei variables for which the most extensive observational data have been gathered up to now, i.e., θ Oph, ν Eri, γ Peg and 12 Lac. We rely on the Kurucz LTE models and the BSTAR2006 NLTE models.

62 - Szewczuk, W., Walczak, P., Daszynska-Daszkiewicz, J.

Studying the hybrid pulsator 12 Lacertae: extended mode identification and complex seismic modelling

12 Lacertae is one of the most studied early B-type pulsator of the last years. Frequency analysis of observations from dedicated photometric and spectroscopic campaigns allowed to confirmed already known frequency peaks and to detect new ones (Handler et al. 2006, MNRAS, 365, 327; Desmet et al. 2009, MNRAS, 396, 1460). As a result, currently we know that at least ten pulsational frequencies of the beta Cep type and one of the SPB type are excited in 12 Lac.
We present an extended identification of the mode degree, l, for all observed frequencies and complex seismic modelling of 12 Lac. Because the star rotates with a significant velocity of about 50 km/s, we consider rotational mode coupling for close p-mode frequencies and, in the case of high order g-mode, we apply the traditional approximation appropriate for slow modes. Seismic models of 12 Lac were constructed by fitting simultaneously centroid mode frequencies and corresponding values of the nonadiabatic parameter f. This approach is called complex asteorseismology and yields vastly more constraints on parameters of model and theory. Here, we take into account effects of chemical composition, opacities and non-LTE atmospheres.

63 - Ulusoy,C. and Engelbrecht C.A

“New studies of a variety of Southern pulsating B stars“

We present preliminary results of multi-colour photometry of pulsating B stars observed in the Large Magellanic Cloud (LMC). Tentative identifications of pulsation modes have been made, and a number of new B pulsators have been noted.

We also present preliminary results of multi-colour photometry of B-type pulsating stars in the Southern open cluster NGC 6200 that were previously identified in the All Sky Automated Survey-3 database (ASAS-3). Extensive UBVI data have been obtained for these stars using the 1.0-m and 0.75-m telescopes at SAAO in South Africa. An intriguing range of pulsation frequencies have been identified, some of which suggest rotational splitting. Interesting features have also been discovered in the light curves of some of these stars. These discoveries are expected to throw further light on the rotational behaviour and interior structure of B type stars.

64 - Vicente Maestro, Daniel Huber, Peter Tuthill, Michael Ireland

Interferometric observations of rapid rotators

The PAVO instrument located at CHARA array is known as the instrument with the highest intrinsic spatial resolution. PAVO observations on a sample of selected targets suitable for PAVO capabilities (with angular sizes < 1 miliarcsec) will enable us to create images of rapid rotators in an unprecedented detail.
We present the first results of our study. Simple models including some basic assumptions on the shape and symmetry of some observed stars have been fitted, constraining the values of some of the physical parameters of these stars.

65 - Zsófia Bognár, Margit Paparó

Investigation of rotational splitting in the pulsating white dwarf GD 154

We observed the ZZ Ceti star GD 154 over a whole season on a time base of six months at the mountain station of Konkoly Observatory. We confirmed the frequencies obtained in the previous analyses (Robinson et al. 1978, Pfeiffer et al. 1996, Hürkal et al. 2005) and also found additional frequencies. Our long time base allowed to detect the sign of rotational triplets around the independently excited modes. However, the single site dataset does not allow us to adequately resolve these triplets by standard Fourier analysis. Adopting the method of Handler et al. (1997) we searched for characteristic spacing values performing Fourier analysis of numerous peaks determined around five frequencies in the main pulsation region. The analysis revealed regular peak spacings with separations of 3.7 and 2.4 microHz. These values are in accordance with the 2.5 and 3.9 microHz spacings determined by consecutive prewhitening of the Whole Earth Telescope observations.

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VENUE ZONE MAP