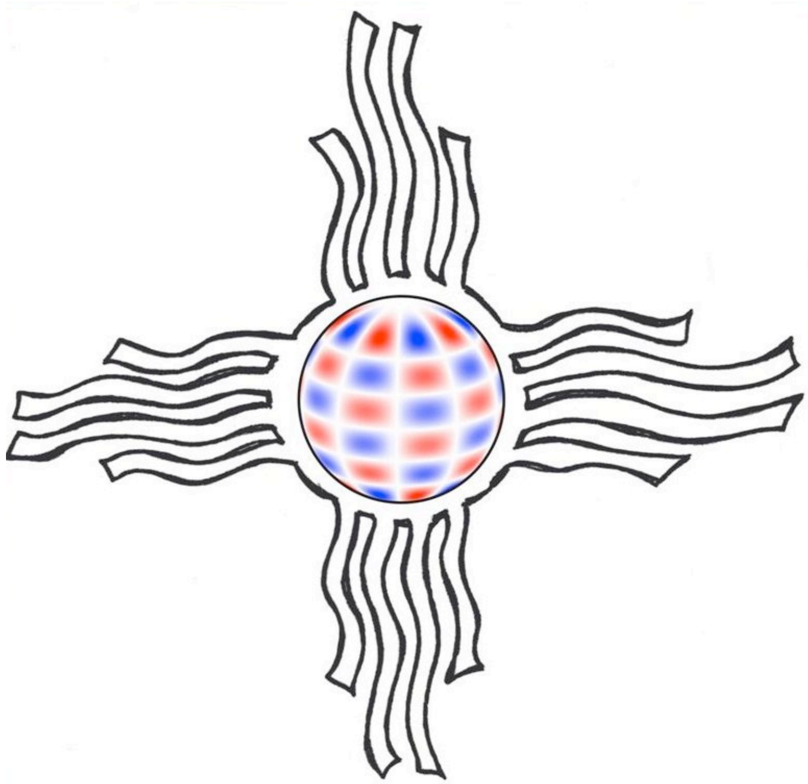
Stellar Pulsation:
Challenges for Theory and Observation



Santa Fe, New Mexico, USA
May 31 – June 5, 2009

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La Fonda on the Plaza

Local Information

La Fonda on the Plaza
100 E. San Francisco St.
Santa Fe, NM 87501
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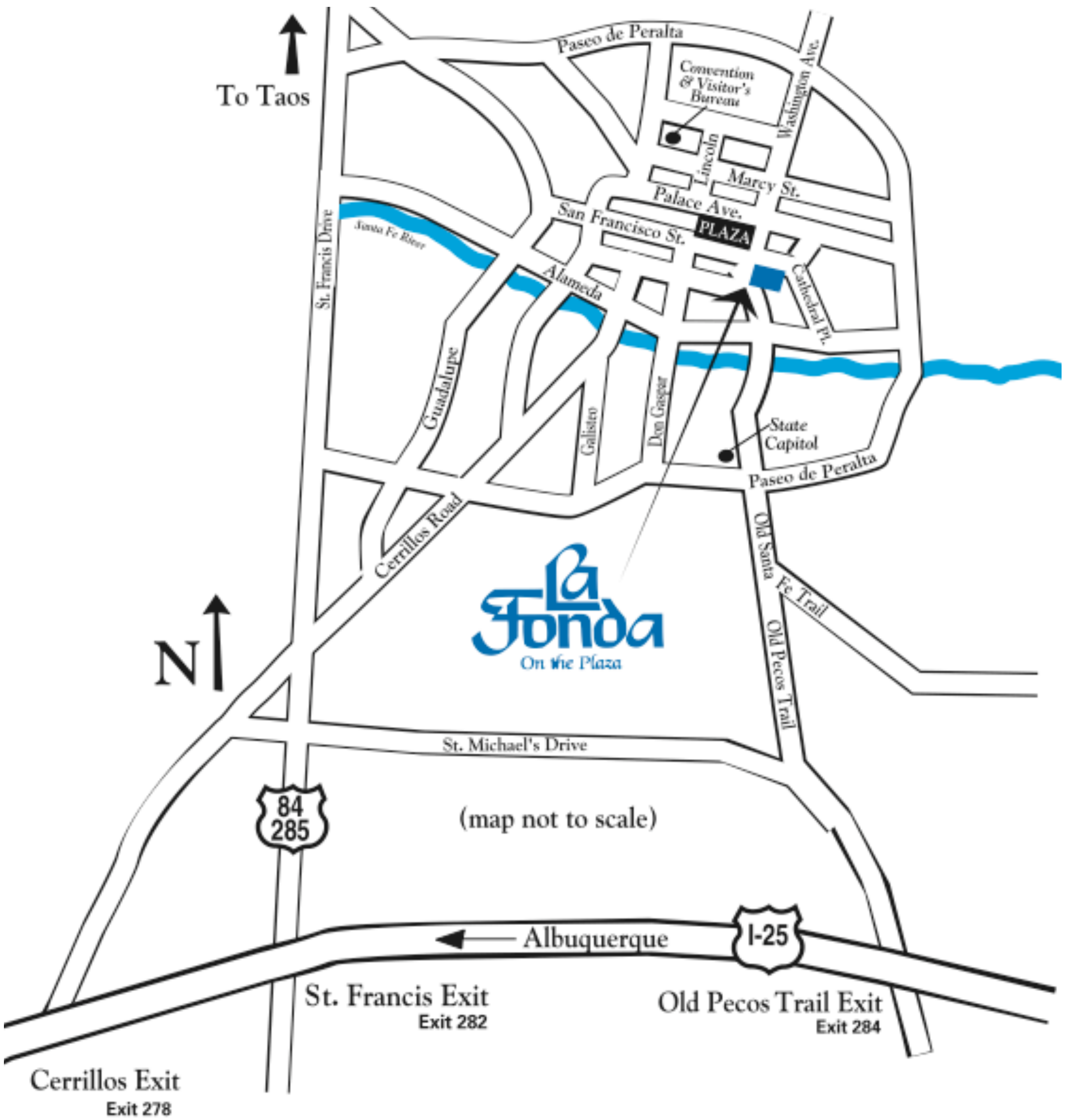
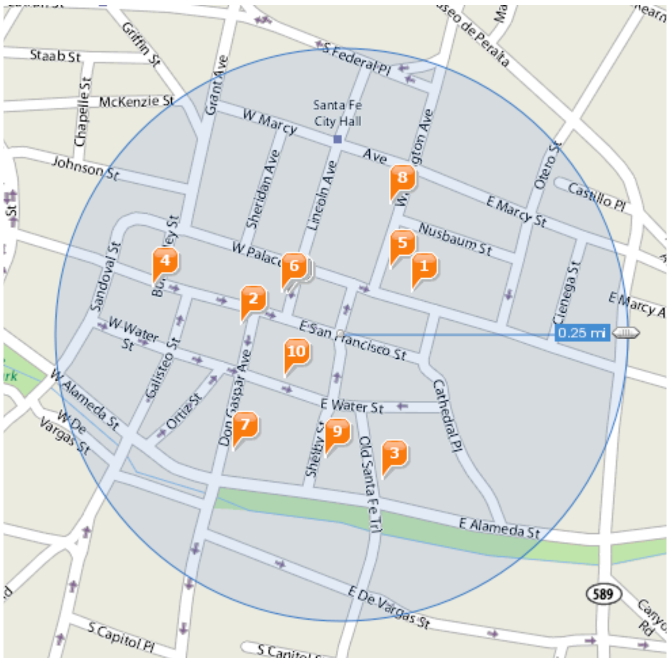


Restaurants within 0.25 miles of La Fonda



1 [The Shed](sfshed.com) — (63) — 0.07 mi
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8 Bull Ring — (13) — 0.12 mi
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150 Washington Ave, #108, Santa Fe, NM
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10 Blue Corn Cafe & Brewery — (6) — 0.06 mi
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Stellar Pulsation Meeting Program

Sunday, May 31

16:00–18:00 Put up posters
18:00–20:00 Reception and Registration (La Terraza at the La Fonda Hotel)

Monday, June 1

8:00–8:45 Put up posters
8:45–9:00 Welcome

Session I. Cepheids and the Distance Scale, Chair: Wolfgang Gieren

9:00–9:30 Thomas Barnes, Cepheid Distance Scale (Invited)

9:30–9:45 Wolfgang Gieren, A direct distance to the LMC from Cepheid variables

9:45–10:00 Giuseppe Bono, The Cepheid period-luminosity relation and the extragalactic distance scale

10:00–10:15 Lucas Macri, The SH0ES project: HST observations of Cepheids in NGC 4258 and type Ia SN hosts and implications for the Hubble Constant

10:15–10:45 Coffee break and poster viewing

10:45–11:00 Nicolas Nardetto, From the dynamics of Cepheids to the Milky Way rotation, and the distance scale calibration

11:00–11:15 Shashi Kanbur, Multiphase PC/PL relations: Comparison between theory and observations

Session II. Cepheid Theory and Observations, Chair: John Keady

11:15–11:45 J. Robert Buchler, Cepheid Pulsation Theory (Invited)

11:45–12:00 Victoria Scowcroft, The effect of metallicity on Cepheid magnitudes and the distance to M33

12:00–13:15 Lunch

13:15-13:45 David Turner, Polaris and its Kin (Invited)

13:45-14:00 Nancy Evans, Fundamental parameters of Cepheids: Masses and multiplicity

14:00-14:15 Radek Smolec, On resonant and non-resonant origin of double-mode Cepheid pulsation

14:15-14:30 Antoine Merand, What we learned from interferometric observations of Cepheids

14:30-14:45 Igor Soszynski, OGLE Data (short invited talk)

14:45-15:00 Edward Schmidt, Mining sky surveys for astrophysically interesting variable stars: The Cepheid period range

15:00-15:30 Coffee break and poster viewing

Session III. Red Giants and Supergiants, Chair: Peter Wood

15:30-16:00 Lee Anne Willson, Red Giant and Supergiant Pulsations (Invited)

16:00-16:15 Christine Nicholls, New results on long secondary periods in red giants

16:15-16:30 Saskia Hekker, Red giants observed with CoRoT

16:30-16:45 Michelle Creech-Eakman, Multiwavelength study of pulsation and dust production in Mira variables using optical interferometry for constraints

16:45-17:00 Hilding R. Neilson, The connection between pulsation, mass loss, and circumstellar shells in classical Cepheids

Tuesday, June 2

Session IV. RR Lyrae Variables in Stellar Systems, Chair: Steve Becker

9:00-9:30 Horace Smith, RR Lyrae Variables in Stellar Systems (Invited)

9:30-9:45 James Nemec, The variable stars in the LMC star cluster NGC 2257

9:45-10:00 George Wallerstein, Carbon-rich RR Lyrae stars

Session V. RR Lyrae Pulsation Theory and Observations, Chair: Giuseppe Bono

10:00–10:30 Marcella Marconi, RR Lyrae Pulsation Theory (Invited)

10:30–12:00 Coffee break and poster viewing

12:00–13:00 Lunch

13:00–13:15 Annie Baglin, Seismic Landscape as Seen from CoRoT (short invited talk)

13:15–13:30 Merieme Chadid, First RR Lyrae light curve from CoRoT: Big challenge and constraint to the theoretical models

13:30–13:45 Margit Paparo, Shock wave and pulsation connection in a monoperiodic CoRoT RR Lyrae star

13:45–14:00 Istvan Dekany, Physical properties of double-mode RR Lyrae stars based on pulsation and evolution models

14:00–14:30 Coffee break and conference photo

Session VI. The Blazhko Effect, Chair: Merieme Chadid

14:30–15:00 Geza Kovacs, The Blazhko Effect (invited)

15:00–15:15 Johanna Jurcsik, New results of the Konkoly Blazhko group

15:15–15:30 Arthur N. Cox, Radial and nonradial beating modes for RR Lyrae variable star Blazhko effects

15:30–15:45 Short stretching break

15:45–16:00 Katrien Kolenberg, Observational constraints on the magnetic field of RR Lyrae stars

16:00–16:15 Adam Sodor, Changes in mean global physical parameters of Blazhko variables derived from multicolour photometry

16:15–17:00 Additional poster viewing time

Wednesday, June 3

Session VII. B Star Pulsations, Chair: Wojciech Dziembowksi

9:00-9:30 Arthur N. Cox, LBV and Wolf Rayet Variables (invited)

9:30-10:00 Luis Balona: Beta Cephei, SPB, and Be Variables (Invited)

10:00-10:15 A. Pigulski, Beta Cephei Stars from the ASAS: A New Look at Hot Pulsators (short invited talk)

10:15-10:45 Coffee break and poster viewing

10:45-11:00 Richard Townsend, Toward self-consistent angular momentum transport in pulsating massive stars

11:00-11:15 Catherine Lovekin, Rotation and overshoot in the beta Cephei star theta Ophiuchi

11:15-11:30 Robert Deupree, Rotational splitting of pulsation modes in rapidly rotating stars

Session VIII. Solar-Type Variable Stars, Chair: J. Molenda-Zakowicz

11:30-12:00 Günter Houdek, Solar-type Variable Stars (invited)

12:00-12:15 Andrea Miglio, Inference from adiabatic analysis of solar-like oscillations in red giants

12:15-13:30 Lunch

13:30 Tour of Los Alamos, free afternoon

Thursday, June 4

Session IX. Delta Scuti Stars, Chair: Michel Breger

9:00-9:30 Gerald Handler, delta Scuti Variables (Invited)

9:30-9:45 Michel Breger, Period variations in delta Scuti stars

9:45-10:05 D.H. McNamara, Interesting properties of delta Scuti stars

10:05–10:20 Arti Garg, HADS in the LMC: Initial findings from the SuperMACHO project

10:20–10:35 Ennio Poretti, The CoRoT era: a new look to delta Sct stars from space

10:35–12:00 Coffee break and poster viewing

12:00–13:00 Lunch

Session X. Solar Oscillations Part 1, Chair: J. Christensen–Dalsgaard

13:00–13:30 Alexander Kosovichev, Solar Oscillations (Invited)

13:30–13:45 Rafael Garcia, SOHO Data (short invited talk)

13:45–14:00 Irina Kitiashvili, Realistic MHD numerical simulations of solar convection and oscillations in magnetic regions

Session XI. Gamma Doradus Variables, Chair: J. Matthews

14:00–14:30 Karen Pollard, Gamma Doradus Variables (Invited)

14:30–14:45 Duncan Wright, Results from classification observations and a multi–site campaign on gamma Doradus and SPB type stars

14:45–15:15 Coffee break and poster viewing

Session XII. Rapidly Oscillating Ap and Chemically–Peculiar stars, Chair: H. Shibahashi

15:15–15:30 Jaymie Matthews, MOST Data (short invited talk)

15:30–16:00 Don Kurtz, Pulsation in Chemically Peculiar Stars of the Upper Main Sequence (Invited)

16:00–16:15 Hiromoto Shibahashi, Numerical simulations of line profile variation in roAp stars

16:15–16:30 Hideyuki Saio, Modelling pulsations of the roAp star HR 1217 (HD 24712)

18:00 Banquet at La Fonda Hotel Guest speaker Robert Christy and also featuring Mozart clarinet quintet performed by Bob Chrien, Jim Knudson, Alice Mutschlechner, Rachel Hixson, and Carol Nielson

Robert Christy Biography

Robert F. Christy (born 1916) is an American theoretical physicist and later astrophysicist who worked on the Manhattan Project. He is a Professor Emeritus at Caltech.

Christy was born in Vancouver, British Columbia and attended the University of British Columbia in the 1930s, where he studied mathematics and physics. He then entered the PhD program at UC Berkeley under Robert Oppenheimer where he found himself in the middle of the most active program in nuclear and theoretical physics. He obtained his PhD in 1941 and after a few months at the Illinois Institute of Technology he joined the Manhattan Project at the University of Chicago working on the first chain reaction. He then joined the joined the project at Los Alamos in the spring of 1943 and worked on the first implosion bomb.

After a few months at the University of Chicago he joined the faculty at Caltech in 1946 and remained there until retirement in 1986. Christy was awarded the Eddington Medal of the Royal Astronomical Society in 1967. In 1968 he became Provost and then Acting President.

He worked in cosmic rays, elementary particles, nuclear physics, and astrophysics.

Friday, June 5

Session XIII. Solar Oscillations Part II, Chair: J. Christensen-Dalsgaard

9:00-9:15 Joanna Molenda-Zakowicz, Spectroscopic and photometric observations for Kepler asteroseismic targets

9:15-9:30 Travis Metcalfe, An asteroseismic model-fitting pipeline for solar-like oscillations

9:30-9:45 Joyce Ann Guzik, Early solar mass loss, opacity uncertainties, and the solar abundance problem

Session XIV. SDB, White Dwarf, and Post AGB Stars, Chair: Paul Bradley

9:45-10:15 Stephane Charpinet, Subdwarf B Stars Pulsations (Invited)

10:15-10:45 Coffee break and poster viewing

10:45-11:00 Bruce Hrivnak, Pulsational light and velocity variability in post-AGB stars

11:00-11:30 Mike Montgomery, White Dwarf and Pre-White Dwarf Pulsations (Invited)

11:30-11:45 Barbara Castanheira, Seismological studies of ZZ Ceti stars

11:45-12:30 Poster viewing

12:30-13:30 Lunch

13:30-13:45 Agnes Kim, Asteroseismological analysis of rich pulsating white dwarfs

13:45-14:00 Ann Marie Cody, Pulsation powered by deuterium burning in brown dwarfs and low-mass stars

14:00-14:15 Stephane Mathis, Magneto-gravito-inertial waves in strongly stratified stellar radiation zones

14:15-14:30 Zsofia Bognar, Light curve patterns and seismology of a white dwarf with complex pulsation

14:30-14:45 Giuliana Fiorentino, The ancient population of Messier 32

14:45-15:00 Short stretching break

15:00-16:00 Wrap-up, closing remarks, thanks, next pulsation meeting, proceedings directions

17:00 Bus departs for Albuquerque Grand Hotel near airport

Cepheid Distance Scale

Thomas Barnes
National Science Foundation and University of Texas at Austin

This review will examine progress on the Pop I Cepheid distance scale with particular emphasis on recent developments in techniques for Cepheid distance determination. Specifically I will examine the surface brightness method, interferometric determinations, and trigonometric measurements. The role of the velocity p-factor in the first two of these methods will be discussed.

NOTES:

A Direct Distance to the LMC from Cepheid Variables

Wolfgang Gieren[1], Jesper Storm, Pascal Fouque, Grzegorz Pietrzynski,
Nicolas Nardetto, Tom Barnes, and Igor Soszynski
[1]Departamento de Astronomia, Universidad de Concepcion, Chile

We use the infrared surface brightness technique and fresh radial velocity and photometric data for 35 Cepheids in the LMC to calibrate the relation between the p factor and pulsation period, and derive a consistent set of individual distances to these Cepheids. The resulting period-luminosity relations in the LMC are consistent with the corresponding Milky Way relations in their slopes, arguing for no metallicity effect on the slopes of Cepheid PL relations. We obtain a new determination of the LMC distance modulus from our technique which has lower error bars than previous determinations from this method.

NOTES:

The Cepheid Period-Luminosity Relation and the Extragalactic Distance Scale

Giuseppe Bono
Department of Physics, University of Rome Tor Vergata

We plan to perform a detailed comparison between theory and observations to constrain the impact of the metal content on optical PL relations. In particular, we adopt Cepheids in systems with distance estimates based either on geometrical methods (maser emission: NGC4258, M33) or accurate standard candles (Magellanic Clouds, M31), together with extragalactic Cepheids measured by the HST Key projects. Finally, we discuss pros and cons of the Period-Wesenheit relations to estimate extragalactic distances.

NOTES:

The SH0ES Project: HST Observations of Cepheids in NGC 4258 and Type Ia SN Hosts and Implications for the Hubble Constant

Lucas Macri[1], Adam Riess[2], and the SH0ES team
[1]Texas A&M University, [2] Johns Hopkins University/STScI

NGC 4258 plays a crucial role in the Extragalactic Distance Scale because it is the only nearby galaxy with a very accurate and precise distance measurement (3% total uncertainty). I will present results from recent HST observations of Cepheids in this galaxy, obtained as part of the SH0ES project. By combining ACS and WFPC2 observations from Cycles 12, 13 and 15, we have been able to discover long-period Cepheids (up to P~100 d) and obtain better constraints on blending/crowding issues affecting the original photometry. Additionally, we have obtained a more accurate measurement of the abundance gradient across the disk of this galaxy, with implications for the metallicity effect of the Cepheid P-L relation.

I will also discuss the strategy of the SH0ES project to characterize the properties of Cepheids in NGC 4258 and hosts of "ideal" type Ia SNe, with the ultimate aim of estimating the Hubble constant with a total uncertainty below 5%.

NOTES:

From the Dynamics of Cepheids to the Milky Way Rotation, and the Distance Scale Calibration

N. Nardetto[1], P. Kervella, T. Barnes, D. Bersier, A. Fokin, P. Fouqué, W. Gieren, D. Gillet, J. Groh, S. Kraus, P. Mathias, A. Mérand, F. Millour, D. Mourard, and A. Stoekl

[1]Departamento de Astronomia, Universidad de Concepcion

High precision spectroscopic measurements of 10 southern Galactic Cepheids with HARPS allowed us to analyse in details the dynamical structure of their atmosphere and close environment. Our results have consequences on the distance scale calibration, and show that the rotation of the Milky Way is probably simpler than previously thought. However, the full understanding of spectral line asymmetries still require the development of dedicated models.

NOTES:

Multiphase PC/PL Relations: Comparison Between Theory and Observations

S. Kanbur[1], M. Marconi, C. Ngeow, I. Musella, M. Turner, S. Magin, J. Halsey, and C. Bissel
[1]Departments of Physics and Earth Sciences, SUNY Oswego

Cepheids are fundamental objects astrophysically in that they hold the key to a CMB estimate of Hubble's constant. A number of researchers have pointed out the possibilities of breaking degeneracies between Ω_{Matter} and H_0 if there is a CMB independent distance scale accurate to a few percent. Current uncertainties in the distance scale are about 10% but future observations with, for example, the JWST, will be capable of estimating H_0 to within a few percent. A crucial step in this process is the Cepheid PL relation. Recent evidence has emerged that the PL relation, at least in optical bands, is nonlinear and that a neglect of such a nonlinearity can lead to errors in estimating H_0 up to 2 percent. Hence it is important to critically examine this possible nonlinearity both observationally and theoretically. Existing work on PC/PL relations relies exclusively on evaluating these relations at mean light. However, since such relations are the average of multiphase relations, here we report on recent attempts to compare theory and observations in the mulitphase PC/PL planes. We construct state of the art Cepheid pulsation models appropriate for the LMC/Galaxy and compare the resulting PC/PL relations as a function of pulsation phase with observations of LMC and Galactic Cepheids. For the LMC, the (V-I) period-color relation at minimum light can have quite a narrow dispersion (0.2-0.3 mags) and thus could be useful in placing strong constraints on models. At longer periods, the models predict significantly redder (about 0.2-0.3 mags) V-I colors. We discuss possible reasons for this and also compare PL relations at various phases of pulsation and find clear evidence in both theory and observations for a nonlinear PL relation.

NOTES:

Stellar Pulsation Theory

J. Robert Buchler
University of Florida

We present our views on the status of the modeling of Cepheid pulsations. In the spirit of the conference we concentrate on the current deficiencies and disagreements with observation. We discuss what, in our opinion, are the remaining great challenges for Cepheid modeling and how achievable their solution is.

NOTES:

The Effect of Metallicity on Cepheid Magnitudes and the Distance to M33

Victoria Scowcroft[1], David Bersier[1], Jeremy Mould[2], and Peter Wood[3]
[1]Astrophysics Research Institute, Liverpool John Moores University, UK, [2]School of Physics, University of Melbourne, Australia, [3]Research School of Astronomy & Astrophysics, Australian National University, Australia

We present the results from a multi-epoch survey of two regions of M33 using the 3.5m WIYN telescope. The inner field is located close to the centre of the galaxy, with the outer region situated about 5.1 kpc away in the southern spiral arm, allowing us to sample the two extremes of the metallicity range of M33. We have data for over 150 fundamental mode Cepheids in the two regions. The reddening-free Wesenheit magnitude period-luminosity relations were used to establish the distance modulus of each region, with μ_{inner} = 24.44±0.04 mag and μ_{outer} = 24.58±0.03 mag. The apparent discrepancy between these two results can be explained by the significant metallicity gradient of the galaxy. We determine a value for the metallicity parameter of the Period-Luminosity relation gamma = -0.27±0.1 mag dex-1, consistent with previous measurements. This leads to a metallicity corrected distance modulus to M33 of μ_{γ} = 24.53±0.12 mag.

NOTES:

Polaris and Its Kin

David G. Turner
Saint Mary's University, Canada

A review is presented of the past 165 years of observation of the 4-day Cepheid Polaris, including the exciting results of the last 50 years, an interval that has produced three orbital solutions for the spectroscopic binary subsystem, recently resolved by HST, parameters for the optical companion, precise measurement of the star's trigonometric parallax and angular diameter, evidence for a rapid increase in its pulsation period, and observations of the dramatic decline and recent partial recovery of its light amplitude. There has been considerable discussion about the exact nature of the star, with potential resolutions summarized here. It is also noted that many of the star's characteristics are shared by a small number of other Cepheids that display rapid period increases identical to those predicted for stars in the first crossing of the instability strip, small light amplitudes, and intrinsic colors typical of variables lying near the center of the strip, where Cepheids of largest amplitude reside. While all members of the group appear to display the canonical traits of first crossers of the instability strip, Polaris has one unique peculiarity: a brief hiatus in its monotonic period increment between 1963 and 1966 during which the pulsation period underwent a dramatic decrease. Has the average brightness of the Cepheid also been increasing over the years?

NOTES:

Fundamental Parameters of Cepheids: Masses and Multiplicity

Nancy Remage Evans
Harvard/Smithsonian Center for Astrophysics

Masses determined from classical Cepheids in binary systems are a primary test of both pulsation and evolutionary calculations. The first step is to determine the orbit from ground-based radial velocities. Complementary satellite data from Hubble, FUSE, IUE, and Chandra provide full information about the system. A summary of recent results on masses will be given. Cepheids have also provided copious information about the multiplicity of massive stars, as well as information about the distribution of mass ratios and separations. This is provides some important tests for star formation scenarios including differences between high and low mass results and differences between close and wide binaries. Funding for this work was provided by Chandra X-ray Center NASA Contract NAS8-39073.

NOTES:

On Resonant and Non-Resonant Origin of Double-Mode Cepheid Pulsation

Radoslaw Smolec and Pawel Moskalik
Nicolaus Copernicus Astronomical Center, Warsaw, Poland

Double-mode Cepheids yield important constraints on stellar parameters and evolutionary models. They also present a challenge to stellar pulsation theory, as we still do not fully understand why the vibrational instability leads in some, rather rare instances, to simultaneous excitation of two radial modes. In principle, such form of pulsation may either arise due to resonant excitation of a parasite mode or in a non-resonant way, that is, due to a specific modification of mean stellar structure by pulsation. The latter mechanism led to double-mode pulsation in models calculated over the past ten years with convective hydrocodes. However, as we argued (Smolec and Moskalik, 2008) the effect arose from unjustified neglect of negative buoyancy in radiative layers. There are two types of resonances occurring in the Cepheid parameter range that may lead to double-mode pulsation. One involving two modes with the frequency ratio close to 2:1 (the R2 resonance) and one involving three modes, with intermediate frequency close to the mean of remaining two (the R3 resonance). Our nonlinear modeling showed that in a narrow range of parameters, the R3 resonance may be responsible for the F/1O pulsation. Linear analysis shows that, both, R2 and R3 resonances occur in the short period range of the observed 1O/2O pulsators. By means of nonlinear modeling, we found that the instability is saturated in the form of the sustained 1O/2O pulsation. However, none of the resonances may explain the majority of the double-mode Cepheids. Thus, we must search for a new non-resonant mechanism.

NOTES:

What We Learned from Interferometric Observations of Cepheids

Antoine Merand[1], Pierre Kervella[2], and Alexandre Gallenne[1,2]
[1]European Southern Observatory, Chile, [2] Observatoire de Paris, France

The pulsation parallax method, or Baade-Wesselink method (BW), is a powerful way to measure distances to Cepheids in a pseudo-geometric way. In the quest for obtaining the most precise distance using long baseline interferometry (we reached 1.5%), we obtained two maybe not so unsuspected results. First of all, our studies show that we reached a point where the assumption that the pulsating photosphere can be approximated using static models is not valid in the context of the BW method. Secondly, we unveiled the systematic presence of Circum Stellar Envelopes (CSE) at a few stellar diameters scale, as a slight near-infrared excess, which could be an indication that mass loss is currently taking place. Not only these two results represent biases to the BW method, and deserve to be observationally studied, they also shed new lights on our knowledge of the Cepheids themselves and call for extensive modeling.

NOTES:

The OGLE-III Catalog of Variable Stars –
100k Pulsating Stars in the LMC

Igor Soszynski
Warsaw University Observatory, Poland

The Optical Gravitational Lensing Experiment during its third stage (OGLE-III) has collected massive photometric database of hundreds of millions of stars, mainly in the Magellanic Clouds and the bulge of the Milky Way. This huge dataset is the base of a new catalog of variable stars – the largest such catalog in the history of astronomy. Our presentation includes over 100 000 pulsating variables in the Large Magellanic Cloud: classical, type II and anomalous Cepheids, RR Lyrae stars, high amplitude δ Scuti stars and long period variables. We present some statistical features of these samples of pulsating stars and show particularly interesting individual objects.

NOTES:

Mining Sky Surveys for Astrophysically Interesting Variable Stars: The Cepheid Period Range

Edward G. Schmidt
University of Nebraska

The large area photometric sky surveys that have appeared in the last decade are revolutionizing variable star astronomy. The sheer number of newly identified variables runs into the many tens of thousands and the opportunities to find new, astrophysically interesting stars are vast. This is particularly important for studies of unusual types of variables or studies that require sizable samples of variables. However, to fully exploit this resource, careful follow-up studies are required. We have undertaken a program to identify new type II Cepheids in the Northern Sky Variability Survey and the northern portion of the All Sky Automated Survey. Nearly one thousand candidates have been selected so far and photometric and spectroscopic observations are well under way. In the course of this work a number of surprising and sometimes problematic issues have surfaced. A majority of the candidates are clearly not type II Cepheids although at least some they may be closely related to them; we propose that they may represent a new class of variable. We will discuss the wide variety of light curve forms found among these stars. The combination of the survey data with our observations suggests that long-term changes in amplitude, mean magnitude, period and light curve are common among variables in this period range. The effect of this in conjunction with the limitations of the survey data and the algorithms used to identify and classify variables will be discussed. In particular, we will consider the likelihood that many stars of interest have probably been missed in searching the surveys.

NOTES:

Miras and RV Tauri stars –
Or How Most Stars Die

Lee Anne Willson
Iowa State University

Miras are pulsating variables with periods ~ year and large visual amplitudes, stars near or at the tip of the AGB. They also have massive winds, typically 0.1 (1/L dL/dt) < (1/M dM/dt) < 10 (1/L dL/ dt). If we identify this range of mass loss rates with this class of variable stars, we recover the P-L relation that is observed. Thus, the selection criteria for Mira classification – large visual amplitude and relatively regular pulsation, late spectral type, giants – appear to select an interesting phase of stellar evolution. The RV Tauri variables are thought to be stars that have left the AGB, and are thus in a post-Mira stage. I will review the background and recent progress in understanding these two related classes of pulsating variable stars.

NOTES:

New Results on Long Secondary Periods in Red Giants

C. P. Nicholls[1], P. R. Wood, M.-R. Cioni, and I. Soszynski
[1]Australian National University

Approximately 30% of variable red giants have light curves which show a Long Secondary Period (LSP) in addition to their primary oscillation. No model has been proposed that can satisfactorily explain the LSPs. Here we present velocity curves obtained from VLT spectra for a large sample of LMC red giants exhibiting LSPs. We use the velocity data in addition to both MACHO and OGLE light curves to examine the properties of the stars, and to evaluate models for the cause of LSPs. Extant models generally involve either binarity or pulsation. We show that both of these have severe problems explaining the light and velocity variations. However, new mid-infrared observations of stars with LSPs indicate the presence of a significant amount of circumstellar dust, most likely in a disk-like configuration. This observation favours the presence of a binary companion.

NOTES:

Red Giants Observed with CoRoT

S. Hekker[1], J. De Ridder, F. Baudin, C. Barban, F. Carrier, A. P. Hatzes,
T. Kallinger, and W. W. Weiss
[1]Royal Observatory of Belgium and University of Birmingham, UK

Red giants have solar-like oscillations and these stars are therefore interesting for asteroseismology. All stars with low or intermediate masses go through a red giant phase and they are common and well distributed over the sky. Indeed, many red giants appear to be present in the fields observed by CoRoT. We selected red-giant candidates in the first and second long runs (~ 150 days) observed with the CoROT-eye dedicated to exo-planet research. For these stars we first perform an automated classification to identify the ones which seem most promising for asteroseismology. This is followed by a more detailed analyses of the individual stars.

NOTES:

Multiwavelength Study of Pulsation and Dust Production in Mira Variables using Optical Interferometry for Constraints

M. Creech-Eakman[1], J. Hora, Z. Ivezic, C. Jurgenson, M. Marengo, A. Speck, R. Stencel, and R. Thompson
[1]New Mexico Institute of Mining and Technology

Optical interferometry is a technique by which the diameters and indeed the direct pulsations of stars are routinely being measured. As a follow-on to a 7 year interferometric campaign to measure the pulsations of over 100 mira variables, our team has been using the Spitzer Space telescope to measure the mid-infrared spectral signatures of about 25 miras during their pulsations while simultaneously ascertaining their near-infrared diameters using the Palomar Testbed Interferometer. These data will then be combined with modeling from NLTE and radiative transfer codes to place hard constraints on our understanding of these stars and their environments. We present some initial results from this work and discuss the next steps toward fully characterizing the atmosphere, molecular photosphere and dust production in mira variables.

NOTES:

The Connection Between Pulsation, Mass Loss, and Circumstellar Shells in Classical Cepheids

Hilding R. Neilson[1], Chow-Choong Ngeow, Sashi Kanbur, and John B. Lester
[1]University of Toronto, Canada

Recent observations of Cepheids using IR interferometry and Spitzer photometry have detected the presence of circumstellar envelopes (CSE) of dust and it has been hypothesized that the CSE's are due to dust forming in a Cepheid wind. Here we use a modified Castor, Abbott & Klein mechanism to produce a Cepheid wind, and this is used to estimate the contribution of mass loss to the Cepheid mass discrepancy. Furthermore, we test the OGLE-III Classical Cepheids using the IR fluxes from the SAGE survey to determine if Large Magellanic Cloud Cepheids have CSE's. It is found that IR excess is a common phenomenon for LMC Cepheids and that the resulting mass-loss rates can explain at least a fraction of the Cepheid mass discrepancy, depending on the assumed dust-to-gas ratio in the wind.

NOTES:

RR Lyrae Variables in Stellar Systems

Horace A. Smith
Michigan State University

The pioneering studies of RR Lyrae stars in globular clusters by Oosterhoff and by Sawyer Hogg in the 1930s and 1940s called attention to interesting systematic differences among RR Lyrae populations in different systems. When such studies were extended to the dwarf spheroidal companions of the Milky Way in the 1960s, it was found that the average properties of their RR Lyrae stars were often different from those that had previously been observed in globular clusters. Observations of RR Lyrae stars have now extended to the Andromeda Galaxy and other Local Group systems, with still greater variety being apparent. Our understanding of the reasons for these differences among the RR Lyrae populations in different systems is by no means complete. However, progress has been made in several areas. I will review aspects of studies of RR Lyrae variables in globular clusters of the Milky Way, the Milky Way halo, and other Local Group systems. Properties of RR Lyrae stars within these different systems are tied to differing horizontal branch morphologies and also shed light upon scenarios for the formation of the Galaxy.

NOTES:

The Variable Stars in the LMC Star Cluster NGC 2257

James Nemec
Dept. of Physics & Astronomy, Camosun College, Canada

The variable stars in the LMC star cluster NGC 2257 are reinvestigated using photometry (to ~20th mag) of over 400 new *B,V* CCD images taken with the CTIO 0.9-m telescope on 14 nights in December 2007 and January 2008. New period searches have been made using two independent algorithms (CLEAN, Period04); for most of the stars the resultant periods are consistent with the pulsation periods derived previously, but several discrepancies have been resolved. For the *B* and *V* light curves accurate Fourier coefficients and parameters are given. Six new variable stars have been discovered (V45-50), including a bright candidate long-period variable star showing secondary oscillations (V45) and two anomalously bright RRc stars (V48 and V50). Also discovered among the previously known variable stars are three double-mode RR Lyrae stars (V8, V16 and V34) and several Blazhko variables (one of which has a Blazhko period of only 6.1 days). Archival HST images and the photometry by Johnson et al. (1999) have been used to define better the properties of the most crowded variable stars. The total number of cluster variable stars now stands at forty-seven: 23 RRab stars, four of which show Blazhko amplitude variations; 20 RRc stars, one showing clear Blazhko variations and another showing possible Blazhko variations; the three RRd stars, all having the dominant period ~0.36 day and period ratios P_1/P_0~0.7450; and the LPV star located near the tip of the red giant branch. A comparison of the RRd stars with similar stars in other environments shows them to be more similar to those in IC4499 and M3 than those in M15 and M68.

NOTES:

Carbon-rich RR Lyrae Stars

George Wallerstein[1], V. V. Kovtyukh, and S. M. Andrievsky
[1]University of Washington

We have derived CNO and heavier element abundances in 12 RR Lyrae stars. Four stars show [C/Fe] near 0.0 and two stars show [C/Fe] = 0.52 and 0.65. Red giant branch stars, which are known to be the predecessors of RR Lyrae stars, usually show a deficiency of carbon due to proton capture during their evolution from the main sequence to the red giant tip. We suggest that the enhancement of carbon is due to production during the helium flash combined with mixing to the surface by vigorous convection induced by the flash itself.

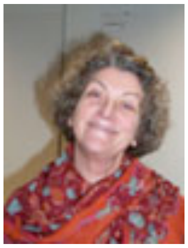
NOTES:

RR Lyrae Pulsation Theory

Marcella Marconi
Osservatorio Astronomico di Capodimonte

RR Lyrae stars play an important role as distance indicators and stellar population tracers. In this context the construction of accurate pulsation models is crucial to understand the observed properties and to constrain the intrinsic stellar properties of these pulsators. The physical mechanism driving pulsation in RR Lyrae stars is known since the middle of the 20th century and many efforts have been performed during the last few decades in the construction of more and more refined pulsation models. In particular, nonlinear pulsation models including a nonlocal time-dependent treatment of convection, such as the ones originally developed in Los Alamos in the seventies, allow us to reproduce all the relevant observables of stellar pulsation and to establish accurate relations and methods to contrain the intrinsic stellar properties and the distances of these variables. The most recent results on RR Lyrae pulsation obtained through this kind of models will be presented and a few still debated problems will be discussed.

NOTES:



Asteroseismology Results from CoRoT

Annie Baglin, Eric Michel
and the CoRoT seismology working group
Observatoire de Paris, Fance

After a description of the characteristics of the CoRoT photometric data, and of the observing programme past and future, recent results will be presented. Emphasis will be made on solar like pulsations in different type of stars, on the new vision of large amplitude pulsators, and on the detection of very low frequency modes. In addition the interest of the exoplanet targets for seismology will be illustrated by a few examples.

NOTES:

First RR Lyrae Light Curve from CoRoT
Big Challenge and Constraint to the Theoretical Models

Merieme Chadid and the RR Lyrae CoRoT Team
University of Nice, France

RR Lyrae stars have contributed to almost every branch of modern astronomy. They are standard candles, witnesses of the evolution of the Universe at a young age. They have served as test objects for theories of low-mass star evolution and theories of stellar pulsation. In recent years, their atmosphere has been considered as a laboratory of hypersonic shock wave simulation. With their large amplitudes, the RR Lyrae stars have been known for more than a century. Although these stars are well studied, the major questions concerning their pulsation and their atmospheric dynamics remain to be solved. Our team, RR Lyrae_CoRoT Team (http://fizeau.unice.fr/corot), is an international collaboration focusing at a better understanding of RR Lyrae stars using CoRoT.

The CoRoT Space Mission, successfully launched on December 2006, is currently monitoring several thousands of stars, for a long period (150 day) and with high photometric precision. As an important consequence, lots of high quality RR Lyrae light curves are obtained with a quasi-uninterrupted coverage over several pulsation & Blazhko cycles, long-term modulations and the unprecedented photometric accuracy. We detected a great number of new RR lyrae stars in the first long runs of the CoRoT mission, "long run center LRc01" and "long run anti-center LRa01" of the Milky Way. Almost all of CoRoT RR Lyrae stars are Blazhko stars with a pulsation period strongly non-linear and multiplet structures of order higher than a quintuplet. This is the first dataset in which we see a whole wealth of multiplets, a big challenge and constraint to the theoretical models. We also report a new class of them and Blazhko stars showing additional non-radial/radial (multimode) pulsation. Among them, the monoperiodic stars give us an unique opportunity to cope with the hydrodynamical challenge in connection with the radial pulsation.

Here, we summarize some of the results obtained so far and point out some of the remaining challenges and our ongoing works in connection with spectroscopic and photometric ground-based dataset and future theoretical investigations.

NOTES:

Shock Wave and Pulsation Connection in a Monoperiodic COROT RR Lyrae Star

M. Paparo[1], R. Szabo, J. Benko, M. Chadid, E. Poretti, K. Kolenberg, and RR Lyrae Working Group
[1]Konkoly Observatory, Hungary

The bump, a manifestation of a shock wave on the descending branch or around minimum, is a very remarkable feature of certain monoperiodic RR Lyrae stars. Excellent theoretical identification, as one of the three shock waves,is given by Fokin, Gillet and Chadid (1999). The COROT Space telescope supports us with increadibly high precision datasets. It allows us to carry on such kind of investigations that we have never had before. Using the ground-based data we tried to collect as much data as possible from season to season. We analysed them together describing the general features of the pulsation. Using a 150-day long COROT dataset we are able to separate it not only into shorter subsets (check for short-term variability) but into segments according to the remarkable feature of the light curve, according to the different phase of the pulsation. EN2_STAR_MON_0101370131 is a monoperiodic COROT RR Lyrae stars on the first long run with a very definite bump on the lower part of the descending branch. The light curve is nicely fitted by the pulsation period and its 37 harmonics. The harmonics are highly needed to describe the descending branch. A definite question was addressed to the dataset can we connect certain harmonics to a special feature of the light curve? How can the bump, a shock wave, be described by the pulsational frequency?

The answer is definite, not only for the bump but for the descending branch, the minimum and for the "pure pulsation" phase. In our presentation we show how the "segment analyses" works. Our observational results are compared to the results of the theoretical light curve selected from a grid of RR Lyrae models. A radial dependence of the shock wave's frequency content is also checked. We are planning to have a similar analyses for a Blazhko star in different Blazhko phases where a bump can be localized.

NOTES:

Physical Properties of Double-mode RR Lyrae Stars Based on Pulsation and Evolution Models

Istvan Dekany
Konkoly Observatory, Hungary

Following our approach employed on the field double-mode RR Lyrae star BS Comae (Dekany et al., 2008, MNRAS, 386, 521), we apply our method of fundamental stellar parameter determination on some 20 double-mode RR Lyrae stars in the Galactic Field and Bulge, and in the Large Magellanic Cloud. The stars were selected to cover wide ranges of periods and period ratios, implying diverse stellar parameters. From the possible observed quantities we use only the periods and determine stellar parameter combinations that satisfy current helium-burning evolutionary models and grids of linear non-adiabatic purely radiative pulsational models. Thus, the periods of an object determine a sequence of solutions for its mass, luminosity, effective temperature and metallicity, parametrized by the time elapsed from the start on the zero age horizontal branch. The derived sets of solutions yield various important theoretical relations between the physical parameters of the stars. Of course, all these relations depend on age. However, interestingly, in the case of some parameter combinations these relations are nearly independent of the age. We get very tight simple linear relations between log(P0) and log(R), log(rho), log(g) and W(B-V), W(V-I). These latter period-luminosity-color (PLC) relations are in fine agreement with the ones derived on empirical basis (Kovacs & Walker, 2001, A&A, 371, 579) and calibrated by the Baade-Wesselink results (Kovacs, 2003, MNRAS, 342, L58). We test the dependency of our results on the effect of nonlinearity.

NOTES:

The Blazhko Effect

Geza Kovacs
Konkoly Observatory, Hungary

Current status of (i.e., the lack of) understanding Blazhko effect is reviewed. We focus mostly on the various components of the failure of the models and touch upon the observational issues only at a degree needed for the theoretical background. Special attention is to be paid to models based on radial mode resonances, since they seem to be not fully explored yet, especially if we consider possible chemical stratification effects recently suggested by spectroscopic observations. To aid further modeling efforts, we stress the need for accurate time-series spectral line analysis to disentangle any possible non-radial component(s) and thereby let to include or exclude non-radial modes in explaining the Blazhko phenomenon.

NOTES:

New Results of the Konkoly Blazhko Group

Johanna Jurcsik
Konkoly Observatory, Hungary

During the recent years the Konkoly Blazhko Group (PIs Johanna Jurcsik and Bela Szeidl, co-workers Adam Sodor, Zsombor Hurta and several students in astronomy) published new important results of Blazhko variables in 15 reviewed Journal articles. These results utilize multicolour CCD observations obtained with an automatic 60 cm telescope, and also published and previously unpublished archive photometric data. Our light curves are the most extended multicolour data-sets ever obtained for Blazhko variables, the observations cover each phase of the pulsation and the modulation as well. We have detected many previously unknown features of the light curve modulation, and based on the different band's observations we could also reveal the underlying variations of the mean physical parameters during the Blazhko cycle. In my contribution the main achievements of the Konkoly Blazhko Group are summarised and significant new results are also presented. Strange behaviour of the modulation of CZ Lac, V759 Cyg and RY Com are discussed in detail.

NOTES:

Radial and Nonradial Beating Modes for RR Lyrae Variable Star Blazhko Effects

Arthur N. Cox
Los Alamos National Laboratory

At the eleventh conference in the Los Alamos pulsation series in 1992, this author suggested that the observed fundamental mode period of the variable star RR Lyrae can beat with the nonradial l=1, g4 mode to produce the observed Blazhko effect seen in that star. Two earlier papers were by Borkowski (1980) and by Moskalik (1986), both using only radial modes. Consideration of nonradial modes for other RR Lyrae variables allows many more modes, with some that are as close as one or two percent in period to the observed radial fundamental mode. My 1992 publication stated that the nonradial mode was weakly pulsationally unstable, but now with my improved nonradial codes, the indication is that the close nonradial modes are always just slightly stable. For this case, then, the nonradial mode needs to be excited by nonlinear coupling to the radial mode, which is often possible. See Dziembowski and Mizerski (2004), Van Hoolst, Dziembowski, and Kawaler (1998), and Nowakowski and Dziembowski (2001, two papers) for these RR Lyrae type variables. Many other stars have these solar-like non self-excited pulsations. For the observed double-mode RR Lyrae variables, beating is possible with both the observed radial modes, and complicated nonlinear pulsations can be predicted. It is found that the cooler RR Lyrae variables have large nonradial mode damping, making coupling less likely, and so the Blazhko effect ones must be hotter, near the ab type fundamental node blue edge, as observed.

NOTES:

Observational Constraints on the Magnetic Field of RR Lyrae Stars

Katrien Kolenberg[1] and Stefano Bagnulo[2]
[1]Institut fuer Astronomie, Universitaet Wien, Austria, [2]Armagh Observatory, U.K.

Valuable clues for understanding the Blazhko effect can be obtained from spectroscopy. In this talk we will present the implications of our observational work for the Blazhko models. In some of the models for explaining the Blazhko effect, the modulation is caused by the effects of a magnetic field. We carried out a survey to determine whether RR Lyrae stars are generally characterized by the presence of a magnetic field organized on a large scale. With the help of the FORS1 instrument at the ESO VLT we obtained spectropolarimetric observations of 17 relatively bright southern RR Lyrae stars, both Blazhko stars and non-modulated stars, and determined their mean longitudinal magnetic field with a typical error bar < 30 G.

From our data we can set an upper limit for the strength of the dipole component of the magnetic fields of the RR Lyrae stars in our sample. The outcome of our survey reveals that the Blazhko modulation in the pulsation of RR Lyrae stars is not correlated with the presence of a strong, quasi-dipolar magnetic field.

NOTES:

Changes in Mean Global Physical Parameters of Blazhko Variables Derived from Multicolour Photometry

Adam Sodor
Konkoly Observatory of the Hungarian Academy of Sciences

We developed an Inverse Photometric method (IPM) to determine global physical parameters of RR Lyrae stars exclusively from multicolour light curves (Sodor, Jurcsik & Szeidl, 2009, MNRAS, accepted). We showed that for good quality photometric observations of unmodulated RRab stars, the IPM gives similarly good results to spectroscopic Baade-Wesselink (BW) analyses, but without the need for spectroscopic measurements. During the development, we paid special attention to the applicability of the IPM for modulated RR Lyrae stars. Since there is no simultaneous spectroscopic radial velocity and photometric observations of any Blazhko star with good phase coverage both in pulsation and modulation, which would allow direct BW analysis, the IPM is the only possibility today to study changes in global physical parameters of Blazhko RR Lyrae stars during the Blazhko cycle. With the IPM, we studied many extensive Blazhko RRab light curves we observed with the 24-inch telescope of the Konkoy Observatory during the past 5 years. Small but unambiguous changes in the pulsation-averaged mean temperature, mean radius and mean luminosity have been detected in each stars.

NOTES:

LBV and Wolf Rayet Variables

Arthur N. Cox
Los Alamos National Laboratory

Evolution, linear pulsation studies, and hydrodynamic calculations at Los Alamos over the last decades will be reviewed to discuss mechanisms that can cause primordial homogeneous composition massive stars to pulsate and destroy themselves, and also to discuss somewhat evolved stars of about half this upper mass limit of near 80 solar mass to produce observed mild mass-losing outbursts as seen for S Doradus. Eddington found long ago that inside stellar models where the radiation luminosity exceeds his Eddington luminosity, the internal pressure gradient is steeper than can be constrained by the local gravity. Then local outward motions occur and, if the super-Eddington luminosities exist in thick layers, hydrodynamic outbursts occur. Local large luminosities are accompanied in stellar models with a significant convection zone to carry the large luminosity, but if the convection only slowly turns on and off during pulsations, and it is not able to adapt rapidly enough relative to the natural pulsation period of the model, significant outward motions during super-Eddington radiation luminosities can occur. I believe that super-Eddington luminosities and time-dependent convection are important mechanisms for mass loss outbursts from luminous stars early in their evolution.

NOTES:

Beta Cephei, SPB Star, and Be Star Variables

L. A. Balona
South African Astronomical Observatory

The current observational status of beta Cep, SPB and Be stars are presented and confronted with theory. In the low-metallicity environments of the LMC and SMC recent observations of beta Cep and SPB stars are posing a challenge to theory. We also do not understand why low-degree beta Cep pulsations do not occur among the O stars and why SPB stars have substantially smaller rotational velocities than stars in the same spectral type and luminosity class. The well-known opacity problem and the limitations of astroseismic investigations for these stars is discussed. An understanding of pulsation in Be stars requires models of pulsation in rapidly rotating stars. Attempts in this regard are discussed and compared. The idea that Be stars rotate at critical velocity is not supported by an analysis of photometric rotational periods. We highlight problems with the idea that Be star variations are explained entirely by pulsation with reference to recent MOST and COROT results. We show that these data are consistent with co-rotating circumstellar clouds. Finally we present a simple model for mass loss in Be stars which agrees with all major observational characteristics of these stars.

NOTES:

Beta Cephei Stars from the ASAS:
A New Look at Hot Pulsators

A. Pigulski and G. Pojmanski
University of Wroclaw, Poland

The All Sky Automated Survey (ASAS) data, covering nearly 70% of the whole sky south of declination +28°, was recently used to discover ~300 Beta Cephei stars brighter than V ~ 11.5 mag which increased the number of the known stars of this type nearly fourfold. The homogeinity of the ASAS survey allows us to use these hot pulsators for the study of their distribution in the local Galaxy. In patricular, we discuss this distribution in the context of the location of nearby spiral arms and star-forming regions. In addition, we discuss pulsational (periods, amplitudes) and kinematic properties of the whole sample of known Beta Cephei stars. Some ASAS objects interesting for asteroseismology are also indicated.

NOTES:

Toward Self-Consistent Angular Momentum Transport in Pulsating Massive Stars

Richard Townsend
University of Wisconsin

Angular momentum transport by stochastically excited internal gravity waves has been invoked in a number of recent studies as an important mechanism for modifying the rotation profile of the Sun and other low-mass stars. However, relatively little attention has been paid to a similar phenomenon that can arise in massive stars: angular momentum transport by the globally unstable g modes excited by the iron-bump kappa mechanism. Because the amplitudes of these unstable modes are much higher than the stochastic case, the expected timescales for significant transport are short, and the resulting impact on stellar evolution may be great. In this talk, I will present results from an ongoing project that seeks to model angular momentum transport in pulsating massive stars in a self-consistent manner. Particular emphasis will be placed on the feedback between the changing rotation profile and the kappa-mechanism instability, as this embodies quite different physics than in the stochastic excitation case. One significant result I will highlight concerns the patterned deposition of angular momentum in the mu-gradient zone; this leads to unstable shear structures that may be able to mix the zone toward homogeneity over evolutionarily short timescales.

NOTES:

Rotation and Overshoot in θ Ophiuchi

C. C. Lovekin and M. J. Goupil
Observatoire de Paris, Meudon

Recent 1D modeling of the β Cephei stars such as θ Ophiuchi and ν Eridani suggests that core overshooting is required to match the observed frequencies. However, it is possible that the mixing produced by core overshoot in these 1D models could be produced by other processes, such as rotation. We use a 2D stellar evolution code and a 2D linear adiabatic pulsation code to investigate the effects of uniform rotation and overshoot on low order p-modes. By comparing models with different combinations of rotation and overshoot, we are able to determine to what extent core overshoot is necessary in the presence of rotation. These models are presented in the context of the β Cephei star θ Ophiuchi, for which 7 frequencies have been identified, with $l = 0$–2.

NOTES:

Rotational Splitting of Pulsation Modes in Rapidly Rotating Stars

Robert G. Deupree
Institute for Computational Astrophysics, Department of Astronomy and Physics, Saint Mary's University

I compute linear, adiabatic pulsation frequencies for axisymmetric and nonaxisymmetric low order p modes to examine the rotational splitting. The calculations are not restricted to low rotation rates or a single Legendre polynomial representation of the horizontal variation of the eigenfunction. At low rotation, the splitting is proportional to the rotation rate and the nonazimuthal order of the mode (m), as one would expect. At higher rotation rates the splitting ceases to be linear as a quadratic term begins to influence the splitting. This first manifests itself as a difference in the magnitude of the splitting between positive and negative values of m. Still higher rotation rates change the spacing between adjacent values of m. These results are used to determine the range of applicability of each regime. The effects of nonuniform rotation on rotational splitting are also explored.

NOTES:

Solar-type Variable Stars

Günter Houdek
Institute of Astronomy, University of Vienna, Austria

A review on acoustic mode damping and excitation in solar-type stars is presented. Current models for linear damping rates are discussed in the light of recent linewidth measurements in the Sun and other stars. Recent developments in stochastic excitation models are reviewed and tested against the latest high-quality data of solar-like oscillations and against results obtained from hydrodynamical simulations.

NOTES:

Inference from Adiabatic Analysis of Solar-like Oscillations in Red Giants

A. Miglio[1], J. Montalban, A. Noels, P. Eggenberger, M.-A. Dupret, R. Scuflaire, P. Ventura, and F. DíAntona
[1]University of Liege, Belgium

The clear detection with CoRoT of radial and non-radial solar-like oscillations in many red giants paves the way to seismic inferences on the structure of such stars. We present an overview of the properties of the adiabatic frequencies and frequency separations of radial and non-radial oscillation modes, highlighting how their detection allows a deeper insight into the properties of the internal structure of red giants. In our study we consider models of red giants in different evolutionary stages, as well as of different masses and chemical composition; the effects of other physical processes and uncertainties (such as rotation, treatment of convection) are also addressed. We describe how the large and small separations computed with radial modes, and with non-radial modes mostly trapped in the envelope, are related to the properties of the acoustic cavity and we investigate the diagnostic potential of the observed modes.

NOTES:

Delta Scuti Stars

Gerald Handler
Institut für Astronomie, Universität Wien, Austria

Exciting times have begun and lie ahead for research on Delta Scuti stars. Present space missions such as MOST and CoRoT have revealed large numbers of oscillation frequencies in some of these variables to be used for asteroseismology; the recently launched Kepler is expected to push even further due to its longer monitoring period. Oscillation properties of stars in young open clusters, but also of radial pulsators tell us about stellar opacities, whereas multicolour measurements help to parametrize convection models. Pulsating components of eclipsing binary systems provide additional information for stellar modelling, as do predominantly radial pulsators with nonradial modes. Delta Scuti stars remain highly attractive targets to increase our understanding of stellar physics, and we are learning how to exploit their full potential now.

NOTES:

Period Variations in Delta Scuti Stars

Michel Breger
Institut fuer Astronomie, Austria

Hundreds of nights of photometric measurements of selected nonradial pulsators covering several years or decades allow us to examine the period and amplitude changes for a number of simultaneously excited pulsation modes. The measured changes are always larger than those expected from stellar evolution. We examine two main hypotheses: beating of independent modes with close frequencies and stellar cycles.

For period and amplitude changes with time scales less than one year, we confirm the beating hypothesis in three stars. This is shown by the correctly correlated relationship between amplitude and phase changes as well as the repetitions of these cycles.

The observed period variations with longer time scales are not due to simple beating between two close frequencies. For the star 4 CVn we can derive accurate annual frequency values for at least seven radial and nonradial modes. The phases are in excellent agreement with predictions from nearby years, thereby confirming the values and their observed long-term changes. For prograde and retrograde modes, the period variations are of identical size, but with opposite signs. The radial mode shows no (or little) changes. Furthermore, all period variations show a reversal around 1990. These results suggest long-term, regular cycles affecting modes differently in a systematic way.

NOTES:

Interesting Properties of delta Scuti Stars

D. H. McNamara
Department of Physics and Astronomy, Brigham Young University

We describe the results of calculations relating the absolute magnitudes, radii, surface gravities, temperatures, masses, and ages of delta Scuti stars to their fundamental radial periods and chemical compositions. We apply these results, utilizing δ Scuti variables in clusters, to finding the distance and age of the Pleiades cluster, and to finding the ages of the Hyades and Praesepe clusters. We also find the distances of two globular clusters utilizing δ Scuti variables along with the ages of the variables, and show why the metal-poor variables are confined to short periods. We also identify the periods when the variables transition from H- burning core stars to H-shell burning stars as a function of metallicity.

The delta Scuti stars in nearby galaxies can also be employed to finding a galaxy distance and information related to a galaxy's star formation history.

NOTES:

HADS in the LMC: Initial Findings from the SuperMACHO Project

Arti Garg
Lawrence Livermore National Laboratory

The SuperMACHO Project is a five-year survey toward the Large Magellanic Cloud (LMC) aimed at understanding the nature of the populations of lenses responsible for the excess microlensing rates observed by MACHO (Alcock et al. 2000). Survey observations were completed in 2006. A rich side-product of this survey is a catalog of variable sources down to a depth of VR~23, including many classes of pulsating variables such as delta-Scuti and RR Lyrae. Through their position in the Period-Luminosity diagram and their light curve characteristics we have identified several hundred delta-Scuti (or SX Phe) having high quality light curves. We find evidence suggesting these stars fall along multiple PL-relations including the subluminous relation observed by Poretti et al. (2008). We discuss these findings and implications for the evolutionary history of the LMC.

NOTES:

The CoRoT Era: A New Look to Delta Sct Stars from Space

Ennio Poretti, et al.
INAF-Osservatorio Astronomico di Brera, Italy

The ground-based photometric timeseries of the Delta Scuti star FG Vir allowed us to detect up to 75 frequencies (Breger et al., 2005) on the basis of multisite campaigns spanning several years. MOST photometry from space detected 88 frequencies in the light curve of HD 209775 (Matthews et al., 2007) in a 44-d almost continuous run. CoRoT is imparting a strong acceleration in the number of the detected frequencies. For instance, the analysis of the data obtained on HD 50844 (V=9.1, observed in the IR01) shows us that we need several hundreds of excited modes to explain the very dense power spectrum observed in the Delta Scuti frequency domain. The amplitude of the noise is down to the 10^{-5} mag level. The comparison with the spectroscopic frequencies (observations performed in the ESO Large Programme 178.D-0361) greatly helps in the mode identification and in the verification of the effectiveness of the cancellation effects in the high l-degree modes.

NOTES:

Solar Oscillations

Alexander Kosovichev
Stanford University

In recent years solar oscillations have been studied in great detail, both observationally and theoretically; so, perhaps, the Sun currently is the best understood pulsating star. The observational studies include long, almost uninterrupted series of oscillation data from the SOHO spacecraft and ground-based networks, GONG and BiSON, and more recently, extremely high-resolution observations from the Hinode mission. These observational data cover the whole oscillation spectrum, and have been extensively used for helioseismology studies, providing frequencies and travel times for diagnostics of the internal stratification, differential rotation, zonal and meridional flows, subsurface convection and sunspots. Together with realistic numerical simulations they lead to better understanding of the excitation mechanism and interactions of the oscillations with turbulence and magnetic fields. However, many problems remain unsolved. In particular, the precision of the helioseismology measurements is still insufficient for detecting the dynamo zone and deep routes of sunspots. Our knowledge of the oscillation physics in strong magnetic field regions is inadequate for interpretation of MHD waves in sunspots and for sunspot seismology. A new significant progress in studying the solar oscillations is expected from the Solar Dynamics Observatory scheduled for launch in 2009.

NOTES:

The Sun as-a-Star: SOHO Results

Rafael Garcia
Service d'Astrophysique, IRFU/DSM/CEA Saclay, France

The best known Solar oscillation-like star is the Sun. During the last 14 years, the ESA/NASA Solar and Heliospheric Observatory (SoHO) has been continuously observing this star from the Lagrange point L1 with an enormous success. Among the 11 instruments placed onboard, 3 of them are dedicated to helioseismology: GOLF, VIRGO and MDI. The first two observe the Sun as-a-star by integrating the velocity or intensity signal of the visible solar disk into a single point. They are thus similar to any other observation done in asteroseismology. During this talk I will present the most important results obtained during the mission concerning the Sun seen as-a-star and how this results have evolved our thoughts of the inside of our star.

NOTES:

Realistic MHD Numerical Simulations of Solar Convection and Oscillations in Magnetic Regions

I. N. Kitiashvili[1], L. Jacoutot[1], A. G. Kosovichev[2], A. Wray[3], and N. N. Mansour[3]
[1]Center for Turbulence Research, Stanford University, [2]Hansen Experimental Physics Laboratory, Stanford University, [3]NASA Ames Research Center

Solar observations show that the spectra of turbulent convection and oscillations significantly change in magnetic regions, resulting in interesting phenomena, such as high-frequency "acoustic halos" around active regions. In addition, recent observations from SOHO/MDI revealed significant changes of the wave properties in inclined magnetic field regions of sunspots, which affect helioseismic inferences. We use realistic 3D radiative MHD numerical simulations to investigate properties of solar convection and excitation and propagation of oscillations in magnetic regions. A new feature of these simulations is implementation of a dynamic sub-grid turbulence model, which allows more accurate description of turbulent dissipation and wave excitation. We present the simulation results for a wide range of the field strength and inclination in the top 6 Mm layer of the convection zone. The results show interesting and unexpected effects in the dynamics and large-scale organization of the magnetoconvection (including traveling waves and shearing flows), and also changes in the excitation properties and spectrum of oscillations, suggesting an explanation of the acoustic "halos" observed above the acoustic cut-off frequency.

NOTES:

A Review of Gamma Doradus Stars

Karen Pollard
University of Canterbury, Christchurch, New Zealand

An overall of the properties and characteristics of this relatively new class of variable star will be presented. Recent observational and theoretical advances will be reviewed and the prospects for new insights into this interesting class of variable star will be examined.

NOTES:

Results from Classification Observations and a Multi-site Campaign on gamma Doradus and SPB Type Stars

Duncan Wright
Royal Observatory of Belgium

As part of a two year observational project aiming to investigate the effects of rotation on main-sequence g-mode non-radial pulsation we have obtained at least one (generally more) high-resolution spectroscopic observation of 50 confirmed or candidate gamma Doradus and SPB stars and have completed a spectroscopic multi-site campaign. The campaign included five observatories and focussed on the gamma Doradus star HD218396 and the SPB stars HD21071 and HD25558. I will present the first results from this work.

NOTES:

MOST Travels Across the
HR Diagram Asteroseismically

Jaymie Matthews
University of British Columbia, Canada

How do g-modes in Be stars tell us their rotation rates, independent of vsini or rotational modulation? Can p-mode seismology and IR interferometry of K giants improve the physics we use in atmospheric models of these stars? What can lambda Bootis pulsations tell us about exoplanets vs. brown dwarfs? These are a few questions posed by the MOST space mission as it explores the parameter space of the HR Diagram, and I'll give at least some of the answers during this talk.

NOTES:

Pulsation in Chemically Peculiar Stars of the Upper Main Sequence

D. W. Kurtz
Jeremiah Horrocks Institute of Astrophysics and Supercomputing,
University of Central Lancashire

In the regions of the delta Sct and gamma Dor instability strips in the HR Diagram there are many chemically peculiar stars, the cool magnetic Ap stars, metallic line Am stars, evolved Am, or rho Pup stars, lambda Boo stars. Some of the Ap stars pulsate in high overtone modes as rapidly oscillating Ap stars – which do not show low-overtone delta Sct pulsations – while a few Am and rho Pup stars are delta Sct stars. In all of these stars the pulsation and chemical peculiarity are related. For the lambda Boo stars this may not be true. This talk will mostly discuss recent spectroscopic discoveries in the roAp stars, with some discussion of the pulsating Am and rho Pup stars.

NOTES:

Numerical Simulation of Line Profile Variation in roAp Stars

Hiromoto Shibahashi and T. Nomura
Department of Astronomy, University of Tokyo

Prior to the last decade, most observations of roAp stars have concerned the light variations. Recently some new, striking results of spectroscopic observations with high time resolution, high spectral dispersion, and high signal-to-noise ratio became available. Since the oscillations found in roAp stars are high overtones (they oscillate so rapidly!), the vertical wavelengths of the oscillations are so short that the amplitude and phase of variation of each spectroscopic line are highly dependent on the level of the line profile. Hence the analyses of variation of spectroscopic lines of roAp stars potentially provide us with new information about the vertical structure of the atmosphere of these stars. In order to extract such information, numerical simulation of line profile variation beyond a single-surface approximation is necessary. We have succeeded in carrying out numerical simulation of line profile variation by taking account of finite thickness of the line forming layer. We demonstrate how effective this treatment is, by comparing the simulation with the observed line profiles.

NOTES:

Modelling Pulsations of the roAp Star HR 1217 (HD 24712)

Hideyuki Saio[1], T. Ryabchikova, and M. Sachkov
[1]Tohoku University, Japan

HR 1217 is one of the most frequently observed roAp stars. It has 6 nearly equally spaced frequencies ranging from 2.62 to 2.79 mHz and some additional ones. We attempt to fit these frequencies (obtained by Kurtz et al. 2005) with theoretical ones obtained by including the effect of the magnetic field. We also compare theoretical predictions for the depth variations of pulsation phase and amplitude with spectroscopically obtained variations.

NOTES:

Spectroscopic and Photometric Observations for Kepler Asteroseismic Targets

Joanna Molenda-Zakowicz
Institute of Astronomy, University of Wroclaw, Poland

I summarize the results of our spectroscopic and photometric observations of stars selected as asteroseismic targets for Kepler. I introduce the international group of scientists involved in this projectand present their individual input.

Then, I describe the actual status of the Kepler mission and the list of its asteroseismic targets, highlighting stars that are the subject of our study. Our program of ground-based observations of Kepler asterosiesmic targets has been started in 2005. It aims at derivation of effective temperatures, gravities, metallicities, radial velocities and the projected velocities of rotation, as well as the detection and a detailed study of new binary systems, variable stars in the open clusters NGC 6866 and NGC 6811, and the determination of the interstellar reddening in the Kepler field. The theoretical part of our research includes determination of the evolutionary status of the stars and the properties of their asteroseismic modes.

Finally, I describe Internet archives which contain the spectroscopic data collected in the last four observing seasons.

NOTES:

An Asteroseismic Model-fitting Pipeline for Solar-like Oscillations

Travis S. Metcalfe[1], O. L. Creevey, and J. Christensen-Dalsgaard
[1]High Altitude Observatory, National Center for Atmospheric Research

Over the past two decades, helioseismology has revolutionized our understanding of the interior structure and dynamics of the Sun. Asteroseismology will soon place this knowledge into a broader context by providing structural data for hundreds of Sun-like stars. Solar-like oscillations have already been detected from the ground in several stars, and NASA's Kepler mission is poised to unleash a flood of stellar pulsation data. Deriving reliable asteroseismic information from these observations demands a significant improvement in our analysis methods. We report the initial results of our efforts to develop an objective stellar model-fitting pipeline for asteroseismic data. The cornerstone of our automated approach is an optimization method using a parallel genetic algorithm. We describe the details of the pipeline and we present the initial application to Sun-as-a-star data, yielding an optimal model that accurately reproduces the known solar properties.

NOTES:

Early Solar Mass Loss, Opacity Uncertainties, and the Solar Abundance Problem

Joyce Ann Guzik, John Keady, and David P. Kilcrease
Los Alamos National Laboratory

Solar models calibrated with the new solar abundance mixture of Asplund et al. (2004) do not agree as well with helioseismic determinations of the sound speed, convection zone depth, and convection zone helium abundance compared to earlier models that used the Grevesse and Noels (1993) or Grevesse and Sauval (1998) abundances. A number of modifications to the standard solar model have been explored to mitigate the discrepancy, with limited success. Here we revisit the constraints on early solar mass loss in light of the new abundances. A more massive early sun and stronger solar wind were proposed to deplete surface lithium to observed values, and to mitigate the faint early sun problem for the Earth's climate. With the old abundances, the maximum amount of mass lost was limited to about 0.1 solar masses to avoid depleting too much Li. However, with the new abundances, the convection zone becomes shallower so more mass loss can be accommodated. The final calibrated models also have a deeper convection zone and a core structure with a steeper composition gradient; both effects will partially offset the structure changes produced by the new abundances. Opacity enhancements of 10-30% below the solar convection zone have also been proposed to restore agreement with seismic inferences; we have explored adding additional trace elements to the opacity mixture using the Los Alamos opacity databases, and find that adding these elements has negligible effect on the opacities. We also comment on remaining potential uncertainties in opacity calculations for conditions below the solar convection zone, where the important ionizing elements are C, N, O, Ar, and Ne and prospects for opacity increases.

NOTES:

Progress in Sounding the Interior of Pulsating Hot Subdwarf Stars

Stephane Charpinet
Observatoire Midi-Pyrénées, France

Hot subdwarf stars, including helium core burning sdB stars and more evolved sdO stars, host three classes of nonradial pulsators. Two of them show rapid acoustic mode oscillations (with periods in the 60 – 600 s range), while the third class features slow gravity mode vibrations of period typically 1h. All three classes provide a very strong potential for sounding the internal properties of stars in these evolved phases of stellar evolution. This has been exploited mainly for the rapid p-mode sdB pulsators to date. The long period g-mode pulsators, with the advent of space observations, carry very strong promises of sounding even deeper regions inside these stars. In this review, I will summarize some of the properties of pulsating hot subdwarf stars and I will present the main progresses that have recently occured in the asteroseismic exploitation of the pulsations observed in sdB stars.

NOTES:

Pulsational Light and Velocity Variability in Post-AGB Stars

B. J. Hrivnak and W. Lu
Valparaiso University

We present the results of a long-term (15 year) photometric monitoring program of ~25 post-AGB stars. They are classified as proto-planetary nebulae (PPNs), objects in the evolutionary transition between the AGB and planetary nebula phases. They all show variability and periods have been determined for most of these. However, the variability is not strictly periodic or at least not with a single period. We will highlight a sample of 12 carbon-rich objects, all with bright central stars (V=8-14 mag) of F-G spectral types and faint nebulae (as seen with HST). The pulsational periods range from 35 to 153 days, with the longer periods associated with later spectral types. In fact, a tight correlation is seen between the period and effective temperature. The light variations range from 0.15 to 0.5 mag and the systems are cooler when fainter. The four brightest have also been monitored for radial velocity variations and show periods similar to the photometric ones and peak-to-peak variations of 10 km/s. These observations will 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 NSF and by the Indiana Space Grant Consortium.

NOTES:

White Dwarf and Pre-White Dwarf Pulsations

Michael Montgomery
University of Texas at Austin

I will review the similarities and differences of the pre-white dwarf (DOV) and white dwarf (DAV and DBV) pulsators, with an emphasis on recent advances in the field. I will also describe a newly discovered class of pulsating white dwarf, the carbon-dominated hot DQVs, and show where they fit in relation to the previously known pulsators.

NOTES:

Seismological Studies of ZZ Ceti Stars

Barbara G. Castanheira[1] and S. O. Kepler
[1]Institut für Astronomie, Universität Wien, Austria

White dwarfs are the evolutionary end point of almost 98% of all stars. Their evolution is dominated by cooling; as they cool, they cross three distinct instability strips. We compared the observed modes to a fine grid of adiabatic models to determine the internal structure of 83 pulsating white dwarfs with H dominated atmosphere (DAVs or ZZ Cetis). Prior to this work there were only 12 ZZ Ceti stars that had been studied seismologically. Our main contribution was the inclusion of relative weights proportional to the observed amplitudes in the fits. We performed a broader search in the parameter space, using the spectrocopic determinations as a guide. By searching the whole grid, we avoid local minima. We determined that the average hydrogen mass is $10^{-6.3\pm1.6}$ M* and that the helium mass is $10^{-2.5\pm0.6}$ M*. We did not find evidence for accretion nor for mass loss while the stars evolve through the instability strip.

NOTES:

Asteroseismological Analysis of Rich Pulsating White Dwarfs

Agnes Kim
Georgia College & State University

We present the results of the asteroseismological analysis of two rich DAVs, G38-29 and R808, recent targets of the Whole Earth Telescope. 20 periods between 413s and 1089s were found in G38-29's pulsation spectrum, while R808 is an even richer pulsator, with 24 periods between 404s and 1144s. Traditionally, DAVs that have been analysed asteroseismologically have had less than half a dozen modes. Such a large number of modes presents a special challenge to white dwarf asteroseismology, but at the same time has the potential to yield a detailed picture of the interior chemical make-up of DAVs. We explore this possibility by varying the core profiles as well as the layer masses. We use an iterative grid search approach to find best fit models for G38-29 and R808 and comment on some of the intricacies of fine grid searches in white dwarf asteroseismology.

NOTES:

Pulsation Powered by Deuterium Burning in Brown Dwarfs and Low-mass Stars

Ann Marie Cody
California Institute of Technology

Pulsation powered by deuterium burning in brown dwarfs and very low mass stars has been put forth (Palla & Baraffe 2005) as a novel probe of the interiors of these objects in the 1-15 Myr age range. Previous observations have hinted at variability on the expected timescales of a few hours, suggesting but not confirming that the phenomenon is at work in young brown dwarfs. We have recently carried out a dedicated campaign to search for this putative class of pulsators among known low-mass members of five young star clusters. Our survey achieves sensitivity to periodic oscillations with photometric amplitudes down to several millimagnitudes. We will present the census of variability over timescales ranging from minutes to days and discuss the current prospects for pulsation as a tool in the study of young, objects near the substellar boundary. As a byproduct, this work provides new insights into the distribution of stellar rotation periods at young ages via the detection of variability due to cool surface spots.

NOTES:

Magneto-Gravito-Inertial Waves in Strongly Stratified Stellar Radiation Zones

Stephane Mathis
CEA/DSM/IRFU/SAP, Laboratoire Plasmas Stellaires et Astrophysique Nucléaire, France

Stellar radiation zones are stable strongly stratified rotating magnetic regions. The buoyancy force, the Coriolis acceleration and the Lorentz force are thus ruling the gravity waves dynamics, such waves being thus equivalent to the MAC waves studied in Geophysics. In this work, we examine the behaviour of these waves in stellar interiors and we show how the approximations assumed in the non-magnetic case (for gravito-inertial waves) can be generalized. The associated angular momentum transport, which strongly impacts on the evolution of stars over secular times-scales, is then discussed.

NOTES:

Light Curve Patterns and Seismology of a White Dwarf with Complex Pulsation

Zsofia Bognar[1], M. Paparo, P. A. Bradley, and A. Bischoff-Kim
[1]Konkoly Observatory, Hungary

The ZZ Ceti star KUV 02464+3239 was observed over a whole season at the mountain station of Konkoly Observatory. A rigorous frequency analysis revealed 6 certain periods between 619 and 1250 seconds, with no shorter period modes present. We use the observed periods, published effective temperature and surface gravity, along with the model grid code of Bischoff-Kim, Montgomery & Winget (2008) to perform a seismological analysis. We find acceptable model fits with masses between 0.60 and 0.70 Mo. The hydrogen layer mass of the acceptable models are almost always between 10^{-4} M* and 10^{-6} M*. In addition to our seismological results, we also show our analysis of individual light curves to see if the observed amplitude variability is intrinsic, due to unresolved modes, or mode switching. A refereed version of part of this work is being submitted to MNRAS.

NOTES:

The Ancient Population of Messier 32

Giuliana Fiorentino[1], A. Monachesi[1], S. C. Trager[1], E. Tolstoy[1], T. R. Lauer[2], A. Saha[2], K. Mighell[2], W. L. Freedman[3], A. Dressler[3], and C. J. Grillmair[4]
[1]Kapteyn Institute, [2]NOAO, [3]OCIW, [4]Spitzer Science Center

During Cycle 14 (Program GO-10572, PI: T. Lauer) on board HST, we observed two fields near M32 with the Advanced Camera for Surveys High Resolution Channel (ACS/HRC). These fields were located at distances of about 1.8' (hereafter F1) and 5.4' (the M31 background field, hereafter F2) from the center of M32. To obtain a very detailed and deep CMD and to look for short period variability, time-series imaging of each field were obtained in 32 orbits in each the F435W (narrow B) and F555W (narrow V) filters, spanning a temporal range of 2 days per filter. We focus on our detection of variability on RR Lyrae variable stars, which represents the only way to obtain information about the presence of a very old population (larger than 8-10 Gyrs) in M32. Here we present results obtained from the detection of 33 RR Lyrae in these field, 19 in F1 and 14 in F2. By analysing all the pulsation properties of these RR Lyrae stars, we conclude that these two groups of stars do not present any significant differences. In fact they have nearly the same mean V magnitudes (=25.34±0.15 mag and mu_0 =24.53±0.15 mag for F1; =25.31±0.12 mag and mu_0 = 24.50±0.14 mag for F2), the same mean periods (=0.59±0.11 day Nc/Nab=0.36 and =0.57±0.08 day and Nc/Nab=0.62), and the same distribution in the Bailey diagram (V-Amplitudes vs Periods). This evidence could be interpreted as both groups are belonging to M31 halo, as F2, the M31 background field, is located at a large distance from the center of M32. However, by collecting all the available data from HST and ground-based telescopes for fields close to M32 where RR Lyrae have been found so far, for the first time we are able to demonstrate that there is a clear gradient in the spatial distribution of the RR Lyrae towards the center of M32. This spatial gradient cannot be due only to the contribution of the M31 halo, and so the RR Lyrae we found, at least the ones in F1, are surely belonging to Messier 32. On this basis we can claim the first reliable proof of the presence of a purely ancient stellar population in Messier 32.

NOTES:

Poster Abstracts

Key:
1 = Monday – Tuesday
2 = Wednesday – Friday
Ceph = Cepheids
RRL = RR Lyrae
RG = Red giant/LPV
CGS = Clusters, Galaxies, and Surveys
B = B stars
Solar = Sun and solar-type stars
DSC = delta Scuti and related stars
GD = gamma Doradus stars
roAp = rapidly-oscillating Ap stars

Presenting Author	Poster Title	Section	#
Amado, P. J.	Mode identification using simultaneous optical and NIR spectroscopy	DSC 2	1.
Ando, H.	Detection of solar-like oscillations in 4 G-giants by precise radial velocity measurement and their characteristics	Solar 2	2.
Antoci, V.	The delta Scuti star Rho Puppis: The perfect target to probe the theory predicting solar-like oscillations in cool delta Scuti stars	DSC 2	3.
Barcza, S.	Physical parameters of RR Lyrae stars from multicolor photometry and Kurucz atmospheric models	RRL 1	4.
Benko, J. M.	An alternative mathematical treatment of the modulated RR Lyrae stars	RRL 1	5.
Bernard, E.	The ACS LCID Project: Short-period variables	RRL 1	6.
Bersier, D.	A large-scale survey for variable stars in M33	CGS 1	7.
Bouabid, M.-P.	Frequency analysis of the SISMO γ Doradus star HD 49434	GD 2	8.
Bouabid, M.-P.	Hybrid γ Doradus/δ Scuti stars: Theory versus observations	GD 2	9.
Cameron, C.	Asteroseismic tuning of the magnetic field of the roAp star HR 1217	roAp 2	10.

Cameron, C.	Near-critical rotation offers the MOST asteroseismic potential	B 2	11.
Cameron, C.	Frequency analysis of the beta Cephei pulasting star delta Ceti from MOST space-based photometry: One period or more?	B 2	12.
Cash, J.	A long term photometric and spectroscopic study of RV Tauri stars	RG 1	13.
Chadid, M.	First light curves from Antarctica: PAIX monitoring of the Blazhko stars	RRL 1	14.
Chavez, J. M.	A Cepheid distance to the Antennae	Ceph 1	15.
De Cat, P.	Is HD147787 a double-lined binary with two pulsating components?	GD 2	16.
De Cat, P.	Towards asteroseismology of main-sequence g-mode pulsators: Spectroscopic multi-site campaigns for slowly pulsating B stars and gamma Doradus stars	GD 2	17.
Demers, S.	AGB variables in the Local Group dwarf galaxy NGC 6822	RG 1	18.
Desmet, M.	Simultaneous MOST photometry and high-resolution spectroscopy of Spica, a binary system with a massive beta Cep star component	B 2	19.
Dukes, R. J.	Comparison of frequency determinations of slowly pulsating B stars from Stromgren and Geneva data	B 2	20.
Dziembowski, W. A.	Multi-mode Cepheids in the LMC - Challenges for theory	Ceph 1	21.
Endl, M.	Detection of stellar pulsations in the planet host star gamma Cephei A by high precision radial velocity measurements	Solar 2	22.
Escobar, M. E.	The globular cluster M69: Variable stars and new CCD BV color-magnitude diagram	CGS 1	23.
Fox Machado, L.	Stromgren photometry of the Delta Scuti stars 7 Aql and 8 Aql	DSC 2	24.
Fox Machado, L.	CCD photometry of the Pleiades delta Scuti star V650 Tauri	DSC 2	25.
Fu, J.	Bi-site observations of the SX Phoenicis star GP Andromedae	DSC 2	26.
Gallenne, A.	Mid infrared observations of Cepheids using VLT/VISIR: More evidence for circum-stellar environments	Ceph 1	27.
Greco, C.	Searching for variable stars in Galactic open clusters	CGS 2	28.

Greco, C.	Galactic halo formation: The role of pulsating stars	RRL 1	29.
Guggenberger, E.	High-resolution magnetic field measurements of RR Lyrae stars with SemPole	RRL 1	30.
Handler, G.	Asteroseismology of hybrid pulsators made possible: Simultaneous *MOST* space photometry and ground-based spectroscopy of gamma Peg	B 2	31.
Hoffman, D.	Masses and pulsation modes in eclipsing delta Scuti systems	DSC 2	32.
Hoffmann, S.	Cepheids and long-period variables in NGC 4258	CGS 1	33.
Hrivnak, B.	Periodic light variability in twelve carbon-rich proto-planetary nebulae	CGS 2	34.
Huat, A.-L.	Correlation between a light outburst and pulsations in a CoRoT Be star	B 2	35.
Ita, Y.	Near-infrared (J, H, and K) monitoring survey toward Magellanic Clouds using IRSF/SIRIUS at South Africa Observatory, first results	CGS 2	36.
Jackiewicz, J.	Seismic inversion methods	Solar 2	37.
Jeon, Y.-B.	Variable stars in the LMC globular cluster NGC 2210	CGS 1	38.
Kaiser, A.	The domain of delta Scuti stars: CoRoT IRa01 results	DSC 2	39.
Kanbur, S.	A preliminary estimate of Hubble's constant using SNIa data and OGLE III Cepheids in the LMC	CGS 1	40.
Kinemuchi, K.	Spectroscopic study of NSVS RR Lyrae stars	RRL 1	41.
Kopacki, G.	Search for pulsating stars in the globular cluster M80 from ground and space observations	CGS 1	42.
Kuehn, C.	RR Lyrae in LMC globular clusters	RRL 1	43.
Lampens, P.	Towards accurate component properties of the Hyades binary Theta 2 Tauri	DSC 2	44.
Laney, C. D.	The calibration of the P-Factor in Baade-Wesselink radii for classical and dwarf Cepheids	Ceph 1	45.
Laney, C. D.	The distance to the LMC from red clump stars, and the metallicity correction to the Cepheid PL relation	Ceph 1	46.
Marconi, M.	Discovery of RR Lyrae stars in M31 globular clusters	RRL 1	47.

Mathur, S.	Analysing solar-like oscillations with an automatic pipeline	Solar 2	48.
Matsunaga, N.	Period-luminosity relations for type II Cepheids	Ceph 1	49.
Matsunaga, N.	The IRSF/SIRIUS survey of Miras toward the Galactic center	RG 1	50.
Medupe, T. R.	The effect of pulsational opacity fluctuations on the oscillations in the atmospheres of A stars	roAp 2	51.
Medupe, T. R.	Frequency analysis of roAp star: HD 217522	roAp 2	52.
Miglio, A.	The combined CORALIE+UVES+UCLES time series of α Cen A: Preliminary results	Solar 2	53.
Miglio, A.	The enigma of B-type pulsators in the SMC	B 2	54.
Moya, A.	Study of the nature of the lambda Bootis star 29 Cygni using asteroseismology	DSC 2	55.
Ngeow, C.	IRAC band period-luminosity relations from LMC Cepheids: Application to three nearby galaxies	Ceph 1	56.
Niyogi, S. G.	The effect of stellar pulsation cycles on dust formation: A temporal study of the mid-infrared spectrum of O-rich AGB Star, T Cep	RG 1	57.
Onifer, A. J.	Two-dimensional hydrodynamical simulations of Cepheids and RR Lyrae	Ceph 1	58.
Pamyatnykh, A.A.	Modelling hybrid beta Cep/SPB pulsations – Gamma Pegasi	B 2	59.
Pellerin, A.	Cepheids, eclipsing binaries, and other variables in M33	CGS 1	60.
Peña, J. H.	Physical parameters of four field RR Lyrae stars in Bootes	RRL 1	61.
Pollard, K.	Spectroscopic mode-identification of gamma Doradus stars	GD 2	62.
Pricopi, D.	Pulsational stability of red giant stars	RG 1	63.
Quirion, P.-O.	To automatically get the stellar parameters of Solar-like stars observed by the Kepler satellite	Solar 2	64.
Ratcliff, S. J.	Spectroscopic observations of SRd and RV Tau variables at Middlebury College	RG 1	65.
Ripepi, V.	Stellar archaeology in the Milky Way Halo: Variable stars and stellar populations in the new Milky Way satellites discovered by the SDSS	CGS 1	66.

Romaniello, M.	The dependency of the Cepheid period-luminosity relation on chemical composition	Ceph 1	67.
Semaan, T.	Characterization and parameter determination of CoRoT variable stars with FLAMES	B 2	68.
Simoniello, R.	Evidence of increasing acoustic emissivity over solar cycle 23 at high frequency in integrated sunlight measurements	Solar 2	69.
Spano, M.	Variability morphologies in the color-magnitude diagram	CGS 1	70.
Suárez, J. C.	Analysis of the internal rotation profile of stars using rotational mode splitting asymmetries	B 2	71.
Szabo, R.	Strange and low amplitude Cepheid candidates in the CoRoT observations	Ceph 1	72.
Szabo, R.	Amplitude and phase modulation in CoRoT RR Lyrae stars	RRL 1	73.
Szczygiel, D.	Galactic fundamental mode RR Lyrae stars: Period-amplitude diagram, metallicities and distribution	RRL 1	74.
Templeton, M. R.	Long-term variability in o Ceti: Signs of supergranular convection?	RG 1	75.
Templeton, M. R.	Long-term, multicolor photometry of W Vir and Type II Cepheids	Ceph 1	76.
Turner, D. G.	Enhancing our knowledge of northern Cepheids through photometric monitoring	Ceph 1	77.
Turner, D. G.	Stochastic processes in yellow and red pulsating variables	RG 1	78.
Uytterhoeven, K.	The asteroseismic ground-based observational counterpart of CoRoT	CGS 2	79.
Uytterhoeven, K.	Abundance analysis and mode identification for the beta Cephei CoRoT main target HD180642	B 2	80.
Uytterhoeven, K.	Time-scales of line-broadening variability in OB supergiants	B 2	81.
Uytterhoeven, K.	Gamma Doradus stars in the CoRoT exoplanets fields	GD 2	82.
Varadi, M.	Detecting short period variables with Gaia	CGS 2	83.
Wang, Q.	Approaches to mass-loss modeling, and the Bowen code	RG 1	84.
Wood, P. R.	Spectropolarimetric observations of the sequence-D red giant variables S Lep and Z Eri	RG 1	85.

Mode Identification Using Simultaneous Optical and NIR Spectroscopy

Pedro J. Amado
Instituto de Astrofisica de Andalucia (CSIC), Granada, Spain

The main difficulty of Asteroseismology lies in determining the quantum numbers for each frequency among the tens to hundreds of those observed, which is known as mode identification. White-light photometry has proved insufficient, while the use of optical multi-colour photometry and/or optical spectroscopy have started to provide some results. It is known that the use of a large wavelength baseline when applying the mode-identification multi-colour photometric techniques greatly improves the significance of the identification. In spectroscopy, differences between line profiles in the optical and in the near infrared are expected. Therefore, using simultaneous optical and NIR spectroscopic observations should improve our mode identification techniques. However no investigation in the NIR had been conducted before now. In this contribution I will provide some insight in this new field that will make use of forthcoming near infrared high-resolution spectrographs but which, in turn, needs of observations in already existing instruments like CRIRES.

NOTES:

Detection of Solar-like Oscillations in 4 G-giants by Precise Radial Velocity Measurement and Their Characteristics

Hiroyasu Ando
Division of Optical and Infrared Astronomy, National Astronomical Observatory of Japan

We have detected solar-like oscillations in 4 G giants (zeta Hya, eta Her, 11 Com, and eps Tau) by radial velocity measurement with iodine cell. Period analysis for these variations has been done to extract significant peaks, frequencies at power maximum, large separations. We have confirmed to follow the scaling laws. We have also estimated damping times for the oscillations. We will summarize the general characteristics of solar-like oscillations in G giants.

NOTES:

The delta Scuti star Rho Puppis: The Perfect Target to Probe the Theory Predicting Solar-like Oscillations in Cool delta Scuti Stars

V. Antoci[1], G. Handler, F. Carrier, F. Grundahl, J. J. Matthews, M. Hareter, R. Kuschnig, and G. Houdek
[1]University of Vienna, Austria

Theoretical predictions of solar-like oscillations in cool Delta Scuti stars, motivated us to organize a spectroscopic observing campaign of the metal-rich star Rho Puppis. High precision radial velocity measurements obtained in 2008 through an iodine cell attached to UCLES at the Anglo Australian Telescope (extracted with the code iSONG) as well as high resolution spectra observed with CORALIE at the Swiss 1.2-m Leonard Euler telescope, are the basis material for detecting the solar-like pulsation. Furthermore we have 30 days of photometry observed with the MOST satellite, which lead to the detection of three additional frequencies attributed to nonradial modes. In this poster we present preliminary results.

NOTES:

Physical Parameters of RR Lyrae Stars from Multicolor Photometry and Kurucz Atmospheric Models

S. Barcza and J. M. Benko
Konkoly Observatory, Hungary

The most comprehensive photometric material exists for RR Lyrae stars in Johnson-Cousins system $UBV(RI)_C$. In this system the colors of the Kurucz atmospheric models are available allowing to determine the effective temperature and surface gravity as a function of phase. Using the $UBV(RI)_C$ photometry of the RRab star SU Dra as an example we determine the phase intervals where the quasi-static atmosphere approximation defined by Ledoux and Whitney (in Aerodynamic phenomena in stellar atmospheres, IAU Symp. No. 12, Ed. by R. N. Thomas, Bologna, 1961) is valid i.e. where the Kurucz atmospheric models do and do not reproduce the observed $UBV(RI)_C$ colors sufficiently.

NOTES:

An Alternative Mathematical Treatment of the Modulated RR Lyrae Stars

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The light curve of an RR star is conventionally described by a Fourier series of limited number of terms. In the case of modulated (Blazhko) RR Lyrae stars the Fourier sum includes terms of harmonics of the main pulsation frequency and side frequencies due to the modulation. The conventional description uses about 400 parameters for a long time series of good quality, such as CoRoT data of V1127 Aql (an RRab star showing strong modulation both in its amplitude and phase).

We present here a different analytical description of the light curves in which we take into account both the amplitude and phase modulation directly. The treatment is used in telecommunication technique for a long time. Comparing to the conventional description, the approach allow us to reduce the number of necessary parameters by a factor of 10. The higher order side frequencies in the Fourier spectrum are a natural consequence of the strength of the phase modulation. If phase modulation exists, any trial to distinguish between the competitor physical models (oblique rotator and mode coupling) on the basis of the side-peak patterns only (triplet, quintuplet), may not be applied.

The treatment gives possibility to test the mathematical nature of both the amplitude and phase modulations by comparing the Fourier spectra of model light curves to the CoRoT data of V1127 Aql. This mathematical model could help to find the proper physical model of modulations.

NOTES:

The ACS LCID Project: Short-period Variables

Edouard Bernard, for the LCID Team
Instituto de Astrofísica de Canarias (IAC)

We present results of the search for variable stars in a sample of Local Group isolated dwarf galaxies, namely LGS3, IC1613, Cetus and Tucana, based on very deep (V~29) HST/ACS data. About 900 variables have been found in total, the majority of which being RR Lyrae stars and Cepheids. Our in depth study of the RR Lyrae population of the dSph Tucana reveals interesting details about the early evolution of this galaxy, and the origin of its stellar population gradients. We find that the fainter RR Lyrae stars, also having a shorter period, are more centrally concentrated than the more luminous, longer period RR Lyrae variables. Through comparison with the predictions of theoretical models of stellar evolution and stellar pulsation, we interpret the fainter RR Lyrae stars as a more metal-rich subsample, suggesting that a metallicity gradient must have appeared very early on in the history of this galaxy.

NOTES:

A Large-Scale Survey for Variable Stars in M33

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J. Kaluzny, J.-B. Marquette, A. Schwarzenberg-Czerny, and P. B. Stetson
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We have started a survey of M33 in order to find variable stars and Cepheids in particular. We have obtained 35 epochs of g'r'i' data with the Canada-France-Hawaii Telescope and the one-square-degree camera MegaCam. Over 36000 variable objects have been found. We will describe the search for variable objects and some basic facts about the variables we have found. We will also describe the current status of the project, including complimentary optical and infrared data, as well as the progress being made on the calibration of the data and the resulting deep color-magnitude diagrams. We will also present several projects we are currently working on, in the areas of variable stars and stellar populations.

NOTES:

Frequency Analysis of the SISMO γ Doradus Star HD 49434

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HD 49434 has been confirmed as a hybrid γ Doradus/δ Scuti star from ground based observations (Uytterhoeven et al. 2008). A first semi-automatic analysis of the COROT light curve reveals more than one thousand frequencies and confirms all the ground-based confirmed and suspected frequencies. Among these peaks, we discuss empirical criterions based on amplitudes, phases and frequency properties in order to determine which ones are really present in the oscillation spectrum.

NOTES:

Hybrid γ Doradus/δ Scuti Stars: Theory Versus Observations

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[1]Observatoire de la Côte d'Azur, France, [2]Institut d'Astrophysique et de Géophysique de Liège, Belgium, [3]Centro de Astrofísica da Universidade do Porto, Portugal

γ Doradus (γ Dor) are F-type stars pulsating with high order g-modes. Their instability strip (IS) overlaps the red part of the δ Scuti (δ Sct) one, what has led to search for objects in that region of the HR diagram which show p and g-modes simultaneously. Even if the existence of such hybrid pulsators has not been yet confirmed, the number of candidates has recently increased (e.g. Mattews 2007). Moreover, from the theoretical points of view, non-adiabatic computations including a time-dependant treatment of convection predict the existence of γ Dor/δ Sct hybrid pulsators (Dupret et al. 2004). Our aim in this poster is to confront the theory to the observed hybrid stars using the BAG (Belgian Asteroseismology Group) grid of models for γ Dor stars and the calculations from Dupret et al. 2005, and to search for eventual common characteristics of these objects, what could help us to understand their hybrid behaviour.

NOTES:

Asteroseismic Tuning of the Magnetic Field of the roAp Star HR 1217

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HR 1217 is a well studied rapidly oscillating Ap (roAp) star that pulsates in high-overtone (magneto-) acoustic p-modes with periods near 6 minutes. Two global (ground-based) photometric campaigns led to asteroseismic constraints on the global properties of HR 1217 and evidence for magnetic perturbations of its eigenfrequencies. This was the motivation to make this star a MOST space mission target, resulting in 30 days of near-continuous photometry. The MOST data confirm the previously identified frequencies and reveal additional frequencies that provide further evidence of magnetic perturbations, and/or possibly fine splitting in the eigenspectrum.

We present a grid of more than 50,000 stellar pulsation models spanning a range of luminosity and effective temperature appropriate for HR 1217, and including a large range of magnetic dipole field strengths (1 - 10 kG). This is the largest grid of stellar pulsation models of any Ap star to date and is critical to the interpretation of the MOST photometry (as well as spectroscopic data sets for HR 1217). We present the details of the model grid and the methods used to match these models to the observed frequencies. The results highlight the sensitivity to physics which has not been usually incorporated in Ap interior models, and the complex nature of the interaction of globally organized magnetic fields with stellar pulsation eigenmodes.

NOTES:

Near-critical Rotation Offers the MOST Asteroseismic Potential

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In the past few years, the MOST team has discovered slow (g- and r-mode) pulsations in four Be stars rotating near their critical velocities. The rich oscillation spectra of these stars not only offer the potential for g-mode asteroseismology, but provide an immediate way to estimate the stellar rotation rate independently of vsini measurements. We present 30 days of MOST photometry of a new slowly pulsating Be (SPBe) star HD 165783. These observations, along with our models of HD 165783, are compared to the other SPBe stars in the MOST sample.

NOTES:

Frequency Analysis of the β Cephei Pulsating Star δ Ceti from MOST Space-based Photometry: One Period or More?

C. Cameron[1,2], R. Moldovan[1], and J. M. Matthews[1]
[1]University of British Columbia, Canada, [2]Saint Mary's University, Canada

The hot, massive pulsating star δ Ceti (a member of the β Cephei class) was considered one of the few mono-periodic variables in its class until analysis by Aerts et al. (2006) of MOST photometry obtained during the commissioning of the satellite indicated four other frequencies, including a harmonic of the known frequency. They used some of these frequencies to obtain an asteroseismic model fit to the surface gravity and effective temperature of the star. Jerzykiewicz (2007) later claimed that three of the newly reported periodic signals are not significant detections, and that δ Ceti is in fact mono-periodic. This claim would invalidate the asteroseismic model fit. His assertion was that Aerts et al. did not take into account the rising noise level with decreasing frequency in the MOST photometry.

We have conducted an independent frequency analysis of the data, estimating the uncertainties of the frequencies, amplitudes and phases of periodic signals through a Monte-Carlo-style bootstrap technique, which was not used by either Aerts et al. or Jerzykiewicz. We have also checked the ways the investigators estimated the noise levels in their S/N estimates to try to understand the differences in their findings. Both used a window in frequency around each candidate peak in the Fourier spectrum to estimate the noise level; Aerts et al. adopted the standard deviation of the Fourier amplitude spectrum in that window; Jerzykiewicz adopted the mean of the amplitude values within a 2-cycle/day window.

In this analysis, the uncertainties of all the signal parameters were estimated from the distribution of the bootstrap fits, based on 100,000 trials. We find that three of the four new frequencies reported by Aerts et al. ($2f_1$ = 12.4082 cycles/day, f_2 = 3.73 c/d, f_3 = 3.66 c/d) have significances of 21.5 σ, 14.5 σ and 11.8 σ respectively. The fourth frequency (f_4 = 0:3181 c/d), the lowest in both frequency and amplitude, is only a 1.8 σ detection, and is not significant. We also calculated the noise levels using the approaches of Aerts et al. and Jerzykiewicz, but for a range of frequency window sizes around each reported signal. The noise is relatively independent of the window size except for windows less than 1 c/d in width.

The frequencies used by Aerts et al. in their asteroseismic modeling are all found to be highly significant in this analysis. The frequency f_4, not a significant detection (the sole agreement with Jerzykiewicz' claims), was not employed by Aerts et al. in any analysis of the star. Our results support their fit to the structure of δ Ceti.

NOTES:

A Long Term Photometric and Spectroscopic Study of RV Tauri Stars

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We will present the planned research for a new long term project at South Carolina State University in partnership with the National Optical Astronomy Observatory through the NSF PAARE program. The focus of the project is RV Tauri stars and we will work to model physical processes that relate the period(s) of these stars to their luminosity, temperature and other physical parameters that may have cosmological significance through their potential use in distance calculations. RV Tau stars are a somewhat mixed group of evolved stars containing giants and supergiants, some of which are fairly regular single mode pulsators, others are semi-regular and show multiple periods and beats. We will begin with over 800 high signal-to-noise, archival coude spectra and the large AAVSO photometric database. We will add new spectra from the Kitt Peak National Observatory (KPNO) coude-feed telescope taken contemporaneously with new UBVRI photometry from other telescopes at KPNO. Our modeling efforts will use computational searches for the (quasi)period(s) of pulsation in the light curves using photometry from the AAVSO and examine the typical stability of the discovered period(s). Connection of the period structures with the stellar parameters derivable from the spectra will allow us to examine a phase space of physical properties, enabling classification of the various RV Tau type variables into scientifically useful groups. Knowing which stars have specific period structures with respect to their spectral appearance may produce a viable period - luminosity relationship similar to Cepheids, making these highly luminous stars additional distance indicators. The investigation of their modulated light output in connection with the changing stellar properties will also provide additional insight into the underlying physical processes and evolutionary state of the RV Tauri variables.

Support for this work was provided by the NSF PAARE program to South Carolina State University under award AST-0750814

NOTES:

First Light Curves from Antarctica: PAIX Monitoring of the Blazhko Stars

M. Chadid[1], J. Vernin, H. Trinquet, E. Chapellier, and D. Mekarnia
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We still lack a solution to solve the problems associated with the Earth's day-night cycle. To cope with this challenge we took advantage of the long and continuous time-series photometry which had been achieved with either large ground-based networks of observatories at different geographic longitudes or when conducted from space. Recently, a new possibility is offered by a polar location with astronomical site testing.

We present here the first time-series optical photometry from Dome C in Antarctica obtained using PAIX photometer (Photometer AntarctIca eXtinction), attached at the focus of the Blazhko telescope (Chadid et al. 2008, SPIE 7012, 144) from June to August 2007. Almost two thousand hours (80 days) of high precision multi-color photometric measurements were obtained continuously, with a 1 mn exposure time. We perform new frequency analysis and hydrodynamical studies of the RR Lyrae star: S Arae. Our results show that S Arae is "bona fide" a Blazhko star with high multiplet structures and new phenomenological descriptions of the light curve variation.

The hump and the bump are clearly marked and the ascending branch of the light curve occurs during a very small phase interval, the so-called rising time, corresponding to ~10 % of the pulsation period. There are significant differences in the ligh curve ascending branch from one pulsation cycle to another one due to the irregularity mechanisms in the atmosphere caused by the existence of an hypersonic shock wave. We conclude that high-precision CCD photometry with exceptional time coverage can be undertaken at Dome C in Antarctica and be successfully used to gain an understanding of the Blazhko effect.

NOTES:

A Cepheid Distance to the Antennae

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[1]Texas A&M University, [2] Johns Hopkins University

An accurate measurement of the Hubble constant provides important constraints on the equation of state of dark energy. Currently, the most robust determination of H_0 is based on Cepheid distances to nearby type Ia supernovae. The occurrence of SN 2007sr in the Antennae (NGC 4038/39) provides an important additional calibrator for this method, since this galaxy pair is within a distance that Cepheid variables can be resolved with HST.

We have recently obtained a set of 12 epochs of WFPC2 images which we have analyzed using a previously obtained set of ACS data as reference. An earlier WFPC2 image was also included in our study. We present preliminary periods and magnitudes of Cepheids in this galaxy pair and derive a tentative distance.

JMC acknowledges support by the Department of Education through the GAANN Fellowship Program

NOTES:

Is HD147787 a Double-lined Binary with Two Pulsating Components?

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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 (v sin i ~ 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 (1) present a new orbital solution based on all available spectroscopic data and (2) discuss the possibility that both components are pulsating stars.

NOTES:

Towards Asteroseismology of Main-sequence g-mode Pulsators: Spectroscopic Multi-site Campaigns for Slowly Pulsating B Stars and gamma Doradus Stars

P. De Cat[1], D. J. Wright[1], K. R. Pollard[2], F. Maisonneuve[2], P. Kilmartin[2], H. Lehmann[3], S. Yang[4], E. Kambe[5], S. Saesen[6], D. Mkrtichian[7], and L. Mantegazza[8]

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In 2007, we started a project, dedicated to main-sequence g-mode pulsators, to improve the mode identification techniques for g-mode pulsators and to study the relation between rotation and pulsation from an observational point of view. We therefore selected a sample of slowly pulsating B stars and gamma Doradus stars with a significant spread in projected rotational velocity as targets for dedicated spectroscopic multi-site campaigns. The main goal of these multi-site campaign is to provide both a reliable identification of the strongest modes (degree l and azimuthal number m) and severe restrictions on stellar parameters (including the effective temperature, surface gravity, metallicity, inclination and rotation speed), making asteroseismic modelling to become possible for these types of stars. Currently, 11 observatories, which all have excellent high-resolution spectroscopic facilities, are involved in our observational efforts. In this poster, we introduce the sample of selected objects and give an overview of the multi-site campaigns, and their first results, that have been organised up to now.

NOTES:

AGB Variables in the Local Group Dwarf Galaxy NGC 6822

Serge Demers[1] and Paolo Battinelli[2]
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We present preliminary results of a 4 year NIR variable star survey of NGC 6822. The first 32' x 32' field yielded 28 periodic variables, with periods ranging from 124 to 1100 days, along with 24 irregular variables. Cross identification with known carbon stars of NGC 6822 reveals that: 1- Nearly 60% of these variables are carbon stars; 2- Among the cyclic variables, ~75% of carbon stars have periods P < 400 days suggesting ages > 3 Gyr. The analysis of the second field, symmetrical to the first one, will allow a global investigation of the spatial distribution of various variable types.

NOTES:

Simultaneous MOST Photometry and High-resolution Spectroscopy of Spica, a Binary System with a Massive Beta Cep Star Component

Maarten Desmet[1], G. Walker, S. Yang, D. Bohlender, R. Oestensen, M. Briquet, C. Aerts, J. Matthews, C. Cameron, R. Kuschnig, and the MOST satellite team
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We present the results of a unique observational study of Alpha Virginis (Spica), a binary system with a primary component of beta Cep type. We exploit simultaneous high-precision photometry obtained by the MOST satellite and numerous high-resolution spectroscopic observations. By disentangling the spectra of this binary and by combining both datasets, we get the first accurate determination of the orbit. In addition, we detect and investigate the stellar pulsations of both components. Spica is a promising case study for asteroseismic modelling of a massive star in a close binary system.

NOTES:

Comparison of Frequency Determinations of Slowly Pulsating B Stars from Stromgren and Geneva Data

Robert J. Dukes, Jr.
The College of Charleston

Slowly Pulsating B Stars have been on the observing program of the Four College Consortium Automatic Photometric Telescope (FCAPT) since shortly after its commissioning in 1989. Many of the same stars have also been observed by the Mercator telescope. Since these telescopes are separated by approximately 6 hours of longitude there is little overlap in the time of observation of any target. Also the APT observations are obtained with Stromgren filters while the Mercator observations are with the Geneva filters. Since neither the time of observation, the filter set, or the telescope are the same we feel that frequency determinations from the two data sets should be essentially independent. Thus the occurrence of the same frequency in both data sets should be a good indication of its reality. In this paper we compare the frequency spectra of five of these stars (HD1976, HD21071, HD25558, HD222555, and HD182225). Doing this allows us to verify the strongest frequencies of each star as well as some of the weaker terms. We have also attempted to combine our Stromgren y measures with Geneva V measures. We have found that the results of using the combined data sets are in general no better than those from either of the two subsets except for the ability to decide between one cycle per day aliases. This work has been supported in part by NSF grants #AST86-16362, #AST91-15114, #AST95-28906, and #AST-071260 to the College of Charleston.

NOTES:

Multi-mode Cepheids in the LMC – Challenges for Theory

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The OGLE-III catalog of the LMC Cepheids (Soszynski et al., 2008) contains a large number of Cepheids with more than one mode excited. We confronted data on these objects with results from model calculations. Models that are consistent with observational data are not always in agreement with published evolutionary models. The greatest challenge for theory is explanation of doublemode pulsators with period ratios near 0.6.

NOTES:

Detection of Stellar Pulsations in the Planet Host Star Gamma Cephei A by High Precision Radial Velocity Measurements

Michael Endl[1], Jacob Bean, Robert A. Wittenmyer, Artie P. Hatzes, and William D. Cochran
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The Gamma Cephei system is a binary system with a K1 III-IV primary and a M4 V secondary in a 66 year orbit. A planetary companion with a minimum mass of 1.6 M_Jup was found in a 900 day orbit around the primary. We used 7 nights at the Harlan J. Smith 2.7 m telescope at McDonald Observatory to carry out an asteroseismology campaign of gam Cep A to search for stellar oscillations. We obtained ~1200 spectra with the Coude spectrograph to measure very precise radial velocities. Pulsations with an amplitude of ~10 m/s and a period of ~1.5 hours are clearly detected. These data could help to distinguish between a primordial high metallicity of the star and the alternative accretion scenario, where the outer convection zone of the star was enriched in metals by in-falling rocky material.

NOTES:

The Globular Cluster M69: Variable Stars and New CCD BV Color-Magnitude Diagram

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We present a photometric study and a variable star search for the metal-rich Galactic globular cluster M69 (NGC~6637). Time-series BV images were collected over a one-week run at the Warsaw 1.3 m telescope at the Las Campanas Observatory in April 2003. The photometry was performed using DAOPHOT II/ALLFRAME and the variable star search was made with ISIS package (v2.2) and the TRIAL routine of ALLFRAME.

Our color-magnitude diagram (CMD) shows a red horizontal branch (HB) typical of moderately metal-rich clusters as M69, with significant contamination by field stars. We perform a statistical decontamination, thus obtaining a cleaner CMD, well defined in all its sequences.

In our search for variable stars we found 62 candidates, 54 of which are new discoveries. As expected, the majority of these new variable stars are short- period variables. Among them we have found 13 eclipsing binaries, 11 RR Lyrae stars, and 5 SX Phoenicis stars. We were also able to detect 18 long-period variable star candidates, but no period determination or light curve construction was possible due to the limited timespan of our observations. In the case of the 9 new RR Lyrae star candidates, cluster membership is still being analyzed for 3 of these stars (including a very long-period ab-type star), and discarded for the remainder of the candidates. A possible RR Lyrae star population in M69 would be key to establishing the cluster's relation to other RR Lyrae-rich, moderately metal-rich globular clusters, such as NGC~6441 and NGC~6388.

NOTES:

Stromgren Photometry of the Delta Scuti Stars 7 Aql and 8 Aql

L. Fox Machado[1], M. Alvarez[1], L. Parrao[2], and J. H. Pena[2]
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uvby-beta photoelectric photometry of the Delta Scuti stars 7 Aql and 8 Aql are presented. The observations of 7 Aql and 8 Aql were carried out over the period of June 21 and July 8, 2007 at the Observatorio Astronomica Nacional, San Pedro Martir, Mexico. The physical parameters of both stars are estimated from Stromgren and Hbeta photometry and used as input physics to determine their evolutive status. A mode identification by means of multicolour photometry was attempted.

NOTES:

CCD Photometry of the Pleiades Delta Scuti Star V650 Tauri

L. Fox Machado[1], R. Michel[1], M. Alvarez[1], C. Zurita[2], and J. N. Fu[3]
[1]Observatorio Astronómico Nacional, Instituto de Astronomía–Universidad Nacional Autónoma de México, [2]Instituto de Astrofísica de Canarias, [3]Department of Astronomy, Beijing Normal University

We present the preliminary results of a multi-site photometric campaign carried out in Novembre 2008 on the Pleiades Delta Scuti star V650 Tauri. A period analysis of these data allow us to detect at least five pulsation modes in the target star. A preliminary comparison between observed and theoretical frequencies is also performed.

NOTES:

Bi-site Observations of the SX Phoenicis Star GP Andromedae

J.-N. Fu[1], T. Pribulla[2], and Q. Zha[1]
[1] Department of Astronomy, Beijing Normal University, China, [2] Astronomical Institute, Slovak Academy of Sciences, Slovakia

The high-amplitude δ Scuti star GP And was observed at the Xinglong station of China and astronomical institute of Slovakia between August and December of 2007. During this period we obtained 30 nights of CCD photometric data for the stars in the field of GP And. These bi-site observation data allow us to study the pulsations of GP And in details, and detect the variability of the stars in the field. The preliminary results are presented.

NOTES:

Mid Infrared Observations of Cepheids Using VLT/VISIR: More Evidence for Circum-stellar Environments

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[1]ESO Chile, [2]Observatoire de Paris

We present here our recent results obtained using the mid infrared imaging instrument VISIR, at the ESO VLT. Using a combination of short exposures and lucky imaging, we obtained diffraction limited (for an 8m telescope) images of Cepheids. We detected circum stellar envelopes (CSE) both photometrically and spatially, at a fraction of an arc-second scale. These CSE, most probably due to mass loss, represent a significant bias to distance determination using Baade-Wesselink methods, using surface brightness of interferometric method. This observational study is part of multi instruments/technics effort we are carrying over to detect and characterize CSE.

NOTES:

Searching for Variable Stars in Galactic Open Clusters

Claudia Greco
Observatoire de Geneve, Switzerland and Geneva University, Switzerland

A sample of Galactic Open Clusters have been periodically observed at the Euler 1.2m Swiss Telescope in La Silla (Chile), on a time baseline of almost 6 years. Geneva U,B,V photometry has been obtained for all of them on a field of view of 11 arcmin x 11 arcmin. Time series of more than 2000 V images for each cluster are searched for variability. Details about the method and the results are described in the poster. The sample of clusters cover a wide range of metallicities and age properties. The goal is to fully characterise the variable stars in these clusters to better understand the link between the properties of a cluster and its variable star content.

NOTES:

Galactic Halo Formation: The Role of Pulsating Stars

Claudia Greco

Observatoire de Geneve, Switzerland and INAF – Osservatorio Astronomico di Bologna

Lambda-cold-dark-matter hierarchical models of galaxy formation suggest that the halo of the Milky Way (MW) has been assembled, at least in part, through the accretion of protogalactic fragments partially resembling the present-day dwarf Spheroidal (dSph) satellites of the MW. A number of Galactic halo fragments as well as a fraction of the halo globular clusters (GCs) may thus originate from dSph's that were accreted by the MW. Investigation of the stellar populations of the MW dSph companions can thus provide excellent tests to infer the dominant Galaxy formation scenario, whether merger/accretion or cloud collapse. Pulsating variable stars offer a very powerful tool in this context, since variables of different types allow to trace the different stellar generations in a galaxy and to reconstruct the galaxy star formation history and assembling back to the first epochs of galaxy formation. In particular, the RR Lyrae stars, belonging to the old population ($t > 10$ Gyrs), eyewitnessed the epoch of the halo formation, and thus hold a crucial role to identify the MW satellites that may have contributed to build the Galactic halo. In the MW, most of the GCs with an RR Lyrae population sharply divide into two distinct groups (Oosterhoff types I and II) based on the mean periods and the relative proportion of the fundamental mode (RRab) and first overtone (RRc) RR Lyrae stars. Among the Galactic GCs, a clear gap separates the two Oosterhoff types, with no cluster intermediate between the two groups. On the other hand, the Galactic halo field RR Lyrae stars show a dominance of Oosterhoff I properties.

The work we present here has been focused on the identification of the possible 'building blocks' of the Galactic halo, by investigating the Oosterhoff properties of a number of different stellar systems starting from relatively undisturbed dwarf galaxies (the Fornax dSph and its globular clusters), through distorted and tidally disrupting ones, as the dSphs recently discovered by the SDSS (the Bootes and Canes Venatici II dSphs), to possible final relics of the disruption process (the Galactic globular cluster NGC2419). We are addressing the crucial question of whether the RR Lyrae pulsation properties in these systems conform to the Oosterhoff dichotomy characterizing the MW variables. If they do not, the Galaxy's halo cannot have been assembled by dSph-like protogalactic fragments resembling the present-day dSph companions of the MW. In order to make a comprehensive and deep study of the variable star population in these stellar systems we have been reducing and combining long time series from different telescopes, both ground and space based. Variable stars have been detected with the image subtraction techniques, as performed by the package ISIS2.1. Periods, Amplitudes and Oosterhoff type for all the variable stars, as well as Color-Magnitude diagrams of the stellar populations are discussed in the poster for each single stellar clusters analyzed in this project.

NOTES:

High-Resolution Magnetic Field Measurements of RR Lyrae Stars with SemPol

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For more than 30 years, there have been attempts to explain the Blazhko effect of RR Lyrae stars with the presence of strong magnetic fields. These so called magnetic models are counted among the most promising explanations for the century old puzzle of the Blazhko effect. The measurements of magnetic fields in RR Lyrae stars, however, have for a long time been sparse and contradictory. In December 2007 and 2008 we devoted an observing campaign to the measurement of magnetic fields of a sample of bright RR Lyrae pulsators using the SemPol instrument at the 3.9m Anglo Australian Telescope. Results and challenges of this campaign are presented on this poster.

NOTES:

Asteroseismology of Hybrid Pulsators Made Possible: Simultaneous MOST Space Photometry and Ground-based Spectroscopy of γ Peg

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We have acquired simultaneous high-precision space photometry and radial velocities of the bright hybrid β Cep/SPB pulsator γ Peg. Frequency analyses reveal the presence of six g modes of high radial order together with eight low-order β Cep oscillations in both data sets. Mode identification shows that all pulsations have spherical degrees ℓ=0-2. An 8.5 $M_{\odot}$ model reproduces the observed pulsation frequencies; all theoretically predicted modes are detected. We suggest, contrary to previous authors, that γ Peg is a single star; the claimed orbital variations are due to g-mode pulsation. γ Peg is the first hybrid pulsator for which a sufficiently large number of high-order g modes and low order p and mixed modes have been detected and identified to be usable for in-depth seismic modelling.

NOTES:

Masses and Pulsation Modes in Eclipsing delta Scuti Systems

Doug Hoffman
New Mexico State University

Delta Scuti stars in eclipsing systems are very rare, with only a few dozen known and even fewer are well studied. Eclipsing systems offer the unique opportunity to determine the masses of each component from orbital parameters and to compare that to the masses expected from pulsational mode analysis. Using from the Apache Point Observatory and the New Mexico State University 1-meter telescope, we present radial velocity and multi-color light curves of several eclipsing delta Scuti systems. From these data we have been able to extract the pulsational frequencies and masses of some of the stars. We also present our discovery of a new eclipsing delta Scuti extracted from the Northern Sky Variability Survey and followed up with additional observations. Additionally, the relationship between the orbital and primary pulsational periods of these systems is reexamined with the data from this study.

NOTES:

Cepheids and Long-Period Variables in NGC 4258

Samantha L. Hoffmann[1], Lucas M. Macri, and Anne Pellerin
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We present preliminary results of a survey for Cepheids and long-period variables in NGC 4258. This galaxy plays a key role in the Extragalactic Distance Scale due to its very precise and accurate maser-based distance. Our observations were obtained at the Gemini North Observatory in the gri bands over 22 epochs spanning 4 years.

We have discovered long-period Cepheids which we have used to extend the P-L relation in this galaxy beyond its previous limit of P<45 days. This will enable a more accurate calibration of the P-L relation in this important galaxy. Additionally, we have identified long-period variables and present their properties.

We acknowledge support by NASA through the following grants:
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NOTES:

Periodic Light Variability in Twelve Carbon-rich Proto-Planetary Nebulae

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We present the results of a long-term (14 year) photometric monitoring program of 12 carbon-rich proto-planetary nebulae (PPNs). PPNs are objects in the evolutionary transition between the AGB and planetary nebula phases. These 12 have bright central stars (V=8-14 mag) with F-G spectral types and faint nebulae (as seen with HST). All of the objects show a periodicity in their light variations, although there is evidence for small period changes or secondary periods. The periods range from 35 to 153 days, with the longer periods correlated with later spectral types. In fact, a tight correlation is seen between the period and effective temperature. The light variations range from 0.15 to 0.5 mag and are larger for the cooler objects. The observations were all made with the Valparaiso University Observatory 0.4-m telescope and CCD. This research is partially supported by NSF grant 0407087 and the Indiana Space Grant Consortium.

NOTES:

Correlation Between a Light Outburst and Pulsations in a CoRoT Be Star

Anne-Laure Huat
L'Observatoire Astronomique de Paris-Meudon

A B0.5IVe star observed with CoRoT during the LRA1 run presented an outburst of moderate amplitude (0.03 mag). The analysis of its light curve revealed many frequencies in the Fourier spectrum typical of p and g modes with amplitude variations along the run closely correlated to the outburst. The simultaneous spectroscopic observations allowed us to identify some p modes. Using these results, we performed a preliminary seismic modelling of the Be star taking into account its rapid rotation.

NOTES:

Near-infrared (J, H, and K) Monitoring Survery Toward Magellanic Clouds Using IRSF/SIRIUS at South Africa Observatory, First Results

Yoshifusa Ita and the IRSF/SIRIUS team
National Astronomical Observatory of Japan

We carried out a near-infrared (J, H, and K) monitoring survey toward Magellanic Clouds using IRSF/SIRIUS at South Africa observatory since Dec. 2000 until Apr. 2008. We would like to present some first results from this survey.

NOTES:

Seismic Inversion Methods

Jason Jackiewicz
New Mexico State University

With the rapid advances in sophisticated solar and stellar modeling, coupled to the abundance of high-quality solar and stellar pulsation data, efficient and robust inversion techniques are crucial for seismic studies. We present several variations of a fast new optimally localized averages (OLA) inversion method with examples applied to time-distance helioseismology. The inversion is applicable to other fields of solar seismology and asteroseismology as well.

NOTES:

Variable Stars in the LMC Globular Cluster NGC 2210

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We obtained B,V CCD images taken with CTIO 0.9-m telescope for the LMC globular cluster NGC 2210 on 14 nights in December 2007 and January 2008, and on 9 nights in December 2008. Now, photometry and searching variable stars in the NGC 2210 was finished. The total number of variable stars are about fifty-six: about 30 RRab stars, about 11 RRc stars and about 15 other type variable stars. We will present the processes of observations, photometry and searching variable stars, and also preliminary results for the physical characteristics of variable stars in NGC 2210.

NOTES:

The Domain of δ Scuti Stars: CoRoT IRa01 Results

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[3]IEEC, Spain

We present the first results of determining the δ Scuti population observed with CoRoT during the Initial Run (IRa01). From more than 10000 stars observed continuously in the exoplanet-channel during 58 days, 397 stars show pulsation in the δ Scuti domain. For 39 of the 397 stars low resolution classification spectra and Strömgren uvby photometry were available, thus fundamental parameters like effective temperature and surface gravity could be derived. Classical Fourier techniques and least squares multi-sine fits were applied to identify the pulsation frequencies. For additional 90 stars a pairs of radial modes were found and by comparing with pulsation models it was possible to test the corresponding fundamental parameters and compute a HRD diagram.

NOTES:

A Preliminary Estimate of Hubble's Constant Using SNIa Data and OGLE III Cepheids in the LMC

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We present very preliminary result on the estimation of Hubble's constant via a calibration of the SNIa Hubble diagram using a linear and non-linear PL relation in the LMC obtained from OGLE III data. We find our estimate vary from those derived using OGLE II data and morevover there is a 5% difference in the estimated value of H0 depending on whether a linear or non-linear PL relation is assumed.

We discuss possible reasons for this result.

NOTES:

Spectroscopic Study of NSVS RR Lyrae Stars

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The Northern Sky Variability Survey (NSVS) is an all-sky photometric survey of variable objects found within 7 kpc of the solar neighborhood. The NSVS probes the disk and inner halo components of the Milky Way Galaxy. Field RR Lyrae (RRL) variable stars have been identified and analyzed. We have begun a campaign to obtain spectra for many of these new RRL stars. Low resolution spectra were obtained using the Dual Imaging Spectrograph on the 3.5m telescope at Apache Point Observatory over a span of 2 years. We have collected 65 spectra of the NSVS RRL stars, which were selected for their possible membership of the thick and thin disk components. We have also included RRL stars with long periods (P > 0.75 days) to our study in order to investigate peculiarities in chemical abundance. This second study is done in conjunction with data from high resolution echelle spectra. We present the driving science and goals of these projects, and preliminary results from the low resolution spectra.

NOTES:

Search for Pulsating Stars in the Globular Cluster M80 from Ground and Space Observations

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In the last two decades we observed a rapid increase in the number of variable stars detected in Galactic globular clusters. The main reason for this was the invention of the image subtraction method of photometric reductions and its application to CCD data obtained with small telescopes for mostly northern, bright globular clusters. The image subtraction method enables making a complete inventory of bright variable stars, such as RR Lyrae variables, because it works well in crowded stellar fields in the cluster core. However, there are still many globular clusters poorly searched for variable stars, especially pulsating stars of the RR Lyrae and SX Phoenicis types. In this context, we present results of a variability analysis for the southern cluster M80 which in previous studies was shown to contain a very large population of blue stragglers. From ground-based data, we have detected 8 new RR Lyrae stars; this is more then a twofold increase in the number of stars of this type in the cluster. Revised mean period of RRab stars and relative percentage of RRc stars confirm that M80 belongs to the Oosterhoff's II group of globular clusters. Moreover, we have found 3 SX Phoenicis stars. In two pulsating stars we discovered oscillations with two close frequencies, which indicates excitation of non-radial modes. Since spatial resolution of our ground data is too low for identifying individual faint stars in the cluster core, we also used archival HST observations in our search for SX Phoenicis stars. From these sparse data we were able to discover several candidate SX Phoenicis variables.

NOTES:

RR Lyrae in LMC Globular Clusters

Charles Kuehn
Department of Physics and Astronomy, Michigan State University

We present preliminary results from a study of five globular clusters located in the Large Magellanic Cloud. The goal of this project is to carry out a large, systematic study of the behavior of RR Lyrae stars in Oosterhoff-intermediate globular clusters. The LMC is an ideal target for a study of this sort as it contains Oosterhoff-intermediate clusters as well as Oo-I/II clusters. We seek to answer three main questions. 1.) Are there double-mode RR Lyrae stars (RRd) in Oo-intermediate clusters and if so how do their properties compare to RRd stars in Oo-I/II cluster? 2.) How do the positions of RR Lyrae stars on the Bailey diagram differ between stars in Oo-intermediate clusters compared to those in Oo-I/II clusters? 3.) How do the Fourier decomposition parameters of RR Lyrae stars change when going from Oo-I/II clusters to Oo-intermediate ones? We present Oosterhoff classifications and sample light curves for some of the clusters in our study and discuss their Fourier parameters. We also discuss the implications of our findings on the nature of the Oosterhoff dichotomy and what that implies about Milky Way formation.

NOTES:

Towards Accurate Component Properties of the Hyades Binary Theta 2 Tauri

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The fortunate combination of a pulsating star in a binary system, for which independent constraints on the system's geometry and on the physical properties of the components can be derived, represents a fantastic opportunity for progress in stellar evolution and pulsation modelling. We selected the detached, "single-lined" Hyades binary θ_2 Tau comprising two mid-type A-stars for a detailed spectroscopic investigation of old as well as new high-resolution spectra. Its brighter component, component A, is a well-known δ Scuti star which shows a complex pattern of pulsations. The secondary component is also located in the lower Cepheid instability strip and a potential δ Scuti star. Nothwithstanding the heavily blended lines in the observed composite spectra due to the fast rotation of the secondary component - which previously impeded an accurate determination of the mass ratio of this system - and using a spectra disentangling algorithm, we obtained the component spectra and two sets of radial velocities associated to a new spectroscopic orbit from the analysis of 114 echelle spectra. Combining both spectroscopy and long-baseline optical interferometry, we were able to derive the orbital parallax and the component masses with unprecedented accuracy. The future perspectives of this work are (a) a confrontation of stellar evolution models for the Hyades cluster (both stars are located in the turn-off region of the cluster) (b) an accurate determination of the chemical composition of two Hyades members and (c) a more reliable pulsation modelling for the pulsating component(s).

NOTES:

The Calibration of the P-factor in Baade-Wesselink Radii for Classical and Dwarf Cepheids

C. D. Laney and M. D. J. Joner
West Mountain Observatory, Utah

The Baade-Wesselink method with VJK photometry was shown to give apparently precise results, free of obvious systematics with phase, surface gravity and microturbulence, by Laney and Stobie (1995). Here we extend the empirical calibration of the p-factor in Feast et al. (2008) to a maximal sample of galactic classical Cepheids. HADS or dwarf Cepheids have been shown to follow the same PL relation (at least for high-metallicity objects), and sample of these is therefore added in order to extend the period range and examine the behavior of the p-factor with period. The period dependence is in reasonable agreement with the calculations of Nardetto et al. (2007). The zero point is then compared to a new determination of the red clump distance to the LMC.

NOTES:

The Distance to the LMC from Red Clump Stars, and the Metallicity Correction to the Cepheid PL Relation

C. D. Laney[1] and G. Pieterzynski
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Precise new K-band observations of the brightest red clump stars are used to determine the distance to the LMC. The Cepheid PL relation in the LMC is shown NOT to have a break in slope at 10 days, and the galactic, LMC and SMC PL relations are used to determine empirical metallicity corrections to the Cepheid PL zero point.

NOTES:

Discovery of RR Lyrae Stars in M31 Globular Clusters

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A rich harvest of RR Lyrae stars has been detected for the first time in the globular clusters of the Andromeda galaxy (M31), based on F606W and F814W time-series data obtained with the WFPC2 on board the HST, as part of an observing program (PI G. Clementini) to study the variable star population in the field and globular clusters of M31.

About a hundred RR Lyrae stars have been discovered on the horizontal branch of the metal-poor globular cluster B514 ([Fe/H]=-1.8), one of the brightest clusters in the halo of Andromeda and several tenths in other five M31 clusters spanning the range from -1.1 to -1.8 in [Fe/H]. With the additional help of archival ACS and WFPC2 data periods have been obtained with a good level of accuracy (3rd-4th decimal digit) and well defined light curves have been constructed.

The pulsation properties and "Oosterhoff type" of the RR Lyrae stars in the M31 clusters are discussed and compared with those of the Milky Way globular clusters for a critical analysis of the respective stellar population characteristics.

NOTES:

Analysing Solar-like Oscillations with an Automatic Pipeline

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Kepler mission will provide a huge amount of data during the next few years, among which hundreds of solar-like stars will be targeted. The amount of stars and their observation length represent a step forward in the comprehension of the stellar evolution that has already been initiated by CoRoT and MOST missions. Up to now, the slow cadence of observed targets allowed an individual and personalized analysis of each star. With Kepler, this will be impossible.

This is the reason why, within the AsteroFLAG team, we have been developing pipelines for the Kepler solar-like oscillation stars. Our code starts by finding the frequency-range where p-mode power is present and, after fitting the background, it looks for the mode amplitudes as well as the central frequency of the p-mode hump. A good estimation of the large separation can thus be inferred in this region. If the signal to noise is high enough, the code obtains the characteristics of the p modes by doing a global fitting on the power spectrum.

Here, we will first describe a few features of this pipeline and its application to AsteroFLAG synthetic data to check the validity of the code. Finally, we will show the results obtained on some targets already observed by CoRot.

NOTES:

Period-Luminosity Relations for Type II Cepheids

Noriyuki Matsunaga[1], Michael W. Feast, and John W. Menzies
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JHKs magnitudes corrected to mean intensity are estimated for type II Cepheids in the OGLE-III survey. Period-luminosity (PL) relations are derived in JHKs as well as in a reddening-free VI parameter. Within the uncertainties the BL Her stars (P<4d) and the W Vir stars (P=4 to 20d) are co-linear in these PL relations. Using the pulsation parallaxes of nearby type II Cepheids, V553 Cen and SW Tau, the data lead to an LMC modulus uncorrected for any metallicity effects of 18.46±0.10 mag. It is suggested that the Galactic variable kappa Pav is a member of the peculiar W Vir class found by the OGLE-III group in the LMC. The LMC RV Tau stars, as a group, are not co-linear with the shorter-period type II Cepheids in the infrared PL relations in marked contrast to such stars in globular clusters. Other differences between LMC, globular cluster and Galactic field type II Cepheids are also discussed.

NOTES:

The IRSF/SIRIUS Survey of Miras Toward the Galactic Center

Noriyuki Matsunaga and the IRSF/SIRIUS team
Kyoto University, Japan

We report a result of our near-infrared survey for variable stars in a field-of-view of 20'*30' toward the Galactic center. We have detected 1364 long-period variables, among which 343 variables are identified with the variables reported in Glass et al. (2001). We establish a method of using the period-luminosity relation in JHK to estimate distance and extinction at the same time. These two values can be obtained for Miras with period between 100 and 350 days and mean magnitudes in two or more bands. We obtained the distances and extinctions for more than 150 Miras. We find that most of them are located at the same distance within our accuracy. As a barycenter of the stellar population with these Miras, we estimated the distance modulus of the Galactic center at 14.50±0.02 (stat.) ±0.15 (syst.) mag, i.e. 8.0±0.07 (stat.) ±0.55 (syst.) kpc, with the assumed distance modulus to the LMC of 18.39 mag. We also discuss large and highly variable extinction toward the Galactic center. The amount of extinction ranges from 1.5 mag to larger than 4 mag in A(K) except toward thicker dark nebulae and it complicatedly changes with lines of sight. The foreground extinction of the region near Sgr A* is estimated at A(K)=2.9 mag.

NOTES:

The Effect of Pulsational Opacity Fluctuations in the Atmospheres of A Stars

T. R. Medupe[1], J. Christensen-Dalsgaard, D. W. Kurtz, and M. Phorah
[1]University of Cape Town and South African Astronomical Observatory

We present a computer code that solves radial pulsation equations with consistent treatment of radiative transfer. The code is used to investigate the effects of pulsational opacity flactuations in the atmospheres of A star models. We find that the flactuations are responsible for the "bump" often seen in the temperature eigenfunctions near the region of the hydrogen ionization zone. We also derive a formula that relates perturbations in the surface flux to those in Teff. This formula shows that for cooler A stars, opacity flactuations can introduce a phase difference between perturbations in surface flux and those in Teff. The new formula can used for mode identification of radial modes.

NOTES:

Frequency Analysis of the roAp star: HD 217522

T. R. Medupe
University of Cape Town and South African Astronomical Observatory

We describe our recent analysis of the frequency content of the cool (Teff ~ 6750 K) roAp star HD 217522 (= BP Gru) originally discovered by Kurtz (1983, MNRAS, 205, 3).

NOTES:

The Combined CORALIE+UVES+UCLES Time Series of α Cen A: Preliminary Results

A. Miglio[1], de Meulenaer[1], F. Carrier[2], T. Bedding[3], F. Bouchy[4], P. Eggenberger[5,1], H. Kjeldsen[6], J. Montalbán[1], et al.

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The lack of long and uninterrupted observations of α Centauri A prevents to derive an accurate set of seismic constraints to compare to models, limiting the seismic inferences on the internal structure of our closest stellar neighbour.

In this work we combine and analyse the radial velocity time series obtained in 2001 in Chile and Australia with three spectrographs: CORALIE, UVES and UCLES. While the resulting combined time series is as long as the CORALIE one (12.45 days), it contains almost 5 times more data points, and allows to reduce by a factor ~2.5 the 1-d^{-1} alias peaks in the window function. Fifty two frequencies, in overall good agreement with previous studies, have been detected along with several rotational splittings. New values for the large $\Delta\nu$ and small separations ($\delta\nu_{02}$, $\delta\nu_{13}$, d_{01}) have been derived.

A first comparison with stellar models indicates that the seismic constraints determined in this study (namely d_{01} and $\delta\nu_{13}$) allows to set an upper limit to the amount of convective-core overshooting needed to model stars of mass and metallicity similar to those of α Cen A.

NOTES:

The Enigma of B-type Pulsators in SMC

A. Miglio, S. Salmon, J. Montalbán, et al.
University of Liege, Belgium

Since the early nineties it is accepted that the excitation mechanism of B-type pulsators on the main sequence is due to the opacity peak in the Iron elements group at T~200,000 K. The content of Fe plays then a major role in the excitation of β Cep and SPB pulsations. Well then, while theoretical non-adiabatic computations predict no β Cep pulsators for low metallicity environments such as that of the Magellanic Clouds (MC), and only a small number of SPBs, recent observations and analysis of Small MC variability report the detection of a significant number of SPB and β Cep candidates.

Since SMC is the least metallic (Z~0.001-0.004) of the MC, it becomes an interesting object for investigating the disagreement between theory and observation, that is the main aim of this poster.

We approach the problem calling into question some of the hypothesis at the base of previous studies: given the different chemical evolution of SMC compared with our local galactic environment, it is appropriate to describe the chemical composition of SMC B-stars by scaling the solar mixture to lower Z? Is that composition uniform in space and time?

Different studies in the literature suggest in fact a clear increase of metallicity in B-stars populations in the SMC. In this poster we present the results of the stability analysis of B-type stellar models computed with such revised chemical composition and metallicity, and we derive as well the minimum value of Z required to excite β Cep and SPB-type oscillations in SMC.

NOTES:

Study of the Nature of the Lambda Bootis Star 29 Cygni Using Asteroseismology

Andres Moya
Instituto de Astrofisica de Andalucia – CSIC, Spain

Up to now, all the possible explanations of the chemical peculiarities of the lambda bootis stars are focused in superficial phenomena. The present talk changes the object of this discussion. The lambda bootis nature of the multiperiodic Delta Scuti star HD 192640, through a comprehensive asteroseismic modelling, is studied. Some of the most recent asteroseismic tools are used to check for the first time whether the observed low metallicity is internal, i.e., intrinsic, present throughout the star, or due to superficial processes as accretion, diffusive settling, radiative levitation, mass loss, etc. The modelling method uses some of the most recent tools, including: 1) effects of rotation on equilibrium models, on the adiabatic oscillation spectrum, and its influence in multicolour observables, 2) non-adiabatic stability of radial and non-radial modes, 3) inclusion of the atmosphere-pulsation interaction for a more accurate multicolour mode identification, and 4) ratio between radial modes n=4 and n=5 in the framework of Petersen diagrams. The analysis performed reveals that the models fulfilling all the constraints are those in the middle of the Main Sequence, with sub-solar metallicity, except some other unlikely possibilities. Therefore this study does not support the idea of the lambda bootis stars being ZAMS or Pre-MS stars interacting with their primordial cloud of gas and dust, but suggest the explanation of their nature as sub-metallic MS objects. Nevertheless, more accurate multicolour photometric observations are required for a more conclusive study using the procedure here presented, since the observational errors are too large for a definitive rejection of any of the possible explanations.

NOTES:

IRAC Band Period-Luminosity Relations from LMC Cepheids: Application to Three Nearby Galaxies

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It is well-known in the cosmology community that an accurate determination of the Hubble constant (Ho), to within few percent, can be used to break the degeneracy between Omega_M and Ho in CMB measurements. The current uncertainty in Ho from the HST Key Project is about 10%. In contrast, future observations by the James Webb Space Telescope (JWST) have the potential to deliver an Ho measurement accurate to under a few percent. This is because JWST will operate in the infrared, thus significantly reducing the influence of extinction. Motivated by this, we derive Spitzer IRAC band period-luminosity (PL) relations from LMC Cepheids which can be applied to future distance scale measurements with JWST. To test these PL relations, we search for extra-galactic Cepheids in three nearby galaxies using Spitzer Archival data and use these relations to derive the distances to these galaxies. We compare our results to other distance measurements, especially those using optical PL relations.

NOTES:

The Effect of Stellar Pulsation Cycles on Dust Formation: A Temporal Study of the Mid-infrared Spectrum of O-rich AGB Star, T Cep

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University of Missouri-Columbia

Pulsation is believed to be the driving mechanism behind mass loss and dust formation around AGB. We present a temporal study of T Cep, a long-period Mira variable. T Cep was observed by ISO using SWS seven times in a 16 month period, providing a great opportunity to test hypotheses that link pulsation, stellar variability and dust formation. We present analyses of these spectra which show how the spectral dust features change over the variability cycle of this Mira and compare the results with competing dust formation hypotheses. In general, the overall apparent changes in spectral feature strengths can be attributed to changes in the underlying dust continuum temperature, resulting from the intrinsic pulsation cycle of the central star. However, not all feature changes are so easily explained. In particular, the classic interpretation of the broad complex of features cannot be attributed to a simple mixture of alumina and glassy silicate. The peak features at 9.7, 10.8, 11.3, 13.1 micron are better explained by crystalline silicate or mixtures of crystalline silicate and alumina. We interpret these results in terms of the effect of the star's pulsation on dust formation and processing.

NOTES:

Two-Dimensional Hydrodynamical Simulations of Cepheids and RR Lyrae

Andrew J. Onifer and J. Robert Buchler
University of Florida

Convection plays a crucial role in the behavior of Cepheid and RR Lyrae stars. One-dimensional approximations, such as mixing length and its extensions, are not always adequate. A proper modeling of convection naturally requires multi-dimensional analysis. However, multi-dimensional simulations have proven to be a challenge due to the large range in physical parameters and the need to apply a moving mesh that is capable of adapting to and resolving the regions of sharp temperature gradients, such as the partial H ionization region and the convective boundaries, this without introducing numerical instabilities. We are presenting results from our 2D hydrodynamical simulations of RR Lyrae models.

NOTES:

Modelling Hybrid Beta Cep/SPB Pulsations - Gamma Pegasi

A. A. Pamyatnykh and T. Zdravkov
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Hybrid variables in the upper part of the main sequence show simultaneously two different types of pulsations: (i) low-order acoustic and gravity modes of the Beta Cephei type with periods of several hours, and (ii) high-order gravity modes of the SPB type with periods of a few days. We try to reproduce theoretically the observed frequency spectrum of very slowly rotating star Gamma Pegasi, which has been studied recently by Gerald Handler and co-workers. In many aspects, the frequency spectrum of this star is similar to that of another slowly rotating hybrid variable, Nu Eridani, which has been studied earlier - in particular, by Wojtek Dziembowski and co-workers.

We start from "standard" models of the star which nicely fit three Beta Cep type frequencies: the frequency at 6.590 c/d for the radial fundamental mode, the frequency at 6.016 c/d for the dipole mode g1, and the frequency at 6.978 c/d for the dipole mode p1. The fitting is achieved by suitable choice of stellar mass, heavy element parameter Z and stellar effective temperature. Most of the other observed frequencies also have theoretical counterparts among low degree modes. The models were constructed using both OPAL and OP opacity data.

However, these models are not able to explain all features of the frequency spectrum. Some outstanding questions, similar to those for the Nu Eridani, remain unsolved: a) The theoretical frequency range of the unstable high-order gravity modes of lowest degrees (SPB-type pulsations) does not fit the observed range. For the OPAL case these modes are not excited at all, there is only a tendency to the instability. b) The theoretical frequency of the higher dipole mode p2 is noticeably higher than the closest observed value at 9.109 c/d. c) This and other observed peaks in the 8-9 c/d range are outside the theoretical frequency range of unstable modes.

We try to solve these problems by opacity modifications both in the Z opacity bump region at temperature of about 200,000 K and in the region of the deeper opacity bump at temperature of about 2-2.5 million degrees (this bump is also mainly due to excited ions of the iron-group elements). Moreover, we test models with different efficiency of the convective core overshooting and models with different ("non-standard") initial hydrogen abundance.

NOTES:

Cepheids, Eclipsing Binaries, and Other Variables in M 33

Anne Pellerin[1], Lucas Macri[1], Andrew Bradshaw[1], and Kris Stanek[2]
[1]Texas A&M, [2]OSU

We are conducting a long-term photometric survey of the nearby galaxy M33 to discover Cepheids, eclipsing binaries, and long-period variables. The main goal of the project is to provide an absolute calibration of the Cepheid Period-Luminosity relation and study its metallicity dependence.

This work combines previously-obtained data from the DIRECT project with new observations acquired at the WIYN 3.5-m telescope. The entire data set spans over 7 years with excellent synoptic coverage which will enable the discovery and characterization of stars displaying variability over a wide range of timescales (days, weeks, months, years).

We present representative light curves of different variables, color-magnitude diagrams, and optical Cepheid Period-Luminosity relations for M33.

NOTES:

Physical Parameters of Four Field RR Lyrae Stars in Bootes[1]

[1]Based on observations collected at the San Pedro Mártir Observatory, Mexico
J. H. Peña[2], A. Arellano Ferro[2], M. Chow[3], L. Fox[4], M. Alvarez[4], P. Zasche[2], and L. Parrao[2]
[2]Instituto de Astronomía, Universidad Nacional Autónoma de México, [3]Facultad de Ciencia, UNAN-Managua, Nicaragua, [4]Observatorio Astronomico Nacional, México

As a continuation of the determination of physical parameters of RR Lyrae stars deduced from Stromgren *uvby–Hβ* photometry (see Peña et al., 2006, Paper I) we present now the results obtained for the stars CM, SW, SZ, and UY in Bootes. As a first approach, the metallic content [Fe/H] was inferred from the reported ΔS parameter. From the Fourier decomposition of the light curves and the empirical calibrations developed for this type of stars, the metallicity [Fe/H] was also determined. The physical parameters M/M_0 $\log(L/L_0)$, M_0, $\log T_{eff}$ have been estimated. Detailed behavior of the logTeff and surface gravity for the stars along the cycle of pulsation has been determined from the observed Strömgren *uv uvby–Hβ* photometric indices along the pulsational phase and the synthetic indices from atmospheric models. The reddening of the zone is found to be negligible, as was estimated in Paper I, from the reddening of several objects in the same region of the sky. The distances to the individual objects are also estimated. Analysis on the stability of the pulsational period indicates that CM and UY Boo show secular period variations.

NOTES:

Spectroscopic Mode-identification of gamma Doradus Stars

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We are undertaking an extensive observational campaign of a number of non-radially pulsating stars using the high-resolution HERCULES spectrograph on the 1.0-m telescope at the Mt John University Observatory. This paper outlines our campaign and presents preliminary results for one gamma Doradus star, HD40745, as an example. Over 250 spectra of HD40745 have been obtained. We have used Wright's (2008) representative cross-correlation line-profile technique to extract line profiles and these have then been analysed using the FAMIAS package (Zima 2008) to derive a spectroscopic mode identification.

NOTES:

Pulsational Stability of Red Giant Stars

Dumitru Pricopi and Marian Doru Suran
Astronomical Institute of the Romanian Academy

We revisit the problem of pulsational stability of radial and strongly trapped non-radial modes of red giant stars. We present the results of numerical computations of oscillation properties of an 2.03 $M_{\odot}$ evolutive stellar model along the AGB. We examine the pulsational stability by taking into account the effect of variation of convective flux during the pulsation. Results obtained by using the standard "frozen" convection are presented for comparison.

NOTES:

To Automatically Get the Stellar Parameters of Solar-Like Stars Observed by the Kepler Satellite

Pierre-Olivier Quirion
Aarhus Universitet

The Kepler satellite will soon provide a large amount of data revealing light curves of numerous sun-like stars.

I present a pipeline developed by the Kepler Asteroseismic Science Operation Centre (KASOC) for the complete analysis of Kepler seismic observations of sun-like stars. The pipeline uses Kepler light curves and the Kepler Input Catalogue information as inputs and outputs stellar parameters with uncertainties. I mainly describe the model fitting procedure of the pipeline. It uses an extended grid of stellar models to solve the forward problem of asteroseismology. It then uses Bayesian inference to assess the uncertainties on the stellar parameters.

NOTES:

Spectroscopic Observations of SRd and RV Tau Variables at Middlebury College

Stephen J. Ratcliff
Dept. of Physics, Middlebury College

A program to collect time-series spectra of pulsating variable stars was undertaken over a period of several months in 2004 with the 0.6-m reflecting telescope at the Middlebury College Observatory using a bench-mounted, fiber-fed CCD spectrograph. The spectra were obtained in the red region (580-680 nm) at resolution approximately 0.25 nm. Primarily, stars classified SRd or RV Tau were observed, although other targets (such as delta Scu variables) were included as well. The spectral coverage and resolution allow, for stars brighter than roughly R = 10, the study of H-alpha emission or absorption strength variation, as well as the determination of temperature spectral class. The spectrograph is also capable of radial velocity determinations (for brighter specimens) at the level of a few km/s. This program demonstrated the utility of a dedicated, modest-aperture telescope in acquisition of useful spectroscopic time-series observations for these variable stars.

NOTES:

Stellar Archaeology in the Milky Way Halo: Variable Stars and Stellar Populations in the New Milky Way Satellites Discovered by the SDSS

V. Ripepi, G. Clementini, and M. Dall'Ora
Osservatorio Astronomico di Capodimonte, Naples

We present results of an extensive survey of eight of the faint Milky Way dSph satellites recently discovered by the SDSS (Bootes I, Ursa Major II, Coma, Hercules, Canes Venatici I, Canes Venatici II, Leo IV, Ursa Major I) which we monitored for variability using time-series multiband observations collected at a variety of telescopes from the 1.5 to the 4.3 m size, and reaching each galaxy's main sequence turnoff. The variable stars and the stellar populations of the newly discovered dwarf spheroidals (dSphs) are discussed in light of the insight they can provide to reconstruct the star formation history and the merging episodes that led to the early assembly of the Galactic halo. The pulsation properties and "Oosterhoff type" of the RR Lyrae stars detected in the new dSphs will be presented, to see whether the stellar content is similar to the Milky Way globular clusters.

NOTES:

The Dependency of the Cepheid Period-Luminosity Relation on Chemical Composition

Martino Romaniello
European Southern Observatory, Chile

The dependency of the Cepheid Period-Luminosity Relation at different wavelengths on chemical composition is assessed via direct detailed abundance analysis of Galactic and Magellanic Cepheids, as derived from high resolution, high signal-to-noise spectra.

Our measurements span one order of magnitude in iron content and allow to rule out at the ~ 9 sigma level the universality of the Period-Luminosity Relation in the V band, with metal rich stars being fainter than metal poor ones by ~0.3 mag.

The dependency is less pronounced in the K band. Its magnitude and statistical significance decisively depend on detailed distance measurements to individual stars, as inferred via the Infrared Surface Brightness Method.

NOTES:

Characterization and Parameter Determination of CoRoT Variable Stars with FLAMES

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We present preliminary results from the ground-based ESO/FLAMES observational program set up for the spectroscopic study of variable stars observed in the CoRoT exoplanet fields. In the Initial Run (IR1) and the first long anticenter run (LRA1) about 6000 variable stars have been identified by the CVC (Corot Variable Classifier). The multi-objects FLAMES medium resolution (R~7000) spectroscopic observation of variable CoRoT stars from the IR1 and LRA1 fields allows us to classify the variable stars accurately. In particular, we identified the Be stars and determined their fundamental parameters with synthetic spectral fitting taking NLTE and rapid rotation effects into account. Confronting these parameters to the CoRoT light curves of these objects will allow us to test for correlations between stellar parameters and pulsation properties in a statistical way, in particular to study the instability strips. Moreover, knowing the fundamental parameters of the stars will allow us to perform seismic modelling.

NOTES:

Evidence of Increasing Acoustic Emissivity Over Solar Cycle 23 at High Frequency in Integrated Sunlight Measurements

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The role played by low (2-4mHz) and high-frequency acoustic waves (5.5-8mHz) in the solar chromospheric heating is still an open debate. Within this topic we focus our attention on high-frequency waves. Recent observations using integrated-sunlight measurements such as BiSON, GOLF and VIRGO have shown the presence of peaks up to 7.5mHz, well above the acustic cut-off frequency. Although it is still an open debate of what excited high-frequency waves, we investigate amplitude variations in the high-ν band (5.5-6.5mHz) over solar cycle 23. We applied the cross-spectrum technique to improve the signal-to-noise ratio at high frequencies in velocity observations. We found an enhancement of acoustic emissivity in the high-ν band. A possible explanation of the observed increased acoustic emissivity can be found in the presence of the magnetic field network that can reach strengths up to 1kG. The presence of this magnetic field enhances the generation of sound waves (fast magnetoacoustic waves). To validate this point we determine the phase travel time obtained by the cross phase analysis at the minimum and at the maximum of the solar activity. If indeed the increasing acoustic emissivity is due to fast wave mode, then the phase travel time has to decrease from minimum to maximum of the solar activity. The result of this investigation has a further implication: the Kepler mission will observe stars over 4 years and therefore this will give us the possibility to investigate how the magnetic field network affects the acoustic waves, giving us another idea about the stellar activity.

NOTES:

Variability Morphologies in the Color–Magnitude Diagram

Maxime Spano, Nami Mowlavi, and Laurent Eyer
Geneva observatory, Geneva University, Switzerland

We present the variability morphologies in the V/V-I diagram of several types of variable stars from the Galaxy and the Large Magellanic Cloud. They comprise both periodic variable stars such as classical Cepheids or long period variables and non periodic ones such as Be or R Coronae Borealis stars. The analysis of the morphology in the color magnitude diagram allows the characterization of each group of periodic stars with distinctive parameters such as the shape of variability and the amplitude-color changes in the diagram. Likewise, non periodic stars can also be characterized by both the location and the extent of their variation in the diagram. Some peculiar stars such as FG Sge and V 4334 Sgr display large variations of magnitude and color, crossing the diagram on timescales as short as a decade. The analysis of the variability morphology in the diagram thus helps the identification of the type of variable star observed. This work is in particular part of an effort to detect secular variable objects in large scale surveys by analysing their path in color-magnitude diagrams.

NOTES:

Analysis of the Internal Rotation Profile of Stars Using Rotational Mode Splitting Asymmetries

J. C. Suarez
Instituto de Astrofisica de Andalusia (CSIC), Spain

Rotationally-split modes can provide valious information about the internal rotation profile of stars. This has been used for years to infer the internal rotation behavior of the Sun. The present work presents and discusses a method that may provide additional information from the mode splitting asymmetries. Using a complete second-order theory for the oscillation computations, we examine the theoretical predictions for such asymmetries for different pulsation modes: low-order g modes, mixed modes (around the fundamental radial mode), high-order p modes. The method is applied to the beta Cephei star nu Eridani.

NOTES:

Strange and Low Amplitude Cepheid Candidates in the CoRoT Observations

R. Szabo[1], Z. Kollath, L. Molnar, J. Benko, and L. Szabados
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We present the preliminary results of our search for low amplitude single mode pulsations near the edges of the classical Cepheid Instability Strip (IS). Cepheids entering or leaving the IS are expected to show low amplitude pulsation, while stars outside the IS may pulsate in high-overtone radial mode that is trapped in the stellar atmosphere. Such stars have been recently discovered in the LMC (Buchler et al. 2005, Sosyznski et al. 2008). The high-precision CoRoT light-curves are ideally suited to find the Galactic counterparts of these ultra-low amplitude stars.

We looked for low amplitude and strange Cepheid candidates in the CoRoT IRa01 and LRc01 fields. The selection was based on the expected period range and location on the HRD. According to our numerical simulations, strange modes can be identified on the color – period diagram. 2MASS JHK colors were used to refine our selection.

NOTES:

Amplitude and Phase Modulation in CoRoT RR Lyrae Stars

R. Szabo[1], M. Paparo, J. Benko, M. Chadid, K. Kolenberg, and E. Poretti
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The Corot satellite is an excellent tool in pulsation star research providing high-precision and continuous light curves for up to 150 days. In the first long run of CoRoT (IRa01) five RR Lyrae stars were identified, four of which show Blazhko-modulation. Two of them are possible blends exhibiting low amplitude pulsation. We derived instantaneous amplitudes and periods with the analytic function method for these variables. The advantages and accuracy of this approach will be presented, as well.

With the amplitudes and periods in hand we analyzed and compared the amplitude and phase modulation of the CoRoT Blazhko-stars pointing out the similarities and differences found in the individual cases. Finally we discuss the importance of our results in the context of constraining the models that have been or will be constructed to explain the century-old mystery of the Blazhko-effect.

NOTES:

Galactic Fundamental Mode RR Lyrae Stars: Period-Amplitude Diagram, Metallicities and Distribution

Dorota Szczygiel
Warsaw University Astronomical Observatory

We have analysed 1455 fundamental mode RR Lyrae stars of the Galactic field, using the All Sky Automated Survey data. The sample is complete in the close neighbourhood of the Sun, within 4 kpc distance. Unlike in the previous analysis of the close field RRab, we see a clear manifestation of the Oosterhoff groups on the period - amplitude diagram. The relation for Oosterhoff I type variables becomes strongly flattened at large V amplitudes, which was not observed for globular cluster RR Lyrae.

We calculate photometric metallicities using methods of Jurcsik & Kovacs (1996) and Sandage (2004) and find significant discrepancies between results from both methods. Comparison with spectroscopic metallicities favors the method of Jurcsik & Kovacs (1996). In addition, we notice that RRab of Oosterhoff II type follow a different metallicity-period-phase relation than Oosterhoff I type variables.

The spatial distribution of Galactic field RRab does not show any metallicity gradients with distance from the Galactic Center in either of the Oosterhoff groups. The older, metal poor Oosterhoff II variables are uniformly distributed with the distance from the galactic plane, while the metal rich Oosterhoff I RRab become more concentrated to the Galactic plane with increasing metal content.

NOTES:

Long-term Variability in o Ceti: Signs of Supergranular Convection?

Matthew R. Templeton[1] and Margarita Karovska[2]
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We describe our study of a long-term light curve of o Ceti (Mira A), the prototype of the Mira-type pulsating stars, originally undertaken to search for coherent long-period variability. Such variablility was not found; however, low-frequency "red noise" was detected in the Fourier spectrum of o Ceti's century-long light curve. We have since found similar behavior in other Miras and pulsating giant stars and a study of a large sample of Mira variables is underway. Similar red noise has been previously detected in red supergiants (Kiss et al 2006) and attributed to supergranular convection. Its presence in Miras suggests the phenomenon may be ubiquitous in cool giant pulsators. These results support high-angular resolution observations of Miras and supergiants showing asymmetries in their surface brightness distributions, which may be due to large supergranular convection cells. Theoretical modeling, and numerical simulations of pulsation processes in late-type giants and supergiants should therefore take into account the effects of deep convection and large supergranular structures, which in turn may provide important insights into the behavior of Miras and other giant and supergiant pulsators.

NOTES:

Long-term, Multicolor Photometry of W Vir and Type II Cepheids

Matthew R. Templeton and Arne. A Henden
AAVSO

Long-term, multicolor photometry of W Virginis has revealed the presence of regularly alternating minima, identified as arising from fundamental-first overtone pulsation with a period ratio of P(1) = 2P(0)/3. Such behavior was suspected in W Vir as early as the 1950s, but had not been conclusively identified until now. The presence of an identifiable secondary pulsation mode in the pulsations of this star raises several interesting possibilities for modeling and future observations. Observations of more long-period Type II Cepheids may prove fruitful, particularly as regards the phenomenon of alternating minima; some work has already been done data mining of the MACHO (Pollard et al. 2000) and ASAS (Wils & Otero 2008) databases, and current and upcoming photometric monitoring systems may provide much more useful data on these stars. In this poster, we present a few examples from the long-term photometric program of the AAVSO obtained with the Sonoita Research Observatory in Arizona, with a view toward modeling of these interesting stars and their light curves.

NOTES:

Enhancing Our Knowledge of Northern Cepheids through Photometric Monitoring

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A selection of known and newly-discovered northern hemisphere Cepheids and related objects are being monitored regularly through CCD observations at the automated Abbey Ridge Observatory, near Halifax, and photoelectric photometry from the Saint Mary's Burke-Gaffney Observatory. Included is Polaris, which is displaying unusual fluctuations in its light amplitude, and a short-period, double-mode Cepheid, HDE 344787, with an amplitude smaller than that of Polaris, along with a selection of other classical Cepheids in need of additional observations. The observations are being used to establish basic parameters for the Cepheids, for application to the Galactic calibration of the Cepheid period-luminosity relation as well as studies of Galactic structure.

NOTES:

Stochastic Processes in Yellow and Red Pulsating Variables

David G. Turner[1], John R. Percy[2], Ted Colivas[2], Leonid N. Berdnikov[3], and Mohamed Abdel-Sabour Abdel-Latif[4]
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Random changes in pulsation period are well established in cool pulsating stars, in particular the red giant variables: Miras, semi-regulars of types A and B, and RV Tau variables. Such effects are also observed in a handful of Cepheids and, most recently, a red supergiant variable, BC Cyg, a type C semi-regular. The nature of such fluctuations is seemingly random over a few pulsation cycles of the stars, yet the primary pulsation cycle dominates over the long term. The degree of stochasticity is also linked to the dimensions of the stars, the randomness parameter appearing to correlate closely with mean stellar radius. The physical processes responsible for such fluctuations are uncertain, but presumably they originate in temporal modifications of envelope convection in such stars.

NOTES:

The Asteroseismic Ground-based Observational Counterpart of CoRoT

Katrien Uytterhoeven[1,2], E. Poretti[2], P. Mathias[3], P. Amado[4], M. Rainer[2], C. Catala[5], C. Maceroni[6], I. Ribas[7], S. Martin-Ruiz[4], C. Neiner[5], M. Paparo[8], K. Pollard[9], E. Rodriguez[4], and CoRoT/SWG Ground-based Observations Working Group

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A huge observational effort is undertaken by the CoRoT/SWG Ground-Based Observations Working Group to complement the CoRoT space data with simultaneous ground-based data to guarantee an optimal scientific outcome of the asteroseismic part of the CoRoT mission. Large Programme and normal observing proposals have been applied for, and have been approved for the monitoring of asteroseismic CoRoT targets with several high-resolution spectrographs, multi-colour photometers and spectropolarimeters at several observatories. Also support observations of seismic targets in the exo-planet fields are provided for. We will give an overview of the observational efforts, present some of the ground-based results, and give an outlook to the future.

NOTES:

Abundance Analysis and Mode Identification for the beta Cephei CoRoT Main Target HD180642

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The known beta Cephei star HD180642 was observed by the CoRoT satellite during a run of 156 days in 2007. The very high-precision space white light photometry revealed for the first time the rich pulsation frequency spectrum of this pulsator with a non-linear dominant radial mode (Degroote et al. 2009). In the present study, we provide additional information on the object, based on both extensive ground-based multi-colour photometry and high-resolution spectroscopy. We place the star in the (Teff, log g) diagram. In addition, we derive the chemical abundances of several elements as well as the metallicity of HD180642. Finally, we put constraints on the identification of some modes. All these observational constraints, together with the CoRoT results, will be used for forthcoming asteroseismic modelling of this massive B-type star.

NOTES:

Time-scales of Line-broadening Variability in OB Supergiants

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Several works have recently shown that there is an important extra line-broadening (usually called “macroturbulence”) affecting the spectra of O and B Supergiants that adds to stellar rotation and implies supersonic velocity fields. At present, we completely lack a physical explanation for it, and no evidence supporting any particular origin has been presented. From the various mechanisms suggested, oscillations are the most firmly established, but so far without a firm demonstration of a possible connection. We recently started an observational project to obtain constraints on the time-scales associated to this extra line-broadening and its possible origin. Our observational strategy consists of the study of a well selected group of O and B stars, for which we obtain spectra separated by different time intervals (from less than 1min to several days) and covering different exposure times. In this poster we present some preliminary results from our first campaign with FIES@NOT2.5m on the Observatory of "El Roque de los Muchachos” (La Palma, Spain).

NOTES:

Gamma Doradus Stars in the CoRoT Exoplanets Fields

K. Uytterhoeven[1], Philippe Mathias[2] and The CoRoT gamma Doradus Working Group

[1]Service d'Astrophysique, IRFU/DSM/CEA, France, [2]Observatoire de la Cote d'Azur (Fizeau), France

About 1000 gamma Doradus candidates are identified by the CoRoT Variables Classification (CVC) tool in the exoplanet fields of the 4 first CoRoT runs. Among them, only 32 are recognized as "1st priority" candidate. Some of these targets were observed spectroscopically using the ESO-GIRAFFE instrument in order to derive physical properties. We undertook a frequency analysis of these 32 stars after having corrected for existing trends and jumps in the data. A list of about 10 prime frequencies are derived for some candidates. Not all the candidates are confirmed as members of the gamma Doradus class, thus showing the difficulty of an automated light curve classifier.

NOTES:

Detecting Short Period Variables with Gaia

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The ESA Gaia satellite will observe about one billion sources with unprecedented astrometric and photometric precision. Over its five year long mission, it will systematically scan all the sky and observe each source ~80 times on average, down to magnitude G ~ 20 mag. This observation strategy enables variability studies to be performed on the observed sources in addition to the astrometric solution determination, from which a large number of new variable stars are expected to be discovered. The Gaia time sampling and the ccd data acquisition scheme allow in principle to probe stellar variability on time scales as short as tens of seconds, thereby giving potential access to the study of variable stars with periods less then 2 hours in a large and homogenous sample of stars. Several types of variable stars – mainly pulsators – show variability on this time scale: ZZ Ceti, DBV, GW Vir, EC14026, PG1716, roAp, β Cephei, δ Scuti and eclipsing white dwarf binaries. In our study, we investigate the detectability and period recovery possibilities of these short period variables using simulated Gaia data. In particular, we want to identify what parameters can be extracted from the Gaia data that can characterize the variable objects, knowing that they can be important targets for asteroseismology and for gravitational wave experiments. The determination of parameters such as the variability timescale and amplitude, combined with the luminosity and effective temperature, may allow the identification of the variability type of the source and, in the best cases, the determination of the period.

In this poster we present the first step in that direction, i.e. an analysis in the frequency space of simulated timeseries of short period variables using the Gaia time sampling law and expected photometric precisions. We cover the analysis of simple sinusoidal signals and of more realistic ZZ Ceti light curves.

NOTES:

Approaches to Mass-Loss Modeling, and the Bowen Code

Qian Wang
Iowa State University

The Bowen code, developed in the 1980s and 1990s, was optimized for studying the mass loss mechanism as a system. It allowed inclusion of pulsation with shock development, non-LTE coupling of the gas to the radiation field and departures from radiative equilibrium, grain formation and acceleration by radiation, and radiative acceleration on molecules. Most of these were found to play important roles in the development of a massive wind. All were treated by simple parametrized relations that could be adjusted to test the effects and where values could be chosen using information from more detailed calculations. Most other contemporary codes endeavor to incorporate full physical formulae for at least some of the above processes 'from first principles'. The advantage of the Bowen code is that it may easily be adapted to study any process suspected of playing a role in driving and accelerating the wind from these stars. The disadvantages are that it cannot be used as a basis for spectrum synthesis without violating conservation of energy, something several authors have apparently not recognized; and that it does not shed detailed light on any part of the mechanism. It has also been suggested that (a) the mean opacity used is too low, giving an atmosphere that is too massive; and (b) that the grey approximation will not take into account essential physics of the wind mechanism. We are in the process of working up the code to include more of the physics suspected of playing a role, while preserving its essential nature as a code for the study of the mass loss rather than the details of one or more processes that are involved in driving the wind. We will present a summary of how the code works and outline our plans for improvements.

NOTES:

Spectropolarimetric Observations of the Sequence-D Red Giant Variables S Lep and Z Eri

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The light curves of the sequence-D red giant variables exhibit a long secondary period (LSP) that has so far defied explanation. One of the features of these stars is that even though they have effective temperatures near 3000 K, they show quite strong H-alpha absorption lines. The strength of the H-alpha line varies with the LSP. This leads to the suggestion that these stars may contain a chromosphere driven by strong magnetic fields in the stellar photosphere. We therefore used the SEMPOL spectropolarimeter on the AAT in order to look for evidence of strong magnetic fields in the two nearby sequence-D stars S Lep and Z Eri. We found no evidence for large-scale ordered magnetic fields on the surfaces of these stars. It therefore seems unlikely that magnetic fields cause the LSP in the sequence-D stars.

NOTES: