JD24

Pulsating Stars – Recent Developments in Theory and Observation

Summary by: **D. Sasselov & M. Takeuti**

https://doi.org/10.1017/S1539299600019547 Published online by Cambridge University Press

JOINT DISCUSSION 24

Pulsating Stars - Recent Developments in Theory and Observation

D. SASSELOV & M. TAKEUTI

The past few years have seen the emergence of new observational approaches to the study of pulsating stars. Massive photometric surveys are discovering new variables by the tens of thousands. For example, the number of Cepheids and RR Lyrae has increased manifold over the past two years - many of these new distant pulsating stars have now better light curves than their well-known nearby counterparts. The new observational breakthrough has opened many theoretical issues. Some of these can be tackled with the set of new opacities (from Lawrence Livermore and from the Opacity Project), others seem to require new theoretical insights.

Joint Discussion 24 was held in these very exciting times for pulsating stars research. It was envisioned as a forum for presenting all recent developments which straddle a number of areas and large-scale projects represented in Kyoto. Among them, the most prominent were HIPPARCOS and the Microlensing projects.

The Joint Discussion was arranged in two parts - a morning session on "Progress in Observation of Pulsating Stars", and an afternoon session on "Recent Problems in Modelling Pulsating Stars". A large number of posters was exhibited as part of JD24. They are listed at the end of this summary; their abstracts were published in the IAU GA Abstract Book, Kyoto, August 17–30, 1997, pp. 124-133. A special volume of proceedings for Joint Discussion 24 is in press and will appear in 1998. The book is "Pulsating Stars: Recent Developments in Theory and Observation", eds. M. Takeuti & D. D. Sasselov, Universal Academy Press, Tokyo.

1. Progress in Observation of Pulsating Stars

The observational session was opened by a review of the MACHO microlensing project's results on pulsating stars in the Milky Way Bulge by D. Minniti. He covered briefly some types of objects - RR Lyrae and δ Scuti, with about 1670 and 200 stars respectively. The RR Lyrae do not follow the bar in the inner region. The survey seems to point to 30% occurence of Blazhko effect among the sample. The δ Scuti stars are bulge objects. Minniti put an emphasis on the red semiregular pulsating stars - a sample of 2000 variables with periods between 15 and 100 days. He discussed their period-luminosity relation and pointed out that they trace the bar, unlike the RR Lyrae stars. There are interesting, yet unanswered, questions about the pulsation modes and the long-term pulsational stability of the red semiregular variables. The continuing photometry from the microlensing surveys should provide ample data towards the theoretical understanding of these issues.

A second review by the MACHO project on the LMC pulsating star inventory was presented by D. Alves. He discussed the Cepheids found in the LMC - about 1470 of them, with particular emphasis on the short-period pulsators. No period changes are yet discernible among the candidates to be Cepheids crossing the instability strip for the first time. A large number of red variable stars (about 18,500) help identify new AGB pulsating variables; some of them show evidence for dust formation and mass loss.

The first part of the morning session was completed by the long awaited review of the pulsating stars in the HIPPARCOS sample, presented by M. Grenon. He discussed both the photometry obtained for a total of 2712 periodic variables (including 2 newly discovered Cepheids), and the distances obtained for some of them. A clear result so far is the exact position of the red semiregular pulsating stars on the HR diagram - they form a distinctive branch at almost constant visual luminosity.

J. Andersen (ed.), Highlights of Astronomy, Volume 11B, 1027–1033.

The observational session continued with a review by P. Whitelock on infrared photometry of large amplitude pulsating stars (Miras, OH/IR stars, carbon stars, symbiotic Miras). The results from the long-term monitoring program started by M. Feast 20 years ago at SAAO, were the highlight of her talk. The infrared (JHKL) light curves show the common occurence of dust obscuration events, and suggest changing mass-loss rates.

A short review was presented by S. Y. Jiang on the subject of multisite observations of pulsating stars. It was an informative and up-to-date overview of the major small-telescope networks (e.g. WET, MUSICOS), as well as some incidental campaigns.

In a short talk, A. K. Dupree presented imaging results of Betelgeuse from the Hubble Space telescope. The pulsating cool supergiant was both imaged (with FOC in the UV) and observed spectroscopically at high resolution, revealing surface features and allowing the axis of rotation and its rotational speed to be estimated. The results suggest a non-spherically symmetric shock wave that propagates radially outwards.

The second part of the observational session was completed by the review on VLBI study of Mira stars by M. Miyoshi. At least three types of masers (SiO, H_2O, and OH) can be used to study the extended atmospheres of Miras at different distances from the photosphere. Rapid time variability is observed, as well as acceleration of maser spots, which nature is yet to be understood.

2. Recent Problems in Modelling Pulsating Stars

The afternoon session of Joint Discussion 24 was devoted to the theoretical models of large amplitude pulsation. It was opened by a general review by H. Saio of models of pulsating stars. Saio discussed new models in the classical Cepheid instability strip. Interesting questions arise in the comparison to recent observational data on double-mode Cepheids and Cepheid photometry in the Magellanic Clouds. On the subject of RR Lyrae models, Saio pointed out that some important nonlinear physics is still missing in them. The properties of strange modes and the strange mode instability were also discussed.

A short talk on asteroseismology of Beta Cephei stars was presented by M. Jerzykiewicz. At this time only two stars can be seismologically studied, however the information which can be derived about their interiors is unprecedented.

Another short talk by E. Poretti discussed the analysis of the Galactic double-mode Cepheid light curves. He reviewed their Fourier parameters and emphasized the importance of the cross-coupling terms.

In the realm of much cooler pulsating stars F. Kerschbaum presented a short review of the interrelation of pulsation and mass-loss in AGB variables.

A general review of the subject of pulsation driven winds, and their hydrodynamic simulation in particular, was presented by E. A. Dorfi. He described the level of complexity and the physics which is included in the theoretical models. Dorfi presented recent results which are very successful in the test with observations, giving confidence to the current understanding of the basics of pulsation driven winds in the coolest pulsating stars.

The last review was by Z. Kollath, who discussed deterministic irregularity in pulsating stars. In a informative, as well as entertaining, talk Kollath showed that the nonlinear data analysis of irregular stellar lightcurves can provide quantitative information very useful in constraining models of the RV Tau and W Vir type pulsating stars.

It was generally felt that current efforts in theoretical modeling of stellar pulsation have been very successful in solving long-standing problems and hold a promise to provide us with the means to probe stellar interiors. At the same time, the treatment of convection and turbulence remains to be a major problem, and the new high-quality data seem to reinforce that fact.

3. Posters Presented at Joint Discussion 24

A total of 40 posters were exhibited during Joint Discussion 24. Their abstracts can be found in the IAU GA Abstract Book, Kyoto, August 17–30, 1997, pp. 124-133. Below is a complete list of all presented posters.

JD24-001P : *Cancelled*

JD24-002P : Possibilities for the Study of Pulsating Stars using the OMC Instrument on Board the ESA Mission INTEGRAL

A. Giménez, on behalf of the OMC consortium
LAEFF, Apartado 50727, 28020 Madrid, Spain

JD24-003P : Asteroseismology Results from the MUSICOS Network

B. H. Foing[1], C. Catala[2], A. M. Hubert[3], J. X. Hao[4], E. J. Kennelly[5], L. Balona[6], H. Henrichs[7], and the MUSICOS team
[1] ESA/SSD, Netherlands <BFOING@estec.esa.nl>, [2] OMP, [3] Meudon, [4] Beijing, [5] HAO, [6] SAAO, [7] Amsterdam

JD24-004P : Moscow Programme of Cepheid Radial Velocities

N. Samus[1], N. Gorynya[1], A. Rastorgouev[2], and M. Sachkov[2]
[1] Institute of Astronomy, Russian Acad. Sci., Moscow, Russia <samus@sai.msu.su>,
[2] Sternberg Astron. Institute, Univ. of Moscow, Moscow, Russia <alex@sai.msu.su>

JD24-005P : The Cepheid Radial Velocity Programme at Mount John University Observatory

P. L. Cottrell, M. D. Albrow, and O. K. L. Petterson
Mt John Univ Obs, Univ. of Canterbury, New Zealand <p.cottrell, m.albrow, o.petterson@phys.canterbury.ac.nz>

JD24-006P : Distance Scale of Classical Cepheids from HIPPARCOS Data

L. Szabados
Konkoly Observatory of the Hungarian Academy of Sciences, Budapest, H-1525 Hungary <szabados@buda.konkoly.hu>

JD24-007P : The Nature of Strange Modes in the Classical Variable Stars

J. R. Buchler[1], P. Yecko[1], and Z. Kollath[2]
[1] Physics Dept., Univ. of Florida, USA <buchler@phys.ufl.edu>,
[2] Konkoly Obs., Budapest, Hungary <kollath@buda.konkoly.hu>

JD24-008P : Derivation of the Heavy Element Abundance of Galactic Double-Mode Cepheids from Linear Non-Adiabatic Pulsation Model

T. Ishida
Nishi-Harima Astronomical Observatory, Sayo, Hyogo 679-53 Japan
<ishida@nhao.go.jp>

JD24-009P : A Study of the Classical Cepheids in the Magellanic Clouds with $P > 100$ Days

T. Ishida
Nishi-Harima Astronomical Observatory, Sayo, Hyogo 679-53 Japan
<ishida@nhao.go.jp>

JD24-010P : Hydrodynamic Simulation of a Double-Mode Cepheid Y Carinae

M. Takeuti[1], T. Ishida[2], and Y. Tanaka[3]
[1] Tohoku University, Sendai, Japan <takeuti@astr.tohoku.ac.jp>,
[2] Nishi-Harima Astronomical Observatory, Sayo, Hyogo, Japan <ishida@nhao.go.jp>,
[3] Faculty of Education, Ibaraki University, Mito, Japan <tanaka@mito.ipc.ibaraki.ac.jp>

JD24-011P : A CCD Search for B-type Pulsators in the Northern Open Clusters

A. Pigulski, M. Jerzykiewicz, and G. Kopacki
Wrocław University Observatory, Wrocław, Poland <pigulski@astro.uni.wroc.pl>,
<mjerz@astro.uni.wroc.pl>, <kopacki@astro.uni.wroc.pl>

JD24-012P : The Long-Term Pulsational Behavior of 16EN Lac (the β Cephei Star)

N. Sato
Akita University, Akita 010 Japan <nsastr@quartet.ipc.akita-u.ac.jp>

https://doi.org/10.1017/S1539299600019547 Published online by Cambridge University Press

JD24-013P : Line Profile Variability of Early-Type Stars: the Case of ϵ Per

Petr Harmanec
Astronomical Institute, 251 65 Ondrejov, Czech Republic <hec@sunstel.asu.cas.cz>

JD24-014P : Multiperiodic Behavior in the δ Sct Star AN Lyn

E. Rodríguez[1], S. F. González-Bedolla[2], A. Rolland[1], V. Costa[1], M. J. López-González[1], and P. López de Coca[1]
[1] Instituto de Astrofísica de Andalucía, CSIC, Apartado 3004, 18080 Granada Spain <eloy@iaa.es>,
[2] Instituto de Astronomía, UNAM, Apartado Postal 70-264, CP-4510 México D.F. Mexico

JD24-015P : *Cancelled*

JD24-016P : Colour Phase Shifts and Amplitude Ratios as Population or Overtone Discriminators

Margit Paparo
Konkoly Observatory, Budapest, Hungary <paparo@ogyalla.konkoly.hu>

JD24-017P : δ Sct Stars as Asteroseismology Targets

L. Mantegazza[1], E. Poretti[1], M. Bossi[1], and F. Zerbi[2]
[1] Osservatorio Astronomico di Brera, Italy <poretti@merate.mi.astro.it>, [2] Università di Pavia, Italy

JD24-018P : *Cancelled*

JD24-019P : Interrelation of Pulsation and Mass-Loss for AGB-Variables

F. Kerschbaum[1], H. Olofsson[2], J. Hron[1], and T. Lebzelter[1]
[1] Institut für Astronomie, Türkenschanzstraße 17, A-1180 Wien, Austria <*name*@astro.ast.univie.ac.at>,
[2] Stockholms Observatorium, S-13336 Saltsjöbaden, Sweden <hans@astro.su.se>

JD24-020P : *Cancelled*

JD24-021P : Amplitude and Period Changes in the Light Variations of Some Mira and SR Stars

K. Szatmáry
JATE University, Astronomical Observatory and Department of Experimental Physics, Szeged, Hungary
<k.szatmary@physx.u-szeged.hu>

JD24-022P : *Cancelled*

JD24-023P : *Cancelled*

JD24-024P : *Cancelled*

JD24-025P : To Be a Standard, or Not to Be? – Variable Polarization in 9 Gem

M. Matsumura[1], M. Seki[2], and K. Kawabata[2]
[1] Faculty of Education, Kagawa Univ., Kagawa, Japan <matsu@ed.kagawa-u.ac.jp>,
[2] Astronomical Institute, Tohoku Univ., Sendai, Japan <seki,kawabata@astr.tohoku.ac.jp>

JD24-026P : TiO Photometry of Pulsating Giant and Supergiant M-Type Variable Stars

R. Wasatonic[1] and E. F. Guinan[2]
[1] Astronomy and Astrophysics Dept., Villanova University, AAVSO, USA,
[2] Astronomy and Astrophysics Dept., Villanova University, USA <guinan@ucis.vill.edu>

JD24-027P : Loops in Bandstrength-Color Diagrams for Mira Variables

Robert F. Wing
Ohio State University, USA <wing.1@osu.edu>

JD24-028P : *Cancelled.*

JD24-029P : Linear Polarimetric Observations of Eighteen RV Tauri Stars

K. Yoshioka[1], K. Saijo[2], and H. Sato[3]
[1] Univ. of the Air, Japan <yoshioka@u-air.ac.jp>, [2] National Science Museum, Japan,
[3] National Astronomical Observatory, Japan <satohd@cc.nao.ac.jp>

JD24-030P : The Circumstellar Dust Envelope of a Mira-Type AGB Star R Hya and Its Mass Loss Process

O. Hashimoto[1] and H. Izumiura[2]
[1] Department of Applied Physics, Seikei University, Japan <hasimoto@aps.seikei.ac.jp>,
[2] Okayama Astrophysical Observatory, National Astronomical Observatory, Japan <izumiura@oao.nao.ac.jp>

JD24-031P : A New Perspective of the Dust Formation around Active Stars

K. Kawabata[1], M. Seki[1], and M. Matsumura[2]
[1] Astronomical Institute, Graduate School of Science, Tohoku Univ., Sendai, Japan <kawabata,seki@astr.tohoku.ac.jp>,
[2] Faculty of Education, Kagawa Univ., Japan <matsu@ed.kagawa-u.ac.jp>

JD24-032P : Formation of Dust Grains in Circumstellar Envelopes of Oxygen-Rich AGB Stars

H. Sogawa[1] and T. Kozasa[2]
[1] Kyoto University, Japan <sogawa@cr.scphys.kyoto-u.ac.jp>, [2] Kobe University, Japan <kozasa@icluna.kobe-u.ac.jp>

JD24-033P : Coherent Variation in Distribution Sizes of Water Maser Emission with Stellar Pulsation

H. Imai[1,2] and M. Takeuti[1]
[1] Astronomical Institute, Graduate School of Science, Tohoku University, Japan <imai, takeuti@astr.tohoku.ac.jp>,
[2] Mizusawa Astrogeodynamics Observatory, National Astronomical Observatory, Japan <imai@miz.nao.ac.jp>

JD24-034P : Measurement of Shifts in Line-of-Sight Velocities of Stellar Water Masers using Very Long Baseline Interferometry

H. Imai[1,2], K. M. Shibata[2,3], M. Miyoshi[2], and T. Sasao[2]
[1] Astronomical Institute, Graduate School of Science, Tohoku University, Japan <imai@astr.tohoku.ac.jp>,
[2] Mizusawa Astrogeodynamics Observatory, National Astronomical Observatory, Japan
<imai, shibata, miyoshi, sasao@miz.nao.ac.jp>, [3] VSOP project, National Astronomical Observatory, Japan

JD24-035P : Diagnostic Tools on Symbiotic Stars to Interpret Their General Characteristics

S. Tamura
Astronomical Institute, Graduate School of Science, Tohoku University, Sendai, Japan <tamura@astr.tohoku.ac.jp>

JD24-036P : Mass Transfer and Anomalous Gravity Darkening in Semi-Detached Binary Systems

M. Kiguchi[1], W. Unno[1], and M. Kitamura[2]
[1] Kinki University, Japan <kiguchi@rist.kindai.ac.jp>, [2] National Astronomical Observatory, Japan

JD24-037P : Superhumps and Reflares in the WZ Sge-Type Dwarf Nova EG Cnc

T. Kato[1], D. Nogami[1], H. Baba[1], S. Masuda[1], and K. Matsumoto[2]
[1] Kyoto Univ., Japan <tkato,nogami,baba,masuda@kusastro.kyoto-u.ac.jp>,
[2] Osaka Kyoiku Univ., Japan <matumoto@cosmos.cc.osaka-kyoiku.ac.jp>

JD24-038P : Turbulent Nonlinear Pulsation Models

P. Yecko[1], Z. Kolláth[2], and J.R. Buchler[1]
[1] Physics Dept, University of Florida, USA <buchler@phys.ufl.edu>,
[2] Konkoly Observatory, Budapest, Hungary <kollath@buda.konkoly.hu>

JD24-039P : Chaotic Stellar Pulsations Induced by Two Coupled Hierarchic Mode Triplets

F. Verheest
Sterrenkundig Observatorium, Universiteit Gent, Belgium <Frank.Verheest@rug.ac.be>

JD24-040P : The Effect of the Artificial Viscosity on Hydrodynamic Stellar Models

M. Takeuti[1], T. Ishida[2], and Y. Tanaka[3]
[1] Tohoku University, Sendai, Japan <takeuti@astr.tohoku.ac.jp>,
[2] Nishi-Harima Astronomical Observatory, Sayo, Hyogo, Japan <ishida@nhao.go.jp>,
[3] Faculty of Education, Ibaraki University, Mito, Japan <tanaka@mito.ipc.ibaraki.ac.jp>

JD24-041P : *Cancelled*

JD24-042P : Velocity Field of Nonradial Oscillations in a Rotating Star

Umin Lee and Hideyuki Saio
Astronomical Institute, Graduate School of Science, Tohoku University, Sendai Japan <lee@astr.tohoku.ac.jp>

JD24-043P : Variable Eddington Factors and Critical Points in Radiation Transport

J. M. Smit[1], J. Cernohorsky[2], and C. P. Dullemond[3]
[1]Center for High Energy Astrophysics, Univ. of Amsterdam, the Netherlands <tijn@astro.uva.nl>,

[2]Deutsche Morgan Grenfell, London, UK,
[3]Leiden Observatory, Leiden, the Netherlands <dullemon@strw.LeidenUniv.nl>

JD24-044P : Spatiotemporal Analysis of Stellar Pulsation and Convection

Y. Tanaka[1] and L. M. Saha[2]
[1] Fac. Education, Ibaraki Univ., Mito, Japan <tanaka@mito.ipc.ibaraki.ac.jp>,
[2] Zakir-Husain College, Univ., Delhi, India

JD24-045P : Effect of the Density Variation of the Envelope on a Nonlinear One-Zone Model for Stellar Pulsation

T. Ishida
Nishi-Harima Astronomical Observatory, Sayo, Hyogo 679-53 Japan <ishida@nhao.go.jp>

JD24-046P : *Cancelled*

JD24-047P : *Cancelled*

JD24-048L : Periods of Southern Mira Stars

W.S.G. Walker[1], Frank M. Bateson[2], Albert F. Jones[2], and P.L. Cottrell[3]
[1] Auckland Observatory, Auckland, New Zealand <astroman@voyager.co.nz>,
[2] Variable Star Section, Royal Astronomical Society of New Zealand <varstar,afjones@voyager.co.nz>,
[3] Mt. John Univ. Obs., Univ. of Canterbury, New Zealand <p.cottrell@phys.canterbury.ac.nz>

JD24-049L : Morphological Changes in Giant and Supergiant M-type Variable Stars: Interferometric Observations with FLUOR at IOTA

Coudé du Foresto[1], G. Perrin[1], B. Mennesson[1], J.-M. Mariotti[1], W. Traub[2], and M. Lacasse[3]
[1] Département de Recherche Spatiale (DESPA), Paris Observatory, France <foresto@hplyot.obspm.fr>,
[2] Harvard-Smithonian Center for Astrophysics, Cambridge MA, USA <traub@cfa.harvard.edu>,
[3] Center for Astrophysics, c/o Fred Lawrence Whipple Observatory, Amado AZ, USA <mlacasse@cfa.harvard.edu>

JD24-050L : Gravitational Wave Modes, a Fourth Category of Oscillations in Relativistic Stars, in Post-Newtonian Approximation

V. Rezania[1] and Y. Sobouti[1,2]
[1] Institute for Advanced Studies in Basic Sciences, Gava-Zang, P.O.B. 45195-159, Zanjan, Iran iasbsgz1@rose.ipm.ac.ir>, <sobouti@rose.ipm.ac.ir>, and <rezania@hotmail.com>,
[2] Physics Department, Shiraz University, Shiraz, Iran

https://doi.org/10.1017/S1539299600019547 Published online by Cambridge University Press