SoFAR – Seismology of fast rotating stars

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Abstract

Thanks to the space missions CoRoT and *Kepler*, asteroseismology has successfully probed stellar interiors, especially of solar-like stars and red giants. Such a success has not been achieved yet for non-evolved intermediate-mass and massive stars, as the oscillation spectra of pulsating stars in this mass range exhibit complex patterns that are not well understood. Rapid rotation, a very common feature of these stars, is an identified source of complexity.

Our proposal aims at building a joint effort between modellers and observers, based on existing seismic data for fast rotators, in order to address major difficulties in understanding and studying stars with rapid rotation.

Substantial progress has recently been achieved both in theory and observations. The space missions CoRoT and *Kepler* have provided seismic data with unprecedented quality for classical pulsators such as δ Scuti stars, γ Doradus or SPB (slow pulsating B-type) stars. It allowed us to accurately determine the frequencies of hundreds of oscillation modes in these stars. The mode identification, i.e. associating each frequency with a mode, is a prerequisite for any further seismic inference. This identification needs theoretical support. In the last years, new theoretical approaches as well as new 2D codes taking into account the centrifugal deformation have been developed to model the internal structure of rotating stars and to compute their oscillation spectra.

We are now close to a convergence between theory and observation. Indeed a first breakthrough has been made with the detection of regular patterns that were predicted by the models.

Our team will gather observers who have analysed CoRoT and *Kepler* data of classical pulsators, and modellers who have developped new 2D codes and theoretical seismic tools. The team will involve up to 15 researchers, including young scientists, from Belgium, France, Hungary, and Spain. We plan to organize two team workshops at Bern ISSI at the end of 2017 and about one year later.

We aim at providing new seismic diagnosis, especially for stellar rotation so as to obtain new interpretations of CoRoT and *Kepler* observations of δ Scuti stars, γ Doradus or SPB stars. This work will also help the seismic analyses of future space missions such as TESS and PLATO.

Scientific Rationale

Motivation

Various astrophysical domains (stellar population, galaxy evolution, interstellar enrichment…) rely on our accurate understanding of stellar structure and evolution. Evolution of massive and intermediate-mass stars are of primary importance in this context. Massive stars are a key element

of galaxy evolution as they modify their environment through radiation and winds and supernovae explosions. They are also the progenitors of gamma ray bursts, neutron stars and black holes. Intermediate-mass stars have an internal structure similar to massive stars and are thus perfect laboratories to study essential physical processes that are generally missing in classical stellar models, like rotation, magnetic field, turbulent mixing or atomic diffusion. As of today, models of intermediate-mass and massive stars can be confronted to the classical surface spectroscopic observables (effective temperature, gravity and chemical abundance) and more recently to interferometric observations[1] (radius, oblatness, gravity darkening...). Direct probing of their internal structures and dynamics with asteroseismology would constitute a huge step toward a complete picture of their evolution.

Context

During the past decade, stellar physics has experienced a true revolution thank to the development of asteroseismology. Such a revolution has been possible with the appearance of ultra-precise space-based photometric missions, namely CoRoT[2] and *Kepler*[3]. Unprecedented constraints have been imposed on the internal properties (internal rotation, convective core extent...) of stars while global parameters (radius, masses) are given with unprecedented accuracy. These results mainly concern solar-type stars or red giants, i.e. stars with a convective envelope that stochastically excites oscillation modes. These successes have been possible because their oscillation spectra are rather simple and well-understood, thus easy to interpret. Unfortunately, this is generally not the case for more massive main-sequence pulsating stars, which often exhibit more complex patterns. Interpreting these oscillation spectra is indeed a long-standing issue of stellar seismology. Except for a few cases, it has not yet been possible to obtain a reliable mode identification, i.e. to associate each frequency with a mode, which is a prerequisite for any further seismic inference.

Two main reasons explain this complexity. (1) Contrary to solar-type pulsators, the intrinsic amplitude of the modes of classical pulsators spans many orders of magnitude. Whereas oscillation spectra obtained from Earth are sparse in most cases, CoRoT and *Kepler* provided high-quality data with extremely low noise level and unprecedented high spectral resolution (thanks to continuous month- or year-long observations) giving much more complete sets of modes. Unfortunately we haven't got yet a theory able to predict mode amplitudes, which would help in labelling the numerous observed modes. The amplitudes are governed by non-linear mechanisms that have not been successfully modelled yet. (2) Massive and intermediate-mass stars are rapidly rotating in most cases.[4] Fast rotation is known to add complexity in the spectrum by modifying or suppressing regularities that are present in slow rotators. Significant advances in computing and modelling the structure of rapidly rotating stars and their oscillation spectra have been made in recent years.[5-7]

State of the art

New numerical codes, namely the TOP[8] and ACOR[9] codes, have been successfully built to compute oscillation modes in rotating stars fully taking into account the effects of the rotation on the oscillations. Progresses have been made to understand both the acoustic (or pressure = p) modes and the low-frequency modes known as gravity (=g) and gravito-inertial modes. It enabled us to determine the range of validity of the perturbative methods[8,10] and to explore how the structure of the spectrum changes with the star rotation[11-13]. One of the striking results was to show that regular frequency patterns also exist in the p-mode spectrum of rapidly rotating stars. In slowly rotating

solar-type stars, regular spacings like the so-called large and small separations or the rotational splittings provide fundamental seismic constraints on the star (mean density, internal composition gradient, internal rotation), even before any direct modelling of individual frequencies. Thus, the possibility to detect similar seismic indices in the spectra of typical classical main-sequence pulsators is crucial. Further computations have shown that an equivalent of the large separation and twice the rotation rate are indeed potentially detectable although our incapacity to predict mode amplitudes generally prevents to draw firm conclusions.[14] Meanwhile, an asymptotic theory based on acoustic ray dynamics[15] enabled us to relate these seismic indices to the physical property of the star.[16] In particular, at large rotation rates, the large frequency separation remains closely related to the star's mean density. Similar works may be done for g modes that present regularities in their period. The pattern of g modes in non-rotating stars is evenly spaced. Rotation deeply modifies this spacing, resulting in a new pattern, directly dependent on the rotation rate. A theory of gravity ray dynamics has been recently developed[17] and new asymptotic developments have been proposed.[18] Beyond the perturbative methods that are known to be weak for g-mode pulsators, complete 2D computations allow us to better test the limit of the extensively used and so-called traditional approximation.[19]

On the observational side, parallel to these theoretical aspects, we recently achieved breakthroughs in the interpretation of both δ Scuti p-mode spectra, and SPB and γ Dor g-mode spectra. The analysis of CoRoT and *Kepler* δ Scuti stars indeed revealed the presence of periodic patterns in the p-mode frequency spectra.[20-25] These patterns were found to be compatible with the expected large separation for these stars. A solid confirmation came from the scaling relation found between the observed large separation and the mean density computed for a sample of well-known stars (including binary stars) of different rotations.[26] Regular patterns have also been discovered in g-mode period among *Kepler* γ Dor and SPB stars. First detections of regular period spacing have been done in slowly rotating γ Dor stars,[27] and patterns are now found also in moderate and fast rotators.[28-30] By basing the interpretation on the traditional approximation, it has been possible to infer constraints on rotation[29-32] and internal processes such as mixing[29-30] in these stars making them valuable laboratories for testing massive and intermediate-mass star models.

The proposed project

Our project aims at building a joint effort gathering modellers and observers to propose and/or validate analysis and interpretation tools, in the light of the recent theoretical developments. CoRoT and *Kepler* observations of δ Scuti, γ Dor, and SPB stars will be interpreted on this basis. The project may be decomposed in several tasks carried out by different teams.

Team #1 will focus on p modes and δ Scuti stars. The first objective will be to detect and interpret the regular spacings that may occur. The question of the robustness and reliability of detections is crucial as well as a correct determination of their nature and origin (large spacing, rotation…). The possibility of finer mode identification (e.g. defining the nature of modes, as chaotic modes, island modes,…) will be discussed.

Team #2 will focus on g modes spectra. It concerns the γ Doradus stars and the more massive SPB stars. Several questions raised by these two categories of stars are the similar and may be treated together, since there are intrinsically linked to the g-mode properties. Nevertheless two sub-teams will be in charge of the analysis of the two kind of stars. In the light of last observations, the team

will first focus on seismic rotation measurements. We will determine our capability in measuring reliable internal differential rotation, specify the range of validity of the traditional approximation and consider the opportunity to go beyond with more complete theories. Other internal properties brought by the period spacings, such as core size and mixing, will be also analyzed.

A last work that should be initiated by the project in a third team (gathering also people from team #1 and #2) is the way of using 2D models to perform direct seismic analysis. A direct brute force approach turned out to be inefficient and too time consuming. Brainstorming sessions will be held during the workshops on what should be a correct and fruitful strategy involving 2D models.

Project Schedule

We plan to organise two ISSI workshops for the whole group. We expect to hold the first ISSI workshop during autumn 2017. The first goal of this workshop will be to identify the current weaknesses of the interpretation and analysis tools, to correctly identify the needs of observers and to propose some modelling strategies. We will then split into teams #1 and #2 to apply what is already existing and identify key points that would need theoretical progresses and new developments. It will form the baseline of the objectives for the teams that will continue to work together during the following year. A second workshop will take place no more than one year later. It will be the opportunity to present the recent works of the teams and finalize works in progress.

Expected Outputs

- We expect to publish several papers to refereed academic journals. At least one paper on regularities in δ Scuti stars (team #1) and another on the seismic inference of rotation in g-mode pulsators (team #2). A paper on the limit of traditional approximation should also be submitted. The thoughts and recommendations of the team #3 will be summarized in a report.

- The project and its results will be presented in the next asteroseismology international conferences. We shall first introduce the project during the next Kepler asteroseismic science consoritum (KASC) workshop in July at Birmingham and present our results during the following one in 2018.

- The approaches, methods and models developed by the team will also help the seismic analyses of future space missions such as TESS[33] and PLATO.[34]

List of participants

- J. Ballot (IRAP, Toulouse, France)
- Zs. Bognár (Konkoly Observatory, Hungary)
- A. García Hernández (Universidad de Granada, Spain)
- F. Lignières (IRAP, Toulouse, France)
- E. Michel (Observatoire de Paris, France)
- E. Moravveji (Institute of Astronomy, KU Leuven, Belgium)
- R. M. Ouazzani (Observatoire de Paris, France)
- M. Paparó (Konkoly Observatory, Hungary)
- V. Prat (CEA Saclay, France)
- D. R. Reese (Observatoire de Paris, France)

- M. Rieutord (IRAP, Toulouse, France)
- Á. Sódór (Konkoly Observatory, Hungary)
- J. C. Suárez (Universidad de Granada, Spain)

We will invite one or two young scientists, specialists of this topic, especially T. Van Reeth (KU Leuven, Belgium) through the ISSI Young Scientist scheme.

ISSI at Bern is the preferred implementation site

A few members of the SoFAR Team have already been involved in previous ISSI working groups, such as the AsteroFLAG team, or Georgy's team. The on-site support and facilities are very impressing and provide a perfect work frame. ISSI offers the possibility to scientists from different laboratories to focus during one uninterrupted week on a scientific topic, far from any institutional pressure and distraction. One-week dedicated time has been proved to be very fruitful to progress on projects of the type proposed by our team.

Requested facilities

We will require a meeting room capable of holding 15 scientists, which corresponds to the full SoFAR team including young scientists, with Internet access and data projection facilities. It would also be advantageous to have access to another small room, to allow two splinter meetings of working teams. We would like access to a local printer. Group members will bring their own laptops.

Requested financial support

We request a total of 20 man-weeks of financial support to cover accommodation and per diem costs for 10 participants at each of the two proposed SoFAR meetings. It will thus support up to two scientists per institution. Travel costs for the team leader should not exceed 500€ for each meeting.

Travels for participants and accommodation and per diem costs for the 3 extra participants will be covered by our own institutional funds and grants.

List of References

1. Domiciano de Souza, A. et al. 2005, A&A, 442, 567
2. Baglin, A. et al. 2006, ESA-SP 1306, 33
3. Gilliland, R.L. et al. 2010 PASP 122, 131
4. Royer, F. et al. 2007, A&A, 463, 671
5. Ballot, J. et al. 2013, LNP, 865, 91
6. Espinosa Lara, F., Rieutord, M., 2013, A&A, 552, A35
7. Rieutord, M. et al. 2016, J. Comp. Phys., 318, 277
8. Reese, D. et al. 2006, A&A 455, 621
9. Ouazzani, R-M. et al. 2012, A&A 547, A75
10. Ballot, J. et al. 2010, A&A 518, A30
11. Reese, D. R. et al. 2009, A&A 506, 189
12. Lignières, F., Georgeot, B., 2009, A&A, 500, 1173
13. Ballot, J. et al. 2012, ASP Conf. Proc., 462, 389
14. Reese, D. R. et al., 2017, A&A, in press
15. Lignières, F., Georgeot, B., 2008, PhRvE, 78, 016215
16. Pasek, M. et al. 2012, A&A, 546, A11
17. Prat, V. et al. 2016, A&A, 587, A110
18. Prat, V. et al. 2017, A&A, 598, A105
19. Eckart, C. 1960, Pergamon, New York
20. Mantegazza, L. et al. 2012, A&A 542, A24
21. García Hernández, A., et al., 2009, A&A, 506, 79
22. García Hernández, A. et al., 2013, A&A, 559, A63
23. Paparó, M. et al. 2013, A&A 557, A27
24. Paparó, M. et al. 2016, AJ 822, 100P
25. Paparó, M. et al. 2016, AJSS 224, 41P
26. García Hernández, A. et al., 2015, ApJL, 811, L29
27. Murphy, S.J. et al. 2016, MNRAS 459, 1201
28. Van Reeth, T. et al. 2015, A&A, 574, A17
29. Moravveji, E. et al. 2016, ApJ 823, 130
30. Papícs, P. I. et al. 2017, A&A, 598, A74
31. Van Reeth, T. et al. 2016, A&A, 593, A120
32. Ouazzani, R. M. et al. 2017, MNRAS 465, 2294
33. Ricker, G. R. et al. 2014, Proc. SPIE 9143, 914320
34. Rauer, H. et al. 2014, Experimental Astron. 38, 249

Appendix 1: Full Addresses of participants

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Appendix 2: Short CV of the applicants

NAME, First Name: **BALLOT, Jérôme**

Affiliation: Institut de Recherche en Astrophysique et Planétologie – CNRS, Toulouse, France

Role in the project:
Coordinator of the project. Specialist of gravity modes in fast rotating stars. Interface between theory and data analysis.

Current position:
Chargé de Recherche CNRS (CNRS tenured researcher) (2010-)

Former Positions:
- 2008-2010 Postdoctoral researcher at LATT, Université de Toulouse, France
- 2005-2008 Postdoctoral fellow at Max-Planck Institut für Astrophysik, Garching, Germany
- 2004-2005 GOLF Research Engineer at AIM Laboratory, CEA Saclay, France

Education:
- 2004 Ph.D. in Astrophysics, Université Paris-Sud XI, Orsay, France
- 2001 DEA (Master) in Astrophysics, Université Paris-Sud XI, Orsay, France

Services in National and/or International Committees (last ones):
- IAU member (divisions E & G)
- Member of the European HELAS (Helio & Asteroseismology) network board
- Coordinator of the Toulouse pole in the European SpaceInn (Exploitation of Space Data for Innovative Helio- and Asteroseismology) project (2013-2016)
- Expert for research agencies: Czech Science Foundation, Research Foundation - Flanders (FWO), Institut Polaire Français.

Selected Publications:
- Reese D. R., Lignières F., Ballot J., Dupret M.-A., Barban C., van 't Veer-Menneret C., MacGregor K. B., *Frequency regularities of acoustic modes and multi-colour mode identification in rapidly rotating stars*, A&A in press, ArXiv:1701.09164 (2017)
- Prat V., Mathis S., Lignières F., Ballot J., Culpin P.-M., *Period spacing of gravity modes strongly affected by rotation. Going beyond the traditional approximation*, A&A 598, A105 (2017)
- Mirouh G., Baruteau C., Rieutord M., Ballot J., *Gravito-inertial waves in a differentially rotating spherical shell*, Journal of Fluid Mechanics 800, 213 (2016)
- Prat V., Lignières F., Ballot J., *Asymptotic theory of gravity modes in rapidly rotating stars. I. Ray dynamics*, A&A 587, A110 (2016)
- Deheuvels S., Ballot J., Beck P. G., Mosser B., Østensen R., García R. A., Goupil M. J., *Seismic evidence for a weak radial differential rotation in intermediate-mass core helium burning stars*, A&A 580, A96 (2015)
- Mathur S., Ballot J., Garcia R. A., *Stellar dynamics: Rotation, convection, and magnetic fields*, Extraterrestrial Seismology, Cambridge University Press, p. 294 (2015)
- Ballot J., Lignières F., Reese D. R., *Numerical Exploration of Oscillation Modes in Rapidly Rotating Stars*, Lecture Notes in Physics, Berlin Springer Verlag 865, 91 (2013)
- Gizon L., Ballot J., Michel E., et al. (32 other authors), *Seismic constraints on rotation of*

Sun-like star and mass of exoplanet, Proceedings of the National Academy of Science 110, 13267 (2013)

- Ballot J., Lignières F., Prat V., Reese D. R., Rieutord M., *2D Computations of g-modes in Fast Rotating Stars*, Progress in Solar/Stellar Physics with Helio- and Asteroseismology ASP Conference Proceedings 462, 389 (2012)
- Ballot J., Barban C., van't Veer-Menneret C., *Visibilities and bolometric corrections for stellar oscillation modes observed by Kepler*, Astronomy and Astrophysics 531, A124 (2011)
- Ballot J., Gizon L., Samadi R., et al. (27 other authors), *Accurate p-mode measurements of the G0V metal-rich CoRoT target HD 52265*, Astronomy and Astrophysics 530, A97 (2011)
- Silva Aguirre V., Ballot J., Serenelli A. M., Weiss A., *Constraining mixing processes in stellar cores using asteroseismology. Impact of semiconvection in low-mass stars*, Astronomy and Astrophysics 529, A63 (2011)
- Salabert D., Ballot J., García R. A., *Mode visibilities in radial velocity and photometric Sun-as-a-star helioseismic observations*, Astronomy and Astrophysics 528, A25 (2011)
- Ballot J., Lignières F., Reese D. R., Rieutord M., *Gravity modes in rapidly rotating stars. Limits of perturbative methods*, Astronomy and Astrophysics 518, A30 (2010)
- García R. A., Mathur S., Salabert D., Ballot J., Régulo C., Metcalfe T. S., Baglin A., *CoRoT Reveals a Magnetic Activity Cycle in a Sun-Like Star*, Science 329, 1032 (2010)
- Ballot J., Appourchaux T., Toutain T., Guittet M., *On deriving p-mode parameters for inclined solar-like stars*, Astronomy and Astrophysics 486, 867 (2008)
- García R. A., Turck-Chièze S., Jiménez-Reyes S. J., Ballot J., Pallé P. L., Eff-Darwich A., Mathur S., Provost J., *Tracking Solar Gravity Modes: The Dynamics of the Solar Core*, Science 316, 1591 (2007)
- Ballot J., Brun A. S., Turck-Chièze S., *Simulations of Turbulent Convection in Rotating Young Solarlike Stars: Differential Rotation and Meridional Circulation*, The Astrophysical Journal 669, 1190 (2007)
- Ballot J., García R. A., Lambert P., *Rotation speed and stellar axis inclination from p modes: how CoRoT would see other suns*, Monthly Notices of the Royal Astronomical Society 369, 1281 (2006)
- Ballot J., Turck-Chièze S., García R. A., *Seismic extraction of the convective extent in solar-like stars. The observational point of view*, Astronomy and Astrophysics 423, 1051 (2004)

H-index (refereed papers) = 43 (after 13 years)
85 refereed papers (159 in total)

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Role in the project:
Observations, data processing and analysis.

Current position:
Research fellow (2014-)

Former Positions:
- 2013-2014: Royal Observatory of Belgium, voluntary collaborator
- 2012-2014: Konkoly Observatory, voluntary collaborator
- 2005-2012: Konkoly Observatory, research assistant

Education:
- 2012: PhD in Physics, title of dissertation: Asteroseismic investigations of pulsating white dwarf stars, supervisor: Dr. Margit Paparó
- 2006-2009: Eötvös Loránd University, Faculty of Science, Doctoral School of Physics
- 2005: Astronomer and Certified Teacher of Physics (MSc), title of thesis: Investigation of white dwarfs in international campaigns, supervisor: Dr. Margit Paparó
- 2000-2005: Eötvös Loránd University, Faculty of Science, Budapest
- 1996-2000: Nagy Lajos High School of the Cistercian Order, Pécs

Services in National and/or International Committees (last ones):
IBVS Editor (2011-2012)

Honors:
2003: XXVI. National Scientific Conference for Students, philosophy section, special award

Selected Publications:

- Bognár, Zs., Paparó, M., Molnár, L., Pápics, P. I., Plachy, E., Verebélyi, E., and Sódor, Á., "G 207-9 and LP 133-144: light-curve analysis and asteroseismology of two ZZ Ceti stars", *Monthly Notices of the Royal Astronomical Society*, 461, pp. 4059-4070 (2016)
- Bognár, Zs. and Sódor, Á., "White Dwarf Period Tables I. Pulsators with hydrogen-dominated atmospheres", *Information Bulletin on Variable Stars*, 6184, p. 31 (2016)
- Bognár, Zs., Lampens, P., Frémat, Y., Southworth, J., Sódor, Á., De Cat, P., Isaacson, H. T., Marcy, G. W., Ciardi, D. R., Gilliland, R. L., and Martín-Fernández, P., "KIC 9533489: a genuine γ Doradus - δ Scuti *Kepler* hybrid pulsator with transit events", *Astronomy and Astrophysics*, 581, A77 (2015)
- Bognár, Zs., Paparó, M., Molnár, L., Plachy, E., and Sódor, Á., "Amplitude Modulation in the ZZ Ceti Star GD 244", *ASP Conference Series*, 493, pp. 245-248 (2015)
- Bognár, Zs., Paparó, M., Córsico, A. H., Kepler, S. O., and Győrffy, Á., "Revealing the pulsational properties of the V777 Herculis star KUV 05134+2605 by its long-term monitoring", *Astronomy and Astrophysics*, 570, A116 (2014)
- Bognár, Zs. and Paparó, M., "GD 244: asteroseismology of a pulsator in the middle of the ZZ Ceti instability strip", *American Institute of Physics Conference Series*, 1273, pp. 504-507 (2010)
- Bognár, Zs., Paparó, M., Bradley, P. A., and Bischoff-Kim, A., "Characterizing the pulsations of the ZZ Ceti star KUV 02464+3239", *Monthly Notices of the Royal Astronomical Society*, 399, pp. 1954-1963 (2009)

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Role in the project:
Seismic data analysis of δ Scuti stars

Current position:
Post-doctoral researcher

Former Positions:
- 2012-2016- Post-doctoral researcher at IA-CAUP (Porto, Portugal)
- 2011- Post-doctoral researcher at IAA-CSIC (Granada, Spain)
- 2005-2011- Ph. D. student at IAA-CSIC (Granada, Spain)
- 2005- Graduate fellowship holder at IAA-CSIC (Granada, Spain)

Education:
- 2011- Ph. D. in Astrophysics (Universidad de Granada, Spain)
- 2004- Bachelor's degree in Physics (Universidad Complutense de Madrid, Spain)

Selected Publications:

- *Observational Δν-ρ relation for δ sct stars using eclipsing binaries and space photometry.* A. García Hernández, S. Martín-Ruiz, M. J. P. F. G. Monteiro, et al. Astrophysical Journal Letters, 2015, 811, L29
- *An in-depth study of HD 174966 with CoRoT photometry and HARPS spectroscopy. Large separation as a new observable for δ Scuti stars.* A. García Hernández, A. Moya, E. Michel, et al. Astronomy and Astrophysics, 559, A63, 2013
- *Measuring mean densities of δ Scuti stars with asteroseismology. Theoretical properties of large separations using TOUCAN*. J. C. Suárez, A. García Hernández, A. Moya, et al. Astronomy & Astrophysics, 563, 7, 2014.
- *Asteroseismic analysis of the CoRoT δ Scuti star HD 174936*. A. García Hernández, A. Moya, E. Michel, et al. Astronomy and Astrophysics, 506, 79G, 2009.
- *Evidence of chaotic modes in the analysis of four delta Scuti stars.* S. Barceló Forteza, T. Roca Cortés, A. García Hernandez, R. A. García, Astronomy and Astrophysics, accepted for publication.

NAME, First Name: **LIGNIÈRES, François**

Affiliation: Institut de Recherche en Astrophysique et Planétologie, CNRS, Toulouse

Role in the project:
Expert in hydrodynamics and theory of oscillations in r(fast) otating stars.

Current position:
Directeur de Recherche – CNRS (2012-)

Former Positions:
Chargé de Recherche CNRS at IRAP, Toulouse, France (2000-2012)
Postdoc at Queen Mary and Westfield College, London, UK (1998-2000)

Education:
- HDR, University Toulouse 3 (2010)
- Ph.D., University Paris 7 (1997)

Services in National and/or International Committees (last ones):
- IRAP Deputy Director (2016-2020)
- Expert for the Research Foundation Flanders (FWO)
- Expert for the Time Allocation Committee at Canadian French Telescope
- Expert for national committees: the Agence d'Evaluation de la Recherche et de l'Enseignement Supérieur (AERES), INSU (prospective moyen), PNPS (Programme national de Physique Stellaire), Computing Time Allocation Committee at CALMIP (Toulouse) Computer Center, Hiring committees at Toulouse III University.

Selected Publications:

- Lignières F., Rieutord M. and Reese D., “Acoustic oscillations in rapidly rotating polytropic stars ; I. Effects of the centrifugal distortion”, A&A 455, 2006
- Reese D., Lignières F. and Rieutord M., “Acoustic oscillations in rapidly rotating polytropic stars ; II. Effects of the Coriolis and centrifugal accelerations”, A&A 455, 2006
- Lignières F. and Georgeot, B., ”Asymptotic analysis of high-frequency acoustic modes in rapidly rotating stars”, A&A 500, 2009
- Ballot, J., Lignières, F., Reese, D., Rieutord, M., ”Gravity modes in rapidly rotating stars. Limits of perturbative methods”, A&A 518, 2010
- Pasek, M., Lignières, F., Georgeot, B., & Reese, D. R., ”Regular oscillation subspectrum of rapidly rotating stars”, A&A 546, A11, 2012
- Prat, V., Lignières, F., Ballot, J., ”Asymptotic theory of gravity modes in rotating stars. I. Ray dynamics”, A&A 597, 2016
- Prat, V., Mathis, S., Lignières, F., Ballot, J., Culpin, P, ”Period spacing of gravity modes strongly affected by rotation. Going beyond the traditional approximation”, A&A 598, 2017
- D. Reese, Lignières, F., Ballot, J. et al., ”Frequency regularities of acoustic modes and multi-colour mode identification in rapidly rotating stars”, in press, arXiv:1701.09164, 2017

(62 refereed publications, 2159 citations, H-index=26)

NAME, First Name: **MICHEL, Eric**

Affiliation: Observatoire de Paris-LESIA

Role in the project:
Expert on δ Scuti observations and modelling.
Confrontation observations/models

Current position:
Astronome at Observatoire de Paris since 1994

Education:
Ph.D., HDR

Services in National and/or International Committees (last ones):
Conseil du Programme National de Physique Stellaire 2010-14

Selected Publications:

- Barceló Forteza, S.; Michel, E.; Roca Cortés, T.; García, R. A. 2015 A&A 579 *Evidence of amplitude modulation due to resonant mode coupling in the δ Scuti star KIC 5892969. A particular or a general case?*
- Michel, Eric 2013 ASSP 31, invited review *Impact of High Precision Photometry from Space: Do the Results Meet the Expectations?*
- Michel, Eric; Baglin, Annie; Auvergne, Michel; Catala, Claude; Samadi, Reza; Baudin, Frédéric; Appourchaux, Thierry; Barban, Caroline; Weiss, Werner W.; Berthomieu, Gabrielle; and 34 coauthors 2008 Science 322 *CoRoT Measures Solar-Like Oscillations and Granulation in Stars Hotter Than the Sun*

NAME, First Name: **MORAVVEJI, Ehsan**

Affiliation: Institute of Astronomy, KU Leuven, Belgium

Role in the project:
Seismic analysis of gravity-mode pulsators (SPB, γ Dor)

Current position:
Postdoctoral fellow

Former Position:
Institute for Advanced Studies in Basic Sciences, Zanjan, Iran

Education:

- PhD in astrophysics, Institute for Advanced Studies in Basic Sciences, Zanjan, Iran

Honors:
Marie Curie fellow

Selected Publications:

- Morravveji, E., *Insights from Asteroseismology of Massive Stars: The Need for Additional Angular Momentum Transport Mechanism*s, Proc. "Seismology of the Sun and the Distant Stars 2016". Editors: Mário J. P. F. G. Monteiro, Margarida S. Cunha, João Miguel T. Ferreira, to be published (arXiv:1612.03092)
- Moravveji, E., Townsend, R. H. D., Aerts, C., & Mathis, S., *Sub-inertial Gravity Modes in the B8V Star KIC 7760680 Reveal Moderate Core Overshooting and Low Vertical Diffusive Mixing*,ApJ 823, 130 (2016)
- Moravveji, E., *The impact of enhanced iron opacity on massive star pulsations: updated instability strips*, MNRAS 455, 67 (2016)
- Moravveji, E., Aerts, C., Pápics, P. I., Triana, S. A., & Vandoren, B., *Tight asteroseismic constraints on core overshooting and diffusive mixing in the slowly rotating pulsating B8.3V star KIC 10526294*, A&A 580, A27 (2015)

NAME, First Name: **OUAZZANI, Rhita Maria**

Affiliation: LESIA, Paris Observatory

Role in the project:
Modelling of rapidly rotating stars pulsations. Seismic determination of rotation.

Current position:
CNES Post-doctoral fellow at LESIA

Former Positions:
2014-2016 Post-doctoral researcher at the Stellar Astrophyics Centre, Aarhus University, Denmark
2013 Post-doctoral researcher at the "Institut d'Astrophysique Spatiale", University Paris South, Orsay, France
2011-2012 Post-doctoral researcher at the intsitute of Astronomy, Geology and Oceanography, Liège University, Belgium

Education:
2011 Ph.D. in Physics, Université Pierre et Marie Curie, Paris, France
2007 MSC. in Fundamental Physics, Université Pierre et Marie Curie, Paris, France

Services in National and/or International Committees (last ones):
NASA K2 guest observer review committee.

Selected Publications:

- A new asteroseismic diagnostic for internal rotation in γ Doradus stars, Ouazzani, R.M., Salmon, S., Antoci, V.L., Bedding, T.R., Roxburgh, I.W., Murphy, S.J., 2017, MNRAS, V. 465, I 2, pp 2294-2309
- Pulsations of rapidly rotating stars: II. Realistic modelling for intermediate mass stars, Ouazzani, R.M., Roxburgh, I., Dupret, M-A., 2015 A&A, V. 579, id. A116
- KIC 10080943: a binary star with two γ Doradus / δ Scuti hybrid pulsators. Analysis of the g modes, Keen, M. A., Bedding, T. R., Murphy, S. J., Schmid, V. S., Aerts, C., Tkachenko, A., Ouazzani, R.-M., Kurtz, D. W. 2015 MNRAS, V. 454, issue 2
- Non-perturbative effect of rotation on dipolar mixed modes in red giant stars, Ouazzani, R.M., Goupil, M.J., Dupret, M.A., Marques, J.P., 2013, A&A V. 554, id.A80
- Seismic diagnostics for transport of angular momentum in stars 1. Rotational splittings from the PMS to the RGB, Marques, J.P., Goupil, M.J., Lebreton, Y., Talon, S., Palacios, A., Belkacem, K., Ouazzani, R.M. et al., 2013 A&A, V. 549, id.A74
- Seismic diagnostics for transport of angular momentum in stars 2. Interpreting observed rotational splittings of slowly-rotating red giant stars , Goupil, M.J., Mosser, B., Marques, J.P., Ouazzani, R.M.,et al., 2013, A&A , V. 549, id.A75
- Spin down of the core rotation in red giants, Mosser, B., Goupil, M-J., Belkacem, K., Marques, J.P., Beck, P.G., Bloemen, S., De Ridder, J., Barban, C., Deheuvels, S., Elsworth, Y., Hekker, S., Kallinger, T., Ouazzani, R-M. et al., 2012, A&A, V. 548, id.A10
- Pulsation of rapidly rotating stars: I. The ACOR numerical code, Ouazzani, R-M., Dupret, MA., Reese, D., 2012 A&A, V. 547, id.A75
- Rotational splitting for fast rotators: Latitudinal dependency or higher order effects in Ω ? Ouazzani, RM., Goupil, M-J., 2012 A&A, V. 542, id.A99

NAME, First Name: **PAPARÓ Margit**

Affiliation: MTA CSFK, Konkoly Observatory, Hungary

Role in the project:
Seismic analysis of δ Scuti stars

Current position:
Research professor emerita (2016-)

Former Positions:
- 2004-2016 Scientific advisor, Konkoly Observatory
- 1994-2004 Senior research fellow (permanent), Konkoly Observatory
- 1978-1993 Research fellow (permanent), Konkoly Observatory
- 1974-1977 Assistant research fellow, Konkoly Observatory

Education:
- 2004 D.Sc. highest scientific degree of the Hungaraian Academy of Sciences
- 1994 C.Sc. scientific degree of the Hungarian Academy of Sciences
- 1979 Ph.D. Eötvös University, Budapest
- 1969-1974 undergraduate student, Eötvös University, Budapest

Services in National and/or International Committees (last ones):
- IAU member (1988 IAU Variable Star Commission)
- 2006-2010 Member of the Executive Committee of Astronomy and Astrophysics Board
- 2003-2006 Hungarian representative in Astronomy and Astophysics Board

Selected Publications:

- Paparó, M., Benkő, J. M., Hareter, M., and Guzik, J. A., *Unexpected Series of Regular Frequency Spacing of δ Scuti Stars in the Non-asymptotic Regime. I. The Methodology*, The Astrophysical Journal, 822, id.100 (2016)
- Paparó, M., Benkő, J. M., Hareter, M., and Guzik, J. A., *Unexpected Series of Regular Frequency Spacing of δ Scuti Stars in the Non-asymptotic Regime. II. Sample-Echelle Diagrams and Rotation*, The Astrophysical Journal Supplement Series, 224, id.41 (2016)
- Hareter, M., Paparó, M., Weiss, W., García Hernández, A., Borkovits, T., Lampens, P., Rainer, M., De Cat, P., Marcos-Arenal, P., Vos, J., Poretti, E., Baglin, A., Michel, E., Baudin, F., and Catala, C., *HD 51844: An Am delta Scuti in a binary showing periastron brightening*, Astronomy and Astrophysics, 567, A124 (2014)
- Paparó, M., Bognár, Zs., Plachy, E., Molnár, L., and Bradley, P. A., *Multimode pulsation of the ZZ Ceti star GD 154*, MNRAS, 432, pp. 598-608 (2013)
- Paparó, M., Bognár, Zs., Benkő, J. M., Gandolfi, D., Moya, A., Suárez, J. C., Sódor, Á., Hareter, M., Poretti, E., Guenther, E. W., Auvergne, M., Baglin, A., and Weiss, W. W., *CoRoT 102749568: mode identification in a δ Scuti star based on regular spacings*, Astronomy and Astrophysics, 557, A27, 13 pages (2013)
- Paparó, M., Chadid, M., Chapellier, E., Benkő, J. M., Szabó, R., Kolenberg, K., Guggenberger, E., Regály, Zs., Auvergne, M., Baglin, A., Weiss, W. W. *Periodicity search as a tool for disentangling the contaminated colour light curve of CoRoT 102781750*, Astronomy and Astrophysics, 531, A135, (2011)

NAME, First Name: **PRAT, Vincent**

Affiliation: Laboratory Dynamics of Stars, (Exo-)planets, and their Environment
CEA/DRF/IRFU/SAp & UMR AIM Paris-Saclay

Role in the project:
Expert on theory of gravito-inertial waves, especially on ray-based asymptotic developments.

Current position:
Postdoctoral Researcher

Former Position:
- Postdoctoral fellow at Max-Planck Institute for Astrophysics, Garching, Germany (2013-2015)

Education:
- Ph.D., Astrophysics, Toulouse University (2013)
  Dissertation: Turbulent transport of chemical elements in stellar radiative zones
- Master, Astrophysics, Toulouse University (2010)
  Master-Thesis: Study of gravity modes in rapidly rotating stars

Selected Publications:
- Prat, V., Mathis, S., Lignières, F., Ballot, J. & Culpin, P.-M., 2017, *Period spacing of gravity modes strongly affected by rotation. Going beyond the traditional approximation*, A&A, 598, A105
- Prat, V., Guilet, J., Viallet, M. & Müller, E., 2016, *Shear mixing in stellar radiative zones. II. Robustness of numerical simulations*, A&A, 592, A59
- Prat, V., Lignières, F. & Ballot, J., 2016, *Asymptotic theory of gravity modes in rapidly rotating stars. I. Ray dynamics*, A&A, 587, A110.
- Prat, V. & Lignières, F., 2014, *Shear mixing in stellar radiative zones. I. Effect of thermal diffusion and chemical stratification*, A&A, 566, A110.
- Prat, V. & Lignières, F., 2013, *Turbulent transport in radiative zones of star*s, A&A 551, L3.

NAME, First Name: **REESE, Daniel**

Affiliation: LESIA, Observatoire de Paris

Role in the project:
Computation of oscillation modes in rotating stars
Provide numerical methods

Current position:
Astronome Adjoint (French Associate Astronomer)

Former Positions:
- SPACEINN Postdoc in Birmingham (Jan 2014 - Sept 2015)
- Postdoc at l'Université de Liège (Dec 2011 - Nov 2013)
- CNES Postdoc at LESIA, Observatoire de Paris-Meudon (Dec 2009 - Nov 2011)
- HELAS Postdoc at the University of Sheffield (Nov 2006 - Nov 2009)

Education:
- PhD at l'Université de Toulouse III (Paul Sabatier) (Sept 2003 - Oct 2006)
- DEA Astrophysique, Planétologie, Sciences et techniques spatiales, Toulouse (2002 - 2003)
- Aeronautics and space engineering at Supaero (Ecole Nationale Supérieur de l'Aeronautique et de l'Espace), Toulouse (2000 - 2003)

Honors:
- Prix Pierre Maury for my PhD, from l'Académie des Sciences, Inscriptions et Belles-Lettres de Toulouse (2007)

Selected Publications:

- Reese, D. R., Lignières, F., Ballot, J., Dupret, M.-A., Barban, C., van 't Veer-Menneret, C., MacGregor, K. B. 2017. "Frequency regularities of acoustic modes and multi-colour mode identification in rapidly rotating stars", A&A, in press, astro-ph.SR:1701.09164
- Reese, D. R., Prat, V., Barban, C., van ’t Veer-Menneret, C., MacGregor, K. B. 2013. Mode visibilities in rapidly rotating stars , A&A 550, A77, 28 pages.
- Reese, D. R., MacGregor, K. B., Jackson, S., Skumanich, A., Metcalfe, T. S. 2009. Pulsation modes in rapidly rotating stellar models based on the Self-Consistent Field method, A&A 506, 189-201.
- Reese, D., Lignières, F., Rieutord, M. 2006. Acoustic oscillations of rapidly rotating polytropic stars. II. Effects of the Coriolis and centrifugal accelerations, A&A 455, 621-637

NAME, First Name: **RIEUTORD, Michel**

Affiliation: Institut de Recherche en Astrophysique et Planétologie, Université Paul Sabatier, Toulouse

Role in the project:
Expert in hydrodynamics, magnetohydrodynamics, theory of rotating fluids,
dynamics of rotating stars, turbulence, stellar and solar physics.
Provide Methods for solving fluid dynamics equations and 2D models of fast rotating stars,

Current position:
Professor of Physics and Astrophysics, Toulouse University (since 2000)

Education:
1987 PhD., Astrophysics, Observatoire de Paris-Meudon - Paris-Orsay University Paris, France
Dissertation: Tidal heating in close binary stars

Selected Publications:

- Espinosa Lara F., Rieutord M. (2007), *The dynamics of a fully radiative rapidly rotating star enclosed within a spherical box*, in Astron. Astrophys., vol. 470, pp. 1013-1022
- Espinosa Lara F., Rieutord M. (2011), *Gravity darkening in rotating stars*, in Astron. Astrophys., vol. 533, p. A43
- Espinosa Lara F., Rieutord M. (2013), *Self-consistent 2D-models of fast rotating early-type stars*, in Astron. Astrophys., vol. 552, A35
- Rieutord M., Beth A. (2014), *Dynamics of the radiative envelope of rapidly rotating stars: Effects of spin-down driven by mass loss*, in Astron. Astrophys., vol. 570, A42
- Rieutord M., Espinosa Lara F., Putigny B. (2016), *An algorithm for computing the 2D structure of fast rotating stars*, in J. Computational Phys., vol. 318, 277-304

NAME, First Name: **SÓDOR, Ádám**

Affiliation: Konkoly Observatory of the Hungarian Academy of Sciences

Role in the project:
Observations, data processing and analysis.

Current position:
senior research fellow

Former Positions:
- Post-doc at the Royal Observatory of Belgium (PI: Peter De Cat) 2012-2014
- Research fellow at Konkoly Observatory since 2005

Education:
- Eötvös University PhD in Particle physics and astronomy (2009)
- Eötvös University MSc in Astronomy and Physics teacher (2005)
- Landler Jenő high school Computer and electric technician (1995)

Services in National and/or International Committees (last ones):
- KASC member
- IAU member
- IBVS Editor (2012-2013)

Honors:
2009 Young Researcher Award of the Hungarian Academy of Sciences

Selected Publications:

- Sódor, Á., Skarka, M., Liška, J., Bognár, Zs. 2017, MNRAS, 465L, 1: "KIC 2831097 - a 2-yr-orbital-period RR Lyrae binary candidate"
- Sódor, Á., Chené, A.-N., De Cat, P., Bognár, Zs., Wright, D. J. et al. 2014, A&A, 568, 106: "MOST light-curve analysis of the γ Doradus pulsator HR 8799, showing resonances and amplitude variations"
- Sódor, Á., De Cat, P., Wright, D. J., Neiner, C., Briquet, M. et al. 2014, MNRAS, 438, 3535: "Extensive study of HD 25558, a long-period double-lined binary with two SPB components"
- Sódor, Á., Hajdu, G., Jurcsik, J., Szeidl, B., Posztobányi, K. et al. 2012, MNRAS, 427, 1517: "The light-curve modulation of XY And and UZ Vir: two Blazhko RR Lyrae stars with additional frequencies"
- Sódor, Á., Jurcsik, J., Szeidl, B., Váradi, M., Henden, A. et al. 2011, MNRAS, 411, 1585: "The multiperiodic Blazhko modulation of CZ Lacertae"
- Sódor, Á., Jurcsik, J., Szeidl, B. 2009, MNRAS, 394, 261: "A new method for determining physical parameters of fundamental mode RR Lyrae stars from multicolour light curves"
- Sódor, Á., Szeidl, B., Jurcsik, J. 2007, A&A, 469, 1033: "The Blazhko behaviour of RR Geminorum II. Long-term photometric results"

NAME, First Name: **SUÁREZ, Juan Carlos**

Affiliation:
Dept. Física Teórica y del Cosmos. Universidad de Granada, Spain

Role in the project:
Expert in asteroseismology of moderately-to-fast rotating stars and the rotation-pulsation interaction. I will provide my expertise in the study of (quasi)-periodicities in the oscillation spectra of A-F stars, seeking for signatures of rotation and other physical properties that may be obtained from the global (statistical) analysis of the pulsations.

Current position:
Researcher/Lecturer at University of Granada under Ramón y Cajal Senior Fellowship.

Former Positions:
- (2009-2014) CoRoT/PLATO dedicated post-doc funded by the Spanish MINECO
- (2006-2009) I3P-CSIC post-doc fellowship at IAA-CSIC. Granada Spain
- (2004-2005) Doctor specialisation fellowship funded by the "Junta de Andalucía" local government at Observatoire de Meudon
- (2003-2004) Post-doc contract at IAA-CSIC for the preparation of the CoRoT mission.

Education:
- (2002) PhD in Astrophysics and Space Techniques (Observatoire de Meudon, Université Paris 7). France
- (1999) Degree in Physics (5yr) with specialisation in Astrophysics. Universidad de La Laguna - IAC. Spain.

Services in National and/or International Committees (last ones):
- (2015-16) Member of the ESO-OPC international committee in P97 and P98
- (2014 -) Member of the PLATO2.0 Mission Board

Selected Publications:

- J. Pascual-Granado, R. Garrido, & J.C Suárez "MIARMA: A minimal-loss information method for filling gaps in time series. Application to CoRoT light curves.", A&A 575, A78 – A86 (2015)
- J.C. Suárez, A. García Hernández, A. Moya, et al. "Measuring mean densities of δ Scuti stars with asteroseismology. Theoretical properties of large separations using TOUCAN", A&A, 536, 7 – 18 (2014)
- J.C. Suárez, R. Garrido, L.A. Balona, J. Christensen-Dalsgaard. "Stellar Pulsations: Impact of New Instrumentation and New Insights, Astrophysics and Space Science Proceedings", Vol. 31. Springer-Verlag Berlin Heidelberg (2013)
- K. Uytterhoeven, A. Moya, A. Grigahcène, et al. "The Kepler characterization of the variability among A- and F-type stars. I. General overview", A&A 534, 125 (2011)
- J.C. Suárez, M.J. Goupil, D.R. Reese, et al. "On the Interpretation of Echelle Diagrams for Solar-like Oscillations Effect of Centrifugal Distortion", ApJ 721, 537 – 546 (2010)
- J.C. Suárez, A. Moya, P.J. Amado, et al. "Seismology of β Cephei Stars: Differentially Rotating Models for Interpreting the Oscillation Spectrum of ν Eri", ApJ 690, 1401 (2009)
- A. García Hernández, A. Moya, R. Garrido, et al. " Asteroseismology of the δ Scuti star HD 174936", A&A 506, 79 – 83 (2009)
- J.C. Suárez, M.J. Goupil & P. Morel "Effects of moderately fast shellular rotation on adiabatic oscillations", A&A 449, 673 – 685 (2006)