

Dr. Joey S.G. Mombarg



Born: 09-12-1993, Arnhem, The Netherlands

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🏠 <https://jmombarg.github.io/PersonalWebsite/>

Employment

Postdoctoral researcher

Département d'Astrophysique, CEA. Funded by the European Research Council (ERC) synergy programme (4D-STAR, PIs: C. Aerts, A. Dotter, S. Mathis and M. Rieutord).

Paris-Saclay, France

Oct 2024 - Present

Postdoctoral researcher

Institut de Recherche en Astrophysique et Planétologie, Université Paul Sabatier III. Funded by the French National Research Agency (ANR) programme (MASSIF, PI: A. Meilland).

Toulouse, France

Sep 2022 - Sep 2024

Postdoctoral researcher

Institute of Astronomy, KU Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium. Funded by the European Union's Horizon 2020 research and innovation programme (grant agreement No 670519: PARADISE, PI: C. Aerts).

Leuven, Belgium

Mar 2022 - Aug 2022

Education

PhD Astronomy and Astrophysics

Institute of Astronomy, KU Leuven.

Leuven, Belgium

Mar 2018 - Feb 2022

- Thesis title: “*Asteroseismic Modelling of Intermediate-mass Stars*”.
- Supervisors: Prof. Dr. C. Aerts and Dr. Timothy Van Reeth.
- Topic: My PhD focused on modelling gravity mode pulsations in A/F-type pulsators to derive masses, ages, and mixing efficiencies with the goal of improving our understanding of the mechanism(s) behind the transport of angular momentum and chemical elements. My PhD thesis can be found [here](#).

MSc Physics and Astronomy

Radboud University. Specialization in Particle and Astrophysics. Graduated Bene Meritum.

Nijmegen, The Netherlands

Aug 2015 - Feb 2018

BSc Physics and Astronomy

Radboud University. Minor in Astrophysics. Graduated Bene Meritum.

Nijmegen, The Netherlands

Sep 2012 - Jul 2015

Seminars

(Invited) IAU working group on active B stars

“*The formation of single Be stars studied with the first two-dimensional stellar structure and evolution models of rapid rotators*”

Online

June 2024

Good vibrations seminar

“Asteroseismic modelling of gravito-inertial modes in γ Doradus pulsators”

Link to video [here](#).

Online

July 2021

Institut de Recherche en Astrophysique et Planétology

“Constraining stellar evolution theory with asteroseismology of γ Doradus stars using deep learning”

Toulouse, France

May 2021

Institute of Astronomy

“Pulse fiction: Gravito-inertial asteroseismology of intermediate-mass stars”

KU Leuven, Belgium

Dec 2019

Scientific Awards and Grants

- 2021 **IRAP PhD day Best poster award** Toulouse, France
Title: “Asteroseismic modelling of A- and F-type pulsators”.
Authors: J.S.G Mombarg
- 2020 **Long-stay travel grant Research Foundation - Flanders (FWO)** Leuven, Belgium
9-month travel grant (14850EUR) for research stay at Institut de Recherche en Astrophysique et Planétology (IRAP), Toulouse, France. (Shortened to 6.5 month due to COVID pandemic.)
- 2018 **Netherlands Astronomy Conference 2018 Best poster award** Groningen, The Netherlands
Title: “Atomic diffusion and pulsations in young stars with a convective core”.
Authors: J.S.G Mombarg, M. Michielsen, M.G. Pedersen and C. Aerts.
- 2018 **De Zeeuw-Van Dishoeck 2018 award** Haarlem, The Netherlands
Award (3000EUR) for best astronomy Master thesis in The Netherlands awarded by the “Koninklijke Hollandse Maatschappij der Wetenschappen”.

Software development

Computing Pulsation Periods and Photospheric Observables (C-3PO)

Python, Tensorflow

Designed neural network to for modelling of gravity-mode pulsators. See Mombarg et al. (2021) in publication list.

Github repo: <https://github.com/JMombarg/c3po>

Modules for Experiments in Stellar Astrophysics (MESA)

Fortran

Developer. Method for computing radiative accelerations and consistent Rosseland mean opacities from monochromatic opacity tables. See Mombarg et al. (2022) and Jermyn et al. (2022) in publication list.

Github repo: <https://github.com/MESAHub/mesa>

Evolution STellaire en Rotation (ESTER)

C++

2D stellar structure and evolution. See Mombarg et al. (2023, 2024) in publication list.

Github repo: <https://github.com/ester-project/ester>

Teaching

Student project co-supervisor

Leuven, Belgium

KU Leuven

May - July 2022

- Co-supervisor of BSc student Rebecca Rehm.
Project title: ‘The impact of radiative levitation on mode excitation of B-type pulsators’
Publication led by student (see Rehm et al. (2024) in publication list).

MSc thesis co-supervisor

KU Leuven

Leuven, Belgium

Sep 2019 - July 2020

- Mentor of MSc student Jan Henneco (Supervisor: Dr. T. Van Reeth).
Thesis title: 'The effect of the centrifugal deformation of stars on g-mode pulsations'
Publication led by student (see Henneco et al. (2021) in publication list).

Teaching Assistant

KU Leuven

Leuven, Belgium

Mar 2018 - ongoing

- TA for the BSc introductory courses to astronomy, and mechanics.
- TA for MSc course 'Astero-seismology'.

Teaching Assistant

Radboud University

Nijmegen, Netherlands

Sep 2015 - Jan 2016

- TA of the BSc biology and physics courses 'Mathematics for Biologists', 'Biophysics' and 'Mechanics' (3h/week).

Scientific community work

Scientific reviewer

- The Astrophysical Journal
- Astronomy & Astrophysics
- Monthly Notices of the Royal Astronomical Society

2020 - 2024

Gaia DR3 PR event

ESA

Brussels, Belgium

Jun 2022

- In the context of pulsating stars observed with Gaia DR3, I made an animation demonstrating asteroseismology. Link to the article can be found [here](#).

STEM University

KU Leuven

Leuven, Belgium

Feb 2022

- Workshop on stars and (exo)planets for primary and high school children, ~15 participants, 1.5-hour workshop.

Member of the SOC for the EAS 2022 conference

Special session on Machine Learning in astronomy.

Valencia, Spain

2022

Lecture at high school

Berthoutsinstituut, Mechelen

Online

May 2021

- Online lectures for high school students on stellar evolution, black holes, exoplanets, and space travel.
~50 participants, 2 times 45-min lecture.

High School visit

KU Leuven

Leuven, Belgium

March 2019

- Departmental visit high school students, ~20 participants, 1-hour workshop.

Ladies@Science

KU Leuven

Leuven, Belgium

April 2019, April 2018

- Exoplanet workshop for high school girls, ~20 participants, 1-hour workshop.

Kids University

KU Leuven

Leuven, Belgium

Oct 2018

- Solar system workshop for primary school children, ~30 participants, 1-hour workshop.

Publications

9 first-author, 14 co-author, 840+ citations, h-index 13 (6 for first-author publications)

[Link to ADS Library](#)

Mombarg, J. S. G.; Aerts, C.; Van Reeth, T.; Hey, D.; “Estimates of (convective core) masses, radii, and relative ages for ~14,000 Gaia-discovered gravity-mode pulsators monitored by TESS”, *Astronomy & Astrophysics*, in press.

Rieutord M.; Reese D. R.; **Mombarg, J. S. G.**; Charpinet, S.; “An improved asteroseismic age of the rapid rotator Altair from TESS data”, *Astronomy & Astrophysics*, Volume 687, A259

Li, G.; Aerts, C.; Bedding, T. R.; Fritzewski, D. J.; Murphy, S. J.; Van Reeth, T.; Montet, B. T.; Jian, M.; **Mombarg, J. S. G.**; Gossage, S.; Sreenivas, K. R.; “Asteroseismology of the young open cluster NGC 2516. I. Photometric and spectroscopic observations”, *Astronomy & Astrophysics*, Volume 686, A142

Rehm R.; **Mombarg, J. S. G.**; Aerts C.; Michielsen, M.; Burssens, S.; Townsend, R. H. D.; “The impact of radiative levitation on mode excitation of main-sequence B-type pulsators”, *Astronomy & Astrophysics*, Volume 687, A175

Mombarg, J. S. G.; Aerts C.; Molenberghs G.; “Probability distributions of initial rotation velocities and core-boundary mixing efficiencies of γ Doradus stars”, *Astronomy & Astrophysics*, Volume 685, A21

Fritzewski, D. J.; Aerts, C.; **Mombarg, J. S. G.**; Gossage, S.; Van Reeth, T.; “Age uncertainties of red giants due to cumulative rotational mixing of progenitors calibrated by asteroseismology”, *Astronomy & Astrophysics*, Volume 684, A121

Mombarg, J. S. G.; Rieutord M.; Espinosa Lara F.; “A two-dimensional perspective of the rotational evolution of rapidly rotating intermediate-mass stars. Implications for the formation of single Be stars”, *Astronomy & Astrophysics*, Volume 683, A94

Mombarg, J. S. G.; Rieutord M.; Espinosa Lara F.; “The first two-dimensional stellar structure and evolution models of rotating stars. Calibration to β Cephei pulsator HD 192575”, *Astronomy & Astrophysics*, Volume 677, L5

Mombarg, J. S. G.; “Calibrating angular momentum transport in intermediate-mass stars from gravity-mode asteroseismology”, *Astronomy & Astrophysics*, Volume 677, A63

Moyano, F. D.; Eggenberger, P.; Salmon, S. J. A. J.; ; **Mombarg, J. S. G.**; Ekström, S. “Angular momentum transport by magnetic fields in main sequence stars with Gamma Doradus pulsators”, *Astronomy & Astrophysics*, Volume 677, A6

Burssens, S.; Bowman, D. M.; Michielsen, M.; Simón-Díaz, S.; Aerts, C.; Vanlaer, V.; Banyard, G.; Nardetto, N.; Townsend, R. H. D.; Handler, G.; **Mombarg, J. S. G.**; Vanderspek, R.; Ricker, G. “A calibration point for stellar evolution from massive star asteroseismology”, *Nature Astronomy*, Volume 7, p. 1138-1138

Jermyn, A. S.; Bauer, E. B.; Schwab, J.; Farmer, R.; Ball, W. H.; Bellinger, E. P.; Dotter, A.; Joyce, M.; Marchant, P.; **Mombarg, J. S. G.**; Wolf, W. M. ; Wong, T. L. S. ; Cinquegrana, G. C. ; Farrell, E. ; Smolec, R. ; Thoul, A.; Cantiello, M.; Herwig, F.; Toloza, O.; Bildsten, L.; Townsend, R. H. D.; Timmes, F. X. “Modules for Experiments in Stellar Astrophysics (MESA): Time-Dependent Convection, Energy Conservation, Automatic Differentiation, and Infrastructure”, 2023, *The Astrophysical Journal Supplement Series*, 265, 15

Mombarg, J. S. G.; Dotter, A.; Rieutord, M.; Michielsen, M.; Van Reeth, T.; Aerts, C, “Predictions for gravity-mode periods and surface abundances in intermediate-mass dwarfs from shear mixing and radiative levitation”, 2022, *The Astrophysical Journal*, Volume 925, Issue 1, id.154

Pavlovski, K.; Hummel, C. A.; Tkachenko, A.; Dervisoglu, A.; Kayhan, C.; Zavala, R. T.; Hutter, D. J.; Tycner, C.; Sahin, T.; Audenaert, J.; Baeyens, R.; Bodensteiner, J.; Bowman, D. M.; Gebruers, S.; Janssen, N. E.; **Mombarg, J. S. G.**, “Dynamical parallax, physical parameters and evolutionary status of the components of the bright eclipsing binary α Draconis”, 2022, *Astronomy & Astrophysics*, Volume 658, id.A92

Aerts C.; Augustson K.; Mathis S.; Pedersen M. G.; **Mombarg J. S. G.**; Vanlaer V.; Van Beeck J.; Van Reeth T, “Rossby numbers and stiffness values inferred from gravity-mode asteroseismology of rotating F- and B-type dwarfs”, 2021, *Astronomy & Astrophysics*, Volume 656, id.A121

Serenelli, Aldo; Weiss, Achim; Aerts, Conny; Angelou, George C.; Baroch, David; Bastian, Nate; Bergemann, Maria; Bestenlehner, Joachim M.; Czekala, Ian; Elias-Rosa, Nancy; Escorza, Ana; Van Eylen, Vincent; Feuillet, Diane K.; Gandolfi, Davide; Gieles, Mark; Girardi, Leo; Lodieu, Nicolas; Martig, Marie; Miller Bertolami, Marcelo M.; **Mombarg, Joey S. G.**; Morales, Juan Carlos; Moya, Andres; Nsamba, Benard; Pavlovski, Kresimir; Pedersen, May G.; Ribas, Ignasi; Schneider, Fabian R. N.; Silva Aguirre, Victor; Stassun, Keivan; Tolstoy, Eline; Tremblay, Pier-Emmanuel; Zwintz, Konstanze, “Weighing stars from birth to death: mass determination methods across the HRD”, 2021, *The Astronomy and Astrophysics Review*, Volume 29

Gebruers, Sarah; Straumit, Ilya; Tkachenko, Andrew; **Mombarg, Joey S. G.**; Pedersen, May G.; Van Reeth, Timothy; Li, Gang; Lampens, Patricia; Escorza, Ana; Bowman, Dominic M.; De Cat, Peter; Vermeylen, Lore; Bodensteiner, Julia; Rix, Hans-Walter; Aerts, Conny, “A homogeneous spectroscopic analysis of a Kepler legacy sample of dwarfs for gravity-mode asteroseismology”, 2021, *Astronomy & Astrophysics*, Volume 650, id.A58, 23 pp, Impact factor: 5.802

Mombarg J. S. G., Van Reeth T., and Aerts C., “Constraining stellar evolution theory with asteroseismology of γ Doradus stars using deep learning”, 2021, *Astronomy & Astrophysics*, Volume 650, id.A58, 23 pp

Henneco, Jan; Van Reeth, Timothy; Prat, Vincent; Mathis, Stéphane; **Mombarg, Joey S. G.**; Aerts, Conny, “The effect of the centrifugal acceleration on period spacings of gravito-inertial modes in intermediate-mass stars”, 2021, *Astronomy & Astrophysics*, Volume 648, id.A97

Mombarg J. S. G., Dotter A., Van Reeth T., Tkachenko A., Gebruers S. and Aerts C., “Asteroseismic modeling of gravity modes in slowly rotating A/F stars with radiative levitation”, 2020, *The Astrophysical Journal*, Volume 895, Issue 1, id.51

Mombarg J. S. G., Van Reeth T., Pedersen M. G., Molenberghs G., Bowman D. M., Johnston C., Tkachenko A. and Aerts C., “Asteroseismic masses, ages and core properties of gamma Doradus stars using gravity-inertial dipole modes and spectroscopy”, 2019, *Monthly Notices of the Royal Astronomical Society*, Volume 485, Issue 3, Pages 3248-3263

Aerts C. Molenberghs G., Michielsen M., Pedersen M. G., Björklund R., Johnston C., **Mombarg J. S. G.**, Bowman D. M., Buysschaert B., Pápics P. I., Sekaran S., Sundqvist J. O., Tkachenko A., Truyaert K., Van Reeth T. and Vermeyen E., 2018, “Forward Asteroseismic Modeling of Stars with a Convective Core from Gravity-mode Oscillations: Parameter Estimation and Stellar Model Selection”, *The Astrophysical Journal Supplement Series*, 237, id15

Van Reeth T., **Mombarg J. S. G.**, Mathis S., Tkachenko A., Fuller J., Bowman D. M., Buysschaert B., Johnston C., García Hernández A., Goldstein, J. Townsend, R. H. D. and Aerts, C., 2018, “On the sensitivity of gravito-inertial modes to differential rotation in intermediate-mass main-sequence stars”, *Astronomy & Astrophysics*, 618:A24

Conference and Workshop Participation

Invited lecturer morning session MESA summer school 2024

5-day workshop on the stellar evolution code Modules for Experiments in Stellar Astrophysics (MESA).

Sydney, Australia

17 - 21 June 2024

TA MESA summer school 2023

5-day workshop on the stellar evolution code Modules for Experiments in Stellar Astrophysics (MESA).

Budapest, Hungary

28 Aug - 1 Sep 2023

TASC7/KASC14

Oral contribution: ‘Testing angular momentum transport on the main sequence’

Honolulu, Hawaii, USA

17-21 Jul 2023

<p>TA MESA summer school 2022 5-day workshop on the stellar evolution code Modules for Experiments in Stellar Astrophysics (MESA).</p>	<p>UCSB, California, USA 8-12 Aug 2022</p>
<p>TASC6/KASC13 conference</p> <ul style="list-style-type: none"> • 90-min tutorial (invited): <i>'Forward seismic modelling of gravity modes'</i> • Poster contribution: <i>'Improved stellar evolution models with radiative levitation and rotational mixing'</i> Online version can be found here. 	<p>Leuven, Belgium 11-15 Jul 2022</p>
<p>Workshop stellar physics group Institut de Recherche en Astrophysique et Planétologie Oral contribution: <i>'Improving the theory of chemical mixing inside intermediate-mass stars with asteroseismology'</i></p>	<p>Villalier, France 18-19 Oct 2021</p>
<p>European Astronomical Society (EAS) 2020 Poster contribution: <i>'Predicting stellar gravity-mode pulsations and evolution tracks with neural networks'</i></p>	<p>Online 29 Jun -3 Jul 2020</p>
<p>Stars and their Variability: Observed from Space Oral contribution: <i>'Improving stellar evolution models with atomic diffusion from asteroseismology of intermediate-mass stars'</i></p>	<p>Vienna, Austria 19-23 Aug 2019</p>
<p>Tess Sci Con I Poster contribution: <i>'High-precision mass and age estimates of F-type stars from asteroseismology'</i></p>	<p>Cambridge, USA 29 July - 2 Aug 2019</p>
<p>TASC5/KASC12 Oral contribution: <i>'Improving stellar evolution models with atomic diffusion from asteroseismology of intermediate-mass stars'</i></p>	<p>Cambridge, USA 22-26 July 2019</p>
<p>Nederlandse Astronomen Conferentie 2019 Oral contribution: <i>'Masses, Ages, and Core Properties of Intermediate-mass Stars from Asteroseismology and Spectroscopy'</i></p>	<p>Groningen, The Netherlands 27-29 May 2019</p>
<p>Lorentz workshop: 'Weighting stars from birth to death' Oral contribution: <i>'Probing the fundamental parameters and core properties of γ Dor stars'</i></p>	<p>Leiden, The Netherlands 19-23 Nov 2018</p>
<p>PHOST 2018 Oral contribution: <i>'The effect of atomic diffusion on gravity modes of young stars with a convective core'</i></p>	<p>Banyuls-sur-mer, France 2-7 Sep 2018</p>
<p>MESA Summer School 2018 5-day workshop on the stellar evolution code MESA.</p>	<p>UCSB, California, USA 13-17 Aug 2018</p>
<p>Nederlandse Astronomen Conferentie 2018 Poster contribution: <i>'Atomic diffusion in young stars with a convective core'</i></p>	<p>Groningen, Netherlands 16-18 May 2018</p>