Dr. Joey S.G. **Mombarg**

Born: 09-12-1993, Arnhem, The Netherlands
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https://jmombarg.github.io/PersonalWebsite/

Employment

Postdoctoral researcher — *Toulouse, France*
Institut de Recherche en Astrophysique et Planétologie, Université Paul Sabatier III. Funded by the French National Research Agency (ANR) programme (MASSIF, PI Meilland). — *Sep 2022 - Present*

Postdoctoral researcher — *Leuven, Belgium*
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 Aerts). — *Mar 2022 - Aug 2022*

Education

PhD Astronomy and Astrophysics — *Leuven, Belgium*
Institute of Astronomy, KU Leuven. — *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 — *Nijmegen, The Netherlands*
Radboud University. Specialization in Particle and Astrophysics. — *Aug 2015 - Feb 2018*

BSc Physics and Astronomy — *Nijmegen, The Netherlands*
Radboud University. Minor Astrophysics. — *Sep 2012 - Jul 2015*

Seminars

(Invited) IAU working group on active B stars — *Online*
"*The formation of single Be stars studied with the first two-dimensional stellar structure and evolution models of rapid rotators*" — *June 2024*

Good vibrations seminar — *Online*
"*Asteroseismic modelling of gravito-inertial modes in γ Doradus pulsators*" — *July 2021*
Link to video here.

Institut de Recherche en Astrophysique et Planétology — *Toulouse, France*
"*Constraining stellar evolution theory with asteroseismology of γ Doradus stars using deep learning*" — *May 2021*

Institute of Astronomy — *KU Leuven, Belgium*
"*Pulse fiction: Gravito-inertial asteroseismology of intermediate-mass stars*" — *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 — *Leuven, Belgium*
KU Leuven — *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 Assistent — *Leuven, Belgium*
KU Leuven — *Mar 2018 - ongoing*
- TA for the BSc introductory courses to astronomy, and mechanics.
- TA for MSc course 'Asteroseismology.

Teaching Assistent *Nijmegen, Netherlands*
Radboud University *Sep 2015 - Jan 2016*
- TA of the BSc biology and physics courses 'Mathematics for Biologists', 'Biophysics' and 'Mechanics' (3h/week).

Publications

8 first-author, 14 co-author, 700+ citations, h-index 12 (6 for first-author publications)
Link to ADS Library

Rieutord M.; Reese D. R.; **Mombarg, J. S. G.**; Charpinet, S; "The impact of radiative levitation on mode excitation of main-sequence B-type pulsators", *Astronomy & Astrophysics*, in press

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*, in press

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*

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.; Jannsen, 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 — *Sydney, Australia*

5-day workshop on the stellar evolution code Modules for Experiments in Stellar Astrophysics (MESA). — *17 - 21 June 2024*

TA MESA summer school 2023 — *Budapest, Hungary*

5-day workshop on the stellar evolution code Modules for Experiments in Stellar Astrophysics (MESA). — *28 Aug - 1 Sep 2023*

TASC7/KASC14 — *Honolulu, Hawaií, USA*

Oral contribution: *'Testing angular momentum transport on the main sequence'* — *17-21 Jul 2023*

TA MESA summer school 2022 — *UCSB, California, USA*
5-day workshop on the stellar evolution code Modules for Experiments in Stellar Astrophysics (MESA). — *8-12 Aug 2022*

TASC6/KASC13 conference — *Leuven, Belgium*
- 90-min tutorial (invited): *'Forward seismic modelling of gravity modes'*
- Poster contribution: *'Improved stellar evolution models with radiative levitation and rotational mixing'* Online version can be found here.

11-15 Jul 2022

Workshop stellar physics group Institut de Recherche en Astrophysique et Planétologie — *Villalier, France*
Oral contribution: *'Improving the theory of chemical mixing inside intermediate-mass stars with asteroseismology'* — *18-19 Oct 2021*

European Astronomical Society (EAS) 2020 — *Online*
Poster contribution: *'Predicting stellar gravity-mode pulsations and evolution tracks with neural networks'* — *29 Jun -3 Jul 2020*

Stars and their Variability: Observed from Space — *Vienna, Austria*
Oral contribution: *'Improving stellar evolution models with atomic diffusion from asteroseismology of intermediate-mass stars'* — *19-23 Aug 2019*

Tess Sci Con I — *Cambridge, USA*
Poster contribution: *'High-precision mass and age estimates of F-type stars from asteroseismology'* — *29 July - 2 Aug 2019*

TASC5/KASC12 — *Cambridge, USA*
Oral contribution: *'Improving stellar evolution models with atomic diffusion from asteroseismology of intermediate-mass stars'* — *22-26 July 2019*

Nederlandse Astronomen Conferentie 2019 — *Groningen, The Netherlands*
Oral contribution: ''*Masses, Ages, and Core Properties of Intermediate-mass Stars from Asteroseismology and Spectroscopy'* — *27-29 May 2019*

Lorentz workshop: 'Weighting stars from birth to death' — *Leiden, The Netherlands*
Oral contribution: *'Probing the fundamental parameters and core properties of γ Dor stars'* — *19-23 Nov 2018*

PHOST 2018 — *Banyuls-sur-mer, France*
Oral contribution: *'The effect of atomic diffusion on gravity modes of young stars with a convective core'* — *2-7 Sep 2018*

MESA Summer School 2018 — *UCSB, California, USA*
5-day workshop on the stellar evolution code MESA. — *13-17 Aug 2018*

Nederlandse Astronomen Conferentie 2018 — *Groningen, Netherlands*
Poster contribution: *'Atomic diffusion in young stars with a convective core'* — *16-18 May 2018*