

# DAVID DOUWE HENDRIKS

## CONTACT

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## RESEARCH INTERESTS

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My research interests primarily focus on the fields of computational (astro)physics. Specifically, I specialize in theoretical stellar population evolution, exploring interactions between binary stars and their impact on the surrounding environment, including aspects such as chemical evolution. Additionally, I investigate which of these binary systems form compact-object pairs that eventually merge and become observable through gravitational wave detectors.

In recent work, I have been dedicated to enhancing sampling techniques and improving uncertainty estimation. This involves integrating cutting-edge machine learning methods, such as normalizing flows and probabilistic programming languages, with well-established sampling techniques like Hamiltonian Monte Carlo. I aim to leverage the knowledge and expertise gained from this project to further advance my research in other areas.

## RESEARCH AND PROFESSIONAL ACTIVITIES

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JAN 2022 - PRESENT | Research Fellow: “Bayesian data-assimilation methods for models with thousands to millions of parameters”

*Collaborators: Dr. Payel Das, Dr. Yunpeng Li, Dr. Simon Hadfield*

Improved Hamiltonian Monte-Carlo parameter uncertainty inference techniques using normalising flows and action-angle transformations. Benchmark test indicate faster sampling and uncertainty inference than the current standard, NUTS, after building the transport map. Implemented the workflow in PYRO/NUMPYRO/TORCH and working on the public release and accompanying paper. Applied for a low-TRL UKRI funding grant to develop and apply the technique further.

OCT 2018 - PRESENT | PhD study: “Stellar binaries throughout the cosmos: interactions and remnants”

*Supervisors: Dr. R.G. Izzard, Dr. A. Gualandris, UNIVERSITY OF SURREY, UNIS, Guildford*

Through population-synthesis studies I have studied the interactions and remnants of stellar binaries throughout the cosmos, resulting in a [published study](#) on the mass-stream trajectories and orbital torques in mass-transferring systems with asynchronous donors, and a [published study](#) on pulsational pair-instability supernovae (PPISNe) that shows that the peak in the primary-mass distribution of binary black-hole mergers at  $35 M_{\odot}$  is not caused by PPISNe because that would be in tension with observed super-luminous supernova rates. I have supervised several students throughout the course of the PhD, including an international summer student on a project on globular cluster evolution and black hole retention. Moreover, I have developed and [published](#) an extensive Python-based population-synthesis tool and robust interface to the rapid stellar evolution code BINARY\_C called [BINARY\\_C-PYTHON](#).

SEP 2017 - SEP 2018 | Master Thesis: “Black hole mass distribution with Pulsational Pair Instability Supernova and the measure of stellar explodability”

*Supervisors: Dr. S.E. de Mink, Dr. M. Renzo, API, UvA, Amsterdam*

Used population synthesis techniques to model high-mass binary systems and compact object formation. Implemented several pulsational pair-instability mechanisms and quantitatively compared their primary mass distributions.

JAN 2017 - SEP 2018 | Entrepreneur at Demonstrator lab VU, Amsterdam

*Supervisor: Dr. T. in 't Veld, Prof D. Iannuzi, VU, UvA, Amsterdam*

Entrepreneur at VU Demonstrator lab. Developing a diagnostic apparatus for quantitatively determining the severity of a patients Dry Eye Syndrom. With the use of sensors we correlate the evaporation of the eye surface to the rise of humidity in preocular compartments. This includes in-depth evaporation knowledge, doing field research and correlation questionnaire results with the measurements.

APR 2014 - JUN 2014 | Bachelor thesis: “Analyzing the Higgs particle”

*Supervisor: Prof. S. Bentvelsen, Nikhef, UvA, Amsterdam*

Through simulations and comparisons to existing datasets, I studied the spin of the Higgs particle. Specifically, I investigated the possibility of the Higgs particle having a spin of value 2, by looking at the leptonic decay in the Collins-Sopfer frame.

## TECHNICAL SKILLS

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Proficient in using GNU/Linux and Windows. My preferred programming stack includes Python and C. I have hands-on experience with a variety of tools and technologies, such as MySQL, Django, Mathematica, HTML, CSS, JavaScript, Perl, Git, Flask, Docker, and text processing with LaTeX, Emacs (org-mode), HUGO, and Obsidian. I have worked as a technical software engineer at True, I have developed several websites. Additionally, I chaired the web development

committee at the NSA association and gained valuable experience as a system administrator. In the field of astrophysics, I have used and contributed to detailed stellar evolution codes (MESA), detailed accretion-disk evolution codes (VADER), population synthesis codes (I developed BINARY\_C-PYTHON), N-body simulation codes (NBODY6++), and created a ballistic stream integrator.

## CAREER & EMPLOYMENT

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MAR 2017 - OCT 2018	<p>Administrative/technical employee at ANTON PANNEKOEK INSTITUUT, Amsterdam</p> <p><i>Administrative/technical employee at the Anton Pannekoek Instituut (API).</i></p> <p>Developed and maintained a website for alumni at the API astronomy institute. Created views to visualise supervisor and student connections, built automatic survey tools and export mechanisms for the administration department. Website was built with Python &amp; Django, powered by a PostgreSQL database and hosted on a Linux machine using Docker.</p>
SEP 2016 - DEC 2016	<p>Graduate Teaching Assistant at UVA, Amsterdam</p> <p><i>Teaching assistant at Programming for Physics and Astronomy, assisting dr. I. van Vulpen and drs. M. Stegeman.</i></p> <p>Teaching first year students the basics of Python, and skills to tackle physics problems through scripts and simulations.</p>
MAR 2015 - DEC 2016	<p>Technical Assistance Engineer at TRUE, Amsterdam</p> <p><i>Investigating and improving the server monitoring system</i></p> <p>Technical employee focused on the improvement of the server status monitoring system at True. I implemented an early form of time-series analysis machine learning using the Holt-Winters exponential smoothing algorithm to create a dynamical warning system that learned from the behaviour of each of the servers.</p>
SEP 2013 - SEP 2018	<p>Research assistant at OOGHEELKUNDIG MEDISCH CENTRUM (OMC) and Entrepreneur at D-LAB VU UNIVERSITY</p> <p><i>Investigating and assisting the research on Dry-eye diseases</i></p> <p>Assistent at the development and design of protocols to investigate the “Dry eye” syndrome. We developed a spectacle to measure evaporation rates of tear fluid in a compartment enclosing the eyes. We got lab-space to develop the tools further during years 2017 and 2018, under the name Dr. Dry-eye. We set up data analysis workflow and business plans to roll out the measurement device to several optthalmologists.</p>
FEB 2014 - FEB 2015	<p>Boardmember, Treasurer at NSA, Amsterdam</p> <p><i>Financial responsible at the study association for physics and mathematics</i></p> <p>As a full-time board member of the study association for physics and mathematics I was responsible for all the financial aspects of the organisation. This included making the budget, checking the finances of each committee, contacting debtors and creditors, managing the treasury, doing financial analysis and keeping the financial policy in check. Next to these project specific responsibilities there were many general organisational activities. During this year we streamlined the financial administration, set up a new digital system to buy things in our common room and launched a new website.</p>

## EXTRA CURRICULAR ACTIVITIES

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JAN 2018 - JULY 2018	<p>Organizing national astronomy olympiad at UVA in June 2018, Amsterdam</p> <p>Under supervision of DR. A. WATTS (API), AMSTERDAM</p>
2014 - 2019	<p>Committees Study association at NSA, Amsterdam</p> <p><i>Committee member of the following committees:</i></p> <ul style="list-style-type: none"> <li>• <b>Treasury committee:</b> Checking the finances of the study association, and analyzing the activities of the current treasurer.</li> <li>• <b>Outreach committee (<i>Physicsfair</i>):</b> Organizing outreach activities regarding physics demonstrations for classes and public events..</li> <li>• <b>Website committee:</b> Developing and maintaining the new website of the physics association, as chairman. The development team works with Python and Django.</li> </ul>
FEB 2017 - APR 2017	<p>Developing a software package to visualise (GIFs) physics simulations</p> <p>For DR. I. VAN VULPEN(NIKHEF), AMSTERDAM</p>

## EDUCATION

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SEP 2018 - NOW	PhD ASTRO (ASTRONOMY AND ASTROPHYSICS), <b>University of Surrey</b> , Guildford, Surrey, UK ASTROPHYSICS
SEP 2015 - SEP 2018	Master ASTRO (ASTRONOMY AND ASTROPHYSICS), <b>University of Amsterdam</b> , Amsterdam Sciencepark, NL GRAVITATIONAL ASTROPARTICLE PHYSICS IN AMSTERDAM (GRAPPA) TRACK GRADUATION DATE: 28 SEPTEMBER 2018
SEP 2011 - AUG 2015	Bachelor PHYSICS AND ASTRONOMY, <b>University of Amsterdam</b> , Amsterdam Sciencepark, NL MINOR: COMPUTATIONAL SCIENCES GRADUATION DATE: 15 JULY 2015

## PUBLICATION LIST

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ACCEPTED FOR PUBLICATION IN JOSS.	R. G. Izzard, <b>D. D. Hendriks</b> , and D. P. Nemergut, <i>libcdict: fast dictionaries in C</i>
ACCEPTED FOR PUBLICATION IN MNRAS.	R. M. Yates, <b>D. D. Hendriks</b> , A. P. Vijayan, R. G. Izzard, P. A. Thomas, P. Das, <i>The impact of binary stars on the dust and metal evolution of galaxies</i> , <a href="https://arxiv.org/abs/2310.15218">https://arxiv.org/abs/2310.15218</a>
IN PREP.	M. Matteuzzi, <b>D. D. Hendriks</b> , R. G. Izzard, A. Miglio, K. Brogaard, M. Tailo, J. Montalbán, <i>Metal-rich red horizontal branch stars as post-common-envelope phase products</i>
IN PREP.	N. R. Rees, R. G. Izzard, <b>D. D. Hendriks</b> , G. M. Mirouh, <i>The Impact of Envelope Mass on Stellar Evolution</i>
IN PREP.	<b>D. D. Hendriks</b> , R. G. Izzard, <i>Disky business: disk mass-transfer onto main-sequence accretors</i>
IN PREP.	<b>D.D. Hendriks</b> , P. Das, Y. Li, S. Hadfield. <i>Accelerating Hamiltonian Monte-Carlo sampling with Action-Angle transformations</i>
PUBLISHED.	<b>D.D. Hendriks</b> , L.A.C. van Son, M. Renzo, R.G. Izzard, R. Farmer. <i>Pulsational pair-instability supernovae in gravitational-wave and electromagnetic transients</i> , Monthly Notices of the Royal Astronomical Society, Volume 526, Issue 3, December 2023, Pages 4130–4147, <a href="https://doi.org/10.1093/mnras/stad2857">https://doi.org/10.1093/mnras/stad2857</a>
PUBLISHED.	<b>D. D. Hendriks</b> , R. G. Izzard, <i>Mass-stream trajectories with non-synchronously rotating donors</i> , Monthly Notices of the Royal Astronomical Society, Volume 524, Issue 3, September 2023, Pages 4315–4332, <a href="https://doi.org/10.1093/mnras/stad2077">https://doi.org/10.1093/mnras/stad2077</a>
PUBLISHED.	G. M. Mirouh, <b>D. D. Hendriks</b> , S. Dykes, M. Moe, R. G. Izzard, <i>Detailed equilibrium and dynamical tides: impact on circularization and synchronization in open clusters</i> , Monthly Notices of the Royal Astronomical Society, Volume 524, Issue 3, September 2023, Pages 3978–3999, <a href="https://doi.org/10.1093/mnras/stad2048">https://doi.org/10.1093/mnras/stad2048</a>
PUBLISHED.	<b>D. D. Hendriks</b> , R. G. Izzard. <i>BINARY_C-PYTHON: A Python-based stellar population synthesis tool and interface to BINARY_C</i> . Journal of Open Source Software, 8(85), 4642, May 2023 <a href="https://doi.org/10.21105/joss.04642">https://doi.org/10.21105/joss.04642</a>
PUBLISHED.	N. S. Sartorio, A. Fialkov, T. Hartwig, G. M. Mirouh, R. G. Izzard, M. Magg, R. S. Klessen, S. C. O. Glover, L. Chen, Y. Tarumi, <b>D. D. Hendriks</b> , <i>Population III X-ray binaries and their impact on the early universe</i> , Monthly Notices of the Royal Astronomical Society, Volume 521, Issue 3, May 2023, Pages 4039–4055, <a href="https://doi.org/10.1093/mnras/stad697">https://doi.org/10.1093/mnras/stad697</a>
PUBLISHED.	M. Renzo, <b>D. D. Hendriks</b> , L. A. C. van Son, R. Farmer, <i>Pair-instability Mass Loss for Top-down Compact Object Mass Calculations</i> , American Astronomical Society. Research Notes of the AAS, Volume 6, Number 2, February 2022, <a href="https://doi.org/10.3847/2515-5172/ac503e">https://doi.org/10.3847/2515-5172/ac503e</a>
PUBLISHED.	L. A. C. van Son, S.E. De Mink, F. S. Broekgaarden, M. Renzo, S. Justham, E. Laplace, J. Moran-Fraile, <b>D. D. Hendriks</b> , and R. Farmer, <i>Polluting the Pair-instability Mass Gap for Binary Black Holes through Super-Eddington Accretion in Isolated Binaries</i> , 2020 ApJ 897 100 <a href="https://doi.org/10.3847/1538-4357/ab9809">https://doi.org/10.3847/1538-4357/ab9809</a>

## TALKS, POSTERS, WORKSHOPS AND ORGANISATION

WINTERSCHOOL TENERIFE 2019	Attended the winter school “Universe in a box” in Tenerife 2019.
TALK BRIDGCE 2020	Conference talk at the BridGCE 2020 conference on disk mass-transfer and population statistics.
TALK/ORGANISED BINARY_C WORKSHOP 2020	Workshop talk at the BINARY_C workshop 2020 on software development and mass transfer in populations. Supporting organiser of the event.
PUBLIC LECTURE GAS 2021	Public lecture on gravitational waves and their astrophysical origins at the Guildford astronomical society.
ORGANISED PIMMS 2021	Co-organised the PIMMS 2021 Workshop on astroseismology in binary star systems.
POSTER EAS 2022	Improving Hamiltonian monte-carlo samplers action-angle transformations techniques: <a href="#">Link to interactive poster</a>
POSTER EAS 2022	Matching the feature in the observed binary black hole mass distribution by varying the pulsational pair instability mass loss and onset mass: <a href="#">Link to interactive poster</a>
(INVITED) TALK NSA LUSTRUM AMSTER- DAM APR 2022	Talk at NSA lustrum science conference on pulsational pair-instability and features in the primary-mass distribution.
TALK BRIDGCE DEC 2022	Talk at BridGCE 2020 conference on recent developments in BINARY_C and BINARY_C-PYTHON with focus on nuclear yields and data formats.
TALK IMITATION GAME MAR 2023	Talk at Imitation game conference on pulsational pair-instability and features in the primary-mass distribution.
TALK DEVISE AI WORKSHOP JUL 2023	Talk at DEVISE AI workshop at university of Surrey on uncertainty quantification and sampling techniques in AI.
(INVITED) TALK IRENA NOV 2023	Talk at IrenA seminar series on pulsational pair-instability and features in the primary-mass distribution.
(INVITED) TALK CAR HERTFORDSHIRE FEB. 2024	Talk at CAR seminar series, Hertfordshire on binary interactions, population synthesis and gravitational wave mergers.

## SUPERVISION

SUPERVISED SUMMER- EXCHANGE	<b>Sergi Pradas, 2019:</b> Project on retention of black holes in cluster. Varied cluster mass, density and natal kick prescriptions and used NBODY6++ and BINARY_C.
CO-SUPERVISED THIRD-YEAR PROJECT	<b>Sam Green, 2019:</b> Project on orbital evolution of stars in binary systems with post(AGB) circumbinary accretion and jets. Varied angular-momentum loss in winds (equatorial vs polar) and used BINARY_C.
CO-SUPERVISED THIRD-YEAR PROJECT	<b>Will Dickinson, 2019:</b> Project on neutron-star natal kicks and orbital evolution of stars in binary systems after a supernova. Varied kick prescriptions and used BINARY_C.
CO-SUPERVISED FINAL-YEAR PROJECT	<b>Sophie Dykes, 2020:</b> Project on mass-dependent birth-property distributions and multiplicity fractions of stellar systems. Implemented <a href="#">Moe &amp; diStefano (2017)</a> initial distributions in BINARY_C-PYTHON and generated population statistics.
CO-SUPERVISED FINAL-YEAR PROJECT	<b>Stefan Bell, 2020:</b> Project on L2 mass-loss from binary systems and orbital torques. Wrote a ballistic trajectory integrator and varied mass-ratio of binary system.
CO-SUPERVISED FINAL-YEAR PROJECT	<b>Daniel Tracey, 2021:</b> Project on uncertainty analysis of initial properties of <a href="#">binary system V106</a> . Implemented MCMC sampling interfacing with BINARY_C-PYTHON.
CO-SUPERVISED FINAL-YEAR PROJECT	<b>Jeffrey Lau, 2023:</b> Project age-velocity dispersion relation of stars in the Milky Way. Using GAIA and LAMOST data to find the velocity dispersion of RGB-stars and red-clump stars as a function of galactrocentric distance and age. Using impulse-approximation theory to estimate the mass and other interaction properties of a recent fly-by of Sagittarius dwarf galaxy.

## WEBSITES

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2023 - CURRENT	<a href="https://devise-ff.notion.site/">devise-ff.notion.site/</a> Knowledge-base on machine learning and AI tools for research for the DEVISE-FLLF collaboration. Focussed on writing low-threshold articles that include examples and resources on machine-learning techniques and AI tools for researchers.
2018 - CURRENT	<a href="#">Astrotalks</a> Created static aggregate website for online astrophysics seminar talks. Using scrapers to collect new talks and online video material of astronomy and astrophysics. Currently rewriting to a dynamic website with mongo-db backend.
2018 - CURRENT	<a href="#">Physics-fair.nl</a> Created and maintained Django-based website for the Physics-Fair outreach organisation at the University of Amsterdam. Used to manage outreach events, an experiment database, generates instruction manuals for the experiment presentations.
2014 - AUG 2018	<a href="#">NSAweb.nl</a> Created Django-based website for the physics student association at the University of Amsterdam. Used to manage events, members, media and newsletters.
2017 - 2018	<a href="#">API-alumni.nl</a> Created Django-based website for the Anton Pannekoek Institute for Astronomy Alumni at University of Amsterdam. Used to manage alumni members, send automated surveys, create student-supervisor relation and current alumni occupation visualisations and insights.

## COURSES AND CERTIFICATES

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APRIL 2015	Mathematica Student Certificate
SEP 2010 - SEP 2011	Cambridge Certificate in Advanced English

## OUTREACH ACTIVITIES

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During my bachelors and masters I organized many physics-demonstration events (open-days, workshops, quizzes) through the [Physics-Fair](#), which after retirement of Paul-Vlaanderen we took over as an outreach organisation/committee. Organized [astronomy Olympiad 2018](#) at the API. During my PhD I frequently helped with open days and public stargazing events where we showed the public around the telescope. I also often participated in the World Space Week in Guildford, where we demonstrated models of single star evolution using [Window to the stars](#) and binary-star evolution using [Hyperion](#)

## REFERENCES

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Dr. R. G. Izzard, University of Surrey Astrophysics ([r.izzard@surrey.ac.uk](mailto:r.izzard@surrey.ac.uk)),  
Dr. P. Das, University of Surrey Astrophysics ([p.das@surrey.ac.uk](mailto:p.das@surrey.ac.uk)),  
Dr. A. Gualandris, University of Surrey Astrophysics ([a.gualandris@surrey.ac.uk](mailto:a.gualandris@surrey.ac.uk)),  
Dr. M. Renzo, University of Arizona & Steward Observatory ([mrenzo@arizona.edu](mailto:mrenzo@arizona.edu)),