Dr. Desmond Kabus

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Work Experience

02/2025 – 01/2026: post-doctoral researcher in Applied Mathematics in Cardiology

- *Mathematical Institute, Leiden University*, Leiden, the Netherlands:
  group: Analysis and Dynamical Systems, Dr. Martina Chirilus-Bruckner
  tutor for the course: *Mathematical Biology*
- *Leids Universitair Medisch Centrum*, Leiden, the Netherlands:
  group: Laboratory of Experimental Cardiology, Prof. Daniël Pijnappels, Dr. Tim De Coster

02/2021 – 06/2025: joint PhD in Applied Mathematics in Cardiology

- *KU Leuven campus Kortrijk*, Belgium:
  group: Mathematics of Cardiac Arrhythmias, Prof. Hans Dierckx
  tutor for the courses: *Partial Differential Equations* & *Problem Solving and Development*,
  supervision of two master and two bachelor thesis projects
- *Leids Universitair Medisch Centrum*, Leiden, the Netherlands:
  group: Laboratory of Experimental Cardiology, Prof. Daniël Pijnappels

  keywords: machine learning (AI), digital twins, optimisation, data-driven models, data processing, optical voltage mapping data, function approximation, neural networks, statistics, general purpose computation on GPUs (GPGPU), computational physics, numerical mathematics, cardiology, tissue models, human immortalised atrial myocytes (hiAMs)

since 2019: *Segelsport-Interessentengemeinschaft an der Ruhr-Universität Bochum*, Germany
sailing instructor for internal waters (up to 2 weeks per year)

Education

10/2016 – 09/2019: *Ruhr-Universität Bochum*, Germany
Master of Science in Physics with distinction (overall grade 1.0)
major: plasma physics, minor: computational physics, machine learning
tutor for the course *Theoretical Mechanics*

10/2013 – 09/2016: *Ruhr-Universität Bochum*, Germany
Bachelor of Science in Physics (overall grade 1.8)
tutor for the courses: *Mechanics and Thermodynamics*, *Electromagnetism and Optics*, *Physics for Biologists II*, & *Physics Lab Course for Geoscientists*; manager of an experimental project of physics students

2013: *Landfermann-Gymnasium Duisburg*, Germany
Allgemeine Hochschulreife (Abitur) – general qualification for university entrance (overall grade 1.2)

Cultural Experience

09/2019 – 04/2020: *working holiday* in New Zealand
exchange of culture and language

08/2015 – 01/2016: *Stockholms Universitet*, Sweden
semester abroad in Sweden funded by an ERASMUS grant

11/2010, 03/2011: *Russell High School*, Kansas, USA
exchange of culture and language with a school in the US state of Kansas

Languages

German: native speaker

English: full professional proficiency (reference level > C2 in accordance with CEFR)

Dutch: working proficiency (reference level > B1 in accordance with CEFR)

Latin: proficiency certificate awarded in 07/2010

Classical Greek: proficiency certificate awarded in 07/2012

Technical Skills

published software:

- **Pigreads** (Python-integrated GPU-enabled reaction-diffusion solver) `Python`, `NumPy`, `OpenCL`
  https://gitlab.com/pigreads/pigreads
- **Ithildin** (parallellised simulations of excitable media) `C++`, `MPI`
  https://gitlab.com/heartkor/ithildin
- **Distephym** (data-driven in-silico tissue-based electrophysiology model) `Python`, `NumPy`, `C++`, `OpenMP`
  https://gitlab.com/heartkor/distephym
- and more at https://gitlab.com/dkabus and https://gitlab.com/heartkor

programming languages:

- proficient: `C`, `C++`, `CUDA`, `OpenCL`, `Python`, `Lua`, `LaTeX`, `(ba)sh`, `HTML`, `CSS`, `JavaScript`
- basic skills: `SQL`, `C#`, `Matlab`, `Java`

software: GNU/Linux, Git, GitLab (CI/CD), NumPy, SciPy, Pandas, TensorFlow, LLMs (Claude, ChatGPT, Copilot, Ollama), ParaView, iRODS, Docker, Inkscape, Windows, Office

Hobbies

sailing, rowing, hiking, travelling, video game design, Dungeons & Dragons

Publications

1. **Kabus, D.**, Arno, L., Leenknegt, L., Panfilov, A. V., & Dierckx, H. (2022). Numerical methods for the detection of phase defect structures in excitable media. *PLOS ONE*, *17*(7), 1–31. https://doi.org/10.1371/journal.pone.0271351
2. Cloet, M., Arno, L., **Kabus, D.**, Van der Veken, J., Panfilov, A. V., & Dierckx, H. (2023). Scroll waves and filaments in excitable media of higher spatial dimension. *Physical Review Letters*, *131*(20), 208401. https://doi.org/10.1103/PhysRevLett.131.208401
3. **Kabus, D.**, De Coster, T., de Vries, A. A. F., Pijnappels, D. A., & Dierckx, H. (2024). Fast creation of data-driven low-order predictive cardiac tissue excitation models from recorded activation patterns. *Computers in Biology and Medicine*, *169*, 107949. https://doi.org/10.1016/j.compbiomed.2024.107949
4. **Kabus, D.**, Cloet, M., Zemlin, C., Bernus, O., & Dierckx, H. (2024). The Ithildin library for efficient numerical solution of anisotropic reaction-diffusion problems in excitable media. *PLOS ONE*, *19*(9), 1–26. https://doi.org/10.1371/journal.pone.0303674
5. Legat, T., Grachev, V., **Kabus, D.**, Lettinga, M. P., Clays, K., Verbiest, T., de Coene, Y., Thielemans, W., & Van Cleuvenbergen, S. (2024). Imaging with a twist: Three-dimensional insights of the chiral nematic phase of cellulose nanocrystals via SHG microscopy. *Science Advances*, *10*(44), eadp2384. https://doi.org/10.1126/sciadv.adp2384
6. Arno, L., **Kabus, D.**, & Dierckx, H. (2024). Analysis of complex excitation patterns using Feynman-like diagrams. *Scientific Reports*, *14*(1), 28962. https://doi.org/10.1038/s41598-024-73544-z
7. Arno, L., **Kabus, D.**, & Dierckx, H. (2025). Strings, branes and twistons: Topological analysis of phase defects in excitable media such as the heart. *Physical Review Letters*, *135*(12), 128402. https://doi.org/10.1103/5pgp-1wj6
8. Gobeyn, A., **Kabus, D.**, Tolkacheva, E. G., & Dierckx, H. (2025). ZEUS: Numerical methods to detect quasi-particles describing excitable media. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, *35*(12), 123105. https://doi.org/10.1063/5.0288713
9. **Kabus, D.**, Dierckx, H., & De Coster, T. (2026). Pigreads: The Python-integrated GPU-enabled reaction-diffusion solver using OpenCL for cardiac electrophysiology and other applications. *Computer Physics Communications*, 110088. https://doi.org/10.1016/j.cpc.2026.110088

Forthcoming

10. De Coster, T., **Kabus, D.**, Verkerk, A. O., Veldkamp, M. W., Harlaar, N., Dekker, S. O., Vries, A. A. F. de, Pijnappels, D. A., & Panfilov, A. V. (2026). *Ionic mechanisms underlying human immortalised atrial action potential properties: Insights from a mathematical model*.
11. Kamphuis, J. M., **Kabus, D.**, Bonnet, S., Hupkes, H. J., & De Coster, T. (2026). *Microscopic variability alters macroscopic rotation speed in stochastic spiral waves*.
12. Leenknegt, L., Omara, S., Cloet, M., **Kabus, D.**, Zeppenfeld, K., Panfilov, A. V., & Dierckx, H. (2026). *The EGM generated by an oblique wave front and its application in solving the inverse problem*.

Theses

13. **Kabus, D.** (2016). *Comparison of phase field and interpolation methods for the representation of geometries in the numerical analysis of reaction-diffusion systems* [Bachelor's thesis, Ruhr-Universität Bochum]. https://hbz-ubo.primo.exlibrisgroup.com/permalink/49HBZ_UBO/mnkbqv/alma991012283309706471
14. **Kabus, D.** (2019). *Analysis of parametric level set functions for the representation of geometry in the optimal control of reaction-diffusion systems* [Master's thesis, Ruhr-Universität Bochum]. https://hbz-ubo.primo.exlibrisgroup.com/permalink/49HBZ_UBO/mnkbqv/alma991018264849706471
15. **Kabus, D.** (2025). *Towards data-driven generation of individualised human heart models from scalable heart muscle sheets* [PhD thesis, KU Leuven; Leiden University Medical Center]. https://dkabus.gitlab.io/thesis-phd

Conference contributions

16. **Kabus, D.**, Arno, L., Leenknegt, L., Harlaar, N., Dekker, S. O., Panfilov, A. V., De Vries, A. A. F., Pijnappels, D. A., & Dierckx, H. (2022). Centres of spiral waves can be detected as phase defect lines in optical voltage mapping data and numerical simulations. *Conference of the European Heart Rhythm Association (EHRA)*. https://esc365.escardio.org/presentation/247532
17. **Kabus, D.**, Harlaar, N., Dekker, S. O., de Vries, A. A. F., Pijnappels, D. A., & Dierckx, H. (2023). Creation of predictive cardiac excitation models at the tissue scale with machine learning in augmented state space. *SIAM Conference on Applications of Dynamical Systems (DS23)*. https://meetings.siam.org/sess/dsp_talk.cfm?p=127148
18. **Kabus, D.**, & De Coster, T. (2025). Pigreads enables rapid scientific prototyping through integration into the Python ecosystem. *Dynamics Days Europe 2025*. https://websites.auth.gr/ddeu2025/wp-content/uploads/sites/321/2025/06/Kabus.pdf
19. **Kabus, D.**, Dierckx, H., & De Coster, T. (2025). Accelerated simulation of cardiac tissue using data-driven models. *Conference on Mathematics of Wave Phenomena 2025*. https://conference25.waves.kit.edu/wp-content/uploads/2025/02/BoA.pdf