Kamila Zdybał

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LinkedIn | Google Scholar | Personal website | GitHub

I am a 4th year PhD student at Université Libre de Bruxelles, supervised by Professor Alessandro Parente and co-supervised by Professor James C. Sutherland. Previously, I was a research student at The von Karman Institute, supervised by Professor Miguel A. Mendez.

In my research, I work on development of reduced-order models for turbulent reactive flows. I am passionate about science outreach, creating educational content, academic writing and developing scientific software.

Education

- Sep 2018 – Jan 2023 **(expected)**, PhD student, Université Libre de Bruxelles, Brussels, Belgium
    - Jan 2020 – Apr 2020, research stay at The University of Utah, Salt Lake City, UT, USA

    Dissertation: *Reduced-order modeling of turbulent reacting flows using data-driven approaches*.
- Jul 2016 – Sep 2016, Research student, The von Karman Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium
  Report: *POD and DMD decomposition of numerical and experimental data*.
- 2015–2016, Master degree in Civil Engineering, Cracow University of Technology, Cracow, Poland
  Thesis: *Quasi-static model of wind action in flutter of bridge structures*.
- 2010–2014, Bachelor degree in Civil Engineering, Cracow University of Technology, Cracow, Poland
  Thesis: *Analysis of wind action on a support structure of a dual-rotor wind turbine*. Graduated with honors.

Work experience

- Feb 2017 – Aug 2018, Software test engineer, Nokia, Cracow, Poland
    - Automating regression tests in Elixir language and manual black-box tests of base station software in the Long Term Evolution (LTE) standard, Python scripting, tutoring team members, writing *know-how* documentation, setup works of telecom laboratory equipment.
- May 2014 – Dec 2014, Civil structures intern, BMT Fluid Mechanics, Teddington, United Kingdom
    - Taking part in all stages of commercial wind tunnel tests of high-rise buildings and offshore structures. This included determining cladding pressures, forces and moments on structures, assessing pedestrian wind comfort, assisting in wind environment workshops with the clients, drawing 3D CAD models and communicating with the modeling team.

Academic awards & grants

- 2022, Student Travel Award for the SIAM Conference on Mathematics of Data Science
- 2021, F.R.S.-FNRS Aspirant Research Fellow grant renewal
- 2020, Funding for an abroad research stay, CCCI, Université Libre de Bruxelles
- 2019, F.R.S.-FNRS Aspirant Research Fellow grant
- 2018, Scholarship for the first year of my PhD, Université Libre de Bruxelles
- 2016, Funding for an abroad research stay, Erasmus+
- 2016, Dean's scholarship for the best students, Cracow University of Technology
- 2012, GE Foundation Scholar Leaders scholarship

Contributions to teaching & science outreach

- 2022, Contributing to the course *Data-driven engineering*, Université Libre de Bruxelles
    - Preparing and delivering exercise sessions for students using Jupyter notebooks
    - Delivering a seminar talk on my research at the end of the semester

    `</>` https://github.com/burn-research/data-driven-engineering-course
- 2021, Developing Python software for a graduate course on multicomponent mass transfer
- 2019, Teaching *Fluid mechanics and transport phenomena* class, Université Libre de Bruxelles
- 2018–present, Developing open-source educational materials
    https://kamilazdybal.github.io
- 2018–present, Co-organizing annual *Pinguino Lecture Series* for fellow PhD students and academics
- 2016–2017, Leading *Arduino Study Group*, Jagiellonian University
- 2016, One of my educational articles is published in *Neutrino*, a popular science magazine issued by the Physics Department at the Jagiellonian University
    http://www.neutrino.if.uj.edu.pl/archiwum/2016/33
- 2013–2015, Developing online materials in STEM for high school students as part of the GE Foundation Scholar Leaders voluntary experience
    https://wszechswiatnauki.wordpress.com

Software development

- **multipy** – an educational Python library for multicomponent mass transfer
    `</>` https://multipy-lib.readthedocs.io
- **PCAfold** – a Python software package for generating, analyzing and improving low-dimensional manifolds
    `</>` https://pcafold.readthedocs.io
- **reduced-order-modelling** – a collection of MATLAB® tools for data pre-processing, reduced-order modeling and results visualization
    `</>` https://github.com/burn-research/reduced-order-modelling
- **plotting** – a collection of MATLAB® functions for automating plotting scientific results in our research group
    `</>` https://github.com/burn-research/plotting
- **POD-DMD-GUI** – a MATLAB® GUI for POD and DMD decomposition of experimental or numerical data
    `</>` https://github.com/kamilazdybal/POD-DMD-decompositions

Peer-reviewed journal articles (5)

2022 A. C. Ispir, K. Zdybał, B. H. Saracoglu, T. Magin, A. Parente, and A. Coussement. Reduced-order modeling of supersonic fuel-air mixing in multi-strut injection scramjet engine using machine learning techniques. *Acta Astronautica*, 2022 **(currently in peer review)**.

2022 K. Zdybał, G. D'Alessio, A. Attili, A. Coussement, J. C. Sutherland, and A. Parente. Local manifold learning and its link to domain-based physics knowledge. *Applications in Energy and Combustion Science*, Special issue: Machine Learning Methods for Reactive Flows, 2022 **(currently in peer review)**.
    `</>` https://github.com/kamilazdybal/local-manifold-learning
    https://doi.org/10.48550/arXiv.2207.00275

2022 K. Zdybał, E. Armstrong, J. C. Sutherland, and A. Parente. Cost function for low-dimensional manifold topology assessment. *Scientific Reports*, 2022 **(accepted)**.
    `</>` https://github.com/kamilazdybal/cost-function-manifold-assessment

2022 K. Zdybał, J. C. Sutherland, and A. Parente. Manifold-informed state vector subset for reduced-order modeling. *Proceedings of the Combustion Institute*, 39:1–10, 2022.
    `</>` https://github.com/kamilazdybal/manifold-informed-state-vector-subset
    https://doi.org/10.1016/j.proci.2022.06.019

2020 K. Zdybał, E. Armstrong, A. Parente, and J. C. Sutherland. PCAfold: Python software to generate, analyze and improve PCA-derived low-dimensional manifolds. *SoftwareX*, 12:100630, 2020.
    `</>` https://gitlab.multiscale.utah.edu/common/PCAfold
    https://doi.org/10.1016/j.softx.2020.100630

Book chapters & reports (3)

2022   K. Zdybał, M. R. Malik, A. Coussement, J. C. Sutherland, and A. Parente. Reduced-order modeling of reactive flows using data-driven approaches. In N. Swaminathan and A. Parente, editors, *Lecture notes in Energy: Machine Learning and its Application to Reacting Flows*, chapter 9. Springer, 2022 **(accepted)**.
     </> https://github.com/kamilazdybal/ROM-of-reacting-flows-Springer

2022   K. Zdybał, G. D'Alessio, G. Aversano, M. R. Malik, A. Coussement, J. C. Sutherland, and A. Parente. Advancing reactive flow simulations with data-driven models. In M. A. Mendez, A. Ianiro, B. R. Noack, and S. L. Brunton, editors, *Data-Driven Fluid Mechanics: Combining First Principles and Machine Learning*, chapter 15. Cambridge University Press, 2022 **(accepted)**.
     https://www.datadrivenfluidmechanics.com

2016   K. Zdybał. POD and DMD decomposition of numerical and experimental data. *The von Karman Institute for Fluid Dynamics*, 2016.
     🗎 https://doi.org/10.13140/RG.2.2.34150.91201

Invited talks (4)

2022   K. Zdybał. Adventures in low-dimensional manifolds and reduced-order modeling. In *Université Libre de Bruxelles*, Brussels, Belgium, 2022. Seminar.

2022   K. Zdybał. Cost function for low-dimensional manifold topology optimization. In *Université Libre de Bruxelles and Vrije Universiteit Brussel BRITE workshop*, Brussels, Belgium, 2022. Talk.

2022   K. Zdybał. Cost function for low-dimensional manifold topology optimization. In *The von Karman Institute for Fluid Dynamics*, Rhode-Saint-Genese, Belgium, 2022. Seminar.
     🖵 https://www.vki.ac.be/index.php/vki-seminars

2018   K. Zdybał. Principal Component Analysis for chemistry reduction. In *Pinguino Lecture Series*, Brussels, Belgium, 2018. Talk.

Conference presentations (9)

2023   K. Zdybał, R. M. Galassi, J. C. Sutherland, R. Vinuesa, and A. Parente. Reduced-order modeling with a regression-aware autoencoder. In *SIAM Conference on Computational Science and Engineering*, Amsterdam, The Netherlands, 2023 **(upcoming)**.

2022   K. Zdybał, E. Armstrong, J. C. Sutherland, and A. Parente. Cost function for assessing the quality of low-dimensional manifolds. In *SIAM Conference on Mathematics of Data Science*, San Diego, CA, USA, 2022 **(upcoming)**.

2022   K. Zdybał, J. C. Sutherland, and A. Parente. Manifold-informed state vector subset for reduced-order modeling. In *39th International Symposium on Combustion*, Vancouver, Canada, 2022.
     🖵 https://www.youtube.com/watch?v=MMldWMduCp0

2022   K. Zdybał, M. R. Malik, E. Armstrong, J. C. Sutherland, and A. Parente. Characterizing manifold topologies for reduced-order modeling. In *18th International Conference on Numerical Combustion*, La Jolla, CA, USA, 2022.

2022   A. Parente, L. Donato, K. Zdybał, A. Procacci, and M. Savarese. Data-enhanced analysis, parameterisation and reduced-order modelling of turbulent reacting flows. In *18th International Conference on Numerical Combustion*, La Jolla, CA, USA, 2022.

2022   K. Zdybał. Manifold-informed state vector subset for reduced-order modeling. In *26th Journees D'Etudes of the Belgian Section of the Combustion Institute*, Ghent, Belgium, 2022.

2022   E. Armstrong, K. Zdybał, A. Parente, and J. C. Sutherland. A cost function for optimizing manifold topology in reduced-order modeling. In *2022 WSSCI Spring Technical Meeting*, Stanford, CA, USA, 2022.

2021   K. Zdybał, J. C. Sutherland, and A. Parente. Manifold-informed state vector subset for reduced-order modeling. In *Combura Symposium*, pages 39–40, Soesterberg, The Netherlands, 2021.

2019   G. D'Alessio, G. Aversano, K. Zdybał, A. Cuoci, and A. Parente. Feature extraction in combustion applications. In *17th International Conference on Numerical Combustion*, Aachen, Germany, 2019.

Posters (2)

2021 K. Zdybał, E. Armstrong, A. Parente, and J. C. Sutherland. PCAfold: Python software to generate, analyze and improve PCA-derived low-dimensional manifolds. In *Combura Symposium*, pages 88–89, Soesterberg, The Netherlands, 2021.
📄 Poster file

2019 K. Zdybał, M. R. Malik, and A. Parente. Nonlinear regression of chemical source terms using Deep Neural Networks. In *Tsinghua-Princeton-CI 2019 Summer School on Combustion*, Beijing, China, 2019.
📄 Poster file

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