Daan **Camps**, PhD

COMPUTATIONAL SCIENTIST · APPLIED MATHEMATICIAN

Berkeley, California

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Computational mathematics postdoctoral researcher at Lawrence Berkeley National Laboratory with a broad scientific interest and a passion for problem-solving. Two years research experience in quantum information and quantum algorithms, 6+ years experience in computational mathematics, and 2+ years experience as project engineer. Recent collaborations resulted in a robust publication record.

Work Experience

Lawrence Berkeley National Laboratory *Berkeley, USA*

POSTDOCTORAL RESEARCHER IN COMPUTATIONAL MATHEMATICS *Nov. 2019 - Current*

- Research on quantum information and quantum algorithms with a focus on circuit compilation and synthesis.
- Completed projects on Hamiltonian simulation, quantum chemistry, quantum linear algebra, and quantum image processing.
- Currently working on nonlinear tensor factorization models with applications in deep learning.
- Developed `QCLAB`, `QCLAB++`, `F3C`, `F3C++`, `QPIXL++` and `FunFact`.
- Team scientist.

IPCOS NV *Leuven, Belgium*

PROJECT ENGINEER IN DIGITAL OILFIELD TEAM *Aug. 2013 - Sep. 2015*

- Deployment and maintenance of upstream production monitoring models based on real-time process data.
- Development and deployment of new data-driven pipeline leak detection models.
- Customer-oriented role: presenting on-site training sessions and providing end user support.

Skills, Competencies & Training

Programming

- MATLAB, C++, Python, Fortran 90.
- OpenMP and MPI.
- git, CMake

Open source projects

- `QCLAB` and `QCLAB++`: quantum circuit development, analysis and simulation.
- `F3C` and `F3C++`: fast and scalable quantum circuit compilation for Hamiltonian simulation.
- `QPIXL++`: efficient and compressible representations for quantum images.
- `FunFact`: tensor algebra and deep learning via Einstein notations.

Research interests

Quantum algorithms, Quantum circuit synthesis, Numerical linear algebra, Tensor decomposition techniques, Manifold optimization, Eigenvalue problems, Randomized algorithms, Scientific machine learning, Image processing.

Formal training

- Mathematics of Big Data: Sketching and (Multi-)Linear Algebra (MSRI Graduate Summer School, 2021)
- Fundamentals of Machine Learning (SOCN Graduate School, 2018)
- Low-Rank Tensor Techniques (Haussdorff School, 2016)

Personal & Communication

Collaborations

- Started new collaborations with physicists from Lawrence Berkeley National Laboratory and North Carolina State University that resulted in `F3C` and `F3C++`.
- Contributed to existing collaborations with computational chemists at Lawrence Berkeley National Laboratory.

Languages

- Dutch: Native
- English: Fluent
- French: Moderate

Teaching

- TA for B.Sc. courses on numerical modeling and approximation, numerical mathematics at KU Leuven.
- Mentor of M.Sc. thesis projects at KU Leuven.
- Mentor of summer intern at Lawrence Berkeley National Laboratory.

Publications & Preprints

2021 *Quantum pixel representations and compression for N-dimensional images*, Amankwah M. G., Camps D., Bethel E.W., Van Beeumen R., Perciano T. arXiv:2110.04405.

2021 *An algebraic quantum circuit compression algorithm for Hamiltonian simulation*, Camps D., Kökcü E., Bassman L., de Jong W.A., Kemper A.F., Van Beeumen R. arXiv:2108.03283.

2021 *Algebraic compression of quantum circuits for Hamiltonian evolution*, Kökcü E., Camps D., Bassman L., Freericks J.K., de Jong W.A., Van Beeumen R., Kemper A.F. arXiv:2108.03282.

2021 *A multishift, multipole rational QZ method with aggressive early deflation*, Steel T., Camps D., Meerbergen K., Vandebril R., SIAM J. Matrix Anal. Appl. 42(2), 753–774. DOI: 10.1137/19M1249631

2020 *Approximate quantum circuit synthesis using block encodings*, Camps D., Van Beeumen R., Phys. Rev. A 102, 052411. DOI: 10.1103/PhysRevA.102.052411

2020 *Chemistry on quantum computers with virtual quantum subspace expansion*, Urbanek M., Camps D., Van Beeumen R., de Jong W. A., J. Chem. Theory Comput. 16(9), 5425–5431. DOI: 10.1021/acs.jctc.0c00447

2020 *Quantum Fourier transform revisited*, Camps D., Van Beeumen R., Yang C., Numer. Linear Algebra Appl. 28(1). DOI: 10.1002/nla.2331

2020 *On pole-swapping algorithms for the eigenvalue problem*, Camps D., Mach T., Vandebril R., Watkins D. S., Electron. Trans. Numer. Anal. 52, 480–508. DOI: 10.1553/etna_vol52s480

2019 *Swapping 2x2 blocks in the Schur and generalized Schur form*, Camps D., Mastronardi N., Vandebril R., Van Dooren P., J. Comput. Appl. Math. 373. 112274. DOI: 10.1016/j.cam.2019.05.022

2019 *A rational QZ method*, Camps D., Meerbergen K., Vandebril R., SIAM J. Matrix Anal. Appl. 40(3), 943–972. DOI: 10.1137/18M1170480

2019 *An implicit filter for rational Krylov using core transformations*, Camps D., Meerbergen K., Vandebril R., Linear Algebra and its Applications, DOI: 10.1016/j.laa.2018.09.021

2014 *Block term decomposition for modelling epileptic seizures*, Hunyadi B., Camps D., Sorber L., Van Paesschen W., De Vos M., Van Huffel S., De Lathauwer L., EURASIP Journal on Advances in Signal Processing, DOI: 10.1186/1687-6180-2014-139

Education

KU Leuven (University of Leuven) — *Leuven, Belgium*
PhD in Computer Science and Applied Mathematics — *Sep. 2015 - Sep. 2019*

- Thesis: *Pole swapping methods for the eigenvalue problem — Rational QR algorithms*.
- Generalized dense QR eigenvalue algorithms to rational QR methods.
- Implicitly restarted rational Krylov methods for large-scale, sparse eigenvalue problems.
- Focus on theory, numerical stability and efficient implementations.

KU Leuven (University of Leuven) — *Leuven, Belgium*
M.Sc.Eng. in Mathematical Engineering — *Sep. 2011 - Jun. 2013*

- Thesis: 'Epileptic seizure monitoring using tensor decomposition techniques'.

KU Leuven (University of Leuven) — *Leuven, Belgium*
M.Sc. in Physics: Astronomy and Astrophysics — *Sep. 2009 - Sep. 2011*

- Thesis: 'Heschel/PACS observations of water in the carbon-rich AGB star V Hya'.

UHasselt (University of Hasselt) — *Hasselt, Belgium*
B.Sc. in Physics — *Sep. 2006 - Jun. 2010*

Talks

SIAM Conference on Applied Linear Algebra — *Virtual*
Approximate quantum circuit synthesis using block encodings — *May 2021*

AIDE-QC All-Hands Meeting — *Virtual*
An Algebraic and Scalable Synthesis Algorithm for Computing Dynamic Simulation Constant-Depth Circuits — *Apr. 2021*

APS March Meeting — *Virtual*
Approximate quantum circuit synthesis using block encodings — *Mar. 2021*

SIAM Conference on Computational Science and Engineering — *Virtual*
Understanding the quantum Fourier transform through matrix decompositions — *Mar. 2021*

CS Area 2nd Annual Postdoc Symposium — *Berkeley, USA*
Approximate quantum circuit synthesis using block encodings — *Feb. 2021*

Berkeley Lab Seminar — *Berkeley, USA*
Pole swapping methods for the eigenvalue problem – Rational QR algorithms — *Sep. 2019*

ICIAM Conference — *Valencia, Spain*
Pole swapping methods for the eigenvalue problem – Rational QR algorithms — *Jul. 2019*

ETNA25 Conference — *Sardinia, Italy*
Approximate inverse-free rational Krylov methods and the link with FOM and GMRES — *May 2019*

NASCA Conference — *Kalamata, Greece*
A rational QZ method — *Jul. 2018*

SIAM Conference on Applied Linear Algebra — *Hong Kong*
RQZ: A rational QZ method for the generalized eigenvalue problem — *May. 2018*

NUMA Internal Seminar — *Leuven, Belgium*
Rational matrix algorithms for the generalized eigenvalue problem — Iterative and direct methods — *Oct. 2017*

ILAS Conference — *Iowa, USA*
Implicit restart of the rational Krylov method — Chasing algorithms for polynomial, extended and rational Krylov — *Jul. 2017*

ILAS Conference — *Leuven, Belgium*
Towards a computational efficient, implicitly restarted rational Krylov method — *Jul. 2016*

Academic service

Reviewer for

Quantum – the open journal for quantum science, Quantum Information & Computation, Journal of Computational Physics, Applied Mathematics and Computation, SIAM Journal on Matrix Analysis and Applications, Linear and Multilinear Algebra, Electronic Transactions on Numerical Analysis