CV MARIN BUKOV

CONTACT INFORMATION

website: https://mgbukov.github.io *e-mail:* mgbukov@phys.uni-sofia.bg
github: mgbukov *linkedin:* marin bukov

OCCUPATION R3 – Established Researcher (fixed-time contract) Sofia University, Bulgaria

RESEARCH INTERESTS

- *Quantum Many-Body Physics, Ultracold Atoms, Quantum Optics:* out-of-equilibrium dynamics of quantum many-body systems, quantum simulation, quantum control.
- *Machine Learning in Physics:* reinforcement learning for manipulation of quantum many-body systems, optimization landscapes, interplay between statistical mechanics/condensed matter and machine learning, unsupervised learning for quantum many-body physics.

EDUCATION

Postdoc physics dept., 2017–2020 UC Berkeley, USA
supervisors Prof. Norman Yao, Prof. Ehud Altman
Gordon and Betty Moore Foundation's independent postdoctoral fellowship

PhD physics, 2017 Boston University (BU), USA
advisor Prof. Anatoli Polkovnikov
thesis *"Floquet Engineering in Periodically Driven Closed Quantum Systems: from Dynamical Localisation to Ultracold Topological Matter"*

M. Sc. physics, 2013 *(with high distinction)* Ludwig-Maximilians-Universität (LMU), Technische Universität München, Germany
Elite Master Program "Theoretical and Mathematical Physics"
advisors Prof. Lode Pollet, Prof. Immanuel Bloch
thesis *"Bose-Fermi Mixtures: a Mean-Field Study"*

B. Sc. mathematics, 2011 Ludwig-Maximilians-Universität, Germany
advisor Prof. László Erdős
thesis *"Rigorous Approach to Bose-Einstein Condensation"*

B. Sc. physics, 2011 Ludwig-Maximilians-Universität, Germany
advisor Prof. Stefan Kehrein
thesis *"Periodically Driven Luttinger Liquids"*

Abitur Allgemeine Hochschulreife (*Bildungsinländer*), 2008 Galabov-Gymnasium, Bulgaria
Matura Bulgarian state examination, 2008 Galabov-Gymnasium, Bulgaria

SCIENTIFIC RECOGNITIONS

FELLOWSHIPS

- Marie Skłodowska-Curie individual fellowship, 2020. Sofia University
  Research Executive Agency, European Commission.
- Moore Foundation's independent postdoctoral fellowship, 2017. UC Berkeley
  "special postdoctoral positions offered by six leading US centers for theoretical condensed matter physics"

PRIZES and SCHOLARSHIPS

- Alvaro Roccaro Memorial Prize, 2017. BU
  "in recognition of outstanding achievement overall in physics by a graduate student".

- Gertrude and Maurice Goldhaber Prize, 2015. BU
  "in recognition of outstanding achievement by a first-year graduate student".
- DAAD Prize (German Academic Exchange Service), 2012. LMU
  "for the outstanding achievements of a foreign student at German universities".
- Stipendium aus Mitteln des Bayerischen Staates, 2009-13. LMU
  Bavarian State Ministry of Sciences Research and the Arts.

AWARDS

- *highly commended:* International Quantum Technology Emerging Researcher Award Sofia University
  IOP Publishing, 2020.
- Reviewer of the Month, 2019. UC Berkeley
  "for exceptional contributions to peer review", Communications Physics.

PUBLICATIONS (see also appended list)

Bibliometrics: (1/6/2021) *Google scholar:* 2250 citations, *h*-index 17.

- **22 peer-reviewed scientific articles:**
  - 6 in Physical Review X (three first-author, two second-author, one last author)
  - 4 in Physical Review Letters (two first-author, one second-author, one last-author)
  - 6 in Physical Review B (three first-author, one single-author, two last author)
  - 2 in Physical Review A (first-author)
  - 3 in SciPost Physics (one first author, two second-author)
  - 2 in Mathematical and Scientific Machine Learning (one second author, one last author)
- **3 review papers (peer-reviewed):**
  - 1 in Advances in Physics (first and corresponding author)
  - 2 in Physics Reports (one corresponding second author, one second author)

SCIENTIFIC SOFTWARE DEVELOPMENT

Co-developer of QuSpin (with P. Weinberg and M. Schmitt), http://weinbe58.github.io/QuSpin/: an open-source python library for exact diagonalization and quantum dynamics of boson, fermion and spin many-body systems.

publications: SciPost Phys. 2, 003 (2017), SciPost Phys. 7, 020 (2019)
downloads: (9/3/2021) 5941, Anaconda Cloud.

Research groups using QuSpin (list not exhaustive):

- ***experiment:*** Harvard, Max Planck Institute for Quantum Optics, MIT, Stanford, etc.
- ***theory:*** UC Berkeley, Boston U, Flatiron Institute, Hamburg, Heidelberg, Innsbruck, King's College, Mohammad V U, Nijmegen, Northeastern U, Paris-Saclay, SISSA, Tokyo, TUM, U of Ghent, U of Sussex, etc.

SUPERVISED SCIENTIFIC PROJECTS

(2017-18) *Asymptotic Prethermalization in Periodically Driven Classical Spin Chains* BU
publication: O. Howell, P. Weinberg, D. Sels, A. Polkovnikov, and **M.B.** Phys. Rev. Lett. 122, 010602 (2019).

(2019-20) *Thermalization and Prethermalization in Periodically Kicked Quantum Spin Chains* Berkeley/Sofia
publication: C. Fleckenstein and **M.B.**, arXiv:2101.04372, Phys. Rev. B 103, 144307 (2021).

(2020) *Floquet (Pre-)thermalization in Many-Body Systems away from the High-Frequency Limit* Sofia
publication: C. Fleckenstein and **M.B.**, arXiv:2012.10405, Phys. Rev. B 103, L140302 (2021).

(2020) *Reinforcement Learning for Many-Body Ground State Preparation inspired by Counter-Diabatic Driving* Berkeley/Sofia
publication: J. Yao, L. Lin, and **M.B.**, arXiv:2010.03655, accepted in PRX.

(2020) *Noise-Robust End-to-End Quantum Control using Deep Autoregressive Policy Networks* Sofia
publication: J. Yao, P. Köttering, H. Gundlach, L. Lin, and **M.B.**, arXiv:2012.06701.

INTERNATIONAL TEACHING EXPERIENCE

LECTURER

(2020-21)	Introduction to Deep Reinforcement Learning (lecture course).	Sofia
(2020-21)	Applications of Reinforcement Learning in the Physical Sciences (student seminar).	Sofia

TEACHING ASSISTANT

(2013-15)	General Physics I, General Physics II, Physics of Health.	BU
(2009-12)	Mathematical Methods for Physics, Theoretical Mechanics, Electrodynamics, Quantum Mechanics 1, Physics Laboratory Course for Chemistry Students.	LMU

INTERNATIONAL RESEARCH EXPERIENCE

RESEARCHER

(2017-20)	Condensed Matter Theory Center		Berkeley
(2016-17)	Statistical Physics and Biophysics Group	*Prof. Pankaj Mehta*	BU
(2014-15)	Condensed Matter Theory Group	*Prof. Eugene Demler*	Harvard
(2013-17)	Nonequilibrium Dynamics Group	*Prof. Anatoli Polkovnikov*	BU
(2011-13)	Quantum Many-Body Systems Group	*Prof. Lode Pollet*	LMU
(2010-11)	Condensed Matter Theory Group	*Prof. Stefan Kehrein*	LMU

REFERENCES

- Prof. Immanuel Bloch (immanuel.bloch@mpq.mpg.de)
- Prof. Eugene Demler (demler@physics.harvard.edu)
- Prof. Anatoli Polkovnikov (asp@buphy.bu.edu)
- Prof. Nathan Goldman (ngoldman@ulb.ac.be)
- Prof. Pankaj Mehta (pankajm@bu.edu)
- Prof. Lin Lin (linlin@math.berkeley.edu)

REVIEWER

Science, Nature Machine Intelligence, NPJ Quantum Information, Communications Physics, Physical Review X, Physical Review Letters, Physical Review X Quantum, Physical Review A, Physical Review B, SciPost, New Journal of Physics, Annalen der Physik, Annals of Physics, Computer Physics Communications, Quantum Machine Intelligence.

- *editorial board member*, Communications Physics (2021-).

RESEARCH FUNDING

Project title	Funding source	Amount	Year	Role
Reinforcement Learning to Control Quantum Matter away from Equilibrium	VIHREN frontier research grant, Bulgarian Science Fund (BNSF)	EUR 526 580	2020-2021 *(discontinued with decision FNI-2100 from 25/6/2021 by BNSF due to infeasibility to appoint PhD students and scientists during COVID-19 pandemic within the allotted timeframe of six months.)*	principal investigator
Phase Transitions of Quantum Control	Marie Skłodowska-Curie Actions, Research Executive Agency	EUR 121 814	2021-2023	principal investigator

INVITED INTERNATIONAL CONFERENCE / WORKSHOP PRESENTATIONS

scientific meetings and symposia:

1. *Floquet engineering with strongly correlated systems.*
   Interacting Topological Matter: Atomic, Molecular and Optical Systems, KITP workshop, Santa Barbara, USA, June 7, 2021.

2. *Reinforcement Learning Many-Body Ground State Preparation based on Counter-Diabatic Driving.*
   APS March Meeting (invited talk), virtual, USA, Mar 15, 2021.

3. *(Pre-)thermalization in periodically-driven systems: a quantum or classical phenomenon?*
   Thermalization, Many-Body Localization, and Hydrodynamics, ICTS, Bengaluru, India, Nov 19, 2019.

4. *Glassy and Correlated Phases of Quantum Control.*
   Machine Learning for Quantum Design, Perimeter Institute, Waterloo, Canada, Jul 12, 2019.

5. *Reinforcement Learning to Prepare Quantum States Away from Equilibrium.* Machine Learning for Quantum Technology, Max-Planck Institute for the Science of Light, Erlangen, Germany, May 8, 2019.

6. *Reinforcement Learning to Control Quantum Systems away from Equilibrium.*
   Machine Learning for Quantum Many-Body Physics, KITP workshop, Santa Barbara, USA, Feb 26, 2019.

7. *Reinforcement Learning to Prepare Quantum States Away from Equilibrium.*
   Machine Learning and Statistical Physics, CUNY, New York, USA, Nov 13, 2018.

8. *Reinforcement Learning: Introduction and Applications to Nonequilibrium Dynamics.*
   The Dynamics of Quantum Information, KITP workshop, Santa Barbara, USA, Oct 22, 2018.

9. *Glassy and Correlated Quantum Control Phases.*
   "Non-thermal Quantum Systems", Boston, USA, Mar 10-14, 2018.

10. *Reinforcement Learning in Phases of Quantum Control.*
    "Second Physics Informed Machine Learning" (LANL), Sante Fe, USA, Jan 21-26, 2018.

11. *Reinforcement Learning in Phases of Quantum Control.*
    Workshop on "Artificial Intelligence and Quantum Physics", Nanjing University, China Dec 19-22, 2017.

12. *What can Reinforcement Learning Teach us about Quantum State Preparation? The Phase Diagram of Quantum Control.*
    "645. WE-Heraeus Seminar" (best poster winner invited talk), Bad Honnef, Germany, Jun 21, 2017.

13. *The Phase Diagram of the Quantum State Preparation Problem: a Reinforcement Learning Study.*
    "Dynamics and Hydrodynamics of Certain Quantum Matter", CUNY, New York, USA, Mar 20, 2017.

14. *What can Reinforcement Learning Teach us about Quantum State Preparation?* "Quantum Dynamics: from Models to Materials", Aspen Center for Theoretical Physics, USA, Jan 16, 2017.

industry:

1. *Reinforcement Learning to Manipulate Quantum Matter.* Google X, Mountain View, USA, Apr 3, 2020.

2. *Reinforcement Learning and Quantum Control.* Unlearn.AI, start-up, San Francisco, USA, Apr 17, 2018.

PUBLICATION LIST

[1] Christoph Fleckenstein and Marin **Bukov**. Thermalization and prethermalization in periodically kicked quantum spin chains. *arXiv preprint arXiv:2101.04372*, 2021.

[2] Christoph Fleckenstein and Marin **Bukov**. Floquet (pre-) thermalization in many-body systems away from the high-frequency limit. *arXiv preprint arXiv:2012.10405*, 2020.

[3] Jiahao Yao, Paul Köttering, Hans Gundlach, Lin Lin, and Marin **Bukov**. Noise-robust end-to-end quantum control using deep autoregressive policy networks. *arXiv preprint arXiv:2012.06701*, 2020.

[4] Marin **Bukov**, Markus Schmitt, and Maxime Dupont. Learning the ground state of a non-stoquastic quantum hamiltonian in a rugged neural network landscape. *arXiv preprint arXiv:2011.11214*, 2020.

[5] Jiahao Yao, Lin Lin, and Marin **Bukov**. Reinforcement learning for many-body ground state preparation based on counter-diabatic driving. *arXiv preprint arXiv:2010.03655*, 2020.

[6] J. Yao, M. **Bukov**, and L. Lin. Policy gradient based quantum approximate optimization algorithm. *PMLR*, 107:605–634, 2020.

[7] T. Boulier, J. Maslek, M. **Bukov**, C. Bracamontes, E. Magnan, S. Lellouch, E. Demler, N. Goldman, and J. V. Porto. Parametric Heating in a 2D Periodically Driven Bosonic System: Beyond the Weakly Interacting Regime. *Physical Review X*, 9:011047, Jan 2019.

[8] Marin **Bukov**, Dries Sels, and Anatoli Polkovnikov. Geometric Speed Limit of Accessible Many-Body State Preparation. *Physical Review X*, 9:011034, Jan 2019.

[9] Alexandre G. R. Day, Marin **Bukov**, Phillip Weinberg, Pankaj Mehta, and Dries Sels. Glassy Phase of Optimal Quantum Control. *Physical Review Letters*, 122:020601, Jan 2019.

[10] Owen Howell, Phillip Weinberg, Dries Sels, Anatoli Polkovnikov, and Marin **Bukov**. Asymptotic Prethermalization in Periodically Driven Classical Spin Chains. *Physical Review Letters*, 122:010602, Jan 2019.

[11] Marin **Bukov**. Reinforcement learning for autonomous preparation of Floquet-engineered states: Inverting the quantum Kapitza oscillator. *Physical Review B*, 98:224305, Dec 2018).

[12] K. Wintersperger, M. **Bukov**, J. Näger, S. Lellouch, E. Demler, U. Schneider, I. Bloch, N. Goldman, and M. Aidelsburger. Parametric instabilities of interacting bosons in periodically-driven 1D optical lattices. *arXiv e-prints*, page arXiv:1808.07462, Aug 2018.

[13] Marin **Bukov**, Alexandre G. R. Day, Dries Sels, Phillip Weinberg, Anatoli Polkovnikov, and Pankaj Mehta. Reinforcement Learning in Different Phases of Quantum Control. *Physical Review X*, 8:031086, Jul 2018; *135 citations (Google Scholar).*

[14] Marin **Bukov**, Alexandre G. R. Day, Phillip Weinberg, Anatoli Polkovnikov, Pankaj Mehta, and Dries Sels. Broken symmetry in a two-qubit quantum control landscape. *Physical Review A*, 97:052114, May 2018.

[15] Phillip Weinberg and Marin **Bukov**. QuSpin: a Python Package for Dynamics and Exact Diagonalisation of Quantum Many Body Systems. Part II: bosons, fermions and higher spins. *SciPost Physics*, 7:020, Jul 2019.

[16] Pankaj Mehta, Marin **Bukov**, Ching-Hao Wang, Alexandre G. R. Day, Clint Richardson, Charles K. Fisher, and David J. Schwab. A high-bias, low-variance introduction to Machine Learning for physicists. *Physics Reports*, 810, Mar 2019; *217 citations (Google Scholar).*

[17] Phillip Weinberg, Marin **Bukov**, Luca D'Alessio, Anatoli Polkovnikov, Szabolcs Vajna, and Michael Kolodrubetz. Adiabatic perturbation theory and geometry of periodically-driven systems. *Physics Reports*, 688:1–35, May 2017.

[18] S. Lellouch, M. **Bukov**, E. Demler, and N. Goldman. Parametric Instability Rates in Periodically Driven Band Systems. *Physical Review X*, 7:021015, Apr 2017.

[19] Phillip Weinberg and Marin **Bukov**. QuSpin: a Python package for dynamics and exact diagonalisation of quantum many body systems part I: spin chains. *SciPost Physics*, 2:003, Feb 2017; *75 citations (Google Scholar)*.

[20] Marin **Bukov**, Markus Heyl, David A. Huse, and Anatoli Polkovnikov. Heating and many-body resonances in a periodically driven two-band system. *Physical Review B*, 93:155132, Apr 2016.

[21] Marin **Bukov**, Michael Kolodrubetz, and Anatoli Polkovnikov. Schrieffer-Wolff Transformation for Periodically Driven Systems: Strongly Correlated Systems with Artificial Gauge Fields. *Physical Review Letters*, 116:125301, Mar 2016; *108 citations (Google Scholar)*.

[22] Marin **Bukov**, Sarang Gopalakrishnan, Michael Knap, and Eugene Demler. Prethermal Floquet Steady States and Instabilities in the Periodically Driven, Weakly Interacting Bose-Hubbard Model. *Physical Review Letters*, 115:205301, Nov 2015; *114 citations (Google Scholar)*.

[23] Marin **Bukov**, Luca D'Alessio, and Anatoli Polkovnikov. Universal high-frequency behavior of periodically driven systems: from dynamical stabilization to Floquet engineering. *Advances in Physics*, 64:139–226, Mar 2015; *566 citations (Google Scholar)*.

[24] Marin **Bukov** and Anatoli Polkovnikov. Stroboscopic versus nonstroboscopic dynamics in the Floquet realization of the Harper-Hofstadter Hamiltonian. *Physical Review A*, 90:043613, Oct 2014.

[25] Marin **Bukov** and Lode Pollet. Mean-field phase diagram of the Bose-Fermi Hubbard model. *Physical Review B*, 89:094502, Mar 2014.

[26] M. **Bukov** and M. Heyl. Parametric instability in periodically driven Luttinger liquids. *Physical Review B*, 86:054304, Aug 2012.