CV MARIN BUKOV

CONTACT INFORMATION

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OCCUPATION Gordon and Betty Moore independent research fellow UC Berkeley

RESEARCH INTERESTS

- *Quantum Many-Body Physics, Ultracold Atoms, Quantum Optics:* nonequilibrium quantum and classical dynamics and thermalization of many-body systems, phase transitions, critical phenomena.
- *Machine Learning in Physics:* reinforcement learning for optimal control of quantum many-body systems, characterization of optimization landscapes, interplay between statistical mechanics/condensed matter and machine learning, variational Monte Carlo-based unsupervised learning of quantum many-body states.

EDUCATION

Postdoc physics dept., 9/1/2017–present UC Berkeley, USA
Gordon and Betty Moore Foundation's independent postdoctoral fellowship

PhD physics, 9/26/2017 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, 7/3/2013 *(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, 7/26/2011 Ludwig-Maximilians-Universität, Germany
advisor Prof. László Erdős
thesis *"Rigorous Approach to Bose-Einstein Condensation"*

B. Sc. physics, 8/10/2011 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

PRIZES, AWARDS and FELLOWSHIPS

- Moore Foundation's independent postdoctoral fellowship, 2017. UC Berkeley
  "special postdoctoral positions offered by six leading US centers for theoretical condensed matter physics"
- 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.

PUBLICATIONS (see appended list)

Bibliometrics: (9/1/2019) *Google scholar:* 1006 citations, *h*-index 11; *arXiv:* 909 citations, *h*-index 13.

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

I have published 11 papers without my PhD advisor, 1 single-author paper, 1 last-author paper, and 9 papers as a postdoc (numbers not mutually exclusive).

DEVELOPER OF OPEN-SOURCE SCIENTIFIC SOFTWARE

co-developer of QuSpin, http://weinbe58.github.io/QuSpin/: an open-source python package for exact diagonalization and quantum dynamics of arbitrary boson, fermion and spin many-body systems.
Downloads: 1969, Anaconda Cloud.

Groups citing QuSpin in their research (list not exhaustive):

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

TEACHING / MENTORING

SUPERVISED STUDENTS

(2017-18) Owen Howell, undergraduate student BU
publication: O. Howell, P. Weinberg, D. Sels, A. Polkovnikov, and **M.B.** Phys. Rev. Lett. 122, 010602 (2019).

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 - present)	Condensed Matter Theory Group		UC 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

COLLABORATORS

M. Aidelsburger (Munich), I. Bloch (Munich), E. Demler (Harvard), N. Goldman (Brussels), S. Gopalakrishnan (New York), M. Heyl (Dresden), D. A. Huse (Princeton), M. Knap (Munich), M. Kolodrubetz (Dallas), L. Lin (Berkeley), P. Mehta (Boston), A. Polkovnikov (Boston), L. Pollet (Munich), J. V. Porto (Maryland), U. Schneider (Cambridge), D. Sels (Harvard), P. Weinberg (Boston)

SCIENTIFIC JOURNAL REVIEWER / REFEREE

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

PUBLICATION LIST

[1] 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.

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

[3] 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.

[4] 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.

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

[6] 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.

[7] 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.

[8] 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.

[9] 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.

[10] Pankaj Mehta, Marin **Bukov**, Ching-Hao Wang, Alexand re 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*, pages 0370–1573, Mar 2019.

[11] 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.

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

[13] 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.

[14] 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.

[15] 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.

[16] 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.

[17] 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.

[18] 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.

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

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

INVITED CONFERENCE / WORKSHOP PRESENTATIONS

international:

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

2. *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.

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

4. *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, June 21, 2017.

continental US:

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

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

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

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

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

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

7. *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 and Quantum Control.* Unlearn.AI, start-up, San Francisco, USA, April 17, 2018.

INVITED SEMINAR TALKS

1. *Reinforcement Learning to Control Quantum Systems away from Equilibrium*
   Northeastern University, USA, June 2019.
2. *Reinforcement Learning to Prepare States in Floquet Engineered Systems*
   Université libre de Bruxelles, Belgium, June, 2018.
   The University of Nottingham, United Kingdom June, 2018.
   Institute of Physical Chemistry, Bulgarian Academy of Sciences, October 2018.
3. *QuSpin: a Python Package for Quantum Many-Body Systems*
   Universite libre de Bruxelles, Belgium, June, 2018.
   The University of Nottingham, United Kingdom June, 2018.
   LMU München, Germany, May, 2017.
4. *(Pre-)thermalization in Periodically Driven Quantum and Classical Systems,*
   Flatiron Institute, USA, May, 2018.
5. *Reinforcement Learning in Phases of Quantum Control*
   Institute of Solid State Physics, Bulgarian Academy of Sciences, October 2018.
   Institute of Physical Chemistry, Bulgarian Academy of Sciences, October 2018.
   University of Ljubljana, Slovenia, October, 2018.
   SISSA, Italy, October, 2018.
6. *What can Reinforcement Learning Teach us about Quantum State Preparation*
   Teschnische Universität München, Germany, June, 2017.
   Sofia University, Bulgaria, June, 2017.
7. *Schrieffer-Wolff Transformation for Periodically Driven Systems*
   Bar Illan University, Israel, March 3, 2016.
8. *Thermalisation and Prethermalisation in Periodically Driven Systems*
   ETH Zürich, Switzerland, February 24, 2016.
9. *Heating and Many-Body Resonances in a Periodically-Driven Two-Band System,*
   University of Ljubljana, Slovenia, April 1, 2016.
   Technion, Israel, March 6, 2016.
   LMU München, Germany, December 11, 2015.
   Teschnische Universität München, Germany, December 9, 2015.
10. *Prethermal Floquet Steady States and Instabilities in the Periodically Driven, Weakly Interacting Bose-Hubbard Model,*
    Boston University, USA, November 24, 2015.
11. *Universal High-frequency Limits of Periodically Driven Systems,*
    LMU München, Germany, July 23, 2014.
12. *Stroboscopic vs. Non-stroboscopic Dynamics in the Floquet Realisation of the Harper-Hofstadter Model,*
    LMU München, Germany, July 17, 2014.
13. *Mean-Field Phase Diagram for Bose-Fermi Mixtures,*
    Boston University, USA, September 11, 2013.
14. *Periodically Driven Luttinger Liquids,*
    LMU München, Germany, September 19, 2012.