Waseem S. Bakr, Ph.D.

Contact Information

Department of Physics
Jadwin Hall, Princeton University
Princeton NJ, 08540

phone: +1 609 258 4494
e-mail: wbakr@princeton.edu
web: ultracold.princeton.edu

Research Interests

Strongly correlated many-body systems, degenerate gases in optical lattices, quantum gas microscopy, quantum magnetism, topological phases, Rydberg atoms, ultracold polar molecules, novel techniques for cooling quantum gases, fermionic superfluidity in two-dimensional and layered systems, transport in strongly correlated systems, quantum computing with ions and neutral atoms.

Professional Experience

Since 2023	Professor of Physics, Princeton University
2019 – 2023	Associate Professor of Physics, Princeton University
2013 – 2019	Assistant Professor of Physics, Princeton University
2011 – 2013	Post-doctoral Research Fellow, Massachusetts Inst. of Technology

Administrative Experience

2023 – 2025	Associate Chair of Undergraduate Studies, Physics Department, Princeton University
2024 – 2025	Director of Program in Engineering Physics
Since 2020	Princeton Quantum Initiative Executive Committee

Education

2006 – 2011	Ph.D. in Physics, Harvard University (Prof. Markus Greiner)
2005 – 2006	M.Eng. in Electrical Engineering and Computer Science, MIT (Prof. Isaac Chuang)
2001 – 2005	S.B. in Physics, Massachusetts Inst. of Technology
2001 – 2005	S.B. in Electrical Engineering and Computer Science, Massachusetts Inst. of Technology

Honors and Awards

2025	New Horizons Prize in Physics
2022	Brown Science Investigator Award
2016	Packard Fellowship in Science & Engineering
2016	AFOSR Young Investigator award
2014	Alfred P. Sloan Research Fellowship
2013	MIT Infinite K Award
2012	DAMOP Outstanding Doctoral Thesis award
2011	AAAS Newcomb Cleveland Prize
2006	Purcell Fellowship, Harvard University
2001	Fatima bint Mubarak Scholarship

Professional service

- Referee for *Science*, *Nature*, *Nature Physics*, *Nature Communications*, *Physical Review Letters*, *Physical Review X*, *Physical Review A*.
- Proposal reviewer for the National Science Foundation (NSF), Army Research Office (ARO) and Defense Threat Reduction Agency (DTRA).
- Conference & workshop organization: Topological and Strongly Correlated Phases in Cold Atoms (2015), ICAP program committee (2022), Many-body physics with synthetic quantum systems (2023), Princeton Quantum Technology Conference (2022, 2023, 2024, 2025, 2026), New Directions in Quantum Simulation (2026), Program committee for DAMOP at March Meeting (2023, 2024, 2025 as chair).

- Pedagogical lectures: Princeton Society of Physics Students, Princeton Condensed Matter Summer School (2015), Columbia Frontiers of Condensed Matter Physics course (2019), DAMOP Graduate Student Symposium (2021), Boulder Summer School (2021), Quantum Undergraduate Research at IBM and Princeton (2021, 2022, 2023), March Meeting Cold Atoms Tutorial (2022), IMPRS (International Max Planck Research School) Summer School (2022), International Summer School Enrico Fermi, Varenna (2024), Robust Quantum Simulation (RQS) Summer School (2026), Center for Theory of Emergent Quantum Matter (CTEQ) Summer School at Penn State (2026).

Teaching

- PHY 103 (General Physics I): Fall 2013, Fall 2026.
- PHY 104 (General Physics II): Spring 2015, Spring 2016.
- EGR 191 (Integrated Introduction to Engineering, Mathematics & Physics): Fall 2016, Fall 2017.
- PHY 105 (Advanced Physics - Mechanics): Fall 2018-2024.
- PHY 304 (Advanced Electromagnetism): Spring 2017-2021, 2023, 2024.
- PHY 551 / QSE 520 (Atomic Physics): Spring 2025.
- PHY 312 (Experimental Physics): Spring 2026.

Advising

- Stanimir Kondov, postdoc 2013-16, now faculty at University of Strasbourg.
- Peter Schauss, postdoc 2015-18, now faculty at University of Virginia.
- Zoe Yan, postdoc 2020-23, now faculty at University of Chicago.
- Youssef Aziz Alaoui, postdoc 2023-24.
- Yukai Lu, postdoc 2025.
- Debayan Mitra, PhD 2018, now faculty at Indiana University Bloomington.
- Peter Brown, PhD 2019, now at Draper Labs.
- Elmer Guardado-Sanchez, PhD 2021.
- Lysander Christakis, PhD 2023.
- Benjamin Spar, graduate student, PhD 2024.
- Jason Rosenberg, graduate student, PhD 2025
- Max Prichard, graduate student, PhD 2026, now at Google Quantum AI.
- Junlan Jin, graduate student.
- Yue Shi, graduate student.
- Zengli Ba, graduate student
- Jongheum Jung, graduate student.
- Laura Futumura, graduate student.
- Donghyuk Seo, graduate student.
- Vincent Chen, graduate student.
- Yeongyeon Kim, graduate student.

Main Scientific Achievements

- First experimental realization of a bosonic quantum gas microscope (in the group of M. Greiner)
- Single-atom resolved imaging of bosonic Mott insulators.
- Realization of Ising quantum magnets in Hubbard spin chains.
- Realization of spin-orbit coupling in fermions.
- Experimental realization of quantum gas microscopes for fermions (K-40 and Li-6)
- Observation of canted antiferromagnetism of fermions in optical lattices.
- Observation of Ising antfierromagnets of Rydberg atoms in optical lattices.
- Observation of a strange metal in a Hubbard system.
- Development of ARPES for Hubbard systems.
- Realization of Rydberg dressed Fermi gases.
- Development of the first molecular quantum gas microscope.
- First observation of quantum correlations between polar molecules.
- Observation of itinerant spin polarons in kinetically frustrated Hubbard systems.
- Realization of static-field shielded molecules and self-bound droplets.
- Realization of high-fidelity universal gates in a cryogenic Rydberg atom array.

Publications

1. Jin, J., Seo, D., Shi, Y., Lu, Y., Thompson, J. & Bakr, W.
   High-fidelity universal quantum gates in a cryogenic atom array
   arXiv:2610.40329 (2026)
2. Jung, J., Futamura, L., Ciardi, M., Rosenberg, J., Aziz Alaoui, Y., Lu, Y., Pohl, T. & Bakr, W.
   Static-field shielding of bosonic molecules: evaporation to degeneracy and self-bound droplets
   arXiv:2608.3116 (2026)
3. Jin, J., Shi, Y., Aziz Alaoui, Y., Deng, J., Lu, Y., Thompson, J. & Bakr, W.
   Extended Rydberg lifetimes in a cryogenic atom array
   PRX Quantum 7, 033009 (2026)
4. Bakr, W., Ba, Z. & Prichard, M.
   Microscopy of ultracold fermions in optical lattices
   arxiv:2507.04042 (2025)
5. Prichard, M., Ba, Z., Morera, I., Spar, B., Huse, D., Demler, E. & Bakr, W.
   Magnon-polarons in the Fermi-Hubbard model
   Nature Physics, 1548–1554 (2025)
6. Prichard, M., Spar, B., Morera, I., Demler, E., Yan, Z. & Bakr, W.
   Directly imaging spin polarons in a kinetically frustrated Hubbard system
   Nature 629, 323 (2024)
7. Christakis, L., Rosenberg, J., Raj, R., Chi, S., Morningstar, A., Huse, D., Yan, Z. & Bakr, W.
   Probing site-resolved correlations in a spin system of ultracold molecules
   Nature 614, 64 (2023)
8. Morningstar, A. & Bakr, W.
   Anomalous fluid flow in quantum systems
   Science 376, 699 (2022)

9. Yan, Z., Spar, B., Prichard, M., Chi, S., Wei, H.-T., Ibarra-Garcia-Padilla, E., Hazzard, K. & Bakr, W.
A two-dimensional programmable tweezer array of fermions
Phys. Rev. Lett. 129, 123201 (2022)

10. Rosenberg, J., Christakis, L., Guardado-Sanchez, E., Yan, Z. & Bakr, W.
Observation of the Hanbury Brown and Twiss Effect with Ultracold Molecules
Nature Physics 18, 1062 (2022)

11. Spar, B., Guardado-Sanchez, E., Chi, S., Yan, Z. & Bakr, W.
Realization of a Fermi-Hubbard Optical Tweezer Array
Phys. Rev. Lett. 128, 223202 (2022)

12. Guardado-Sanchez, E., Spar, B., Schauss, P., Belyansky, R., Young, J., Bienias, P., Gorshkov, A., Iadecola, T. & Bakr, W.
Quench Dynamics of a Fermi Gas with Strong Nonlocal Interactions
Phys. Rev. X 11, 021036 (2021)

13. Gross, C. & Bakr, W.
Quantum gas microscopy for single atom and spin detections
Nature Physics 17, 1316 (2021)

14. Guardado-Sanchez, E., Morningstar, A., Spar, B., Brown, P., Huse, D. & Bakr, W.
Subdiffusion and heat transport in a tilted 2D Fermi-Hubbard system
Phys. Rev. X 10, 011042 (2020)

15. Brown, P., Guardado-Sanchez, E., Spar, B., Huang, E., Devereaux, T. & Bakr, W.
Angle-resolved photoemission spectroscopy of a Fermi-Hubbard system
Nature Physics 16, 26 (2020)

16. Khatami, E., Guardado-Sanchez, E., Spar, B., Carrasquilla, J., Bakr, W., & Scalettar, R.
Visualizing strange metallic correlations in the two-dimensional Fermi-Hubbard model with artificial intelligence
Phys. Rev. A 102, 033326 (2020)

17. Brown, P., Mitra, D., Guardado-Sanchez, E., Nourafkan, R., Reymbaut, , A., Hebert, C.-D., Bergeron, S., Tremblay, A. -M., Kokalj, J., Huse, D., Schauss, P. & Bakr, W.
Bad metallic transport in a cold atom Fermi-Hubbard system
Science 363, 379 (2019)

18. Guardado-Sanchez, E., Brown, P., Mitra, D., Devakul, T., Huse, D. Schauss, P. & Bakr, W.
Probing the quench dynamics of antiferromagnetic correlations in a 2D quantum Ising spin system
Phys. Rev. X 8, 021069 (2018)

19. Mitra, D., Brown, P., Guardado-Sanchez, E., Kondov, S., Devakul, T., Huse, D. Schauss, P. & Bakr, W.
Quantum gas microscopy of an attractive Fermi-Hubbard system
Nature Physics 14, 173-177 (2017)

20. Brown, P., Mitra, D., Guardado-Sanchez, E., Schauss, P., Kondov, S., Khatami, E., Paiva, T., Trivedi, N., Huse, D. & Bakr, W.
Spin-imbalance in a 2D Fermi-Hubbard system
Science 357, 1385 (2017)

21. Mitra, D., Brown, P., Schauss, P., Kondov, S. & Bakr, W.
Phase separation and pair condensation in a spin-imbalanced 2D Fermi gas
Phys. Rev. Lett. 117, 093601 (2016)

22. Cheuk, L., Nichols, M., Okan, M., Gersdorf, T., Ramasesh, V., Bakr, W., Lompe, T. & Zwierlein, M.
Quantum gas microscope for fermionic atoms
Phys. Rev. Lett. 114, 193001 (2015)

23. Bakr, W.
Ultracold atoms: pairing with a twist
Nature Physics, 10, 90—91 (2014)

24. Yefsah, T., Sommer, A., Ku, M., Cheuk, L., Ji, W., Bakr, W. & Zwierlein, M.
Heavy solitons in a fermionic superfluid
Nature 499, 426-430 (2013) [Selected for a Nature "News and Views"]

25. Bakr, W., Cheuk, L., Ku, M., Park, J., Sommer, A., Will, S., Wu, C., Yefsah, T. & Zwierlein, M.
Strongly interacting Fermi gases
EPJ Web of Conferences 57, 01002 (2013)

26. Cheuk, L., Sommer, A., Hadzibabic, Z., Yefsah, T., Bakr, W. & Zwierlein, M.
Spin-injection spectroscopy of a spin-orbit coupled Fermi gas
Phys. Rev. Lett. 109, 095302 (2012) [Selected for a PRL "Viewpoint" & "Editors' Suggestion"]

27. Sommer, A., Cheuk, L., Ku, M., Bakr, W. & Zwierlein, M.
Evolution of fermion pairing from three to two dimensions
Phys. Rev. Lett. 108, 045302 (2012) [Selected for a PRL "Viewpoint"]

28. Bakr, W., Preiss, P., Tai, M., Ma, R., Simon, J., & Greiner, M.
Orbital excitation blockade and algorithmic cooling in quantum gases
Nature 480, 500-503 (2011) [Selected for a Nature "News and Views"]

29. Ma, R., Tai, M., Preiss, P., Bakr, W., Simon, J., & Greiner, M.
Photon-assisted tunneling in a biased, strongly correlated Bose gas
Phys. Rev. Lett. 107, 095301 (2011)

30. Simon, J., Bakr, W., Ma, R., Tai, M., Preiss, P. & Greiner, M.
Quantum simulation of antiferromagnetic spin chains in an optical lattice
Nature 472, 307-312 (2011) [Selected for a Nature "News and Views"]

31. Brachmann, J., Bakr, W., Gillen, J., Peng, A. & Greiner, M.
Inducing vortices in a Bose Einstein condensate using holographically produced light beams
Optics Express 19, 12984-12291 (2011)

32. Bakr, W., Peng, A., Tai, E., Ma, R., Simon, J., Gillen, J., Foelling, S., Pollet, L. & Greiner, M.
Probing the superfluid-to-Mott-insulator transition at the single-atom level
Science 329, 547-550 (2010) [Selected for a Science "Perspective"]

33. Bakr, W., Gillen, J., Peng, A., Foelling, S. & Greiner, M.
A quantum gas microscope for detecting single atoms in a Hubbard-regime optical lattice
Nature 462, 74-77 (2009)

34. Gillen, J., Bakr, W., Peng, A., Unterwaditzer, P., Foelling, S. & Greiner, M.
Two-dimensional quantum gas in a hybrid surface trap
Phys. Rev. A 80, 021602(R) (2009)

35. Antohi, P., Schuster, D., Akselrod, G., Labaziewicz, J., Ge, Y., Lin, Z., Bakr, W. & Chuang, I.
Cryogenic ion trapping systems with surface-electrode traps
Rev. Sci. Instrum. 80, 013103 (2009)

36. Leibrandt, D., Clark, R., Labaziewicz, J., Antohi, P., Bakr, W., Brown, K. & Chuang, I.
Laser ablation loading of a surface-electrode ion trap
Phys. Rev. A 76, 055403 (2007)

37. Pearson, C., Leibrandt, D., Bakr, W., Mallard, W., Brown, K. & Chuang, I.
Experimental investigation of planar ion traps
Phys. Rev. A 73, 032307 (2006)

Invited presentations

11/2026	Invited Speaker, Quantum Science & Technology with Ultracold Molecules, Kavli Institute of Theoret
09/2026	Invited Speaker, Atomic Quantum Matter, Institute of Science & Technology, Vienna, Austria
02/2026	Brown Institute for Basic Sciences, Caltech, CA
10/2025	Invited Speaker, Workshop on Ultra-Quantum Matter, Institute of Advanced Studies, Princeton, NJ
10/2025	Invited Speaker, Extreme Quantum Materials Alliance Workshop, Rice University, Houston, TX
05/2025	National Academy of Sciences, Washington, DC
03/2025	Invited Speaker, APS Global Physics Summit, Anaheim, CA
01/2025	Invited Speaker, TIQM 2025 Winter Workshop, Univ. of Washington, Seattle, WA
12/2024	Physics Colloquium Speaker, Yale University, New Haven, CT
09/2024	Q-FARM Seminar Speaker, Stanford University, Stanford, CA
08/2024	University of Illinois Urbana-Champaign Colloquium, Champaign, IL
05/2024	Vienna Center for Quantum Science & Technology Colloquium, Vienna, Austria
04/2024	AMO Seminar, Columbia University, New York City, NY
02/2024	Brown Institute for Basic Sciences, Caltech, CA
12/2023	PWA@100, Princeton University, Princeton, NJ
09/2023	BEC 2023, Sant Feliu de Guixols, Spain
09/2023	Long-Range Workshop 2023, San Sebastian, Spain
08/2023	Invited Speaker, QSim 2023, Telluride, CO
06/2023	Quantum Science with Ultracold Molecules Workshop, London, UK
06/2023	Precision Many-body Physics Workshop, Paris, France
06/2023	Invited Speaker, DAMOP Conference, Spokane, WA
05/2023	AMO Seminar, Center for Ultracold Atoms, Harvard University, Cambridge, MA
04/2023	Colloquium Speaker, Purdue University, West Lafayette, IN
03/2023	Invited Speaker, March Meeting, Las Vegas, NV
11/2022	Harvard ITAMP workshop on doped Fermi-Hubbard systems, Cambridge, MA
11/2022	JILA Condensed Matter Seminar, Boulder, CO
11/2022	University of Colorado Physics Colloquium , Boulder, CO
07/2022	Gordon Research Conference, Easton, MA
05/2022	Strange metals: from the Hubbard model to AdS/CFT, Belgrade, Serbia
04/2022	Frontiers of Quantum Gas Microscopy, Bad Honnef, Germany
02/2022	Understand and control collisions of ultracold molecules, Munich, Germany
01/2022	Invited Speaker, Technology Innovation Institute, Abu Dhabi, UAE
12/2021	Quantum Simulation of Novel Phenomena with Atoms & Molecules, HKUST, Hong Kong
04/2021	Colloquium Speaker, UC Santa Cruz, CA
04/2021	Condensed Matter Seminar, Georgia Tech, GA
03/2021	Invited Speaker, March Meeting (virtual)
12/2020	735th Heraeus Seminar, Germany
12/2020	Seminar Speaker, U. Birmingham, Birmingham, UK
10/2020	ITAMP Seminar, Harvard University, Cambridge, MA
09/2020	Diller Quantum Center Seminar, Technion, Haifa, Israel
04/2020	Virtual AMO Seminar (VAMOS)
03/2020	Cold Atoms and Transport at High Temperatures, Aspen, CO
11/2019	Towards Dipolar Physics with Ultracold Molecules, Durham, UK
11/2019	Colloquium Speaker, Stanford University, Stanford, CA
10/2019	Colloquium Speaker, Penn State, State College, PA
09/2019	Invited Speaker, Columbia University, New York City, NY
09/2019	BEC 2019, Sant Feliu de Guixols, Spain
07/2019	MPQ Colloquium, Garching, Germany
05/2019	DAMOP Conference, Milwaukee, WI
05/2019	Princeton Quantum Summit, Princeton University, Princeton NJ
04/2019	2nd Joint Quantum Symposium, Columbia University, New York City, NY
03/2019	Colloquium Speaker, City College of New York, New York City, NY
03/2019	Many-body Quantum Chaos, Aspen Center for Physics, Aspen, CO

01/2019	Seminar Speaker, Flatiron Institute, New York City, NY
10/2018	Colloquium Speaker, MIT, Cambridge, MA
10/2018	ITAMP Workshop, Harvard University, Cambridge, MA
09/2018	Colloquium Speaker, Princeton University, Princeton, NJ
09/2018	Packard Fellows Meeting, San Diego, CA
08/2018	Condensed Matter Seminar, University of Illinois at Urbana-Champaign, Urbana, IL
08/2018	Quantum Gases 2018: Novel Correlations Effects, Beijing, China
07/2018	International Conference on Atomic Physics (ICAP), Barcelona, Spain
06/2018	Exploring Nuclear Physics with Ultracold Atoms, Trento, Italy
05/2018	Quantum Science and Engineering, Ascona, Switzerland
04/2018	Colloquium Speaker, Lehigh University, Bethlehem, PA
04/2018	JQI Seminar, University of Maryland, College Park, MD
03/2018	APS March Meeting, Los Angeles, CA
01/2018	AMO Seminar Speaker, Stanford University, Stanford, CA
11/2017	AMO/CM Seminar Speaker, Columbia University, New York City, NY
10/2017	JFI Seminar Speaker, University of Chicago, Chicago, IL
09/2017	BEC 2017, Sant Feliu de Guixols, Spain
06/2017	DAMOP Conference, Sacramento, CA
03/2017	Colloquium Speaker, Rutgers University, New Brunswick, NJ
03/2017	Atomic Physics Seminar, Rice University, Houston, TX
04/2016	Atomic Physics Seminar, Harvard University, Cambridge, NJ
04/2016	Colloquium Speaker, Rowan University, Glassboro, NJ
04/2016	Condensed Matter Seminar, Duke University, Durham, NC
03/2016	Inter. Conf. on Quantum Physics and Nuclear Engineering, London, UK
07/2015	Princeton Summer School on Condensed Matter Physics, Princeton, NJ
05/2015	Condensed Matter Seminar, Boston University, Boston, MA
10/2014	New Laser Scientist Conference, Tucson, AZ
10/2014	Colloquium Speaker, Lehigh University, Bethlehem, PA
08/2014	Quantum Gases, Fluids and Solids, Universidade de São Paulo, São Carlos, Brazil
08/2014	Inter. Conf. on Low Temp. Physics, Buenos Aires, Argentina
12/2013	Condensed Matter Seminar, Princeton University, Princeton, NJ
03/2013	ITAMP Seminar, Harvard University, Cambridge, MA
02/2013	JQI Seminar, University of Maryland, College Park, MD
02/2013	QI/AMO Seminar, University of Illinois at Urbana-Champaign, Urbana, IL
02/2013	Pennsylvania State University, State College, University Park, PA
01/2013	LASSP Seminar, Cornell University, Ithaca, NY
12/2012	Princeton University, Princeton, NJ
09/2012	Kavli Institute for Theoretical Physics, Santa Barbara, CA
09/2012	Complex Quantum Systems Seminar, University of Texas, Austin, TX
06/2012	DAMOP Conference, Anaheim, CA
05/2011	JQI Seminar, National Institute of Standards (JQI), Gaithersburg, MD
05/2011	Masdar Institute for Science & Tech., Abu Dhabi, UAE
05/2010	CLEO/QELS Conference, San Jose, CA