



## Benjamin Lev

Professor of Applied Physics and of Physics

 Curriculum Vitae available Online

### CONTACT INFORMATION

- **Administrative Contact**

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### Bio

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#### BIO

Benjamin Lev is a Professor of Physics and Applied Physics professor at Stanford University. He received his Bachelor's degree Magna Cum Laude from Princeton in 1999 and his Ph.D. from Caltech in 2005, both in Physics. Benjamin was a National Research Council postdoc at JILA and an Assistant Professor at the University of Illinois at Urbana-Champaign. He joined the Stanford faculty in 2011, where he is an Associate Professor in the Departments of Physics and Applied Physics. Benjamin has received a Packard Foundation Fellowship and the Presidential Early Career Award for Scientists and Engineers (PECASE) award from President Obama. In addition, he received the NSF CAREER award and the Air Force Office of Scientific Research, DARPA, and Office of Naval Research Young Investigator Program awards. Benjamin's research focuses on exploring quantum many-body physics, including quantum neural networks, using techniques at the interface of ultracold atomic physics, quantum optics, and condensed matter physics. He is an APS Fellow and a member of the Defense Science Study Group. His research has been funded by the NSF, DOE, ARO, AFOSR, ONR, DARPA, NTT, and the Moore Foundation.

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#### ACADEMIC APPOINTMENTS

- Professor, Applied Physics
- Professor, Physics
- Member, Bio-X

#### HONORS AND AWARDS

- Fellow of the American Physical Society, APS (2021)
- Editorial Board, Physical Review X, American Physical Society (2021)
- Defense Science Study Group, IDA & DARPA (2020)
- Chambers Fellowship, Stanford University (2015)
- Terman Fellowship, Stanford University (2014)
- Young Faculty Award (YFA), DARPA (2012)

- Young Investigator Award (ONR YIP), Office of Naval Research (2012)
- Presidential Early Career Award for Scientists and Engineers (PECASE), NSF (2011)
- Terman Fellowship, Stanford University (2011)
- Packard Fellowship, David and Lucile Packard Foundation (2010)
- NSF CAREER Award, National Science Foundation (NSF) (2008)
- Office of Scientific Research Young Investigator Award (AFOSR YIP), Air Force (2008)
- Everhart Distinguished Graduate Student Lectureship, Caltech (2004)
- Allen Goodrich Schenstone Prize for Outstanding Work in Experimental Physics, Department of Physics, Princeton University (1999)

## PROFESSIONAL EDUCATION

- Ph.D., California Institute of Technology , Physics (2005)
- A.B., Princeton University , Physics, Magna Cum Laude (1999)
- Valedictorian, Crystal River High School (1995)

## LINKS

- LevLab website: <http://levlab.stanford.edu>

## Research & Scholarship

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### CURRENT RESEARCH AND SCHOLARLY INTERESTS

LevLab is a joint AMO & CM experimental group that explores the question: Can new classes of states and phases of quantum matter be created far away from equilibrium, and if so, what do we learn? We use our new technique, confocal cavity QED, to both engineer out-of-equilibrium quantum gases and 2D materials and to image and control their new properties.

Specifically, we aim to:

-Create and control new forms of highly excited quantum matter using cavity photons coupled to 1D gases of the most magnetic atom, dysprosium;

-`Wire together' nodes of atomic spins with photons to create novel spin glasses and the quantum neural networks they realize;

-Use our novel `CavMat' instrument to control electronic excitations of twisted 2D quantum materials with the goal to shape control their phase diagrams.

We welcome all curious experiment and theory grad students and postdocs to contact Prof. Lev.

## Teaching

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### COURSES

#### 2023-24

- A Taste of Quantum Physics: APPPHYS 13N, PHYSICS 13N (Aut)
- ULTRACOLD QUANTUM PHYSICS: APPPHYS 282, PHYSICS 182, PHYSICS 282 (Win)

#### 2022-23

- A Taste of Quantum Physics: APPPHYS 13N, PHYSICS 13N (Aut)
- ULTRACOLD QUANTUM PHYSICS: APPPHYS 282, PHYSICS 182, PHYSICS 282 (Win)

## 2021-22

- Literature of Quantum Simulation: APPPHYS 376 (Spr)
- Quantum Gases: APPPHYS 282, PHYSICS 182, PHYSICS 282 (Win)

## STANFORD ADVISEES

### Doctoral Dissertation Reader (AC)

Chris Gustin, Omer Hazon, Vasily Kruzhilin, Atsushi Yamamura

### Postdoctoral Faculty Sponsor

Yunpeng Ji, Di Lao, Zhendong Zhang

### Doctoral Dissertation Advisor (AC)

Alexander Bourzutschky, Han Hiller, Henry Hunt, Alex Kiral, Kuan-Yu Lin, Brendan Marsh, Kangning Yang

### Doctoral (Program)

Sebastien Abadi, Derek Baldwin, Logan Bishop-Van Horn, Chiara Brandenstein, Aaron Breidenbach, Sam Carman, Sanyum Channa, Sam Cohen, Elijah Courtney, Yi-Shiou Duh, Nicholas Entin, Ben Foutty, Simai Jia, Bowen Li, Yifan Li, Kuan-Yu Lin, Huiting Liu, Isa Muhammad, Ben Safvati, Samuel Sahel-Schackis, Aviv Simchony, Adithya Sriram, Dhruv Tandon, Josh Tong, Steven Tran, Eleanor Weckwerth, Yawen Xiao, Atsushi Yamamura, Victor Zhang, Henry Zheng, Laura Zhou

## Publications

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### PUBLICATIONS

- **Rapidity and momentum distributions of one-dimensional dipolar quantum gases** *PHYSICAL REVIEW A*  
Li, K., Zhang, Y., Yang, K., Lin, K., Gopalakrishnan, S., Rigol, M., Lev, B. L.  
2023; 107 (6)
- **High Cooperativity Using a Confocal-Cavity-QED Microscope** *PRX QUANTUM*  
Kroeze, R. M., Marsh, B. P., Lin, K., Keeling, J., Lev, B. L.  
2023; 4 (2)
- **Dipolar physics: a review of experiments with magnetic quantum gases.** *Reports on progress in physics. Physical Society (Great Britain)*  
Chomaz, L., Ferrier-Barbut, I., Ferlaino, F., Laburthe-Tolra, B., Lev, B. L., Pfau, T.  
2022; 86 (2)
- **An optical lattice with sound.** *Nature*  
Guo, Y., Kroeze, R. M., Marsh, B. P., Gopalakrishnan, S., Keeling, J., Lev, B. L.  
2021; 599 (7884): 211-215
- **Enhancing Associative Memory Recall and Storage Capacity Using Confocal Cavity QED** *PHYSICAL REVIEW X*  
Marsh, B. P., Guo, Y., Kroeze, R. M., Gopalakrishnan, S., Ganguli, S., Keeling, J., Lev, B. L.  
2021; 11 (2)
- **A scanning quantum cryogenic atom microscope at 6 K** *SCIPOST PHYSICS*  
Taylor, S. F., Yang, F., Freudenstein, B. A., Lev, B. L.  
2021; 10 (3)
- **Quantum Simulators: Architectures and Opportunities** *PRX QUANTUM*  
Altman, E., Brown, K. R., Carleo, G., Carr, L. D., Demler, E., Chin, C., DeMarco, B., Economou, S. E., Eriksson, M. A., Fu, K. C., Greiner, M., Hazzard, K. A., Hulet, et al  
2021; 2 (1)
- **Topological pumping of a 1D dipolar gas into strongly correlated prethermal states.** *Science (New York, N.Y.)*  
Kao, W. n., Li, K. Y., Lin, K. Y., Gopalakrishnan, S. n., Lev, B. L.  
2021; 371 (6526): 296-300

- **Photon-Mediated Peierls Transition of a 1D Gas in a Multimode Optical Cavity.** *Physical review letters*  
Rylands, C., Guo, Y., Lev, B. L., Keeling, J., Galitski, V.  
2020; 125 (1): 010404
- **Photon-Mediated Peierls Transition of a 1D Gas in a Multimode Optical Cavity** *PHYSICAL REVIEW LETTERS*  
Rylands, C., Guo, Y., Lev, B. L., Keeling, J., Galitski, V.  
2020; 125 (1)
- **Nematic transitions in iron pnictide superconductors imaged with a quantum gas** *NATURE PHYSICS*  
Yang, F., Taylor, S. F., Edkins, S. D., Palmstrom, J. C., Fisher, I. R., Lev, B. L.  
2020
- **Dynamical Spin-Orbit Coupling of a Quantum Gas** *PHYSICAL REVIEW LETTERS*  
Kroeze, R. M., Guo, Y., Lev, B. L.  
2019; 123 (16)
- **Sign-Changing Photon-Mediated Atom Interactions in Multimode Cavity Quantum Electrodynamics** *PHYSICAL REVIEW LETTERS*  
Guo, Y., Kroeze, R. M., Vaidya, V. D., Keeling, J., Lev, B. L.  
2019; 122 (19): 193601
- **Emergent and broken symmetries of atomic self-organization arising from Gouy phase shifts in multimode cavity QED** *PHYSICAL REVIEW A*  
Guo, Y., Vaidya, V. D., Kroeze, R. M., Lunney, R. A., Lev, B. L., Keeling, J.  
2019; 99 (5)
- **Spinor Self-Ordering of a Quantum Gas in a Cavity.** *Physical review letters*  
Kroeze, R. M., Guo, Y., Vaidya, V. D., Keeling, J., Lev, B. L.  
2018; 121 (16): 163601
- **Spinor Self-Ordering of a Quantum Gas in a Cavity** *PHYSICAL REVIEW LETTERS*  
Kroeze, R. M., Guo, Y., Vaidya, V. D., Keeling, J., Lev, B. L.  
2018; 121 (16)
- **Tuning the Dipole-Dipole Interaction in a Quantum Gas with a Rotating Magnetic Field** *PHYSICAL REVIEW LETTERS*  
Tang, Y., Kao, W., Li, K., Lev, B. L.  
2018; 120 (23): 230401
- **Thermalization near Integrability in a Dipolar Quantum Newton's Cradle** *PHYSICAL REVIEW X*  
Tang, Y., Kao, W., Li, K., Seo, S., Mallayya, K., Rigol, M., Gopalakrishnan, S., Lev, B. L.  
2018; 8 (2)
- **Tunable-Range, Photon-Mediated Atomic Interactions in Multimode Cavity QED** *PHYSICAL REVIEW X*  
Vaidya, V. D., Guo, Y., Kroeze, R. M., Ballantine, K. E., Kollar, A. J., Keeling, J., Lev, B. L.  
2018; 8 (1)
- **Scanning Quantum Cryogenic Atom Microscope** *PHYSICAL REVIEW APPLIED*  
Yang, F., Kollar, A. J., Taylor, S. F., Turner, R. W., Lev, B. L.  
2017; 7 (3)
- **Anisotropic dependence of tune-out wavelength near Dy 741-nm transition** *OPTICS EXPRESS*  
Kao, W., Tang, Y., Burdick, N. Q., Lev, B. L.  
2017; 25 (4): 3411-3419
- **Supermode-density-wave-polariton condensation with a Bose-Einstein condensate in a multimode cavity.** *Nature communications*  
Kollár, A. J., Papageorge, A. T., Vaidya, V. D., Guo, Y., Keeling, J., Lev, B. L.  
2017; 8: 14386-?
- **Meissner-like Effect for a Synthetic Gauge Field in Multimode Cavity QED** *PHYSICAL REVIEW LETTERS*  
Ballantine, K. E., Lev, B. L., Keeling, J.  
2017; 118 (4)

- **Anisotropic collisions of dipolar Bose-Einstein condensates in the universal regime** *NEW JOURNAL OF PHYSICS*  
Burdick, N. Q., Sykes, A. G., Tang, Y., Lev, B. L.  
2016; 18
- **Anisotropic Expansion of a Thermal Dipolar Bose Gas** *PHYSICAL REVIEW LETTERS*  
Tang, Y., SYKES, A. G., Burdick, N. Q., DiSciaccia, J. M., Petrov, D. S., Lev, B. L.  
2016; 117 (15)
- **Long-Lived Spin-Orbit-Coupled Degenerate Dipolar Fermi Gas** *PHYSICAL REVIEW X*  
Burdick, N. Q., Tang, Y., Lev, B. L.  
2016; 6 (3)
- **Coupling to modes of a near-confocal optical resonator using a digital light modulator** *OPTICS EXPRESS*  
Papageorge, A. T., Kollar, A. J., Lev, B. L.  
2016; 24 (11): 1447-1457
- **Bilayer fractional quantum Hall states with dipoles** *PHYSICAL REVIEW A*  
YAO, N. Y., Bennett, S. D., Laumann, C. R., Lev, B. L., Gorshkov, A. V.  
2015; 92 (3)
- **s-wave scattering lengths of the strongly dipolar bosons Dy-162 and Dy-164** *PHYSICAL REVIEW A*  
Tang, Y., Sykes, A., Burdick, N. Q., Bohn, J. L., Lev, B. L.  
2015; 92 (2)
- **Bose-Einstein condensation of Dy-162 and Dy-160** *NEW JOURNAL OF PHYSICS*  
Tang, Y., Burdick, N. Q., Baumann, K., Lev, B. L.  
2015; 17
- **An adjustable-length cavity and Bose-Einstein condensate apparatus for multimode cavity QED** *NEW JOURNAL OF PHYSICS*  
Kollar, A. J., Papageorge, A. T., Baumann, K., Armen, M. A., Lev, B. L.  
2015; 17
- **Fermionic suppression of dipolar relaxation.** *Physical review letters*  
Burdick, N. Q., Baumann, K., Tang, Y., Lu, M., Lev, B. L.  
2015; 114 (2): 023201-?
- **Fermionic Suppression of Dipolar Relaxation** *PHYSICAL REVIEW LETTERS*  
Burdick, N. Q., Baumann, K., Tang, Y., Lu, M., Lev, B. L.  
2015; 114 (2)
- **Observation of low-field Fano-Feshbach resonances in ultracold gases of dysprosium** *PHYSICAL REVIEW A*  
Baumann, K., Burdick, N. Q., Lu, M., Lev, B. L.  
2014; 89 (2)
- **Trapping ultracold gases near cryogenic materials with rapid reconfigurability** *APPLIED PHYSICS LETTERS*  
Naides, M. A., Turner, R. W., Lai, R. A., DiSciaccia, J. M., Lev, B. L.  
2013; 103 (25)
- **Synthetic gauge field with highly magnetic lanthanide atoms** *PHYSICAL REVIEW A*  
Cui, X., Lian, B., Ho, T., Lev, B. L., Zhai, H.  
2013; 88 (1)
- **Imaging topologically protected transport with quantum degenerate gases** *PHYSICAL REVIEW B*  
Dellabetta, B., Hughes, T. L., Gilbert, M. J., Lev, B. L.  
2012; 85 (20)
- **Quantum Degenerate Dipolar Fermi Gas** *PHYSICAL REVIEW LETTERS*  
Lu, M., Burdick, N. Q., Lev, B. L.  
2012; 108 (21)

- **Atomic interface between microwave and optical photons** *PHYSICAL REVIEW A*  
Hafezi, M., Kim, Z., Rolston, S. L., OROZCO, L. A., Lev, B. L., Taylor, J. M.  
2012; 85 (2)
- **Exploring models of associative memory via cavity quantum electrodynamics** *PHILOSOPHICAL MAGAZINE*  
Gopalakrishnan, S., Lev, B. L., Goldbart, P. M.  
2012; 92 (1-3): 353-361
- **Frustration and Glassiness in Spin Models with Cavity-Mediated Interactions** *PHYSICAL REVIEW LETTERS*  
Gopalakrishnan, S., Lev, B. L., Goldbart, P. M.  
2011; 107 (27)
- **Strongly Dipolar Bose-Einstein Condensate of Dysprosium** *PHYSICAL REVIEW LETTERS*  
Lu, M., Burdick, N. Q., Youn, S. H., Lev, B. L.  
2011; 107 (19)
- **Dynamic polarizabilities and magic wavelengths for dysprosium** *PHYSICAL REVIEW A*  
Dzuba, V. A., Flambaum, V. V., Lev, B. L.  
2011; 83 (3)
- **Spectroscopy of a narrow-line laser-cooling transition in atomic dysprosium** *PHYSICAL REVIEW A*  
Lu, M., Youn, S. H., Lev, B. L.  
2011; 83 (1)
- **Dysprosium magneto-optical traps** *PHYSICAL REVIEW A*  
Youn, S. H., Lu, M., Ray, U., Lev, B. L.  
2010; 82 (4)
- **Atom-light crystallization of Bose-Einstein condensates in multimode cavities: Nonequilibrium classical and quantum phase transitions, emergent lattices, supersolidity, and frustration** *PHYSICAL REVIEW A*  
Gopalakrishnan, S., Lev, B. L., Goldbart, P. M.  
2010; 82 (4)
- **Anisotropic sub-Doppler laser cooling in dysprosium magneto-optical traps** *PHYSICAL REVIEW A*  
Youn, S. H., Lu, M., Lev, B. L.  
2010; 82 (4)
- **Cavity-Based Single Atom Preparation and High-Fidelity Hyperfine State Readout** *PHYSICAL REVIEW LETTERS*  
Gehr, R., Volz, J., Dubois, G., Steinmetz, T., Colombe, Y., Lev, B. L., Long, R., Esteve, J., Reichel, J.  
2010; 104 (20)
- **Trapping Ultracold Dysprosium: A Highly Magnetic Gas for Dipolar Physics** *PHYSICAL REVIEW LETTERS*  
Lu, M., Youn, S. H., Lev, B. L.  
2010; 104 (6)
- **Powerful narrow-line source of blue light for laser cooling Yb/Er and Dysprosium atoms** *Conference on Solid State Lasers XIX - Technology and Devices*  
Kobtsev, S., Lev, B., Fortagh, J., Baraulia, V.  
SPIE-INT SOC OPTICAL ENGINEERING.2010
- **Emergent crystallinity and frustration with Bose-Einstein condensates in multimode cavities** *NATURE PHYSICS*  
Gopalakrishnan, S., Lev, B. L., Goldbart, P. M.  
2009; 5 (11): 845-850
- **Biaxial nematic phases in ultracold dipolar Fermi gases** *NEW JOURNAL OF PHYSICS*  
Fregoso, B. M., Sun, K., Fradkin, E., Lev, B. L.  
2009; 11
- **Optical Interferometers with Reduced Sensitivity to Thermal Noise** *PHYSICAL REVIEW LETTERS*  
Kimble, H. J., Lev, B. L., Ye, J.  
2008; 101 (26)

- **Loss of molecules in magneto-electrostatic traps due to nonadiabatic transitions** *PHYSICAL REVIEW A*  
Lara, M., Lev, B. L., Bohn, J. L.  
2008; 78 (3)
- **Mitigation of loss within a molecular Stark decelerator** *EUROPEAN PHYSICAL JOURNAL D*  
Sawyer, B. C., Stuhl, B. K., Lev, B. L., Ye, J., Hudson, E. R.  
2008; 48 (2): 197-209
- **Prospects for the cavity-assisted laser cooling of molecules** *PHYSICAL REVIEW A*  
Lev, B. L., Vukics, A., Hudson, E. R., Sawyer, B. C., Domokos, P., Ritsch, H., Ye, J.  
2008; 77 (2)
- **Magneto-electrostatic trapping of ground state OH molecules** *PHYSICAL REVIEW LETTERS*  
Sawyer, B. C., Lev, B. L., Hudson, E. R., Stuhl, B. K., Lara, M., Bohn, J. L., Ye, J.  
2007; 98 (25)
- **OH hyperfine ground state: From precision measurement to molecular qubits** *PHYSICAL REVIEW A*  
Lev, B. L., Meyer, E. R., Hudson, E. R., Sawyer, B. C., Bohn, J. L., Ye, J.  
2006; 74 (6)
- **Integration of fiber-coupled high-Q SiNx microdisks with atom chips** *APPLIED PHYSICS LETTERS*  
Barclay, P. E., Srinivasan, K., Painter, O., Lev, B., Mabuchi, H.  
2006; 89 (13)
- **Quantum information processing in optical lattices and magnetic microtraps** *FORTSCHRITTE DER PHYSIK-PROGRESS OF PHYSICS*  
Treutlein, P., Steinmetz, T., Colombe, Y., Lev, B., Hommelhoff, P., Reichel, J., Greiner, M., Mandel, O., Widera, A., Rom, T., Bloch, I., Hansch, T. W.  
2006; 54 (8-10): 702-718
- **Precision measurement based on ultracold atoms and cold molecules** *20th International Conference on Atomic Physics*  
Ye, J., Blatt, S., Boyd, M. M., Foreman, S. M., Hudson, E. R., Ido, T., Lev, B., Ludlow, A. D., Sawyer, B. C., Stuhl, B., Zelevinsky, T.  
AMER INST PHYSICS.2006: 80-91
- **Proposed magneto-electrostatic ring trap for neutral atoms** *PHYSICAL REVIEW A*  
Hopkins, A., Lev, B., Mabuchi, H.  
2004; 70 (5)
- **Feasibility of detecting single atoms using photonic bandgap cavities** *Nanoscale Devices and System Integration Conference (NDSI-2004)*  
Lev, B., Srinivasan, K., Barclay, P., Painter, O., Mabuchi, H.  
IOP PUBLISHING LTD.2004: S556-S561
- **Fabrication of micro-magnetic traps for cold neutral atoms** *QUANTUM INFORMATION & COMPUTATION*  
Lev, B.  
2003; 3 (5): 450-464
- **Atom mirror etched from a hard drive** *APPLIED PHYSICS LETTERS*  
Lev, B., Lassailly, Y., Lee, C., Scherer, A., Mabuchi, H.  
2003; 83 (2): 395-397
- **QUANTUM NETWORKS BASED ON CAVITY QED** *QUANTUM INFORMATION & COMPUTATION*  
Mabuchi, H., Armen, M., Lev, B., Loncar, M., Vuckovic, J., Kimble, H. J., Preskill, J., Roukes, M., Scherer, A., van Enk, S. J.  
2001; 1: 7-12
- **Radiation hardness evaluation of the Analog Devices AD9042 ADC for use in the CMS electromagnetic calorimeter** *NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT*  
Denes, P., Lev, B., Wixted, R.  
1998; 417 (2-3): 371-376