

# Inna Vishik

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## Current Position

*Assistant Professor*, University of California, Davis, Department of Physics

## Professional Preparation

**2013-2016:** Massachusetts Institute of Technology, Cambridge, MA  
Pappalardo Postdoctoral Fellow in Department of Physics

**2006-2013:** Stanford University, Stanford, CA  
Ph.D Department of Applied Physics

- Adviser: Zhi-Xun Shen
- Dissertation title: *Low energy excitations in cuprate high temperature superconductors: angle-resolved photoemission spectroscopy studies*

**2005-2006:** Stanford University, M.S. Department of Materials Science

**2003-2006:** Stanford University, B.S. Department of Physics

- Research Adviser: Martin Greven
- Honors Thesis: *Quantum impurities in the electron-doped high-temperature superconductor Neodymium Cerium Copper Oxide: crystal growth, characterization, and magnetic neutron scattering*

## Prior Research Positions

**2013-2016:** Pappalardo Postdoctoral Fellow with Professor Nuh Gedik  
Massachusetts Institute of Technology, Department of Physics, Cambridge, MA

- Performed ultrafast optical pump-probe experiments on electron-doped cuprate  $\text{La}_{2-x}\text{Ce}_x\text{CuO}_4$  (LCCO) and  $\text{Pr}_{2-x}\text{Ce}_x\text{CuO}_4$  (PCCO) to identify dynamic behavior of antiferromagnetic correlations
- Performed ultrafast optical pump-probe experiments in heavy fermion material  $\text{CeCoIn}_5$  to assess electron relaxation dynamics related to formation of Kondo lattice

**2007-2013:** Research Assistant for Professor Z.-X. Shen  
Stanford University, Department of Applied Physics, Stanford, CA

- Performed angle-resolved photoemission spectroscopy (ARPES) experiments on high-temperature superconducting cuprates, particularly  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$
- Research topics: Quantum phase transitions, phase competition between pseudogap and superconductivity, electron-boson coupling, Fermi arcs, high resolution laser ARPES
- Instrumentation experience: UHV; Maintained and upgraded 7eV laser system for ARPES experiments; Led effort to interface 11eV laser with ARPES system

**2006:** Research Assistant for Professor K. Moler Stanford University, Department of Applied Physics, Stanford, CA

- Searched for signatures of time-reversal symmetry breaking below  $T_c$  in strontium ruthenate, an unconventional superconductor, using scanning hall probe microscopy

**2003-2006:** Research Assistant for Professor M. Greven Stanford University, Department of Applied Physics, Stanford, CA

- Performed neutron scattering experiments on impurity-doped and impurity-free  $\text{Nd}_{2-x}\text{Ce}_x\text{CuO}_4$  to study temperature and doping dependence of antiferromagnetic spin-spin correlations in electron-doped cuprates
- Grew single crystals of  $\text{Nd}_{2-x}\text{Ce}_x\text{CuO}_4$  using traveling-solvent floating zone technique

**2003:** NSF REU Research Assistant for Professor H. L. Swinney University of Texas at Austin, Center for Nonlinear Dynamics, Austin, TX

- Studied low energy impacts in 2-D granular media

## Publications

19. *High Resolution Angle Resolved Photoemission with Tabletop 11eV Laser*  
Yu He, **Inna Vishik**, Ming Yi, Shuolong Yang, Zhongkai Liu, James Lee, Sudi Chen, Slavko Rebec, Dominik Leuenberger, Alfred Zong, Michael Jefferson, Robert Moore, Patrick Kirchmann, Andrew Merriam, Zhi-Xun Shen  
Reviews of Scientific Instruments **87**, 011301 (2016)
18. *Direct spectroscopic evidence for phase competition between the pseudogap and superconductivity in  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$*   
M. Hashimoto, E. A. Nowadnick, R.-H. He, **I. M. Vishik**, B. Moritz, Y. He, K. Tanaka, R. G. Moore, D. H. Lu, Y. Yoshida, M. Ishikado, T. Sasagawa, K. Fujita, S. Ishida, S. Uchida, H. Eisaki, Z. Hussain, T. P. Devereaux, and Z.-X. Shen  
Nature Materials **14**, 37 (2015)
17. *Energy gaps in high-transition-temperature cuprate superconductors*  
M. Hashimoto, **I. M. Vishik**, R. H. He, T. P. Devereaux, Z.-X. Shen  
Nature Physics **10**, 483 (2014)
16. *Angle resolved photoemission spectroscopy study of  $\text{HgBa}_2\text{CuO}_{4+\delta}$*   
**I. M. Vishik**, Neven Barišić, M.K. Chan, Yuan Li, D. D. Xia, Guichuan Yu, Xudong Zhao, W. S. Lee, W. Meevasana, T. P. Devereaux, Martin Greven, and Z.-X. Shen  
Phys. Rev. B **89** 195141 (2014)
15. *Phase competition in trisected superconducting dome*  
**I. M. Vishik**, M. Hashimoto, R.-H. He, W. S. Lee, F. Schmitt, D. H. Lu, R. G. Moore, C. Zhang, W. Meevasana, T. Sasagawa, S. Uchida, K. Fujita, S. Ishida, M. Ishikado, Y. Yoshida, H. Eisaki, Z. Hussain, T. P. Devereaux, and Z.-X. Shen  
Proc. Natl. Acad. Sci. **109** 18332 (2012)
14. *Superconductivity distorted by the coexisting pseudogap in the antinodal region of  $\text{Bi}_{1.5}\text{Pb}_{0.55}\text{Sr}_{1.6}\text{La}_{0.4}\text{CuO}_{6+\delta}$ : A photon-energy-dependent angle-resolved photoemission study*  
M. Hashimoto, R.-H. He, **I. M. Vishik**, F. Schmitt, R. G. Moore, D. H. Lu, Y. Yoshida, H. Eisaki, Z. Hussain, T. P. Devereaux, and Z.-X. Shen  
Phys. Rev. B **86**, 094504 (2012)

13. *Intrinsic ultrathin topological insulators grown via molecular beam epitaxy characterized by in-situ angle resolved photoemission spectroscopy*  
J. J. Lee, F. T. Schmitt, R. G. Moore, **I. M. Vishik**, Y. Ma, and Z. X. Shen  
Appl. Phys. Lett. **101**, 013118 (2012)
12. *Angle-Resolved Photoemission Studies of Quantum Materials*  
Donghui Lu, **Inna M. Vishik**, Ming Yi, Yulin Chen, Rob G. Moore, and Zhi-Xun Shen  
Annual Reviews of Condensed Matter Physics **3**, 129 (2012)
11. *Pseudogap, Superconducting Gap, and Fermi Arc in High-Tc Cuprates Revealed by Angle-Resolved Photoemission Spectroscopy*  
Teppei Yoshida, Makoto Hashimoto, **Inna M. Vishik**, Zhi-Xun Shen, and Atsushi Fujimori  
Journal of the Physical Society of Japan **81**, 011006 (2012)
10. *Evidence for the Importance of Extended Coulomb Interactions and Forward Scattering in Cuprate Superconductors*  
S. Johnston, **I. M. Vishik**, W. S. Lee, F. Schmitt, S. Uchida, K. Fujita, S. Ishida, N. Nagaosa, Z.-X. Shen, and T. P. Devereaux  
Phys. Rev. Lett. **108**, 166404 (2012)
9. *ARPES studies of cuprate Fermiology: superconductivity, pseudogap and quasiparticle dynamics*  
**I. M. Vishik**, W.-S. Lee, R.-H. He, M. Hashimoto, Z. Hussain, T. P. Devereaux, and Z.-X. Shen  
New Journal of Physics **12**, 105008 (2010)
8. *Doping-Dependent Nodal Fermi Velocity of the High-Temperature Superconductor  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$  Revealed Using High-Resolution Angle-Resolved Photoemission Spectroscopy*  
**I. M. Vishik**, W. S. Lee, F. Schmitt, B. Moritz, T. Sasagawa, S. Uchida, K. Fujita, S. Ishida, C. Zhang, T. P. Devereaux, and Z.-X. Shen  
Phys. Rev. Lett. **104**, 207002 (2010)
7. *A momentum-dependent perspective on quasiparticle interference in  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$*   
**I. M. Vishik**, E. A. Nowadnick, W. S. Lee, Z. X. Shen, B. Moritz, T. P. Devereaux, K. Tanaka, T. Sasagawa, T. Fujii  
Nature Physics **5**, 718 (2009)
6. *Dependence of Band-Renormalization Effects on the Number of Copper Oxide Layers in Tl-Based Copper Oxide Superconductors Revealed by Angle-Resolved Photoemission Spectroscopy*  
W. S. Lee, K. Tanaka, **I. M. Vishik**, D. H. Lu, R. G. Moore, H. Eisaki, A. Iyo, T. P. Devereaux, and Z. X. Shen  
Phys. Rev. Lett. **103**, 067003 (2009)
5. *Superconductivity-induced self-energy evolution of the nodal electron of optimally doped  $\text{Bi}_2\text{Sr}_2\text{Ca}_{0.92}\text{Y}_{0.08}\text{Cu}_2\text{O}_{8+\delta}$*   
W. S. Lee, W. Meevasana, S. Johnston, D. H. Lu, **I. M. Vishik**, R. G. Moore, H. Eisaki, N. Kaneko, T. P. Devereaux, and Z. X. Shen  
Phys. Rev. B **77**, 140504 (2008)
4. *Abrupt onset of a second energy gap at the superconducting transition of underdoped  $\text{Bi}2212$*   
W. S. Lee, **I. M. Vishik**, K. Tanaka, D. H. Lu, T. Sasagawa, N. Nagaosa, T. P. Devereaux, Z. Hussain, and Z.-X. Shen  
Nature **450**, 81 (2007)
3. *Spin correlations in the electron-doped high-transition-temperature superconductor  $\text{Nd}_{2-x}\text{Ce}_x\text{CuO}_{4\pm\delta}$*   
E. M. Motoyama, G. Yu, **I. M Vishik**, O.P Vajk, P.K. Mang, and M. Greven  
Nature **455**, 186 (2007)
2. *Magnetic field effect on the superconducting magnetic gap of  $\text{Nd}_{1.85}\text{Ce}_{0.15}\text{CuO}_4$*   
E. M. Motoyama, P.K. Mang, D. Petitgrand, G. Yu, O.P. Vajk, **I. Vishik**, and M. Greven  
Phys. Rev. Lett. **96**, 137002 (2006)
1. *Dynamics of drag and force distributions for projectile impact in a granular medium*  
Massimo Pica Ciamarra, Antonio H. Lara, Andrew T. Lee, Daniel I. Goldman, **Inna Vishik** and Harry L.

## Manuscripts in Preparation

2. *Ultrafast dynamics in the presence of antiferromagnetic correlations in electron-doped cuprate  $La_{2-x}Ce_xCuO_{4\pm\delta}$*   
**I. M. Vishik**, F. Mahmood, Z. Alpichshev, J. Higgins, R. L. Greene, N. Gedik  
Preprint available at ArXiv:1601.06694
1. *Ubiquitous antinodal quasiparticles and deviation from simple d-wave form in Bi-2212*  
**I. M. Vishik**, Makoto Hashimoto, W. S. Lee, T. P. Devereaux, and Z.-X. Shen  
Preprint available at ArXiv:1405.4961

## Invited Talks

19. *Ultrafast dynamics in unconventional superconductors*  
Condensed matter seminar, University of Maryland, Dec. 10, 2015
18. *Ultrafast dynamics in unconventional superconductors*  
Condensed matter seminar, Rutgers University, Nov. 10, 2015
17. *ARPES studies of low energy excitations in cuprate superconductors*  
The 11th International Conference on Materials and Mechanisms of Superconductivity (M2S)  
Geneva, Switzerland, August 2015
16. *Low energy excitations in cuprate high temperature superconductors*  
CORPES 2015, Paris, France, July 2015
15. *Ultrafast dynamics in heavy fermions and electron-doped cuprates*  
Condensed matter seminar, Princeton University, May 2015
14. *Momentum space imaging of cuprate superconductors*  
Kavli Institute for Theoretical Physics, University of California, Santa Barbara, November 2014
13. *Low energy excitations in cuprate high temperature superconductors*  
The New Generation in Strongly Correlated Electron Systems, Nice, France, June 2014
12. *Low energy excitations in cuprate high temperature superconductors*  
Condensed matter seminar, University of Connecticut, April 2014
11. *Low energy excitations in cuprates: an ARPES perspective*  
Aspen conference, *Beyond quasiparticles: new paradigms for quantum fluids*, January 2014
10. *Gap measurements and the cuprate phase diagram*  
Aspen conference, *Unconventional order in strongly correlated electron systems*, January 2014
9. *Laser-ARPES studies of cuprate high temperature superconductors: elucidating low-energy excitations*  
Physics in the field, NHMFL, Los Alamos National Lab., November 2013
8. *Low-energy excitations in cuprates: laser-ARPES studies*  
Condensed matter seminar, Northeastern University, November 2013
7. *Laser ARPES studies of cuprate high temperature superconductors*  
Physics seminar, San Jose State University, October 2013
6. *Phase competition in trisected superconducting dome*  
Spectroscopies of Novel Superconductors, June 2013
5. *ARPES studies of high- $T_c$  cuprates*  
Gordon Research Seminar-Superconductivity, May 2013
4. *Phase competition in trisected superconducting dome*  
American Physical Society March Meeting 2012

3. *Phase competition in cuprate superconducting dome*  
Condensed Matter Seminar at University of California, Riverside, February 2012
2. *Laser-ARPES studies of cuprate Fermiology*  
Condensed Matter Seminar at University of Minnesota, April 2011
1. *Quasiparticles in Bi-2212*  
Workshop on High-Temperature Superconductors at the University of Tokyo, Jan 2009

## Contributed Talks

10. *Dynamics of quasiparticles and antiferromagnetic correlations in electron-doped cuprate  $La_{2-x}Ce_xCuO_{4\pm\delta}$*   
I. M. Vishik, F. Mahmood, Z. Alpichshev, J. S. Higgins, R. L. Greene, N. Gedik  
American Physical Society March Meeting 2016
9. *Ultrafast dynamics in  $CeCoIn_5$*   
I. M. Vishik, F. Mahmood, Z. Alpichshev, S. Saha, J. P. Paglione, N. Gedik  
American Physical Society March Meeting 2015
8. *Angle-Resolved Photoemission Spectroscopy study of  $HgBa_2CuO_{4+\delta}$*   
I. M. Vishik, Neven Barisic, Yuan Li, Guichuan Yu, Xudong Zhao, W. S. Lee, W. Meevasana, T. P. Devereaux, Martin Greven, Z.-X. Shen  
American Physical Society March Meeting 2014
7. *Fermi arcs in Bi-2212*  
I. M. Vishik, W.-S. Lee, M. Hashimoto, F. Schmitt, T. Sasagawa, S. Ishida, K. Fujita, S. Uchida, T. P. Devereaux, Z.-X. Shen  
American Physical Society March Meeting 2013
6. *Laser-ARPES studies on Bi-2212*  
I. M. Vishik, W.-S. Lee, F. Schmitt, T. Sasagawa, S. Ishida, K. Fujita, S. Uchida, T. P. Devereaux, Z.-X. Shen  
American Physical Society March Meeting 2011
5. *Doping-dependent laser ARPES studies on Bi-2212*  
I. M. Vishik, W. S. Lee, F. Schmitt, B. Moritz, T. Sasagawa, S. Uchida, K. Fujita, S. Ishida, C. Zhang, T. P. Devereaux, Z.-X. Shen  
American Physical Society March Meeting 2010
4. *Quasiparticles in Bi-2212*  
I. M. Vishik, W.-S. Lee, K. Tanaka, B. Moritz, E. A. Nowadnick, T. Sasagawa, T. Fujii, T. P. Devereaux, Z.-X. Shen  
American Physical Society March Meeting 2009
3. *ARPES investigation of the electronic properties of  $PdCoO_2$*   
I. M. Vishik, W. S. Lee, H. Takatsu, D. H. Lu, R. G. Moore, Y. Maeno, Z.-X. Shen  
American Physical Society March Meeting 2008
2. *Magnetic Neutron Scattering Study of  $Nd_{1.85}Ce_{0.15}Cu_{1-y}Ni_yO_4$  Single Crystals*  
Inna Vishik, Guichuan Yu, Eugene Motoyama, Owen Vajk, Martin Greven  
American Physical Society March Meeting 2006
1. *Magnetic Neutron Scattering Study of  $Nd_{1.85}Ce_{0.15}Cu_{1-y}M_yO_4$  ( $M=Zn, Fe, Ni$ ) single crystals*  
Inna Vishik, Guichuan Yu, Eugene Motoyama, Patrick Mang, Owen Vajk, Martin Greven  
American Physical Society March Meeting 2005

## Outreach and General Audience Talks

3. *A picosecond in the life of a superconductor*  
MIT 15th Annual Pappalardo Fellowships in Physics Symposium, May 12, 2016
2. *Frontiers in superconductivity*  
MIT Physics IAP Lecture Series, Jan. 2015
1. *Adventures in unconventional superconductivity*  
MIT 13th Annual Pappalardo Fellowships in Physics Symposium, May 16, 2014

## Awards

**2013-2016:** Pappalardo Fellowship, Massachusetts Institute of Technology

**2009-2011:** Stanford Graduate Fellowship

**2006-2009:** National Science Foundation Graduate Research Fellowship

**2006:** American Physical Society Apker Award Finalist

**2006:** Firestone Medal for excellence in undergraduate research, Stanford University

## Teaching

Teaching Assistant for *Physics 107: Intermediate Physics Laboratory II: Experimental Techniques and data analysis*  
Stanford University, Winter 2013