MATTHEW DUK-YING LEW

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EDUCATION

Ph.D. in Electrical Engineering, 4.0 GPA 2010 – 2015
Stanford University, Stanford, CA
Research Advisor: Professor W. E. Moerner
Thesis Title: "Engineering New Capabilities into Optical Microscopes: Toward Measuring the Three-Dimensional Position and Orientation of Single Molecules in Living Cells"

M.S. in Electrical Engineering, 3.9 GPA 2010
Stanford University, Stanford, CA

B.S. with Honor in Electrical Engineering, 4.0 GPA 2008
California Institute of Technology, Pasadena, CA
Research Advisor: Professor Changhuei Yang
Thesis Title: "Quantitative Differential Phase Imaging and Phase Reconstruction based on the Interference Pattern of a Four-Hole Aperture"

ACADEMIC APPOINTMENTS

Assistant Professor 2015 – present
Preston M. Green Department of Electrical and Systems Engineering, Washington University in St. Louis, MO

Postdoctoral Scholar 2014 – 2015
de la Zerda Group, Department of Structural Biology, Stanford University School of Medicine, Stanford, CA

AWARDS AND RECOGNITIONS

National Science Foundation CAREER Award	2017-2022
Hiruma/Wagner Award, *16th Conference of Peace through Mind/Brain Science*	2016
Winner of 2015 After Image Photo Contest, *Optics & Photonics News*	2015
Second Place Poster Award, Gordon Research Conferences: Single-Molecule Approaches to Biology	2012
Stanford Bio-X Travel Award	2010, 2011
PicoQuant Young Investigator Award	2010
National Science Foundation Graduate Research Fellowship	2008
Newport-Spectra Physics Research Excellence Award	2008
Stanford Graduate Fellowship, 3Com Corporation Fellow	2008
Tau Beta Pi Fellow No. 762	2008
Caltech Carnation Merit Award	2007
Caremark Rx Scholarship	2006, 2007
Tau Beta Pi Scholarship	2007
Caltech Summer Undergraduate Research Fellowship, Rita A. and Φistein Skjellum Fellow	2006

Caltech Perpall Speaking Competition Finalist 2006
College Board National Advanced Placement Scholar 2004
MasterCard Alamo Bowl Scholarship 2004
National Merit Scholarship 2004

RESEARCH EXPERIENCE

Research Intern 2014
Google[x], Mountain View, CA

Graduate Researcher 2009 – 2014
Moerner Lab, Stanford University, Stanford, CA
Three-dimensional (3D) super-resolution microscopy of biological structures using single-molecule fluorescent probes. Design of novel point spread functions for measuring the 3D position of nanoscale objects. Development of analytical tools for precise and accurate measurement of 3D position and orientation of single fluorescent molecules.

Undergraduate Researcher 2006 – 2008
Biophotonics Laboratory, California Institute of Technology, Pasadena, CA
Simulated, characterized, and optimized the design of a novel lensless chip-based device to perform quantitative differential interference contrast microscopy.

TEACHING EXPERIENCE

Assistant Professor 2015 – present
Preston M. Green Department of Electrical and Systems Engineering, Washington University in St. Louis, MO
Designing and teaching new course, ESE 582 "Fundamentals and Applications of Modern Optical Imaging."

Course Designer and Lecturer 2012
Stanford University, Stanford, CA
Co-designed lecture, homework, laboratory, and syllabus content for "Introduction to Photonics" with Professor Audrey Ellerbee. Integrated active learning exercises into lecture materials in order to spark student motivation, facilitate connection of content to students' prior knowledge, and expose possible student misconceptions. Taught one week of lectures on wave optics.

Teaching Assistant 2006 – 2008
California Institute of Technology, Pasadena, CA
Served as teaching assistant for "Electronics Laboratory" and "Feedback and Control Circuits" courses. Held office hours, assisting students with both theoretical and lab-related questions, and graded homework and lab exercises.

PROFESSIONAL EXPERIENCE

Program Committee, Stanford University Photonics Retreat (SUPR) 2015 2015
Asilomar Conference Grounds, Pacific Grove, CA

Co-President, Stanford Optical Society, Student Chapter of OSA and SPIE 2013 – 2014
Stanford University, Stanford, CA
-- Recipient of The Optical Society's 2014 Student Chapter Excellence Award

Program Committee, SUPR 2014 2014
Marconi Conference Center, Marshall, CA

Program Chair, SUPR 5 2013
DoubleTree Hotel Sonoma Wine Country, Rohnert Park, CA

Program Committee, SUPR 2012 2012
Asilomar Conference Grounds, Pacific Grove, CA

Program Committee, International OSA Network of Students (IONS) North America-3 2012
Stanford University, Stanford, CA

Co-Mentor for Bing Undergraduate Summer Research Fellowship in Chemistry 2010
Stanford University, Stanford, CA

President, California Beta Chapter, Tau Beta Pi 2007 – 2008
California Institute of Technology, Pasadena, CA

Vice Chair, Caltech Chapter, IEEE 2007 – 2008
California Institute of Technology, Pasadena, CA

Student Engineer 2004 – 2005
Southwest Research Institute, San Antonio, TX

PUBLICATIONS

h-index: 14, i10-index: 15, *equal contribution, †cover article

Refereed Journal Publications

13. O. Liba, **M. D. Lew,** E. D. SoRelle, R. Dutta, D. Sen, D. M. Moshfeghi, S. Chu, and A. de la Zerda, "Speckle-modulating optical coherence tomography in living mice and humans." *Nat. Commun.* **8**, 15845 (2017).
    -- Featured in *Nat. Methods* **14**, 767 (2017): "Research Highlights: Methods in Brief."
12. † A. von Diezmann, M. Y. Lee, **M. D. Lew,** and W. E. Moerner, "Correcting field-dependent aberrations with nanoscale accuracy in three-dimensional single-molecule localization microscopy." *Optica* **2**, 985 (2015).
11. **M. D. Lew** and W. E. Moerner, "Azimuthal polarization filtering for accurate, precise, and robust single-molecule localization microscopy." *Nano Lett.* **14**, 6407 (2014).
10. A. S. Backer, M. P. Backlund, **M. D. Lew**, and W. E. Moerner, "Single-molecule orientation measurements with a quadrated pupil." *Opt. Lett.* **38**, 1521 (2013).
9.† **M. D. Lew***, M. P. Backlund*, and W. E. Moerner, "Rotational mobility of single molecules affects localization accuracy in super-resolution fluorescence microscopy." *Nano Lett.* **13**, 3967 (2013).
8. M. P. Backlund*, **M. D. Lew***, A. S. Backer, S. J. Sahl, G. Grover, A. Agrawal, R. Piestun, and W. E. Moerner, "Simultaneous, accurate measurement of the 3D position and orientation of single molecules." *Proc. Natl. Acad. Sci. USA* **109**, 19087 (2012).
    -- Featured in *Nat. Methods* **10**, 13 (2013): "Research Highlights: Methods in Brief."
7.† H-L. D. Lee*, S. J. Sahl*, **M. D. Lew**, and W. E. Moerner, "The double-helix microscope super-resolves extended biological structures by localizing single blinking molecules in three dimensions with nanoscale precision," *Appl. Phys. Lett.* **100**, 153701 (2012).
6. **M. D. Lew***, S. F. Lee*, J. L. Ptacin, M. K. Lee, R. J. Twieg, L. Shapiro, and W. E. Moerner, "Three-dimensional superresolution colocalization of intracellular protein superstructures and the cell surface in live *Caulobacter crescentus*," *Proc. Natl. Acad. Sci. USA* **108**, E1102 (2011).
5. **M. D. Lew**, S. F. Lee, M. Badieirostami, and W. E. Moerner, "Corkscrew point spread function for far-field three-dimensional nanoscale localization of pointlike objects," *Opt. Lett.* **36**, 202 (2011).

4. M. Badieirostami, **M. D. Lew**, M. A. Thompson, and W. E. Moerner, "Three-dimensional localization precision of the double-helix point spread function versus astigmatism and biplane," *Appl. Phys. Lett.* **97**, 161103 (2010).
3. M. A. Thompson*, **M. D. Lew***, M. Badieirostami, and W. E. Moerner, "Localizing and tracking single nanoscale emitters in three dimensions with high spatiotemporal resolution using a double-helix point spread function," *Nano Lett.* **10**, 211 (2010).
2. X. Cui, **M. Lew**, and C. Yang, "Quantitative differential interference contrast microscopy based on structured-aperture interference," *Appl. Phys. Lett.* **93**, 091113 (2008).
1. **M. Lew**, X. Cui, X. Heng, and C. Yang, "Interference of a four-hole aperture for on-chip quantitative two-dimensional differential phase imaging," *Opt. Lett.* **32**, 2963 (2007).

Review Articles and Book Chapters

3. **M. D. Lew**, S. F. Lee, M. A. Thompson, H-L. D. Lee, and W. E. Moerner, "Single-molecule photocontrol and nanoscopy," in Far-Field Optical Nanoscopy (eds. P. Tinnefeld, C. Eggeling, and S. W. Hell) **14**, 87 (Springer-Verlag, 2015).
2. M. P. Backlund, **M. D. Lew**, A. S. Backer, S. J. Sahl, and W. E. Moerner, "The role of molecular dipole orientation in single-molecule fluorescence microscopy and implications for super-resolution imaging," *ChemPhysChem* **15**, 587 (2014).
1. M. A. Thompson, **M. D. Lew**, and W. E. Moerner, "Extending microscopic resolution with single-molecule imaging and active control," *Annu. Rev. Biophys.* **41**, 321 (2012).

Other Publications

7. A. S. Backer, M. P. Backlund, **M. D. Lew**, A. R. Diezmann, S. J. Sahl, and W. E. Moerner, "Single-molecule orientation measurements with a quadrated pupil," *Proc. SPIE* **8950**, 89500L (2014).
6. **M. D. Lew***, A. R. S. von Diezmann*, and W. E. Moerner, "Easy-DHPSF open-source software for three-dimensional localization of single molecules with precision beyond the optical diffraction limit," *Protocol Exchange* (2013). DOI: 10.1038/protex.2013.026
5. M. P. Backlund*, **M. D. Lew***, A. S. Backer, S. J. Sahl, G. Grover, A. Agrawal, R. Piestun, and W. E. Moerner, "The double-helix point spread function enables precise and accurate measurement of 3D single-molecule localization and orientation," *Proc. SPIE* **8590**, 85900L (2013).
4. **M. D. Lew**, M. A. Thompson, M. Badieirostami, and W. E. Moerner, "*In vivo* three-dimensional superresolution fluorescence tracking using a double-helix point spread function," *Proc. SPIE* **7571**, 75710Z (2010).
3. **M. Lew**, X. Cui, X. Heng, and C. Yang, "Two-dimensional differential interference contrast microscopy based on four-hole variation of Young's interference," *Proc. SPIE* **6859**, 685916 (2008).
2. X. Cui, **M. Lew**, X. Heng, and C. Yang, "On-chip differential interference contrast (DIC) phase imager and beam profiler based on Young's interference," *Proc. SPIE* **6441**, 64411F (2007).
1. **M. Lew**, X. Cui, and C. Yang, "Measuring the phase of light," *Caltech Undergraduate Research Journal* **6**, 18 (2007).

PATENTS

2. **M. D. Lew** and W. E. Moerner, inventors; The Board of Trustees of the Leland Stanford Junior University, assignee. "Apparatus and method for localizing objects for distance and/or in three dimensions using a spiral point spread function," United States Patent US 9,693,034 B2 (2017).
1. O. Liba, **M. D. Lew**, E. D. SoRelle, and A. De La Zerda, inventors; The Board of Trustees of the Leland Stanford Junior University, assignee. "Methods and Apparatus for Speckle-Free Optical Coherence Imaging," International Patent Application PCT/US2016/057656 (2016).

ORAL PRESENTATIONS

Invited

14. "Computational Optics for Imaging Nanoscale Single-Molecule Dynamics," *Washington University in St. Louis Chemistry Seminar*, St. Louis, MO, March 2017.
13. "Single molecules and computational optics for nanoscale biological imaging," *Washington University in St. Louis Optical Radiology Seminar*, St. Louis, MO, October 2016.
12. "Single molecules and computational optics for nanoscale biological imaging," *Washington University in St. Louis Biochemistry and Molecular Biophysics Seminar*, St. Louis, MO, March 2016.
11. "Single molecules and computational optics for nanoscale imaging of living cells," *The Sixteenth Conference of Peace through Mind Brain Science*, Hamamatsu City, Japan, February 2016.
10. "Single molecules and computational optics for nanoscale imaging of living cells," *Washington University in St. Louis Biomedical Engineering Seminar*, St. Louis, MO, February 2016.
9. "Accurate 3D nanoscale imaging of dipole-like emitters," *Laser Science 2015*, San Jose, CA, October 2015.
8. "Accurate nanoscale imaging of dipole-like emitters," *Stefan W. Hell group retreat*, Ringberg Castle, Kreuth, Germany, January 2015.
7. "Engineering new capabilities into optical microscopes: towards measuring the 3D position and orientation of biomolecules within living cells," *Washington University in St. Louis Electrical and Systems Engineering Seminar*, St. Louis, MO, April 2014.
6. "Beyond the clear pupil: engineering new capabilities into optical microscopes," *Washington University in St. Louis Electrical and Systems Engineering Seminar*, St. Louis, MO, March 2014.
5. "Beyond the clear pupil: engineering new capabilities into optical microscopes," *Duke University Electrical and Computer Engineering Seminar*, Durham, NC, March 2014.
4. "Beyond the clear pupil: engineering new capabilities into optical microscopes," *IBM Research Almaden ARC Angels Student Seminar Series*, San Jose, CA, February 2014.
3. "Superresolution far-field optical microscopy: turning mountains into points," *Spectra-Physics company seminar*, Santa Clara, CA, November 2011.
2. "Three-dimensional superresolution fluorescence microscopy using a double-helix point spread function," *Arizona State University Center for Biological Physics Graduate Seminar*, Tempe, AZ, November 2011.
1. "In vivo three-dimensional superresolution fluorescence tracking using a double-helix point spread function," S*PIE Photonics West BiOS (Biomedical Optics)*, San Francisco, CA, January 2010.

Contributed

13. "An azimuthal polarizer assures localization accuracy in single-molecule super-resolution fluorescence microscopy," *OSA CLEO: 2015*, San Jose, CA, May 2015.
12. "Optical methods for measuring single-molecule orientation and position: implications for super-resolution microscopy," *OSA Frontiers in Optics (FiO)*, Orlando, FL, October 2013 (postdeadline).
11. "Measuring the 3D position and orientation of single molecules simultaneously and accurately with the double helix microscope," *OSA CLEO: 2013*, San Jose, CA, June 2013.
10. "The double-helix microscope simultaneously measures single-molecule orientation and 3D position, reducing dipole-induced localization errors," *Understanding Cell Behavior through Single Cell and Single Molecule Biology: Conference on Quantitative Bioimaging*, Albuquerque, NM, January 2013.
9. "The double-helix microscope simultaneously measures single-molecule orientation and 3D position, reducing dipole-induced localization errors," *Gordon Research Conferences: Single-Molecule Approaches to Biology*, West Dover, VT, July 2012 (2nd place poster award).
8. "Superresolution double-helix microscopy resolves extended biological superstructures in 3D within bacterial and mammalian cells," *Stanford Molecular Biophysics Seminar*, Stanford, CA, April 2012.
7. "Super-resolution 3D co-localization of protein superstructures and the cellular surface in live *Caulobacter crescentus*," *OSA FiO*, San Jose, CA, October 2011.

6. "Super-resolution 3D co-localization of protein superstructures and the cellular surface in live *Caulobacter crescentus*," *International OSA Network of Students-North America 3 (IONS-NA3)*, Stanford, CA, October 2011.
5. "Three-dimensional super-resolution imaging with a corkscrew point spread function," *OSA Novel Techniques in Microscopy*, Monterey, CA, April 2011.
4. "Three-dimensional super-resolution co-localization of intracellular protein superstructures and the cell membrane in live *Caulobacter crescentus*," *3rd Annual Center for Biological Imaging at Stanford Symposium*, Stanford, CA, March 2011.
3. "Three-dimensional superresolution imaging of single emitters using a double-helix point spread function," *Picoquant 16th Annual Workshop on Single Molecule Spectroscopy and Ultrasensitive Analysis in the Life Sciences*, Berlin, Germany, September 2010.
2. "Localization precision of three-dimensional superresolution fluorescence imaging using a double-helix point spread function," *OSA Computational Optical Sensing and Imaging*, San Jose, CA, October 2009.
1. "Two-dimensional differential interference contrast microscopy based on four-hole variation of Young's interference," *SPIE Photonics West BiOS*, San Jose, CA, January 2008.

PROFESSIONAL MEMBERSHIPS

American Chemical Society	2015 – present
The Optical Society	2008 – present
SPIE	2007 – 2015
Tau Beta Pi	2007 – present