

# Matthew Duk-Ying Lew

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## MY LAB PUSHES THE FRONTIER OF NANOSCALE IMAGING TECHNOLOGIES.

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The Lew Lab builds computational optical imaging systems to study biological and chemical systems at the nanoscale. Our technology leverages innovations in applied optics, signal and image processing, design optimization, and physical chemistry. We partner with scientists and engineers from all disciplines to develop technologies to solve unmet needs in science, medicine, and society.

## APPOINTMENTS AND EXPERIENCE

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**Associate Professor, Washington University in St. Louis** Jul 2022 – present

- [Preston M. Green Department of Electrical and Systems Engineering](#)
- Affiliate of the [Department of Biomedical Engineering](#); the [DBBS Biochemistry, Biophysics, and Structural Biology Program](#); and the [Institute of Materials Science & Engineering](#).
- Member of the [Center for Biomolecular Condensates](#) and the [Center for Quantum Leaps](#).

**Associate Chair for Academic Programs, Washington University in St. Louis** Jul 2022 – present

Preston M. Green Department of Electrical and Systems Engineering

**Assistant Professor, Washington University in St. Louis** Jul 2015 – Jun 2022

Preston M. Green Department of Electrical and Systems Engineering

**Postdoctoral Scholar, Stanford University School of Medicine** Nov 2014 – Jun 2015

Department of Structural Biology

*Molecular Imaging: Speckle-Modulating Optical Coherence Tomography*

Research Advisor: Adam de la Zerda

**Research Intern, Google[x]** 2014

Mountain View, CA

**Engineering Intern, Southwest Research Institute** 2004, 2005

San Antonio, TX

## EDUCATION

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2008 – 2015 **Ph.D. in Electrical Engineering** at Stanford University (GPA: 4.0/4.0)

*Engineering New Capabilities into Optical Microscopes: Toward Measuring the Three-Dimensional Position and Orientation of Single Molecules in Living Cells*

Research Advisor: W. E. Moerner

2008 – 2010 **M.S. in Electrical Engineering** at Stanford University (GPA: 3.9/4.0)

2004 – 2008 **B.S. with Honor in Electrical Engineering** at the California Institute of Technology (GPA: 4.0/4.0)

*Quantitative Differential Phase Imaging and Phase Reconstruction*

Research Advisor: Changhuei Yang







## AWARDS AND RECOGNITIONS

Outstanding Faculty Award, Washington University Graduate Student Senate	2023
Senior Member, Class of 2021, Optica	2021
Sialog: Advancing Bioimaging Fellow, Research Corporation for Science Advancement	2021
Excellence in Teaching Award, Emerson Electric Co.	2020
Outstanding Teaching Award, Preston M. Green Department of Electrical & Systems Engineering	2020
Full Membership Inductee, Sigma Xi, The Scientific Research Honor Society	2020
CAREER Award, National Science Foundation	2017
Hiruma/Wagner Award, 16 <sup>th</sup> 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
Travel Award, Stanford Bio-X	2010, 2011
Young Investigator Award, PicoQuant GmbH	2010
Graduate Research Fellowship, National Science Foundation	2008
3Com Corporation Stanford Graduate Fellow	2008
Fellow No. 762, Tau Beta Pi	2008
Research Excellence Travel Award, Newport-Spectra Physics	2008
Carnation Merit Award, California Institute of Technology	2007
Record No. 273 Scholarship, Tau Beta Pi	2007
Inductee, Tau Beta Pi, The Engineering Honor Society	2007
Caremark Rx Scholarship	2006, 2007
Rita A. and Øistein Skjellum Summer Undergraduate Research Fellow, Caltech	2006
Perpall Speaking Competition Finalist, California Institute of Technology	2006
MasterCard Alamo Bowl Scholarship	2004
National Advanced Placement Scholar, College Board	2004
National Merit Scholarship	2004

## PUBLICATIONS H-INDEX: 31, I10-INDEX: 46 | JOURNAL COVERS, CITATION & ATTENTION METRICS

 cover article |  editor's pick/hot paper | \*equal contribution | +co-corresponding authors

### Refereed Articles

44. N. A. Erkamp\*, M. Farag\*, Y. Qiu\*, D. Qian, T. Sneideris, T. Wu, T. J. Welsh, H. Ausserwöger, T. J. Krug, G. Chauhan, D. A. Weitz, **M. D. Lew**<sup>+</sup>, T. P. J. Knowles<sup>+</sup>, R. V. Pappu<sup>+</sup>, Differential Interactions Determine Anisotropies at Interfaces of RNA-based Biomolecular Condensates. *Nature Communications* **16**, 3463 (2025).  [Article](#)
43. T. Wu\*, M. R. King\*, Y. Qiu, M. Farag, R. V. Pappu<sup>+</sup>, **M. D. Lew**<sup>+</sup>, Single-Fluorogen Imaging Reveals Distinct Environmental and Structural Features of Biomolecular Condensates. *Nature Physics* **21**, 778–786 (2025).  [Article](#)
42. Y. Chen, Y. Qiu, **M. D. Lew**, Resolving the Orientations of and Angular Separation Between a Pair of Dipole Emitters. *Physical Review Letters* **134**, 093805 (2025).  [Article](#)
41. E. Bruggeman, O. Zhang, L.-M. Needham, M. Körbel, S. Daly, M. Cheetham, R. Peters, T. Wu, A. S. Klymchenko, S. J. Davis, E. K. Paluch, D. Klennerman, **M. D. Lew**, K. O'Holleran, S. F. Lee, POLCAM: Instant Molecular Orientation Microscopy for the Life Sciences. *Nature Methods* **21**, 1873–1883 (2024).  [Article](#)
40. W. Zhou, T. Wu, **M. D. Lew**, Fundamental Limits in Measuring the Anisotropic Rotational Diffusion of Single Molecules. *The Journal of Physical Chemistry A* **128**, 5808–5815 (2024).  [Article](#)  [Cover image](#)

39. B. Sun, T. Ding, W. Zhou, T. S. Porter, **M. D. Lew**, Single-Molecule Orientation Imaging Reveals the Nano-Architecture of Amyloid Fibrils Undergoing Growth and Decay. *Nano Letters* **24**, 7276–7283 (2024). [Article](#) [Correction](#)
38. M. R. King, K. M. Ruff, A. Z. Lin, A. Pant, M. Farag, J. M. Lalmansingh, T. Wu, M. J. Fossat, W. Ouyang, **M. D. Lew**, E. Lundberg, M. D. Vahey, R. V. Pappu, Macromolecular Condensation Organizes Nucleolar Sub-Phases to Set up a pH Gradient. *Cell* **187**, 1889–1906.e24 (2024). [Article](#)
37. W. Zhou, C. L. O'Neill, T. Ding, O. Zhang, J. S. Rudra, **M. D. Lew**, Resolving the Nanoscale Structure of  $\beta$ -Sheet Peptide Self-Assemblies Using Single-Molecule Orientation–Localization Microscopy. *ACS Nano* **18**, 8798–8810 (2024). [Article](#) [Cover image](#)
36. J. Lu, **M. D. Lew**, Single-Molecule Electrochemical Imaging Resolves the Midpoint Potentials of Individual Fluorophores on Nanoporous Antimony-Doped Tin Oxide. *Chemical Science* **15**, 2037–2046 (2024). [Article](#) [Cover image](#)
35. O. Zhang, Z. Guo, Y. He, T. Wu, M. D. Vahey, **M. D. Lew**, Six-Dimensional Single-Molecule Imaging with Isotropic Resolution Using a Multi-View Reflector Microscope. *Nature Photonics* **17**, 179–186 (2022). [Article](#)
34. J. M. Jusuf, **M. D. Lew**, Towards Optimal Point Spread Function Design for Resolving Closely Spaced Emitters in Three Dimensions. *Optics Express* **30**, 37154 (2022). [Article](#) ★
33. T. Wu, P. Lu, M. A. Rahman, X. Li, **M. D. Lew**, Deep-SMOLM: Deep Learning Resolves the 3D Orientations and 2D Positions of Overlapping Single Molecules with Optimal Nanoscale Resolution. *Optics Express* **30**, 36761 (2022). [Article](#)
32. M. Shen, T. Ding, C. Tan, W. H. Rackers, D. Zhang, **M. D. Lew**, B. Sadtler, *In Situ* Imaging of Catalytic Reactions on Tungsten Oxide Nanowires Connects Surface–Ligand Redox Chemistry with Photocatalytic Activity. *Nano Letters* **22**, 4694–4701 (2022). [Article](#)
31. T. Wu, J. Lu, **M. D. Lew**, Dipole-Spread-Function Engineering for Simultaneously Measuring the 3D Orientations and 3D Positions of Fluorescent Molecules. *Optica* **9**, 505 (2022). [Article](#)
30. O. Zhang, W. Zhou, J. Lu, T. Wu, **M. D. Lew**, Resolving the Three-Dimensional Rotational and Translational Dynamics of Single Molecules Using Radially and Azimuthally Polarized Fluorescence. *Nano Letters* **22**, 1024–1031 (2022). [Article](#)
29. T. Ding, **M. D. Lew**, Single-Molecule Localization Microscopy of 3D Orientation and Anisotropic Wobble Using a Polarized Vortex Point Spread Function. *The Journal of Physical Chemistry B* **125**, 12718–12729 (2021). [Article](#) [Cover image](#)
28. M. Shen, T. Ding, W. H. Rackers, C. Tan, K. Mahmood, **M. D. Lew**, B. Sadtler, Single-Molecule Colocalization of Redox Reactions on Semiconductor Photocatalysts Connects Surface Heterogeneity and Charge-Carrier Separation in Bismuth Oxybromide. *Journal of the American Chemical Society* **143**, 11393–11403 (2021). [Article](#)
27. O. Zhang, **M. D. Lew**, Single-Molecule Orientation Localization Microscopy II: A Performance Comparison. *Journal of the Optical Society of America A* **38**, 288 (2021). [Article](#)
26. O. Zhang, **M. D. Lew**, Single-Molecule Orientation Localization Microscopy I: Fundamental Limits. *Journal of the Optical Society of America A* **38**, 277 (2021). [Article](#) ★
25. H. Mazidi, T. Ding, A. Nehorai, **M. D. Lew**, Quantifying Accuracy and Heterogeneity in Single-Molecule Super-Resolution Microscopy. *Nature Communications* **11**, 6353 (2020). [Article](#)

24. J. Lu, H. Mazidi, T. Ding, O. Zhang, **M. D. Lew**, Single-Molecule 3D Orientation Imaging Reveals Nanoscale Compositional Heterogeneity in Lipid Membranes. *Angewandte Chemie International Edition* **59**, 17572–17579 (2020). [Article](#) [Cover image](#) ★
23. O. Zhang, **M. D. Lew**, Quantum Limits for Precisely Estimating the Orientation and Wobble of Dipole Emitters. *Physical Review Research* **2**, 033114 (2020). [Article](#)
22. M. Shen, T. Ding, J. Luo, C. Tan, K. Mahmood, Z. Wang, D. Zhang, R. Mishra, **M. D. Lew**, B. Sadtler, Competing Activation and Deactivation Mechanisms in Photodoped Bismuth Oxybromide Nanoplates Probed by Single-Molecule Fluorescence Imaging. *The Journal of Physical Chemistry Letters* **11**, 5219–5227 (2020). [Article](#)
21. T. Ding\*, T. Wu\*, H. Mazidi, O. Zhang, **M. D. Lew**, Single-Molecule Orientation Localization Microscopy for Resolving Structural Heterogeneities between Amyloid Fibrils. *Optica* **7**, 602 (2020). [Article](#)
20. M. Shen\*, T. Ding\*, S. T. Hartman, F. Wang, C. Krucylak, Z. Wang, C. Tan, B. Yin, R. Mishra, **M. D. Lew**<sup>+</sup>, B. Sadtler<sup>+</sup>, Nanoscale Colocalization of Fluorogenic Probes Reveals the Role of Oxygen Vacancies in the Photocatalytic Activity of Tungsten Oxide Nanowires. *ACS Catalysis* **10**, 2088–2099 (2020). [Article](#)
19. H. Mazidi, E. S. King, O. Zhang, A. Nehorai, **M. D. Lew**, presented at the 2019 IEEE 16th International Symposium on Biomedical Imaging (ISBI 2019), 2019 IEEE 16th International Symposium on Biomedical Imaging (ISBI), pp. 325–329. [Article](#)
18. O. Zhang, **M. D. Lew**, Fundamental Limits on Measuring the Rotational Constraint of Single Molecules Using Fluorescence Microscopy. *Physical Review Letters* **122**, 198301 (2019). [Article](#)
17. H. Mazidi, J. Lu, A. Nehorai, **M. D. Lew**, Minimizing Structural Bias in Single-Molecule Super-Resolution Microscopy. *Scientific Reports* **8**, 13133 (2018). [Article](#)
16. D. Maji, J. Lu, P. Sarder, A. H. Schmieder, G. Cui, X. Yang, D. Pan, **M. D. Lew**, S. Achilefu, G. M. Lanza, Cellular Trafficking of Sn-2 Phosphatidylcholine Prodrugs Studied with Fluorescence Lifetime Imaging and Super-resolution Microscopy. *Precision Nanomedicine* **1**, 128–145 (2018). [Article](#) [Cover image](#)
15. K. Spehar\*, T. Ding\*, Y. Sun, N. Kedia, J. Lu, G. R. Nahass, **M. D. Lew**<sup>+</sup>, J. Bieschke<sup>+</sup>, Super-resolution Imaging of Amyloid Structures over Extended Times by Using Transient Binding of Single Thioflavin T Molecules. *Chem-BioChem* **19**, 1944–1948 (2018). [Article](#) [Cover image](#)
14. O. Zhang, J. Lu, T. Ding, **M. D. Lew**, Imaging the Three-Dimensional Orientation and Rotational Mobility of Fluorescent Emitters Using the Tri-spot Point Spread Function. *Applied Physics Letters* **113**, 031103 (2018). [Article](#) [Correction](#)
13. O. Liba, **M. D. Lew**, E. D. SoRelle, R. Dutta, D. Sen, D. M. Moshfeghi, S. Chu, A. de la Zerda, Speckle-Modulating Optical Coherence Tomography in Living Mice and Humans. *Nature Communications* **8**, 15845 (2017). [Article](#) ★ [Correction](#)
12. L. von Diezmann, M. Y. Lee, **M. D. Lew**, W. E. Moerner, Correcting Field-Dependent Aberrations with Nanoscale Accuracy in Three-Dimensional Single-Molecule Localization Microscopy. *Optica* **2**, 985 (2015). [Article](#) [Cover image](#)
11. **M. D. Lew**, W. E. Moerner, Azimuthal Polarization Filtering for Accurate, Precise, and Robust Single-Molecule Localization Microscopy. *Nano Letters* **14**, 6407–6413 (2014). [Article](#)
10. A. S. Backer, M. P. Backlund, **M. D. Lew**, W. E. Moerner, Single-Molecule Orientation Measurements with a Quadrated Pupil. *Optics Letters* **38**, 1521 (2013). [Article](#)

9. **M. D. Lew\***, M. P. Backlund\*, W. E. Moerner, Rotational Mobility of Single Molecules Affects Localization Accuracy in Super-Resolution Fluorescence Microscopy. *Nano Letters* **13**, 3967–3972 (2013). [Article](#) [Cover image](#)
8. M. P. Backlund\*, **M. D. Lew\***, A. S. Backer, S. J. Sahl, G. Grover, A. Agrawal, R. Piestun, W. E. Moerner, Simultaneous, Accurate Measurement of the 3D Position and Orientation of Single Molecules. *Proceedings of the National Academy of Sciences* **109**, 19087–19092 (2012). [Article](#) ★
7. H.-I. D. Lee\*, S. J. Sahl\*, **M. D. Lew**, W. E. Moerner, The Double-Helix Microscope Super-Resolves Extended Biological Structures by Localizing Single Blinking Molecules in Three Dimensions with Nanoscale Precision. *Applied Physics Letters* **100**, 153701 (2012). [Article](#) [Cover image](#)
6. **M. D. Lew\***, S. F. Lee\*, J. L. Ptacin, M. K. Lee, R. J. Twieg, L. Shapiro, W. E. Moerner, Three-Dimensional Superresolution Colocalization of Intracellular Protein Superstructures and the Cell Surface in Live *Caulobacter Crescentus*. *Proceedings of the National Academy of Sciences* **108**, E1102–E1110 (2011). [Article](#)
5. **M. D. Lew**, S. F. Lee, M. Badieirostami, W. E. Moerner, Corkscrew Point Spread Function for Far-Field Three-Dimensional Nanoscale Localization of Pointlike Objects. *Optics Letters* **36**, 202 (2011). [Article](#)
4. M. Badieirostami, **M. D. Lew**, M. A. Thompson, W. E. Moerner, Three-Dimensional Localization Precision of the Double-Helix Point Spread Function versus Astigmatism and Biplane. *Applied Physics Letters* **97**, 161103 (2010). [Article](#)
3. M. A. Thompson\*, **M. D. Lew\***, M. Badieirostami, W. E. Moerner, Localizing and Tracking Single Nanoscale Emitters in Three Dimensions with High Spatiotemporal Resolution Using a Double-Helix Point Spread Function. *Nano Letters* **10**, 211–218 (2010). [Article](#)
2. X. Cui, **M. Lew**, C. Yang, Quantitative Differential Interference Contrast Microscopy Based on Structured-Aperture Interference. *Applied Physics Letters* **93**, 091113 (2008). [Article](#)
1. **M. Lew**, X. Cui, X. Heng, C. Yang, Interference of a Four-Hole Aperture for on-Chip Quantitative Two-Dimensional Differential Phase Imaging. *Optics Letters* **32**, 2963 (2007). [Article](#)

### Review Articles, Book Chapters, and Commentaries

8. S. Brasselet<sup>+</sup>, **M. D. Lew<sup>+</sup>**, Single-Molecule Orientation and Localization Microscopy. *Nature Photonics* **19**, 925–937 (2025). [Article](#)
7. **M. D. Lew**, Painting Rich Six-Dimensional Pictures Using Polarized Fluorescence Microscopy. *Proceedings of the National Academy of Sciences* **122**, e2501914122 (2025). [Article](#)
6. O. Zhang, **M. D. Lew**, Single-Molecule Orientation-Localization Microscopy: Applications and Approaches. *Quarterly Reviews of Biophysics* **57**, e17 (2024). [Article](#)
5. T. Wu, **M. D. Lew**, Dipole-Spread Function Engineering for Six-Dimensional Super-Resolution Microscopy, in *Coded Optical Imaging*, ed. by J. Liang (Springer International Publishing, Cham, 2024), pp. 207–223. [Article](#)
4. **M. D. Lew**, Computational Modelling Enables Robust Multidimensional Nanoscopy, in *Computational Modeling: From Chemistry to Materials to Biology* (WORLD SCIENTIFIC, 2021), pp. 189–195. [Article](#)
3. M. P. Backlund, **M. D. Lew**, A. S. Backer, S. J. Sahl, W. E. Moerner, The Role of Molecular Dipole Orientation in Single-Molecule Fluorescence Microscopy and Implications for Super-Resolution Imaging. *ChemPhysChem* **15**, 587–599 (2014). [Article](#)
2. **M. D. Lew**, S. F. Lee, M. A. Thompson, H.-I. D. Lee, W. E. Moerner, Single-Molecule Photocontrol and Nanoscopy, in *Far-Field Optical Nanoscopy*, ed. by P. Tinnefeld, C. Eggeling, S. W. Hell (Springer Berlin Heidelberg, Berlin, Heidelberg, 2012), vol. 14, pp. 87–110. [Article](#)



1. M. A. Thompson, **M. D. Lew**, W. Moerner, Extending Microscopic Resolution with Single-Molecule Imaging and Active Control. *Annual Review of Biophysics* **41**, 321–342 (2012). [📄 Article](#)

## Other Publications

1. E. Eshelman, M. Willis, C. Foreman, J. Michels, A. Cerrud, L. Schattner, G. Singh, D. Van Hoesen, W. Medina, T. Carlson, **M. Lew**, presented at the 2024 IEEE Aerospace Conference, pp. 1–10. [📄 Article](#)

## PATENTS

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7. **M. Lew**, T. Wu, Pixel-Wise Point Spread Function Engineering Systems And Methods, US 11994470 B2 (2022). [🔗](#)
6. **M. Lew**, O. Zhang, Multi-View Reflector Microscope, US 2024/0210671 A1 (2021). [🔗](#)
5. **M. Lew**, T. Wu, T. Ding, Systems And Methods For Performing Optical Imaging Using Duo-spot Point Spread Functions, US 2023/0073324 A1 (2021). [🔗](#)
4. **M. Lew**, A. Nehorai, H. Mazidisharfabadi, Methods For Quantifying And Enhancing Accuracy In Microscopy Using Measures Of Localization Confidence, US 11300515 B2 (2020). [🔗](#)
3. O. Zhang, **M. D. Lew**, Systems And Methods For Performing Optical Imaging Using A Tri-spot Point Spread Function (Psf), US 10761419 B2 (2018). [🔗](#)
2. O. Liba, **M. D. Lew**, E. D. Sorelle, A. de la Zerda, Methods And Apparatus For Speckle-free Optical Coherence Imaging, US 2018/0299251 A1 (2016). [🔗](#)
1. **M. D. Lew**, W. E. Moerner, Apparatus And Method For Localizing Objects For Distance And/or In Three Dimensions Using A Spiral Point Spread Function, US 9693034 B2 (2012). [🔗](#)

## ORAL PRESENTATIONS

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### Invited

### Contributed

## TEACHING EXPERIENCE

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## OTHER PROFESSIONAL ACTIVITIES

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Some Skills            This, That, Some of this and that etc.

Some More Skills    Also some more of this, Some more that, And some of this and that etc.