Soon Wei Daniel Lim

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Summary

I am an interdisciplinary applied physicist with a unique background in both life and physical sciences. I have research experience in mouse model studies of neurodegeneration, micro-optical device fabrication by harnessing surface tension, particle-laden computational fluid dynamics, neural network algorithmic tools for optimal design, nanoscale devices to control every degree of freedom in wavefronts, radiofrequency/ultrasound image reconstruction, and bioengineering for drug, protein, and gene delivery to cells.
My research interests are in the design of low-cost, high-accessibility medical diagnostics and therapeutics.

Chronological Employment History

Schmidt Science Fellow, Stanford University School of Medicine — Nov 2023 - present

Advisor: Prof. Steven Chu. Developing low cost, high efficiency intracellular delivery techniques for *in vivo* diagnostics.

Doctoral Researcher, Harvard University — Sep 2018 - Sep 2023

Advisor: Prof. Federico Capasso. Investigated counter-intuitive fundamental behavior of structured wavefields containing singularities ("dark" regions of light). Achieved a flat lens that uses extremely deep and narrow holes, the highest aspect ratio nanostructures for wavefront shaping.

Research Assistant, Bioprocessing Technology Institute, A*STAR — Jan 2018 - Jun 2018

Advisor: Prof. Shireen Goh (now at SUTD, Singapore). Modeled multiphase computational fluid dynamics for inertial focusing in dense particle-laden flows.

Research Engineer, Singapore Institute of Manufacturing Technology, A*STAR — Jul 2017 - Dec 2017

Advisor: Prof. Wong Liang Jie (now at NTU, Singapore). Simulated strong-field light-matter interactions in laser-based particle acceleration.

Undergraduate Researcher, California Institute of Technology — Jan 2015 - Jun 2017

Advisor: Prof. Sandra Troian. Developed microlens arrays in polymer using spatially-varying surface tension.

Research Intern, Institute for Infocomm Research, A*STAR — Jun 2014 - Aug 2014

Advisor: Dr. Ng Tian Tsong. Designed analytical tools for the medical application of micro-NMR devices.

Research Intern, Institute of Materials Research and Engineering, A*STAR — May 2013 - Jul 2013

Advisor: Prof. Chin Jia Min (now at University of Vienna). Self-assembly of non-closed packed pore arrays.

Research Intern, National Neuroscience Institute, Singapore — Dec 2007 - Dec 2009

Advisor: Dr. Jeanne Tan. Mouse model study on the role of heat shock proteins in neurodegeneration.

Education

2018 - 2023 Ph.D. Applied Physics, **Harvard University** — **GPA: 4.0/4.0**
Advisor: Prof. Federico Capasso; Thesis: *Sculpting the dark: Singularity engineering with metasurfaces*

2013 - 2017 B.S. Physics, **California Institute of Technology** — **GPA: 4.3/4.3, rank 1/254**
Advisor: Prof. Sandra Troian; Thesis: *Revolution in large-area curved surface lithography: Nanofilm sculpting by thermocapillary modulation*

2016 Caltech Cambridge Scholar, **Cambridge University** — **Class: First**

Publications - Refereed papers

**equal contribution.*

1. J.S. Park*, S.W.D. Lim*, A. Amirzhan, H. Kang, K. Karrfalt, D. Kim, J. Leger, A. Urbas, M. Ossiander, Z. Li, F. Capasso, All-Glass 100 mm Diameter Visible Metalens for Imaging the Cosmos, ***ACS Nano***, 18, 4, 3187–3198, 2024, 10.1021/acsnano.3c09462 and **Cover Art**.
2. R.J. Tang*, S.W.D. Lim*, M. Ossiander, X. Yin, F. Capasso, Time reversal differentiation of FDTD for photonic inverse design, ***ACS Photonics***, 10, 12, 4140-4150, 2023, 10.1021/acsphotonics.3c00694.
3. J. Lu, V. Ginis, S.W.D. Lim, F. Capasso, Helicity and Polarization Gradient Optical Trapping in Evanescent Fields, ***Physical Review Letters***, 131, 14, 143803, 2023, 10.1103/PhysRevLett.131.143803.
4. D. Hazineh*, S.W.D. Lim*, Q. Guo, F. Capasso, T. Zickler, Polarization Multi-Image Synthesis with Birefringent Metasurfaces, ***IEEE Intl. Conf. on Computational Photography (ICCP)***, 2023, 10.1109/ICCP56744.2023.10233735.
5. C.M. Spaegele, M. Tamagnone, S.W.D. Lim, M. Ossiander, M.L. Meretska, F. Capasso, Topologically protected optical polarization singularities in four-dimensional space, ***Science Advances***, 9, 24, 2023, 10.1126/sciadv.adh0369.
6. S.W.D. Lim*, J.S. Park*, D. Kazakov, C.M. Spaegele, A.H. Dorrah, M.L. Meretska, F. Capasso, Point singularity array with metasurfaces, ***Nature Commun.***, 14, 3237, 2023, 10.1038/s41467-023-39072-6.
7. M. Ossiander*, M.L. Meretska*, H.K. Hampel*, S.W.D. Lim, N. Knefz, T. Jauk, F. Capasso, M. Schultze, Extreme ultraviolet metalens by vacuum guiding, ***Science***, 380, 59-63, 2023, 10.1126/science.adg6881.
8. G. Palermo, A. Lininger, A. Guglielmelli, L. Ricciardi, G. Nicoletta, A. De Luca, J.S. Park, S.W.D. Lim, M.L. Meretska, F. Capasso, G. Strangi, All-optical tunability of metalenses permeated with liquid crystals, ***ACS Nano***, 16, 10, 16539–16548, 2022, 10.1021/acsnano.2c05887.
9. S.W.D. Lim*, M.L. Meretska*, F. Capasso, A high aspect ratio inverse-designed holey metalens, ***Nano Letters***, 21, 8642-8649, 2021, 10.1021/acs.nanolett.1c02612.
10. S.W.D. Lim, J.S. Park, M.L. Meretska, A.H. Dorrah, F. Capasso, Engineering phase and polarization singularity sheets, ***Nature Commun.*** 12, 4190, 2021, 10.1038/s41467-021-24493-y.
11. S. Yu, J. Lu, V. Ginis, S. Kheifets, S.W.D. Lim, M. Qiu, T. Gu, J. Hu, F. Capasso, On-chip optical tweezers based on freeform optics, ***Optica*** 8, 3, 409-414, 2021, 10.1364/OPTICA.418837.
12. M. Shen, S.W.D. Lim, E.S. Tan, H.H. Oon, E.C. Ren, HLA correlations with clinical phenotypes and risk of metabolic comorbidities in Singapore Chinese psoriasis patients, ***Molecular Diagnosis & Therapy*** 23, 6, 751-760, 2019, 10.1007/s40291-019-00423-z.
13. A.Z. Thong, S.W.D. Lim, A. Ahsan, T.W.G. Goh, J.W. Xu, and J.M. Chin, Non-closed-packed pore arrays through one-step breath figure self-assembly and reversal, ***Chemical Science*** 5, 1375-1382, 2014, 10.1039/C3SC52258J.

Manuscripts in progress

1. S.W.D. Lim, Y.H. Kee, S.N.A. Smith, S.M. Tan, A.E. Lim, Y. Yang, S. Goh, "Dense Suspension Inertial Microfluidic Particle Theory (DENSE-IMPACT) Model for Elucidating Outer Wall Focusing at High Cell Densities", ArχiV 2409.12488
2. S.W.D. Lim, C.M. Spaegele, F. Capasso, "Multidimensional optical singularities and their applications", ArχiV 2406.00784.
3. Z. Li, S.D. Campbell, J.S. Park, R.P. Jenkins, S.W.D. Lim, D.H. Werner, F. Capasso, "Heterogeneous Freeform Metasurfaces: A Platform for Advanced Broadband Dispersion Engineering", ArχiV 2412.12028.

Patents

1. M.L. Meretska, S.W.D. Lim, and F. Capasso, "High-aspect ratio metalens," U.S. patent US11860336B2, granted 02 Jan 2024.
2. S.W.D. Lim, J.S. Park, M.L. Meretska, F. Capasso, and A.H. Dorrah, "Systems and methods of phase and polarization singularity engineering", U.S. patent 2023/0021549 A1 (2023), filed 19 Jan 2022, pending.
3. M.T. Ossiander, M.L. Meretska, S.W.D. Lim, F. Capasso, "Nanooptics with high refractive index apertures", World patent WO 2024/215347 (2023), filed 29 Jun 2023, pending.

Conference talks

1. J. Lenaerts, D. Cassara, P. Chevalier, J.S. Park, L. Sacchi, S.W.D. Lim, R. Pestourie, V. Ginis, M.L. Meretska, F. Capasso, "Polychromatic metalens in the NIR for CO2 detection", ***SPIE OPTO*** 2025, 10.1117/12.3041398.
2. S.W.D. Lim, C.M. Spaegele, F. Capasso, "Singularity engineering with metasurfaces: from 0D to 4D", ***SPIE Photonics West*** 2024, 10.1117/12.3004234.
3. S.W.D. Lim, J.S. Park, D. Kazakov, C.M. Spaegele, A.H. Dorrah, M.L. Meretska, F. Capasso, "Point singularity array with metasurfaces for blue-detuned atomic traps", ***SPIE Nanosci. + Eng.*** 2023, 10.1117/12.2676740.
4. R.J. Tang, S.W.D. Lim, M. Ossiander, X. Yin, F. Capasso, "Minimal memory differentiable FDTD for photonic inverse design", ***SPIE Nanoscience + Engineering*** 2023, 10.1117/12.2677131.
5. M. Ossiander, M.L. Meretska, H.K. Hampel, S.W.D. Lim, N. Knefz, T. Jauk, F. Capasso, M. Schultze, "Holey metalens focusing of extreme ultraviolet light", ***Optica Imaging Congress*** 2023, 10.1364/FLATOPTICS.2023.FTh3G.3.
6. D. Hazineh, S.W.D. Lim, Q. Guo, F. Capasso, T. Zickler, Polarization Multi-Image Synthesis with Birefringent Metasurfaces, ***ICCP*** 2023, 10.1109/ICCP56744.2023.10233735.
7. R. Jun, S.W.D. Lim, D. Hazineh, F. Capasso, "Computing the Optical Response of Metasurfaces Under Partially Coherent Illumination", ***CLEO*** 2023, 10.1364/CLEO_FS.2023.FW4H.6.
8. C.M. Spaegele, M. Tamagnone, S.W.D Lim, M. Ossiander, M.L. Meretska, F. Capasso, "Topologically protected polarization singularities in four dimensions", ***CLEO*** 2023, 10.1364/CLEO_FS.2023.FTh3C.7.
9. M. Ossiander, M.L. Meretska, H.K. Hampel, S.W.D. Lim, N. Knefz, T. Jauk, M. Schultze, F. Capasso, "Extreme Ultraviolet Metaoptics enabled by Vacuum Guiding", ***CLEO*** 2023, 10.1364/CLEO_FS.2023.FM3D.6.
10. Z. Sun, M.L. Meretska, F.H.B. Somhorst, J.S. Park, S.W.D. Lim, Y. Hou, J.S. Moodera, F. Capasso, "Freestanding Metasurface-based Faraday Rotator", ***CLEO*** 2023, 10.1364/CLEO_AT.2023.JW2A.98.
11. J.S. Park, K. Vaillancourt, S.W.D. Lim, C.M. Spaegele, F. Capasso, "All-dielectric, visible wavelength focusing metalens with planar surface for mechanical robustness", ***CLEO*** 2023, 10.1364/CLEO_SI.2023.SF3K.3.
12. J.S. Park, S.W.D. Lim, A. Amirzhan, H. Kang, D. Kim, M. Ossiander, Z. Li, F. Capasso, ***The International Conference on Surface Plasmon Photonics 10***, 2023.
13. S.W.D. Lim, J.S. Park, M.L. Meretska, A.H. Dorrah, D. Kazakov, F. Capasso, "Metasurface blue-detuned atom trap arrays using singularity engineering", ***CLEO*** 2022, 10.1364/CLEO_QELS.2022.FF4D.4.
14. J.S. Park, S.W.D. Lim, M. Ossiander, Z. Li, A. Amirzhan, F. Capasso, "All-Glass, Mass-Producible, Large-Diameter Metalens at Visible Wavelength for 100 mm Aperture Optics and Beyond", ***CLEO*** 2022, 10.1364/CLEO_AT.2022.AW4I.1.
15. R. Tang, S.W.D. Lim, X. Yin, F. Capasso, "Minimal memory differentiable FDTD for inverse design", ***CLEO*** 2022, 10.1364/CLEO_QELS.2022.FM5H.4.
16. S.W.D. Lim, J.S. Park, M.L. Meretska, A.H. Dorrah, F. Capasso, "Structuring phase and polarization singularity sheets in 2D", ***CLEO*** 2021, 10.1364/CLEO_QELS.2021.FW4G.5.
17. S.W.D. Lim, M.L. Meretska, F. Capasso, "A high aspect-ratio holey metalens", ***CLEO*** 2021, 10.1364/CLEO_SI.2021.SM4I.4.
18. J. Lu, S. Yu, V. Ginis, S. Kheifets, S.W.D. Lim, M. Qiu, T. Gu, J. Hu, F. Capasso, "On-Chip Optical Tweezers Based on Micro-Reflectors", ***CLEO*** 2021, 10.1364/CLEO_SI.2021.SW3B.1.
19. S.W.D. Lim, J. S. Park, M.L. Meretska, A.H. Dorrah, F. Capasso, "Singularity engineering: sculpting the dark", ***SPIE OPTO*** 2021, 10.1117/12.2577222.
20. M.L. Meretska, S.W.D. Lim, F. Capasso, "Monolithic focusing metasurfaces", ***SPIE OPTO*** 2021, 10.1117/12.2577320.
21. J. Lu, S. Yu, V. Ginis, S. Kheifets, S.W.D. Lim, M. Qiu, T. Gu, J. Hu, F. Capasso, "On-chip optical tweezers based on free-form optics", ***SPIE Nanoscience + Engineering*** 2021, 10.1117/12.2594988.
22. S.W.D. Lim, K. Fiedler, C. Zhou, S.M. Troian, "Fabrication of Converging and Diverging Polymeric Microlens Arrays By Spatiotemporal Control of Thermocapillary Forces", ***APS March Meeting*** 2017.
23. S.W.D. Lim, K. Fiedler, S.M. Troian, "Fabrication of Converging and Diverging Polymeric Microlens Arrays By A Thermocapillary Replication Technique", ***APS Division of Fluid Dynamics*** 2016.
24. S.W.D. Lim, K. Fiedler, S.M. Troian, "Fabrication of Converging and Diverging Polymeric Microlens Arrays By A Thermocapillary Replication Technique", ***APS March Meeting*** 2016.

Selected Awards

- **Schmidt Science Fellowship** (2024).
  - A postdoctoral fellowship enabling the world's best emerging scientists to pivot from their PhD discipline and pursue their goals through bold interdisciplinary research [Source: Schmidt Science Fellows].
  - First Singaporean (jointly) to receive this fellowship, one of 32 fellows for 2024.
- **Lindau Young Scientist** (2019).
  - One of eight young scientists selected to represent Singapore in the 2019 Lindau Nobel Laureate Meetings.
- **A*STAR Roll of Honor** (2017).
  - One of six A*STAR scholars recognized for top undergraduate academic achievement.
- **D.S. Kothari Prize in Physics** (2017), California Institute of Technology.
  - Given to a graduating senior in physics who has produced an outstanding research project during the past year [Source: Caltech Physics].
- **Friends of the Caltech Libraries Senior Thesis Prize** (2017), California Institute of Technology.
  - Recognizes senior theses that exemplify excellent research, writing, and the effective use of library resources [Source: Caltech Libraries].
- **Haren Lee Fisher Memorial Award in Junior Physics** (2016), California Institute of Technology.
  - Awarded annually to a physics major who has completed their second year and demonstrates great promise for future contributions to the field [Source: Caltech Physics].
- **Jack E. Froehlich Memorial Award** (2016), California Institute of Technology.
  - Awarded to a junior in the upper 5 percent of their class who shows outstanding promise for a creative professional career [Source: Caltech Deans].
- **Ken Hass Outstanding Student Paper Award** (2017), American Physical Society.
  - Recognizes an outstanding student paper addressing the subject of industrial applications of physics [Source: APS].
  - Paper: "Fabrication of Converging and Diverging Polymeric Microlens Arrays By Spatiotemporal Control of Thermocapillary Forces"
- **International Physics Olympiad Silver Medal** (2010).
  - One of five students selected to represent Singapore.

Fellowships and grants

US$220,000	**Schmidt Science Fellowship**, Schmidt Sciences (2024-2026).
SGD$20,000	**NUS Development Grant**, National University of Singapore (2024-2025).
8 years full funding	**National Science Scholarship**, A*STAR Singapore (2013-2023).

Teaching

- Fall 2019: Harvard University Physics 123/223, "**Laboratory Electronics**", Teaching Fellow
- Fall 2016: California Institute of Technology Physics 5/105, "**Analog Electronics for Physicists**", Teaching Fellow

Mentorship

1. 2019-2020: Rui Jie Tang (research intern), now Ph.D. candidate at the University of Toronto
2. 2021-2023: Revin Jun (research intern), now undergraduate at Harvard University

Peer Review Service

ACS Omega (American Chemical Society)	2
Journal of the Optical Society of America A (Optica Publishing Group)	1
Journal of the Optical Society of America B (Optica Publishing Group)	2
Laser & Photonics Reviews (Wiley-VCH)	10
Light: Science & Applications (Nature Portfolio)	1
Nanophotonics (de Gruyter)	1
Nature Communications (Nature Portfolio)	4
Optics Express (Optica Publishing Group)	8
Optics Letters (Optica Publishing Group)	2
PhotoniX (Springer)	1
Total	32
	99^{th} percentile, Feb 2024 - Feb 2025 (Clarviate)

Leadership and community service

- **Head**, National Science Challenge Scientific Working Committee (2017 - 2018)
  - Spearheaded a diverse team of 15 members across multiple organizations, overseeing the planning and implementation of scientific projects, competitive rounds, and outreach initiatives for the National Science Challenge, a nationally-broadcast inter-school science contest. Provided expert advice to the national broadcaster (Mediacorp) throughout competition and filming stages.
  - Successfully concluded with the 2017 broadcast (6 episodes) and 2018 broadcast (6 episodes).

Referees

- **Prof. Federico Capasso**, Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering, Harvard University: capasso@seas.harvard.edu
- **Prof. Steven Chu**, William R. Kenan Jr. Professor, Professor of Molecular and Cellular Physiology and of Energy Science and Engineering, Stanford University: schu@stanford.edu
- **Prof. Todd Zickler**, William and Ami Kuan Danoff Professor of Electrical Engineering and Computer Science, Harvard University: zickler@seas.harvard.edu