

Soon Wei Daniel Lim (Daniel)

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Executive Summary

Ph.D. candidate in Applied Physics developing efficient algorithms and advanced nanofabrication techniques for arbitrary optical control and imaging. I employ scalable material platforms and differentiable design in compact form factors, for applications in Augmented/Virtual Reality (AR/VR), non-invasive medical diagnostics, and vision sciences.

Education

- **Harvard University** Cambridge, MA, USA
Ph.D. Applied Physics 2018 - present
 - Research Advisor: Professor Federico Capasso
 - Dissertation title: Sculpting the dark: Singularity engineering with metasurfaces
 - GPA: 4.0/4.0
- **California Institute of Technology** Pasadena, CA, USA
B.S. Physics 2013 - 2017
 - Graduated at the top of a class of 254 students.
 - GPA: 4.3/4.3 (A+ average)
 - Research Group: Laboratory of Interfacial and Small Scale Transport {LIS²T}
 - Research and Senior Thesis Advisor: Professor Sandra M. Troian
 - * Senior Thesis: Revolution in large-area curved surface lithography: Nanofilm sculpting by thermocapillary modulation.
- **Cambridge University** Cambridge, United Kingdom
Caltech Cambridge Scholars Programme, Winter Term 2015
 - College: Corpus Christi College
 - Tripos: Natural Sciences, Part II Physics
 - Predicted honors class by supervisors: First (all 5 courses)
- **Raffles Institution** Singapore
Integrated Programme and 'A' Levels 2005 - 2010
 - Distinctions (A) in all 8 'A' level courses
 - Higher 3 (H3) course: Essentials of Modern Physics (Distinction)
 - Top in school for Biology (2007), Chemistry (Raffles Academy, 2008)

Professional Experience

- **Teaching Fellow** Cambridge, MA, USA
Harvard University Fall 2019
 - Course taught: Engineering Science 153: Laboratory Electronics
 - * Laboratory electronics course ranging from analog circuit design to the construction of an Intel 8051 computer from individual integrated circuits.
 - * Role: Guide students during laboratory sessions, debug circuits, hold office hours.
 - Course instructor: Professor Thomas Hayes and David Abrams
- **Research Officer** Singapore
*Bioprocessing Technology Institute (BTI), A*STAR* 2018
 - Derived and implemented a multiphase computational fluid dynamical model to explain inertial focusing dynamics at high particle concentrations.
 - Awarded the Chairman's Best Poster Award.
 - Advisor: Dr Shireen Goh
- **Research Engineer** Singapore
*Singapore Institute of Manufacturing Technology (SIMTech), A*STAR* 2017
 - Developed and derived intuitive graphical user interfaces and algorithm libraries for an upcoming *ab initio* electrodynamics simulation platform.
 - Derived optimization workflow for optimizing strong-field light-matter interactions in laser-based particle acceleration.
 - Advisor: Dr Wong Liang Jie
- **Undergraduate Teaching Assistant** Pasadena, CA, USA
California Institute of Technology Fall 2016
 - Course taught: Physics 5: Analog Electronics for Physicists.
 - * Laboratory course teaching analysis and design of analog circuits using operational amplifiers, digital logic, and discrete transistors.
 - * Role: Assist development of circuit intuition in students by example, teach design and debugging skills, assess student improvement and provide ability-specific challenges.
 - Course instructor: Frank Rice
- **Kiyo and Eiko Tomiyasu Research Scholar** Pasadena, CA, USA
California Institute of Technology Summer 2016
- **Toshi Kubota Aeronautics Research Fellow** Pasadena, CA, USA
California Institute of Technology Summer 2015
 - Achieved thermocapillary fabrication of micro-optical devices such as microlens arrays and micro-optical resonators.
 - Evaluated fabricated devices through independently constructed novel experimental and computational characterization techniques.
 - Advisor: Professor Sandra M. Troian
- **Research Intern** Singapore
*Institute for Infocomm Research (I²R), A*STAR* Summer 2014
 - Seconded to the Singapore-MIT Alliance for Research and Technology (SMART) to bridge the computational capabilities of I²R and the experimental requirements of SMART.
 - Developed software tools for analysis of biological fluids using micro-NMR devices through 2D Inverse Laplace Transforms.

– Implemented finite element models of macroscale magnetic responses from physical first principles.

– Advisor: Dr Ng Tian-Tsong

Research Intern

Singapore

- *Institute of Materials Research and Engineering (IMRE), A*STAR* Summer 2013

– Proposed a quantitative mechanism for the self-assembly of widely-spaced breath figure features.

– Independently developed an automated image analysis tool for thermal imaging studies.

– Advisor: Dr Chin Jia Min

Corporal First Class

Singapore

- *6th Divisional Air Defence Artillery, Republic of Singapore Air Force* 2011-2013

– Enlisted as a Vehicle Mechanic.

– Independently established and optimized a permanent logistics workflow and information management system.

– Received highest award for enlisted servicemen: Fulltime National Serviceman of the Year.

Research Mentor

Singapore

- *Raffles Institution* 2011

– Facilitated high school student research for the International Young Physicists' Tournament (IYPT) 2011.

– Investigated and visualized convective heat transfer in rotating frames of reference.

Teaching Intern

Singapore

- *Zhonghua Secondary School, Ministry of Education* 2011

– Taught Secondary 3 (9th Grade) Physics and Chemistry (classroom and laboratory) under the MOE Teaching Internship Programme.

– Developed and executed case study-motivated lesson plans.

Research Intern

Singapore

- *National Neuroscience Institute* 2007 - 2009

– Investigated dysfunctions in protein-degradation systems within the mouse model to understand neurodegeneration.

– Received a Distinction award in the Singapore Science and Engineering Fair and the 3M Best Poster Award.

– Advisor: Dr Lim Kah Leong, Dr Jeanne Tan May May

Research Intern

Singapore

- *Plasma Radiation Source Laboratory, National Institute of Education* 2007

– Characterized the effect of plasma shock treatment on magnetic thin films.

– Advisor: Professor Rajdeep Singh Rawat

Publications

**equal contribution*

1. 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, [DOI](#)
2. S.W.D. Lim*, M.L. Meretska*, F. Capasso, A High Aspect Ratio Inverse-Designed Holey Metalens, *Nano Letters*, **21**, 8642-8649, 2021, [DOI](#)

3. S.W.D. Lim, J.S. Park, M.L. Meretska, A.H. Dorrah, F. Capasso, Engineering phase and polarization singularity sheets, *Nature Communications* **12**, 4190, 2021, [DOI](#)
4. 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, [DOI](#)
5. 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, [DOI](#)
6. 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, [DOI](#)

Manuscripts in preparation or submitted

**equal contribution*

1. C.M. Spägle, M. Tamagnone, S.W.D. Lim, M. Ossiander, M.L. Meretska, F. Capasso, “Topologically protected four-dimensional optical singularities”, ArXiv [2208.09054](#), 2022 (submitted)
2. D.S. Hazineh, S.W.D. Lim, Z. Shi, F. Capasso, T. Zickler, and Q. Guo, “D-Flat: A Differentiable Flat-Optics Framework for End-to-End Metasurface Visual Sensor Design”, ArXiv [2207.14780](#), 2022 (working paper)
3. S.W.D. Lim*, J.S. Park*, C.M. Spägle, A. Dorrah, D. Kazakov, M.L. Meretska, F. Capasso, ArXiv [2211.15012](#) “Point Singularity Array Engineering with Metasurfaces” (submitted)
4. R. Tang*, S.W.D. Lim*, X. Yin, F. Capasso, “Minimal Memory Differentiable FDTD for Inverse Design” (in preparation)
5. J.S. Park*, S.W.D. Lim*, A. Amirzhan, M. Ossiander, Z. Li, F. Capasso, “100 mm All-Glass, Mass-Producible Metalens in the Visible” (in preparation)

Conferences

**equal contribution*

1. M. Tamagnone, C.M. Spägle, S.W.D. Lim, F. Capasso, “Optical singularities in higher dimensions: theory and topological protection” (META 2022, Session 3A5)
2. J.S. Park*, S.W.D. Lim*, A. Amirzhan, M. Ossiander, Z. Li, F. Capasso, “All-Glass, Mass-Producible, Large-Diameter Metalens at Visible Wavelength for 100 mm Aperture Optics and Beyond” (CLEO 2022, [AW4L.1](#))
3. R. Tang, S.W.D. Lim, X. Yin, F. Capasso, “Minimal Memory Differentiable FDTD for Inverse Design” (CLEO 2022, [FM5H.4](#))
4. S.W.D. Lim*, J.S. Park*, A. Dorrah, D. Kazakov, M.L. Meretska, F. Capasso, “Metasurface Blue-Detuned Atom Trap Arrays Using Singularity Engineering” (CLEO 2022, [FF4D.4](#))
5. J.S. 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, [SW3B.1](#))

6. [S.W.D. Lim*](#), M.L. Meretska*, F. Capasso, “A high aspect-ratio holey metalens” (CLEO 2021, [SM4I.4](#))
7. [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, [FW4G.5](#))
8. J.S. 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, [117981O](#))
9. M.L. Meretska*, [S.W.D. Lim*](#), F. Capasso, “Monolithic focusing metasurfaces” (SPIE OPTO 2021, [1169509](#))
10. [S.W.D. Lim](#), J.S. Park, M.L. Meretska, A.H. Dorrah, F. Capasso, “Singularity engineering: sculpting the dark’ (SPIE OPTO 2021, [1168018](#))
11. [S.W.D. Lim](#), K.R. Fiedler, C.Z. Zhou and S.M. Troian, “Fabrication of Converging and Diverging Polymeric Microlens Arrays By Spatiotemporal Control of Thermocapillary Forces” (APS March Meeting 2017, [V18.00009](#))
12. [S.W.D. Lim](#), K.R. Fiedler and S.M. Troian, “Fabrication of Converging and Diverging Polymeric Microlens Arrays By A Thermocapillary Replication Technique” (69th Annual Meeting of the APS Division of Fluid Dynamics 2016, [G22.00001](#))
13. [S.W.D. Lim](#), K.R. Fiedler and S.M. Troian, “Fabrication of Converging and Diverging Polymeric Microlens Arrays By A Thermocapillary Replication Technique” (APS March Meeting 2016, [A42.00006](#))

Patents

1. M. L. Meretska, [S.W.D. Lim](#), and F. Capasso, “High-aspect ratio metalens,” U.S. patent [2022/0128734 A1](#) (2022), pending.

Awards

- **Lindau Young Scientist**, 69th Lindau Nobel Laureate Meeting, Germany, 2019. Each year, around 600 young scientists from around the world are selected to engage in scientific exchange alongside 30-40 Nobel Laureates.
- **A*STAR Roll of Honour**, A*STAR, Singapore, 2017. The A*STAR Roll of Honour is awarded “only to the most outstanding NSS(BS) Scholars and AUS scholars who have achieved the highest honours every year in their undergraduate programmes”.
- **D. S. Kothari Prize in Physics**, California Institute of Technology, USA, 2017. Awarded to “a graduating senior in physics who has produced an outstanding research project during the year”.
- **Friends of the Caltech Libraries Senior Thesis Prize**, California Institute of Technology, USA, 2017. Awarded “for excellence in research, writing and the effective use of library resources” in writing a Senior Thesis.
- **Ken Hass Outstanding Student Paper Award**, American Physical Society (APS) Forum on Industrial and Applied Physics (FIAP), 2017. Awarded to “the best student paper addressing the subject of industrial applications of physics” at the APS March Meeting.

- **Haren Lee Fisher Memorial Award in Junior Physics** California Institute of Technology, USA, 2016. Awarded to the junior physics major “demonstrating the greatest promise of future contributions to physics”
- **Jack E. Froehlich Memorial Award** California Institute of Technology, USA, 2016. Awarded to the “junior in the upper 5 percent of his or her class who shows outstanding promise for a creative professional career”.
- **National Science Scholarship** A*STAR, Singapore, 2011–Present. Provides full funding for undergraduate and graduate studies in preparation for a career in research.
- **Lee Kuan Yew Award for Mathematics and Science (both Pre-University and Secondary)** Ministry of Education, Singapore. Awarded “to recognize students for their achievements in mathematics and science and to encourage them to continue to pursue STEM.”
- **41st International Physics Olympiad** Zagreb, Croatia, 2010. Awarded a silver medal (2nd in Singapore, 49th in World).
- **11th Asian Physics Olympiad** Taipei, Taiwan, 2010. Awarded a bronze medal (2nd in Singapore, 28th in Asia).
- **3rd United States Young Physicists’ Tournament** Virginia, USA, 2009. Champion.

Involvements/Activities

- **Head Scholar, Scientific Working Committee, National Science Challenge** Singapore
*A*STAR, Science Center Board, Mediacorp Singapore* 2017 - 2018
 - Planned and implemented scientific projects, competitive rounds, and outreach activities for the National Science Challenge, a publicly-broadcast inter-school science competition. Advised Mediacorp Singapore throughout the competition and filming period.
 - View the 2017 broadcast here:
<https://www.mewatch.sg/show/National-Science-Challenge-2017-29232>
 - View the 2018 broadcast here:
<https://www.mewatch.sg/season/National-Science-Challenge-2018-32311>
- **Monthly Editor’s Pick **Reviewer****
Springer Nature Light: Science and Applications September 2022

Skills

- **Experimental:** Analog and digital circuit design, optical microscopy (confocal, interferometric, polarimetric, atomic force), aseptic technique, cell culture, optical tweezing, X-ray photoelectron spectroscopy.
- **Nanofabrication:** Electron beam lithography, focused ion beam (FIB) lithography, standard semiconductor processes (e.g., dry/wet etch, CVD/PVD/ALD, mask writing).
- **Electron microscopy:** STEM/TEM, FIB TEM sample preparation, EDS, EELS, REELS, environmental/low voltage SEM
- **Computational:** Assembly, C++, Python, R, Mathematica, MATLAB, L^AT_EX, ImageJ, COMSOL, Solidworks, Ansys Lumerical FDTD, Rigorous Coupled Wave Analysis (RCWA), Automatic Differentiation and Machine Learning (e.g., Tensorflow, Pytorch).