

Kenneth L. Ho

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Technical Summary

- Applied mathematics Ph.D. with broad training in computer science, statistics, biology, and chemistry
- Research expertise in fast multipole methods, fast direct solvers, structured matrices; numerical analysis, scientific computing, numerical linear algebra; computational physics, biology, and chemistry
- 6+ years industry experience in computational lithography (OPC, ILT, SMO) and software engineering
- *Computing*: C, C++, CUDA, Fortran, Julia, \LaTeX , MATLAB, MPI, Octave, OpenMP, Python
- *Awards*: NSF graduate and postdoctoral fellowships, NYU dissertation award, Caltech merit award and research fellowship
- 20+ peer-reviewed publications, 5+ patents, 46 conference/seminar presentations, 8 open-source codes
- Google Scholar: 6gr2NYwAAAAJ (900+ citations); ORCID: 0000-0001-5450-4966
- Strong interest in developing new algorithms and building impactful mathematical/numerical libraries, especially for scientific research

Academic and Employment History

- **TSMC** (San Jose, CA). Technical Manager, 7/2021–; Principal Engineer, 8/2017–6/2021; Senior Engineer, 8/2015–8/2017
 - Early member of new US OPC R&D group working on predictive physical modeling for mask correction at the world’s largest semiconductor foundry
 - Core developer of in-house lithography simulator (C++, Python, CUDA), especially numerical methods and computational infrastructure; inverse lithography and high-performance computing team lead; optics theory and fast TCC; CPU/GPU acceleration; technical outreach and recruiting
 - Multiple top performance ratings, spot award
- **Flatiron Institute**. Visiting Scholar/Consultant, Center for Computational Mathematics, 6/2019–12/2020
- **Stanford University**. Postdoctoral Scholar, Mathematics, 1/2013–7/2015
 - NSF fellowship (DMS-1203554); advisor: Lexing Ying
- **Courant Institute, NYU**. Visiting Scholar, 9/2012–12/2012; Assistant Research Scientist, 6/2012–8/2012
- † *Ph.D., Computational Biology (Mathematics), Courant Institute, NYU*, 9/2007–5/2012
 - Thesis: Fast direct methods for molecular electrostatics (advisor: Leslie Greengard)
 - NYU and NSF (DGE-0333389) fellowships, Kurt O. Friedrichs dissertation prize
- **Schrödinger**. Consultant, 10/2011–2/2012; Intern, 6/2010–9/2010
 - Python scripting for PrimeX; protein crystal structure refinement pipeline
- † *B.S. (with honor), Applied and Computational Mathematics, Caltech*, 9/2003–6/2007
 - Upperclass merit award, summer research fellowship

Research Highlights

- $O(N)$ generalized LU decomposition for hierarchical matrices^{4,11,12,14}, e.g., for solving integral equations and PDEs; applications to chemistry⁶, physics⁷, and statistics¹⁶; open-source MATLAB software²¹
- $O(N \log N)$ “butterfly” factorization^{9,19} for high-frequency scattering and Fourier integral operators
- Mathematical theory² for FasL trimerism in apoptosis as the lowest order oligomer enabling irreversible cell death
- Algebraic methods for model selection^{5,13} of chemical reaction networks based on data “structure”
- Automated all-atom protein crystal structure refinement³ via energy minimization, hydrogen-bond network optimization, X-ray diffraction fitting, etc.

Publications

21. K.L. Ho. FLAM: Fast linear algebra in MATLAB – Algorithms for hierarchical matrices. *J. Open Source Softw.* 5 (51): 1906, 2020. doi:10.21105/joss.01906.
20. Z. Chen, J. Zhang, K.L. Ho, H. Yang. Multidimensional phase recovery and interpolative decomposition butterfly factorization. *J. Comput. Phys.* 412: 109427, 2020. doi:10.1016/j.jcp.2020.109427.
19. Q. Pang, K.L. Ho, H. Yang. Interpolative decomposition butterfly factorization. *SIAM J. Sci. Comput.* 42 (2): A1097–A1115, 2020. doi:10.1137/19M1294873.
18. J. Feliu-Fabà, K.L. Ho, L. Ying. Recursively preconditioned hierarchical interpolative factorization for elliptic partial differential equations. *Commun. Math. Sci.* 18 (1): 91–108, 2020. doi:10.4310/CMS.2020.v18.n1.a4.
17. H.A. Harrington, K.L. Ho, N. Meshkat. A parameter-free model comparison test using differential algebra. *Complexity* 2019: 6041981, 2019. doi:10.1155/2019/6041981.
16. V. Minden, A. Damle, K.L. Ho, L. Ying. Fast spatial Gaussian process maximum likelihood estimation via skeletonization factorizations. *Multiscale Model. Simul.* 15 (4): 1584–1611, 2017. doi:10.1137/17M1116477.
15. F. Fang, K.L. Ho, L. Ristroph, M.J. Shelley. A computational model of the flight dynamics and aerodynamics of a jellyfish-like flying machine. *J. Fluid Mech.* 819: 621–655, 2017. doi:10.1017/jfm.2017.150.
14. V. Minden, K.L. Ho, A. Damle, L. Ying. A recursive skeletonization factorization based on strong admissibility. *Multiscale Model. Simul.* 15 (2): 768–796, 2017. doi:10.1137/16M1095949.
13. E. Gross, B. Davis, K.L. Ho, D.J. Bates, H.A. Harrington. Numerical algebraic geometry for model selection and its application to the life sciences. *J. R. Soc. Interface* 13 (123): 20160256, 2016. doi:10.1098/rsif.2016.0256. PMID:27733697.
12. K.L. Ho, L. Ying. Hierarchical interpolative factorization for elliptic operators: differential equations. *Comm. Pure Appl. Math.* 69 (8): 1415–1451, 2016. doi:10.1002/cpa.21582.
11. K.L. Ho, L. Ying. Hierarchical interpolative factorization for elliptic operators: integral equations. *Comm. Pure Appl. Math.* 69 (7): 1314–1353, 2016. doi:10.1002/cpa.21577.
10. V. Minden, A. Damle, K.L. Ho, L. Ying. A technique for updating hierarchical skeletonization-based factorizations of integral operators. *Multiscale Model. Simul.* 14 (1): 42–64, 2016. doi:10.1137/15M1024500.
9. Y. Li, H. Yang, E.R. Martin, K.L. Ho, L. Ying. Butterfly factorization. *Multiscale Model. Simul.* 13 (2): 714–732, 2015. doi:10.1137/15M1007173.
8. K.L. Ho, L. Greengard. A fast semidirect least squares algorithm for hierarchically block separable matrices. *SIAM J. Matrix Anal. Appl.* 35 (2): 725–748, 2014. doi:10.1137/120902677.
7. L. Greengard, K.L. Ho, J.-Y. Lee. A fast direct solver for scattering from periodic structures with multiple material interfaces in two dimensions. *J. Comput. Phys.* 258: 738–751, 2014. doi:10.1016/j.jcp.2013.11.011.
6. K.L. Ho. Fast direct methods for molecular electrostatics. Ph.D. thesis, New York Univ., 2012. UMI: 3524158.
5. H.A. Harrington, K.L. Ho, T. Thorne, M.P.H. Stumpf. Parameter-free model discrimination criterion based on steady-state coplanarity. *Proc. Natl. Acad. Sci. U.S.A.* 109 (39): 15746–15751, 2012. doi:10.1073/pnas.1117073109. PMID:22967512.
4. K.L. Ho, L. Greengard. A fast direct solver for structured linear systems by recursive skeletonization. *SIAM J. Sci. Comput.* 34 (5): A2507–A2532, 2012. doi:10.1137/120866683.
3. J.A. Bell, K.L. Ho, R. Farid. Significant reduction in errors associated with nonbonded contacts in protein crystal structures: automated all-atom refinement with *PrimeX*. *Acta Cryst. D* 68 (8): 935–952, 2012. doi:10.1107/S0907444912017453. PMID:22868759.
2. K.L. Ho, H.A. Harrington. Bistability in apoptosis by receptor clustering. *PLoS Comput. Biol.* 6 (10): e1000956, 2010. doi:10.1371/journal.pcbi.1000956. PMID:20976242.

1. H.A. Harrington, K.L. Ho, S. Ghosh, KC Tung. Construction and analysis of a modular model of caspase activation in apoptosis. *Theor. Biol. Med. Model.* 5: 26, 2008. doi:10.1186/1742-4682-5-26. PMID:19077196.

Patents

5. K.L.K. Ho. Litho-aware source sampling and resampling. U.S. patent 11,256,176 B2, 2022. Google: US11256176.
- 3-4. K.L.K. Ho. Method and apparatus for computing feature kernels for optical model simulation. U.S. patents 10,809,629 B2, 2020; 11,003,092 B2, 2021. Google: US10809629. Also: TWI747036.
- 1-2. D. Beylkin, K.L. Ho, S.V. Trivedi, F. Xu, J. Lei, D. Peng. Synchronized parallel tile computation for large area lithography simulation. U.S. patents 10,671,052 B2, 2020; 10,915,090 B2, 2021. Google: US10671052.

Presentations

- *Conferences and workshops*: NVIDIA GTC 2020; SIAM AN18; SIAM CSE15; MBI WYRMB 2014; SIAM AN14; FACM 2014; SIAM UQ14; BIRS Workshop on Integral Equations, 2013; SIAM CSE13; NYU/Columbia RTG Symp., NYU, 2012; SIAM LS12; SIAM AN12; SIAM ALA12; CJR, Yale, 2012; DOE Appl. Math. Prog. Meet., 2011; Courant 75th Anniv., NYU, 2011; COB Day, NYU, 2009; NSF IGERT PI Meet., 2009; Bioeng. Bootcamp, Caltech, 2008; MBI Summer Grad. Prog., 2007; RIPS-IPAM 2006; SURF Semin. Day, Caltech, 2005
- *Seminars and colloquia*: Argonne Natl. Lab., CMU (2), Caltech, Colorado State, Imperial College London (2), JPL, LBNL, NCSU, NJIT, NYU (4), Stanford, Theranos, TSMC (2), U. Minnesota, U. Wisconsin-Madison, UC Irvine (2), UC Riverside

Codes

8. mortgage.py: a simple state-based mortgage calculator
7. f2mkl: adapter for preloading MKL in applications linked against Fortran BLAS
6. lpscheduler: a simple linear-programming-based scheduling utility
5. SparseFFT.jl: sparse fast Fourier transforms in Julia
4. LowRankApprox.jl: fast low-rank matrix approximation in Julia (doi:10.5281/zenodo.1254147)
 - original developer; now maintained by JuliaMatrices
3. FLAM: fast linear algebra in MATLAB (doi:10.5281/zenodo.1253581)
2. PyMatrixID: fast interpolative decompositions in Python
 - contributed to SciPy as `scipy.linalg.interpolative`
1. hypoct: hyperoctree construction and manipulation