Loren E. Hough
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EDUCATION

University of Colorado, Boulder
PhD in Physics, April 2007
University of California, Santa Barbara
Graduate work in Physics, 2001–2002
Harvard University, Cambridge, Massachusetts
BA in Physics, *Magna cum laude with Highest Honors* 2000

POSITIONS

Faculty Director for DEAI in the Graduate School, University of Colorado Boulder, 2022-present
Associate Professor, Department of Physics and BioFrontiers Institute, University of Colorado Boulder, 2020 – present
Assistant Professor, Department of Physics and BioFrontiers Institute, University of Colorado Boulder, 2012 – 2020
Postdoctoral Fellow, Laboratory of Cellular and Structural Biology, Rockefeller University, 2007-2012

HONORS AND AWARDS

NSF CAREER Award recipient, 2019
CU President's Diversity Award to Physics Department DEI committee, R^3 (Recruitment, Representation, and Retention), 2019
Maximizing Investigators' Research Award, NIH National Institute of General Medical Sciences, 2016
Diversity Service Recognition Award by the Chancellor's Committee on Race and Ethnicity to CU Café, 2016
IMPART Grant recipient, CU Boulder, 2015
Boettcher Investigator, 2014
Postdoctoral Research Award, Intrinsically Disordered Proteins Subgroup of the Biophysical Society, 2011
Charles H. Revson Fellowship in Life Sciences 2010
NIH Ruth L. Kirschstein National Research Service Postdoctoral Fellowship, 2009
Glenn Brown Prize, International Liquid Crystal Society, 2008
Trainee, NIH Biophysics Training Grant (T32-CU Boulder), 2006–2007
GAANN Fellowship, Liquid Crystal Materials Research Center, CU Boulder, 2005–2006
NSF Graduate Research Fellowship, 2002–2005
Broida and GAANN Fellowships, Physics Department, UC Santa Barbara 2001–2002
Phi Beta Kappa, 2000
Barry Goldwater Scholarship, 1998

RESEARCH ACCOMPLISHMENTS

In cell NMR: We were the first lab to perform protein NMR experiments in living budding yeast, opening a new approach to study disordered proteins in their native environments. Using this new technique, we explained why one disordered protein adopts a fundamentally different structural state in cells versus in solution. We are continuing this work to determine how the cell responds to changes in environmental conditions, especially those that induce a stress response.
Microtubule regulation: Microtubules are a key component of the cytoskeleton of eukaryotic cells, and contain small flexible segments called the C-terminal tails that acts as sites of regulation. We were the first to measure NMR spectra of the tubulin tails. We found that despite remaining highly dynamic, the tubulin tails interact significantly with the ordered tubulin body, and that modifications of the disordered tails alter microtubule stiffness. Our results demonstrate a mechanism by which an atomic-level change in a disordered domain modulates the behavior of a protein complex, in this case the mechanical properties of a cytoskeletal filament.
Polymer Biofilters: Disordered proteins are key components of polymer biofilters that define cellular compartments. These filters differ from synthetic filters because they select based on binding rather than size or charge. We have identified a novel mechanism of binding-based filtration in which the inherent flexibility of disordered proteins allows movement of the transported protein. We developed analytical theory and models to determine how transient binding can be used to control transport in diverse biological systems. We are currently using these results to design particles for drug delivery to the eye.

WORKS IN PROGRESS

"Characterization of predicted small proteins", Allison M. Whited, Christina L. Cleveland, Jeffre Allen, Irwin Jungreis, John L. Rinn, Loren E. Hough, (under review).

"Aggregation of an FG nucleoporin under crowded conditions", Laura Maguire, Sophie Reskin, Kathryn Wall, Elena Arroyo, Steven T. Whitten, Annette Erbse, Loren E. Hough, (in revision).

PEER-REVIEWED PUBLICATIONS

An up to date list of publications is available at: https://orcid.org/0000-0002-1104-0126

"Coiled-coil domains are sufficient to drive liquid-liquid phase separation in protein models", Dominique A Ramirez, Loren E Hough, Michael R Shirts, *Biophysical Journal* in press, (2024).

"Programmable de novo designed coiled coil-mediated phase separation in mammalian cells", Maruša Ramšak, Dominique A. Ramirez, Loren E. Hough, Michael R. Shirts, Sara Vidmar, Kristina Eleršič Filipič, Gregor Anderluh, Roman Jerala, *Nature Communications* 14, 7973 (2023).

"ParSe 2.0: A web tool to identify drivers of protein phase separation at the proteome level", Colorado Wilson; Karen A. Lewis; Nicholas C. Fitzkee; Loren E. Hough; Steven T. Whitten, *Protein Science* 32(9), e4756 (2023).

"Intrinsically disordered regions that drive phase separation form a robustly distinct protein class", Ayyam Y. Ibrahim, Nathan P. Khaodeuanepheng, Dhanush Amarasekara, John J. Correia, Karen A. Lewis, Nicholas Fitzkee, Loren E. Hough*, Steven Whitten*, *Journal of Biological Chemistry* 299(1), 102801 (2023).

"Beta turn propensity and a model polymer scaling exponent identify intrinsically disordered phase-separating proteins", Elisia A. Paiz, Jeffre H. Allen, John J. Correia, Nicholas C. Fitzkee, Loren E. Hough*, and Steven T. Whitten*, *Journal of Biological Chemistry* 295(5), 101343 (2021).

"Examining Cultural Structures and Functions in Biology", Richelle L Tanner, Neena Grover, Michelle L Anderson, Katherine C Crocker, Shuchismita Dutta, Angela M Horner, Loren E Hough, Talia Y Moore, Gail L Rosen, Kaitlin S Whitney, Adam P Summer, *Integrative and Comparative Biology* https://doi.org/10.1093/icb/icab140, (2021).

"Physics of the nuclear pore complex: Theory, modeling and experiment", Bart W Hoogenboom, Loren E Hough, Edward A Lemke, Roderick YH Lim, Patrick R Onck, Anton Zilman, *Physics Reports* 921, 1 (2021).

"Moving while you're stuck: A macroscopic demonstration of an active system inspired by binding-mediated transport in biology", Kanghyeon Koo, Shankar Lalitha Sridhar, Noel Clark, Franck Vernerey, and Loren Hough, *Soft Matter* 10.1039/D0SM01808B, (2021).

"Enhanced diffusion by reversible binding to active polymers ", Shankar Lalitha Sridhar, Jeffrey Dunagin, Kanghyeon Koo, Loren Hough, and Franck Vernerey, *Macromolecules* 54(4), 1850-1858 (2021).

"C-terminal tail polyglutamylation alters microtubule mechanical properties", Kathryn Wall, Harold Hart, Thomas Lee, Cynthia Page, Taviere Hawkins, Loren Hough, *Biophysical Journal* 119 (11), 2219-2230 (2020).

"Bound-state diffusion due to binding to flexible polymers in a hydrogel biofilter", Laura Maguire, Meredith Betterton, Loren Hough, *Biophysical Journal* 100(2), 376-385 (2020).

"Design principles of selective transport through biopolymer barriers", Laura Maguire, Michael Stefferson, Meredith Betterton, Loren E. Hough, *Physical Review E* 100, 042414 (2019).

"In-cell NMR within budding yeast reveals cytoplasmic masking of hydrophobic residues of FG repeats", Kathryn P. Wall, Loren E. Hough, *Biophysical Journal* 115(9), 1690-1695 (2018).

"Effects of soft interactions and bound mobility on diffusion in crowded environments: a model of sticky and slippery obstacles.", Michael Stefferson, Samantha Norris, Franck Vernerey, Meredith Betterton, Loren E. Hough, *Physical biology* 14(4), 045008 (2017).

"Physical determinants of bipolar mitotic spindle assembly and stability", Robert Blackwell, Christopher Edelmaier, Oliver Sweezy-Schindler, Adam Lamson, Zachary Gergely, Eileen O'Toole, Ammon Crapo, Loren E. Hough, J. Richard McIntosh, Matthew A. Glaser, Meredith D. Betterton, *Science Advances* 3(1), e1601603 (2017).

"Molecular Determinants of Tubulin's C-Terminal Tail Conformational Ensemble", Kathryn P. Wall, Maria Pagratis, Geoffrey Armstrong, Jeremy L. Balsbaugh, Eric Verbeke, Chad G. Pearson, Loren E. Hough, *ACS Chemical Biology* 11, 2981 (2016).

"Kinesin-8 effects on mitotic microtubule dynamics contribute to spindle function in fission yeast", Zachary Gergely, Ammon Crapo, Loren E. Hough, J. Richard McIntosh, Meredith D. Betterton, *Molecular Biology of the Cell* 27, 3490–3514 (2016).

"Microscopic origins of anisotropic active stress in motor-driven nematic liquid crystals", Robert Blackwell, Oliver Sweezy-Schindler, Christopher Baldwin, Loren E. Hough, Matthew A. Glaser, M. D. Betterton, *Soft Matter* 12, 2676–87 (2016).

"The molecular mechanism of nuclear transport revealed by atomic scale measurement", Loren

E. Hough, Kaushik Dutta, Sam Sparks, Deniz Temel, Jacklyn Tetenbaum-Novatt, Brian Chait, Michael Rout, David Cowburn, *eLife* , eLife 2015;10.7554/eLife.10027 (2015).

"Hysteresis, reentrance, and glassy dynamics in systems of self-propelled rods", Hui-Shun Kuan, Robert Blackwell, Loren E. Hough, Matthew A. Glaser, and M. D. Betterton, *Physical Review E* 92, 060501 (2015).

"Rapid, optimized interactomic screening", Zhanna Hakhverdyan, Michal Domanski, Loren E. Hough, Asha A. Oroskar, Anil R. Oroskar, David J. Dilworth, Kelly Molloy, Vadim Sherman, John D. Aitchison, Brian T. Chait, Torben H. Jensen, Michael P. Rout and John LaCava, *Nature Methods* 12(6), 553-60 (2015).

"The role of competition in karyopherin-FG Nup interactions; a key to efficient transport through the nuclear pore complex", Jaclyn Tetenbaum-Novatt, Loren E. Hough, Roxana Mironska, A. Sophie McKenney, Michael Rout, *Mol Cell Proteomics* 11(5), 31-46 (2012).

"Structure of the B4 Liquid Crystal Phase near a Glass Surface", Dong Chen, Michael S. Heberling, Michi Nakata, Loren E. Hough, Joseph Maclennan, Matthew Glaser, Eva Körblova, David Walba, Junji Watanabe, Noel A. Clark, *ChemPhysChem* 13, 155-159 (2012).

"Interface structure of the dark conglomerate liquid crystal phase", Dong Chen, Yongqiang Shen, Chenhui Zhu, Loren E. Hough, Nélida Gimeno, Matthew A. Glaser, Joseph E. Maclennan, M. Blanca Ros, Noel A. Clark, *Soft Matter* 7, 1879-1883 (2011).

"Chiral isotropic liquids from achiral molecules", Loren E. Hough, Melissa Spannuth, Michi Nakata, David A. Coleman, Christopher D. Jones, G. Dantlgraber, C. Tschierske, Junji Watanabe, Eva Körblova, David M. Walba, Joseph E. Maclennan, Matthwe A. Glaser, Noel A. Clark, *Science* 24, 452-456 (2009).

"Helical nanofilament phases", L.E. Hough, H. T. Jung, D. Krüerke, M. S. Heberling, M. Nakata, C. D. Jones, D. Chen, D. R. Link, J. Zasadzinski, G. Heppke, J. P. Rabe, W. Stocker, E. Körblova, D. M. Walba, M. A. Glaser, N. A. Clark, *Science* 24, 456-460 (2009).

"A model of microtubule depolymerization by kinesin-8 motors", Loren E. Hough*, Anne Schwabe*, Matt Glaser, J. Richard McIntosh, M. D. Betterton, *Biophysical Journal* 96, 3050-64 (2009).

"Direct observation of optical activity produced by layer chirality in bent-core liquid crystals", L.E. Hough, C. Zhu, M. Nakata, N. Chattham, G. Dantlgraber, C. Tschierske, N.A. Clark, *Physical Review Letters* 98, 037802 (2007).

"Phantom nanoparticles as probes of biomolecular interactions", Davide Prosperi, Carlo Morasso, Francesco Mantegazza, Marco Buscaglia, Loren E. Hough, Tommaso Bellini, *Small* 2, 1060–1067 (2006).

"Layer-scale optical chirality of liquid-crystalline phases", Loren E. Hough and Noel A. Clark, *Physical Review Letters* 95, 107802 (2005).

"Giant-block twist grain boundary smectic phases", J Fernsler, L.E. Hough, R.-F. Shao, J. E. Maclennan, L. Navailles, M. Brunet, N. V. Madhusudana, O. Mondain-Monval, C . Boyer, J. Zasadzinski, J. A. Rego, D. M. Walba, and N. A. Clark, *PNAS* 102, 14191-14196 (2005).

"Smooth Vortex Precession in Superfluid ^{4}He", L.E. Hough, L.A.K. Donev, and R.J. Zieve, *Physical Review B* 65, 024511 (2002).

"Depinning of a Superfluid Vortex Line by Kelvin Waves", L.A.K. Donev, L. E. Hough and RJ

Zieve, *Physical Review B* 64, 180512(R) (2001).
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