

Biographical Sketch: Michael F. Hagan

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(i) Professional Preparation

University of Connecticut, Storrs	Chemical Engineering	B.S.E. (summa cum laude), 1998.
University of California, Berkeley	Chemical Engineering	Ph. D., 2003 Advisor: Arup K. Chakraborty
University of California, Berkeley	Chemistry	Postdoctoral, 2003-2006 Advisor: David Chandler

(ii) Appointments

Chair, Biological Physics Program	Brandeis University	7/2013 - present
Associate Professor	Brandeis University	1/2013 - present
Assistant Professor	Brandeis University	1/2007-12/2012
NIH Ruth L. Kirchstein Postdoctoral Fellow	University of California, Berkeley	2004-2006
Postdoctoral Researcher	University of California, Berkeley	2003

(iii) Teaching

- Numerical Modeling Methods in Biology (QB110A): Spring 2013, Spring 2009, Spring 2008, Spring 2007

This is a new course that I designed for undergraduate and graduate students from physics, chemistry, biochemistry, and biology. Applies modern computational techniques to interesting and important problems in biology.

- Graduate Statistical Physics (Phys 163A): Fall 2009
- Biological Physics (QB105A): Fall 2010, Fall 2011, Fall 2013
- Statistical Physics (Phys40): Spring 2011
- Introductory Physics I (Phys11A): Fall 2012

(iv) Research Support

- National Institutes of Health NIAID (Award No. R01GM108021)

Computational modeling of viral assembly: Encapsulation of nucleic acids and envelopment by lipid membranes

Total Costs: \$1,300,000 (1 PI, role=PI)

September 2013 – April 2018

- National Institutes of Health NIGMS (Award No. R01GM100966)

Collaborative experimental and computational studies of conformational transitions in signaling proteins and enzymes

Total Costs: \$1,605,150 (2 PI's, role=PI)

August 2013 – July 2017

- Keck Foundation

Evolutionary Molecular Self-Organization under Extreme Conditions

Total Costs: \$1,000,000 (4 PI's, role=CoPI)

January 2014 – December 2016

- National Science Foundation (CMMI)

Collaborative Research: Mechanics and Structural Polymorphism of Bacterial Flagellar Assemblies

Total Costs: \$600,000 (3 PI's, role=CoPI)

July 2011 – June 2014

- National Science Foundation (MCB)

Building cellular complexity: from molecular motors to synthetic cilia

Total Costs: \$185,472 (3 PI's, role=CoPI)

December 2013 – December 2015

(v) Publications

47. Perket, M.R.; Hagan, M.F., “*The Allosteric Switching Mechanism in Bacteriophage MS2*”, submitted, [arXiv:1503.01204](#) (2015).
46. Perlmutter, J.D.; Hagan, M.F., “*The role of packaging sites in efficient and specific virus assembly*”, submitted, [arXiv:1502.05029](#)
45. DeCamp, S.J.; Redner, G.; Baskaran, A.; Hagan, M.F.*; Dogic, Z., “*Orientational order of motile defects in active nematics*”, [arXiv:1501.06228](#)
44. Fily, Y.; Baskaran, A.; Hagan, M.F., “*Dynamics and density distribution of strongly confined noninteracting nonaligning self-propelled particles in a nonconvex boundary*”, *Phys. Rev. E*, **91**, 012125 (2015), [\[link\]](#), [arXiv:1410.5151](#)
43. Hilitski, F.; Ward, A.R.; Cajamarca, L.; Hagan, M.F.; Grason, G.M.; Dogic, Z., “*Measuring cohesion between macromolecular filaments, one pair at a time: Depletion-induced microtubule bundling*”, *Phys. Rev. Lett.*, (accepted), [arXiv:1408.5068](#)
42. Kerns S.J.; ...; Alber T.; Hagan, M.F.; Kern, D., “*The energy landscape of adenylate kinase during catalysis*”, *Nat. Struct. Mol. Biol.* **22**, 124–131 (2015) doi:10.1038/nsmb.2941, [\[link\]](#)
41. Perlmutter, J.D.; Hagan, M.F., “*Mechanisms of Virus Assembly*”, *Annu. Rev. Phys. Chem.*, **66**, 217–39, [\[link\]](#), [arXiv:1407.3856](#) [invited review] NIHMS 664170
40. Ruiz-Herrero, T., Hagan, M.F., “*Simulations show that Virus Assembly on a Membrane is Facilitated by Membrane Microdomains*”, *Biophys. J.*, **108**, 585–595 (2015), [arXiv:1403.2269](#), [\[link\]](#), PMID 4317536
39. Sharma, P.; Ward, A.R.; Gibaud, T.; Hagan, M.F.; Dogic, Z., “*Hierarchical organization of chiral rafts in colloidal membranes*”, *Nature*, **513**, 77–80 (2014) [\[link\]](#)
38. Perlmutter, J.D.; Perket, M.R.; Hagan, M.F., “*Pathways for virus assembly around nucleic acids*”, *J. Mol. Biol.*, **426**, 3148–3165 (2014), [\[link\]](#), PMID4135015
37. Fily, Y., Baskaran, A., Hagan, M.F. “*Dynamics of Self-Propelled Particles Under Strong Confinement*”, *Soft Matter*, **10**, 5609–5617 (2014) [\[link\]](#), [arXiv:1402.5583](#)
36. Perket, M.R., Hagan, M.F., “*Using Markov State Models to Study Self-Assembly*”, *J. Chem. Phys.*, **140**, 214101 (2014), [\[link\]](#) PMID: PMC4048447 **[Cover Article]**
35. Villali, J., Pontiggia, F., Clarkson, M.W., Hagan, M.F., Kern, D. “*Evidence against the ‘Y-T coupling’ mechanism of activation in the response regulator NtrC*”, *J. Mol. Biol.* **426**, 1554–1567, (2014), doi: [10.1016/j.jmb.2013.12.027](#)
34. Chelakkot, R.; Gopinath, A.; Mahadevan, L.*; Hagan, M.F.*, “*Flagellar dynamics of a connected chain of active, Brownian particles*”, *J. R. Soc. Interface*, **11**, 20130884 (2014) ([http://dx.doi.org/10.1098/rsif.2013.0884](#))
33. Perlmutter, J.D.; Qiao, C.; Hagan, M.F. “*Viral genome structures are optimal for capsid assembly*”, *eLife*, 2:e00632, [http://elifesciences.org/content/2/e00632](#)
32. Redner, G.; Baskaran, A.; Hagan, M.F., “*Reentrant Phase Behavior in Active Colloids with Attraction*”, *Phys. Rev. E*, **88**, 012305 (2013), **[Subject of a Physical Review Focus, [Physics 6, 134 \(2013\)](#)]**
31. Hagan, M.F. “*Modeling Viral Capsid Assembly*”, *Adv. Chem. Phys.*, **155**, Ch 1, 1–68 (2014), [arXiv:1301.1657](#) [invited review article] PMID4318123
30. Redner, G., Hagan, M.F.*, Baskaran, A.*, “*Structure and Dynamics of a Phase-Separating Active Colloidal Fluid*” *Phys. Rev. Lett.*, **110**, 055701 (2013), [arXiv:1207.1737](#)
- * co-corresponding author
29. Yu, N., Hagan, M.F., “*Simulations of HIV capsid protein dimerization reveal the effect of chemistry and topography on the mechanism of hydrophobic protein association*” *Biophys. J.* **103**, 1363–1369 (2012) [Featured Article]
28. Ruiz-Herrero, T., Velasco, E., Hagan, M.F., “*Mechanisms of budding of nanoscale particles through lipid bilayers*” *J. Phys. Chem B*, **116**, 9595–603 (2012) [arXiv:1202.4691](#)
27. Giomi L., Mahadevan L., Chakraborty, B., and Hagan, M.F. “*Banding, excitability and chaos in active nematic suspensions*”, *Nonlinearity*, **25**, 2245–2269 (2012)

26. Dhason, M.S, Wang, J. C., Hagan, M.F., Zlotnick, A. “*Differential assembly of Hepatitis B Virus core protein on single- and double-stranded nucleic acid suggests the dsDNA-filled core is springloaded*”, *Virology*, **430**, 20-29 (2012)
25. Gopinath, A., Hagan, M.F., Marchetti, M.C., Baskaran, A. “*Dynamical Self-regulation in Self-propelled Particle Flows*” *Phys. Rev. E*, **85**, 061903 (2012)
24. Ni, P., Wang, Z., Ma, X., Das, N.C., Sokol, P., Chiu, W., Dragnea, B., Hagan, M.F.*, Kao, C.C*., “*An Examination of the Electrostatic Interactions between the N-Terminal Tail of the Coat Protein and RNA in Brome Mosaic Virus*”, *J. Mol. Biol.*, **419**, 284-300 (2012)
- *co-corresponding author
23. Patel, A.J; Varilly, P.; Jamadagni, S.N.; Hagan, M.F.; Chandler, D.; and Garde, S. “*Sitting at the edge: How biomolecules use hydrophobicity to tune their interactions and function*”, *J. Phys. Chem. B*, **116**, 2498-2503 (2012), arXiv:1109.4431
22. T. Gibaud, E. Barry, M. Zakhary, A. Ward, C. Berciu, Y. Yang, M.F. Hagan, R. Oldenbourg, D. Nicastro, R. Meyer, Z. Dogic. “*Reconfigurable self-assembly through chiral control of interfacial tension*”, *Nature*, **481**, 348 (2012)
21. McCandlish, S.R, Baskaran, A., and Hagan, M.F. “*Spontaneous Segregation of Self-Propelled Particles with Different Motilities*”, *Soft Matter*, **8**, 2527-2534 (2012), arXiv:1110.2479
20. Yang Y., Barry E., Dogic Z. and Hagan, M.F. “*Self-assembly of 2D membranes from mixtures of hard rods and depleting polymers*”, *Soft Matter*, **8**, 707 (2012), arXiv:1103.2760
19. Yang Y. and Hagan, M.F. “*Theoretical calculation of the phase behavior of colloidal membranes*” *Phys. Rev. E*, **84**, 051402 (2011)
18. Hagan, M.F., Elrad O.M., and Jack R.L. “*Mechanisms of kinetic trapping in self-assembly and phase transformation*”, *J. Chem. Phys.*, **135**, 104115 (2011)
17. Giomi L., Mahadevan L., Chakraborty, B., and Hagan, M.F. “*Excitable Patterns in Active Nematics*”, *Phys. Rev. Lett* **106**, 218101 (2011)
16. Sumedha; Hagan, M.F.; Chakraborty, B. “*Prolonging assembly through dissociation: A self-assembly paradigm in microtubules*”, *Phys. Rev. E*, **83**, 051904 (2011)
15. Elrad O.M.; Hagan, M.F. “*Encapsulation of a Polymer by an Icosahedral Virus*”, *Phys. Biol.*, **7**, 045003 (2010), Part of a special focus issue on physical virology.
14. Yang, Y.; Meyer, R.B.; Hagan, M.F. “*Self-limited self-assembly of chiral filaments*”, *Phys. Rev. Lett.*, **104**, 258102 (2010)
13. Kivenson, A.; Hagan, M.F. “*Mechanisms of Capsid Assembly around a Polymer*”, *Biophys. J*, **99**, 619-628 (2010)
12. Hagan, M.F. and Elrad O.M. “*Understanding the Concentration Dependence of Viral Capsid Assembly Kinetics - the Origin of the Lag Time and Identifying the Critical Nucleus Size*”, *Biophys. J*, **98**, 1065-1074 (2010)
11. Hagan, M.F. “*A theory for viral capsid assembly around electrostatic cores*”, *J. Chem. Phys.*, **130**, 114902 (2009)
10. Huang, F.; Addas, K.; Ward, A ; Flynn, N.T.; Hagan, M.F.; Dogic, Z.; Fraden, S. “*The pair potential of colloidal stars*”, *Phys. Rev. Lett.*, **102**, 108302 (2009)
9. Whitelam, S.; Feng, E.H.; Hagan, M.F.; Geissler, P.L. “*The role of collective motion in examples of coarsening and self-assembly*”, *Soft Matter*, **6**, 1251-1262 (2009) (Special issue on Self-Assembly)
8. Elrad, O.M.; Hagan, M.F. “*Mechanisms of size control and polymorphism in viral capsid assembly*”, *Nano Letters*, **8**, 3850-3857 (2008)
7. Hagan, M. F. “*Controlling viral capsid assembly with templating*”, *Phys. Rev. E*, **77**, 051904 (2008)

Publications before I was an independent scientist

6. Jack, R. L.; Hagan, M. F.; Chandler, D. “*Fluctuation-dissipation ratios in the dynamics of self-assembly*”, *Phys. Rev. E*, **76**, 021119 (2007)
5. Hagan, M. F.; Chandler, D. “*Dynamic Pathways for Viral Capsid Assembly*”, *Biophys. J.*, **91**, 42 (2006)
4. Hagan, M. F.; Chakraborty, A. K. “*Hybridization Dynamics of Surface Immobilized DNA*”, *J. Chem. Phys.*, **120**, 4958 (2004)

3. Hagan, M. F.; Dinner, A. R.; Chandler, D.; Chakraborty, A. K. “*Atomistic Understanding of Kinetic Pathways for Single Base-Pair Binding and Unbinding in DNA*”, Proc. Natl. Acad. Sci. USA, **100**, 13922 (2003)
2. Hagan, M. F.; Majumdar, A.; Chakraborty, A. K. “*Nanomechanical Forces Generated by Surface Grafted DNA*”, J. Phys. Chem. B, **106**, 10163 (2002)
1. Wu, G.; Haifeng, J.; Hansen, K.; Thundat, T.; Datar, R.; Cote, R.; Hagan, M. F.; Chakraborty, A. K.; Majumdar, A. “*Origin of Nanomechanical Cantilever Motion Generated from Biomolecular Interactions*”, Proc. Natl. Acad. Sci. USA, **98**, 1560 (2001).

(vi) Patents

- Barry, E., Dogic, Z., Hagan, M.F., Yang, Y., Perlman, D. “*Aligned Arrays of Nanorods, and Methods of Making and Using Them*”, patent pending

(vii) Selected Recent Invited Presentations/Appearances

- Berkeley Mini Stat Mech Meeting, January, 2015
- Kent State University, Liquid Crystal Institute Soft Matter Seminar Series, November, 2014
- Georgia Tech Soft Condensed Matter and Biophysics Seminar Series, November, 2014
- Statistical Mechanics in Physics, Chemistry, and Biology. A symposium celebrating David Chandler's 70th Birthday, MIT, October, 2014
- MIT Biophysics Seminar Series, October, 2014
- Johns Hopkins Biophysics Seminar Series, September, 2014
- Brown University Condensed Matter and Biological Physics Seminar Series, September, 2014
- Lecturer for the summer school on “Self-assembled soft matter nano structures at interfaces” organized by the International Graduate Research Training Group (<http://www.ssni.tu-berlin.de>) and the Research Triangle Materials Research Science and Engineering Center, August 2014, Beverly, MA
- FASEB Science Research Conferences, Virus Structure and Assembly, July, 2014, Saxons River, VT
- Northwestern Engineering Sciences and Applied Math seminar, April 2014
- Kavli Institute for Theoretical Physics workshop, Active Matter: Cytoskeleton, Cells, Tissues and Flocks, Santa Barbara, CA, Spring 2014
- APS Annual Meeting, March 2014, Denver, CO
- Harvard Physical Chemistry Seminar, February, 2014
- UMASS Boston Physics Colloquium Series, February, 2014
- MIT Physical Chemistry Seminar, February, 2014
- U.C. Berkeley Physical Chemistry Colloquium, October, 2013
- FNANO 2013, April, 2013, Snowbird, Utah
- UMASS Amherst Condensed Matter Seminar, February 14, 2013
- Physical Virology Gordon Conference, Ventura, CA, January 20, 2013

(viii) Honors and Awards

- Alberta Gotthardt Strage '56 and Henry Strage Award for Aspiring Young Science Faculty (2012)
- National Institutes of Health Ruth L. Kirchstein National Research Service Award, Individual Postdoctoral Fellowship, 2005
- National Science Foundation Graduate Research Fellow, 1999

(ix) Outreach Activities

- Head organizer for the annual Greater Boston Area Statistical Mechanics Meeting (<https://sites.google.com/a/brandeis.edu/gbasm/>)
- Portal to the Public Science Communications Fellow 2014. This is a program in which scientists participate in 10 hours of professional development workshops to learn effective outreach and

communications skills. Subsequently each Fellow develops a hands-on activity to explain his/her research to the public. I developed an activity explaining the physics and geometry of self-assembly in viruses and technology, which I presented at the Discovery Museums in Acton, MA

<http://discoverymuseums.org/programs-events/portal-public>

- Co-organizer with S. Whitelam (LBL) and R. Jack (U. of Bath) for CECAM workshop entitled “Self-assembly: from fundamental principles to design rules for experiment” March 2013
- Co-organizer with S. Whitelam (LBL) for a focus session at the 2012 APS annual meeting, entitled “Self-assembly of proteins: from capsids to crystals”
- Member of the Lawrence Berkeley National Lab Molecular Foundry Theory Facility Proposal Study Panel 2010-2013
- Session chair at the ACS 2010 National meeting, Boston; APS 2011 March Meeting, Boston; 2011 and 2013 Berkeley Mini Stat Mech Meeting
- Reviewer for journals relevant to the field including: *Nature*, *PNAS*, *JACS*, *Biophysical Journal*, *Nature Physics*, *Nature Materials*, *Nature Comm.*, *ACS Nano*, *Nano Letters*, *Physical Review Letters*, *Physical Review E*, *Journal of Chemical Physics*, *Journal of the Royal Society Interface*, *Physical Biology*, *Chemical Physics*, *J. Mol. Biol.*
- Reviewer for funding proposals from agencies including: *NIH*, *NSF*, *the Israel Science Foundation*, *Swiss National Science Foundation*, *the Medical Research Council (UK)*, and *the Netherlands Foundation for Fundamental Research on Matter*
- Co-wrote transition path sampling module for CHARMM, a publicly distributed program for high-resolution simulations of biological macromolecules. This module makes a new simulation technique for studying rare events accessible to the broader computational biology community.

(x) Affiliations

a) Graduate and Postdoctoral Advisors

Graduate - Arup K. Chakraborty (Massachusetts Institute of Technology)

Postdoctoral - David Chandler (University of California, Berkeley)

b) Thesis Advisor and Postgraduate-Scholar Sponsor

Total Numbers Advised: 8 graduate students (5 graduated), 7 postdoctoral fellows

Postdoctoral Fellows (past 5 years, with current location):

Luca Giomi (Leiden University), Sumedha Sumedha (Assistant Professor at NISER, Bhubaneswar, India), Raghunath Chelakkot (Harvard University), Arvind Gopinath (Haverford and U. Penn.), Jason Perlmutter (Brandeis University), Yaouen Fily (Brandeis University), Dina Mirijanian (Brandeis)

Graduate Students (past 5 years, with current location):

Oren Elrad (Apple), Yasheng Yang (WorldQuant, Greenwich, CT), Aleksandr Kivenson (Gamma Medica, Salem, NH), Naiyin Yu (Brandeis), Matthew Perrett (Brandeis), Gabriel Redner (Brandeis), Cong Qiao (Brandeis University), Raunak Sakhardande (Brandeis)