Ken Kamrin

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Education

2003-2008	*Massachusetts Institute of Technology*	*Ph.D. Applied Mathematics*

Thesis: Stochastic and Deterministic Models for Dense Granular Flow

Doctorate awarded June 2008 under the supervision of Prof. Martin Z. Bazant.

1998-2003	*University of California, Berkeley*	*B.S. Engineering Physics, Mathematics minor*

Graduated with Highest Honors.

Appointments

2011-present	*Massachusetts Institute of Technology*	*Class of '56 Career Development Chair*
2011-present	*Massachusetts Institute of Technology*	*Assistant Professor, Mechanical Engineering*
2008-2011	*Harvard University*	*Applied Mathematics Lecturer and NSF Postdoctoral Research Fellow (Sponsors: J. W. Hutchinson and L. Mahadevan)*

Fellowships

Fellowship Title	Date Awarded
NSF Mathematical Sciences Postdoctoral Research Fellowship	Spring 2009
Aneesur Rahman Postdoctoral Fellowship	Fall 2007
National Defense Science and Engineering Graduate Fellowship	Spring 2005
NSF Graduate Research Fellowship	Spring 2005
Hertz Fellowship (joint with Princeton)	Spring 2003
MIT Applied Mathematics Fellowship	Spring 2003
Akamai Presidential Fellowship	Spring 2003

Scholarly Honors

NSF Early Faculty Career Development (CAREER) Award (2012)
Awarded in the Engineering directorate

The Nicholas Metropolis Award (2010)
Awarded by APS for "outstanding doctoral thesis work in computational physics"

UC Berkeley Certificate of Distinction (2003)
To the top four seniors in the university

UC Berkeley Engineering Science Departmental Citation (2003)
To the top student in engineering science

Phi Beta Kappa Honor Society (2002)

Golden Key International Honor Society (2002)

Robert C. Byrd Scholarship (1998)

Bank of America Scholarship (1998)

Students and Postdocs

Postdocs: David L. Henann (2011-2013, now faculty at Brown), Zakia Sultana (2012-current), Ramin Ghellichi (2013-current).

Graduate students: Sachith Dunatunga (2011-current, MS 2014, continuing to PhD), Boris Valkov (2012-2014, MS 2014), Tyler Olsen (2013-current, PhD expected).

Undergaduate researchers: Amy Guyomard (2012-2013, now grad student at Oxford), James Slonaker (2013-current), David Motley (2014-current).

Professional Activities

Co-Organizer, Symposium on Multiscale Mechanics of Particulate Media, Society of Engineering Science (2013)

Associate Editor, *Computational Particle Mechanics*, Springer (2013)

Organizer, Focus Session on Continuum Descriptions of Particulate Media, APS March Meeting (2011-2014)

Co-founder and co-organizer, New England Workshop on the Mechanics of Materials and Structures (2010-2013)

Co-Organizer, Seminar on Mechanics: Modeling, Experimentation, and Computation, Department of Mechanical Engineering, MIT (2010-2014)

Topic Organizer, Amorphous Solids, ASME Congress (2012)

Co-Organizer, 9th Northeastern Granular Materials Workshop, MIT (2011)

Member: American Society of Mechanical Engineers, American Mathematical Society, American Physical Society, Society for Industrial and Applied Mathematics

Co-Organizer, Simple Person's Applied Math Seminar (Fall 2006 - Spring 2007)

Member, Committee on Special Scholarships, UC Berkeley Academic Senate (2002 - 2003)

Member, Committee on Teaching, UC Berkeley Academic Senate (2001- 2002)

Ad Hoc Reviewer: Journal of Computational Physics, Journal of Fluid Mechanics, International Journal of Plasticity, International Journal of Solids and Structures, Journal of Geophysical Research, Physics of Fluids, Journal of the Mechanics and Physics of Solids, Proceedings of the Royal Society, Physical Review, Nature, PNAS, Computational Mechanics.

DOE National Energy Technology Laboratory, Invited Expert (2013)

Review panels: National Science Foundation (2), Department of Energy (1)

Publications

K. Kamrin and M. Z. Bazant, *Stochastic Flow Rule for Granular Materials*, Phys. Rev. E **75**, 041301 (2007).

K. Kamrin, C. H. Rycroft, and M. Z. Bazant, *The Stochastic Flow Rule: A Multi-Scale Model for Granular Plasticity*, Modelling Simul. Mater. Sci. Eng. **15**, S449-S464 (2007).

C. H. Rycroft, K. Kamrin, and M. Z. Bazant, *Assessing Continuum Postulates in Simulations of Granular Flow*, J. Mech. Phys. Solids **57**:5 828-839 (2009).

K. Kamrin, *Nonlinear Elasto-Plastic Model for Dense Granular Flow*, Int. J. Plasticity **26**, 167-188 (2010).

K. Kamrin, M. Z. Bazant, and H. A. Stone, *Effective Slip Boundary Conditions for Arbitrary Periodic Surfaces: The Surface Mobility Tensor*, J. Fluid Mech. **658**, 409-437 (2010).

K. Kamrin and H. A. Stone, *The Symmetry of Mobility Laws for Viscous Flow Along Arbitrarily Patterned Surfaces*, Phys. Fluids, **23**, 031701 (2011).

K. Kamrin and L. Mahadevan, *Soft Catenaries*, J. Fluid Mech. **691**, 165-177 (2012).

K. Kamrin and G. Koval, *Nonlocal Constitutive Relation for Steady Granular Flow*, Phys. Rev. Lett. **108**, 178301 (2012).

K. Kamrin, C. H. Rycroft, and J.-C. Nave, *Reference Map Technique for Finite-Strain Elasticity and Fluid-Structure Interaction*, J. Mech. Phys. Solids **60**, 1952-1969 (2012).

P. Six and K. Kamrin, *Some exact properties of the effective slip over surfaces with hydrophobic patternings*, Phys. Fluids, **25**, 021703, (2013).

D. Henann and K. Kamrin, *A Predictive, Size-Dependent Continuum Model for Dense Granular Flows*, PNAS, **110**:17, 6730-6735, (2013).

D. Henann, J. Valenza, D. L. Johnson, K. Kamrin, *Small-Amplitude Acoustics in Bulk Granular Media*, Phys. Rev. E., **88**, 042205, (2013).

K. Kamrin and G. Koval, *Effect of Particle Surface Friction on Nonlocal Constitutive Behavior of Flowing Granular Media*, (submitted)

K. Kamrin and E. Bouchbinder, *Two-Temperature Continuum Mechanics of Deforming Amorphous Solids*, (submitted)

D. Henann and K. Kamrin, *Large-Deformation Thermomechanics of the Nonlocal Granular Rheology*, (In prep)

K. Kamrin and J. Goddard, *Edelen-Onsager symmetry in viscoplastic flows: Applications to non-linear Darcy flow and effective slip on textured surfaces*, (In prep)

Seminars and Colloquia

Invited   *Continuum Modeling of Granular Flow*, Levich Institute, City College of New York, February 2013.

Continuum Modeling of Flowing Granular Media, Mechanical Engineering Seminar, Columbia University, November 2013.

Wet and Dry Granular Flows, Schlumberger-Doll Research Center, Cambridge, November 2013.

Continuum Modeling of Flowing Granular Media, Mechanical and Aerospace Engineering, Syracuse University, November 2013.

Size-dependent Continuum Modeling of Flowing Granular Media, Mechanics and Materials Seminar, UC San Diego, October 2013.

Size-dependent Continuum Modeling of Flowing Granular Media, GALCIT Colloquium, Caltech, October 2013.

Size-dependent Continuum Modeling of Flowing Granular Media, Seminar Series of ExxonMobil Research, ExxonMobil Laboratories Newark, October 2013

Size-dependent Continuum Modeling of Flowing Granular Media, Applied Mechanics Colloquium, Harvard University, October 2013.

Constructing and Verifying a Three-Dimensional Nonlocal Granular Rheology (2 Lectures), Yukawa Institute for Theoretical Physics, University of Kyoto, June 2013.

Reference Map Technique for Simulating Deformable Solids, Laboratory of Mechanics and Civil Engineering, Université de Montpellier II, June 2013.

A Size-Dependent Continuum Model for Dense Granular Flows, Institut Universitaire des Systèmes Thermiques Industriels, Polytech Marseille, June 2013.

Continuum Modeling of Granular Flow, Department of Chemical Physics, Weitzmann Institute of Science, April 2013.

Continuum Modeling of Granular Flow, Department of Physics, Rochester Institute of Technology, April 2013.

Understanding and Modeling Granular Material Flows at the Continuum Scale, Department of Physics, University of South Florida, February 2013.

Toward a Predictive Continuum Model for Dense Granular Flows, Center for Nonlinear and Complex Systems Seminar, Duke University, October 2012.

Toward a Predictive Continuum Model for Dense Granular Flows, Soft Matter Seminar, Georgia Tech, October 2012.

Toward a General Constitutive Relation for Steady Granular Flow, Laboratory of Mechanics and Civil Engineering, Université de Montpellier II, June 2012.

Steady Granular Flow: Local and Nonlocal Constitutive Approaches, Materials Science Seminar, Johns Hopkins Materials Science, Februrary 2012.

Constitutive Modeling of Granular Flow, and New Perspectives on Continuum Flow Simulation, Mechanical Engineering Seminar, UC Berkeley Mechanical Engineering, December 2011.

Mobility Laws for Fluid Flow over Arbitrarily Patterned Surfaces, Physical Applied Math Seminar, MIT Applied Mathematics, December 2011.

Granular Flow and FSI: Simultaneous Fluid-like and Solid-like Behaviors, Materials Processing Center Advisory Board, MIT, October 2011.

Continuum Modeling and Computational Aspects of Flowing Granular Media, Seminar of the Applied Mathematics Laboratory, Courant Institute, NYU, April 2011.

Constitutive Modeling and Computational Aspects of Flowing Granular Media, Joint Materials/Solid Mechanics Seminar, Brown University, April 2011.

Modeling Sand Flow, Applied Mathematics Seminar, Southern Methodist University, March 2011.

Reference Map Algorithm for the Simulation of Deformable Solids, Applied Mathematics Seminar, McGill University, March 2011.

Steady Granular Flow, Applied Math Seminar, University of Delaware, October 2010.

A Novel Finite-Difference Method for Large Deformation Solid Mechanics, Numerical Methods for Partial Differential Equations Seminar, MIT Department of Mathematics, May 2010.

Steady Granular Flow: Continuum Theory, Simulation, and Computational Challenges, MMEC Seminar, MIT Department of Mechanical Engineering, March 2010.

A Continuum Model for Dense Granular Flow, Caltech, GALCIT, March 2010.

Shear Flow over Arbitrary Periodic Surfaces, Squishy Physics Seminar, Harvard SEAS, February 2010.

A Continuum Model for Dense Granular Flow, Applied Mechanics Colloquium, Harvard SEAS, December 2009.

A Continuum Model for Dense Granular Flow, MMEC Seminar, MIT Department of Mechanical Engineering, November 2009.

General Continuum Law for Dense Granular Flow, Sandia National Laboratory, July 2009.

General Continuum Law for Dense Granular Flow, Brandeis University Department of Physics, June 2009.

A Continuum Model for the Deformation of Granular Materials, Clark University, Physics Colloquium, February 2009.

A New Continuum Model for Dense Granular Deformations, Univeristy of California, Santa Barbara, Kavli Institute for Theoretical Physics, March 2008.

A New Continuum Model for Dense Granular Deformations, Solid Earth Physics Seminar, Harvard School of Engineering and Applied Sciences, February 2008.

An Elasto-Plastic Model for Dense Granular Flow, Brown University Department of Mechanical Engineering, February 2008.

An Elasto-Plastic Model for Dense Granular Flow, Yale University Departments of Physics and Mechanical Engineering (joint seminar), February 2008.

An Elasto-Plastic Model for Dense Granular Flow, Institut Universitaire des Systèmes Thermiques Industriels, Polytech Marseille, January 2008.

An Elasto-Plastic Model for Dense Granular Flow, Institut Navier, École Nationale des Ponts et Chaussées, January 2008.

An Elasto-Plastic Model for Dense Granular Flow, Theoretical Chemical-Physics, École Supérieure de Physique et de Chimie Industrielles, January 2008.

An Elasto-Plastic Model for Dense Granular Flow, Physics and Mechanics of Heterogeneous Media, École Supérieure de Physique et de Chimie Industrielles, January 2008.

Detailed Story of the Stochastic Flow Rule, Clark University Department of Physics, October 2006.

Flow Rules in Granular Plasticity, Brown Bag Seminar Series, MIT Applied Mathematics, March 2005.

Student-level   *Improving Your Vegas Odds with Probability and Mechanics*, Graduate Association of Mechanical Engineers Seminar, MIT Mechanical Engineering, November 2011.

Mathematics in Music: How the modern day music scales were constructed, Simple Person's Applied Math Seminar, MIT Applied Mathematics, October 2007.

What's the Deal with Entropy and Temperature? Simple Person's Applied Math Seminar, MIT Applied Mathematics, April 2007.

Take the (1/2)th Derivative of This! An introduction to fractional calculus and its applications, Simple Person's Applied Math Seminar, MIT Applied Mathematics, October 2006.

Gambling Tactics: Cashing in on applied math, Simple Person's Applied Math Seminar, MIT Applied Mathematics, May 2006.

Fibonacci Numbers and the Golden Ratio: Natural beauty through optimization, Simple Person's Applied Math Seminar, MIT Applied Mathematics, December 2005.

Fun with Variational Calculus, Simple Person's Applied Math Seminar, MIT Applied Mathematics, April 2005.

Informal   *Stochastic and Deterministic Models for Granular Flow*, Research group of Dr. Igor Aronson, Argonne National Laboratory, Materials Science Division, August 2007.

Solid Mechanics and its Application to Granular Flow (series of 10 lectures), Dry Fluids Group, MIT Applied Mathematics, July 2004.

Conference Talks

Invited   *A Predictive Model for Dense Granular Flow, 57th New England Workshop on Complex Fluids*, Northeastern University, December 2013

Constitutive Modeling of Dense Granular Flow, Non-Newtonian Multiphase Slurry Workshop, DOE National Energy Technology Laboratory, Morgantown, WV, August 2013

A Size-Dependent Continuum Model for Predicting Dense Granular Flows, 7th MIT Conference on Computational Fluid and Solid Mechanics, June 2013

Steady Granular Flow: Local and Nonlocal Approaches, International Congress of Theoretical and Applied Mechanics, Beijing, August 2012.

Steady Granular Flow: Local and Nonlocal Approaches, Gordon Research Conference: Granular and Granular-Fluid Flow, Davidson, July 2012.

Local and nonlocal continuum modeling for dense granular flow, European Solid Mechanics Conference, Graz, June 2012.

Local and Nonlocal Approaches to Steady Granular Flow, International Union on Theoretical and Applied Mechanics Symposium on Mobile Particulate Systems, Bangalore, January 2012.

A Plasticity Model for Steady Flowing Granular Materials, 17th International Symposium on Plasticity, Puerto Vallarta, January 2011.

A Continuum Model for Steady Granular Flow, 16th US National Congress of Theoretical and Applied Mechanics, State College, June 2010.

Steady Granular Flow: Continuum Theory and Simulation, Northeastern Granular Material Workshop, Cambridge, June 2010.

Elasto-Plastic Modeling of Steady Granular Flow, APS March Meeting, Portland, March 2010.

The Stochastic Flow Rule: A Multi-scale Model for Granular Plasticity, 7th World Congress of Computational Mechanics, Los Angeles, July 2006.

Contributed   *Modeling Size-Effects in 2D Granular Flows*, 50th Meeting of the Society of Engineering Sciences, July 2013.

Effective Slip Identities for Viscous Flow Over Arbitrary Patterned Surfaces, APS Division of Fluid Dynamics, San Diego, November 2012.

Nonlocal Model for Steady Granular Flow, ASME Congress, Houston, November 2012.

Local and non-local constitutive approaches for flowing granular materials, ASME Congress, Denver, November 2011.

Fluid Mobility Over Arbitrarily Textured Surfaces, 48th Meeting of the Society of Engineering Science, Evanston, October 2011.

Investigating and Testing the Reference Map Approach for Large-Strain Solid Deformation, 6th MIT Conference on Computational Fluid and Solid Mechanics, Cambridge, June 2011.
A Nonlocal Enhancement to Granular Elasto-Plasticity, APS March Meeting, Dallas, March 2011.

Shear Flow over Arbitrary Periodic Surfaces, APS Division of Fluid Dynamics, Minneapolis, November 2009.
General Continuum Law for Dense Granular Flow, 7th Northeastern Granular Materials Workshop, Yale University, June 2009.

Nonlinear Elasto-plasticity for Dense Granular Flow, Greater Boston Area Statistical Mechanics Meeting, Brandeis University, October 2008.

A Nonlinear Elasto-plastic Model for Dense Granular Flow, 30th New England Complex Fluids Workshop, Harvard University, December 2007.

The Stochastic Flow Rule and Rate Sensitivity in Dense Granular Flows, APS March Meeting, Denver, March 2007.

Testing the Stochastic Flow Rule, 29th New England Complex Fluids Workshop, Harvard University, December 2006.

A Stochastic Flow Rule for Dense Granular Plasticity, 4th Northeastern Granular Materials Workshop, City College of New York, June 2006.

A Theory of Stochastic Plasticity for Dense Granular Flow, APS March Meeting, Baltimore, March 2006.
Evaluation and Comparison of Continuum Models for Dense Granular Flow, 3rd Northeastern Granular Materials Workshop, Wesleyan University, June 2005.

Evaluation and Comparison of Continuum Models for Dense Granular Flow, APS March Meeting, Los Angeles, March 2005.

Teaching

Courses   Class Lecturer in the Mechanical Engineering department at MIT.

Class	Description	Date
2.001	Mechanics and Materials I	Spring 2014
2.001	Mechanics and Materials I	Fall 2013
2.002	Mechanics and Materials II	Spring 2013
2.002	Mechanics and Materials II	Spring 2012

Section and Laboratory Instructor in the Mechanical Engineering department at MIT.

Class	Description	Date
2.001	Mechanics and Materials I	Fall 2012
2.002	Mechanics and Materials II	Spring 2012
2.002	Mechanics and Materials II	Fall 2011
2.002	Mechanics and Materials II	Spring 2011

Applied Mathematics Lecturer at Harvard University. Headed classes of ∼20-40 students in a lead instructor role.

Class	Description	Date
Applied Mathematics 105A	Complex and Fourier Analysis	Fall 2009
Applied Mathematics 147	Nonlinear Dynamical Systems	Spring 2009
Applied Mathematics 105A	Complex and Fourier Analysis	Fall 2008

Teaching Assistant in the MIT mathematics department. Taught bi-weekly recitations, graded homework and exams, and assigned final course grades for ∼20 students.

Class	Description	Date
18.03	Differential Equations	Spring 2005
18.02A	Calculus 2 & start of Multivariable Calculus	Fall 2004

Taught undergraduate mathematics under two official titles at the UC Berkeley Student Learning Center: Group Instructor (GI) and Adjunct Course Instructor (ACI). As GI, led a bi-weekly review discussion for ∼20 students. As ACI, instructed a supplemental course for credit including exams. Two lectures per week, ∼25 students.

Class	Description	Date	Position
Math 1B	Calculus 2	Spring 2003	GI
Math 54	Linear Algebra & Differential Equations	Fall 2002	GI
Math 53	Multivariable Calculus	Spring 2002	GI
Math 53	Multivariable Calculus	Fall 2001	GI
Math 1B	Calculus 2	Spring 2001	ACI
Math 55	Discrete Math	Fall 2000	GI
Math 55	Discrete Math	Spring 2000	GI

Teaching Scores   Student-averaged teaching score at MIT: 6.3/7.0

Teaching Honors   Harvard University Certificate of Distinction in Teaching (2009), UC Berkeley Student Learning Center, Highest Rated Group Instructor (2000).

Software

C++, Fortran 90, Mathematica, MATLAB. Finite element software ABAQUS and the programming of subroutines therein. Experienced in html.