

CURRICULUM VITAE

ARSHAD KUDROLLI

Associate Professor of Physics

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Education

Ph.D. (Physics), Northeastern University, Boston (1995)

Thesis: Experiments on Quantum and Electromagnetic Chaos

B. Tech. (Engineering Physics), Indian Institute of Technology, Bombay (1990)

Employment

9/03 - present, Associate Professor of Physics, Clark University

9/97 - 8/03, Assistant Professor of Physics, Clark University

10/95 - 7/97, Research Associate, Haverford College, with Professor J.P. Gollub

7/92 - 9/95, Research Assistant, Northeastern University, with Professor S. Sridhar

Other Appointments

9/00 - present, Visiting Scholar and Research Affiliate, Department of Mathematics, Massachusetts Institute of Technology

7/06 - 8/06, Visiting Professor, Physics Department, University of Liège, Belgium.

4/05 - 5/05, Member, Kavli Institute for Theoretical Physics, University of California, Santa Barbara

Grants and Awards

“Statistical and Dynamical Properties of Spherical and Non-Spherical Granular Materials,” National Science Foundation - DMR, 06/2006 - 06/2009

“Flow and strength of cohesive granular materials,” ACS Petroleum Research Fund, 02/2006-08/2008

“Physics of Channelization: Experiments, Theory and Observations,” Department of Energy - BES, 01/2006 - 02/2009

“Dense Granular Flows,” Iowa State Univ., Department of Energy, 07/2004 - 08/2005

“Particle diffusion and mixing during silo drainage,” National Science Foundation - CBET, 04/2004 - 03/2008

“Physics of Channelization: Experiments, Theory and Observations,” Department of Energy - BES, 09/2002 - 11/2005

“CAREER: Instabilities in wet and dry granular flows,” National Science Foundation - DMR, 01/2000 -12/2004

Research Innovation Award, Research Corporation (1998)

Petroleum Research Fund Starter Grant, 09/1998-08/2000

Alfred P. Sloan Research Fellow (1998)

Research Interests

Soft-condensed matter physics, Complex matter, Granular materials, Nonlinear physics, Geomorphology, Biomechanics, Elasticity and crumpling, Population dynamics and patterns in biological systems

Publications in Refereed Journals

1. “Swarming and swirling in self-propelled granular rods,” A. Kudrolli, G. Lumay, D. Volfson, and L. Tsimring, *Phys. Rev. Lett.* **100**, 058001 (2008). *Cover*.
2. “Lubrication effects on the flow of wet granular materials,” Q. Xu, A.V. Orpe, and A. Kudrolli, *Phys. Rev. E* **76**, 031302 (2007).
3. “Velocity correlations in dense granular flows observed with internal imaging,” A.V. Orpe and A. Kudrolli, *Phys. Rev. Lett.* **98**, 238001 (2007).
4. “Curvature condensation and twinning in an indented elastic shell,” M. Das, A. Vaziri, A. Kudrolli, and L. Mahadevan, *Phys. Rev. Lett.* **98**, 014301 (2007).
5. “Dynamics of channel incision in a granular bed driven by subsurface water flow,” A.E. Lobkovsky, B. Smith, A. Kudrolli, D.C. Mohrig, and D.H. Rothman, *J. Geophys. Res. - Earth Surface* **112**, F03S12 (2007).
6. “Friction of a slider on a granular layer: Nonmonotonic thickness dependence and effect of boundary conditions,” S. Siavoshi, A.V. Orpe, and A. Kudrolli, *Phys. Rev. E* **73**, 010301 (2006).
7. “Maximum angle of stability of a wet granular pile,” S. Nowak, A. Samadani, and A. Kudrolli, *Nature Physics*, **1**, 50 (2005).
8. “Dynamics of a bouncing dimer,” S. Dorbolo, D. Volfson, L. Tsimring, and A. Kudrolli, *Phys. Rev. Lett.* **95**, 044101 (2005).

9. "Velocity profile of granular flows inside silos and hoppers," J. Choi, A. Kudrolli and M.Z. Bazant, *J. Phys. Cond Matt.* **17**, S2533 (2005).
10. "Failure of a granular step," S. Siavoshi and A. Kudrolli, *Phys. Rev. E* **71**, 051302 (2005).
11. "Geometry of Crumpled Paper," D.L. Blair and A. Kudrolli, *Phys. Rev. Lett.* **94**, 166107 (2005). *Cover.*
12. "Anisotropy driven dynamics in vibrated granular rods," D. Volfson, A. Kudrolli, and L.S. Tsimring, *Phys. Rev. E* **70**, 051312 (2004).
13. "Threshold phenomena in erosion driven by subsurface flow," A.E. Lobkovsky, B. Jensen, A. Kudrolli, and D.H. Rothman, *J. Geophys. Res. - Earth Surface* **109**, F04010 (2004).
14. "Diffusion and mixing in gravity-driven dense granular flows," J. Choi, A. Kudrolli, R.R. Rosales, M.Z. Bazant, *Phys. Rev. Lett.* **92**, 174301 (2004).
15. "Spontaneous channelization in permeable ground: Theory, experiment, and observation," N. Schorghofer, B. Jensen, A. Kudrolli, and D.H. Rothman, *J. Fluid Mech.* **503**, 357 (2004).
16. "Size separation in vibrated granular materials," A. Kudrolli, *Rep. Prog. Phys.* **67**, 209 (2004).
17. "Collision statistics of driven granular materials," D.L. Blair and A. Kudrolli, *Phys. Rev. E* **67**, 041301 (2003).
18. "Vortices in vibrated granular rods," D.L. Blair, T. Neicu, and A. Kudrolli, *Phys. Rev. E* **67**, 031303 (2003).
19. "Clustering transitions in vibro-fluidized magnetized granular materials," D. L. Blair and A. Kudrolli, *Phys. Rev. E* **67**, 021302 (2003).
20. "Shocks in sand flowing in a silo," A. Samadani, L. Mahadevan, and A. Kudrolli, *J. Fluid Mech.* **452**, 293 (2002).
21. "Periodic orbit analysis of an elastodynamic resonator using shape deformation," T. Neicu and A. Kudrolli, *Europhys. Lett.* **57** (3), 341 (2002).
22. "Velocity correlations in dense granular gases," D. L. Blair and A. Kudrolli, *Phys. Rev. E* **64**, 050301(R) (2001).
23. "Angle of repose and segregation of cohesive granular matter," A. Samadani and A. Kudrolli, *Phys. Rev. E* **64**, 051301 (2001).
24. "Swarming ring patterns in bacterial colonies exposed to ultraviolet radiation," A. Delprato, A. Samadani, A. Kudrolli, and L. S. Tsmiring, *Phys. Rev. Lett.* **87**, 158102 (2001).

25. "Eigenmodes of a clover shaped plate with mixed phase dynamics," O. Brodier, T. Neicu, and A. Kudrolli, Euro. Phys. J. B **23**, 365 (2001).
26. "Spectral properties of a mixed system using an acoustical resonator," T. Neicu, K. Schaadt, and A. Kudrolli, Phys. Rev. E **63**, 026206 (2001).
27. "Scarred patterns in surface waves," A. Kudrolli, M. Abraham, and J.P. Gollub, Phys. Rev. E **63**, 026208 (2001).
28. "Segregation transitions in wet granular matter," A. Samadani and A. Kudrolli, Phys. Rev. Lett. **85**, 5102 (2000).
29. "Non-Gaussian velocity distributions in excited granular matter in the absence of clustering," A. Kudrolli and J. Henry, Phys. Rev. E **62**, R1489 (2000).
30. "Extinction transition in bacterial colonies under forced convection," T. Neicu, A. Pradhan, D. Laroche and A. Kudrolli, Phys. Rev. E **62**, 1059 (2000).
31. "Size segregation of granular matter in silo discharges," A. Samadani, A. Pradhan and A. Kudrolli, Phys. Rev. E **60**, 7203 (1999).
32. "Experimental investigation of universal parametric correlators using a vibrating plate," K. Schaadt and A. Kudrolli, Phys. Rev. E **60**, R3479 (1999).
33. "Velocity statistics in vibrated granular media," W. Losert, D.G.W. Cooper, J. Delour, A. Kudrolli and J.P. Gollub, Chaos **9**, 682 (1999).
34. "Superlattice structures in surface waves," A. Kudrolli, B. Pier and J.P. Gollub, Physica D **123**, 99 (1998).
35. "Time resolved studies of stick-slip motion in sheared granular layers," S. Nasuno, A. Bak, A. Kudrolli and J.P. Gollub, Phys. Rev. E **58**, 2161 (1998).
36. "Friction in granular layers: Hysteresis and precursors," S. Nasuno, A. Kudrolli and J.P. Gollub, Phys. Rev. Lett. **79**, 949 (1997).
37. "Cluster formation due to collisions in granular material," A. Kudrolli, M. Wolpert and J.P. Gollub, Phys. Rev. Lett. **78**, 1383 (1997).
38. "Experiments on quantum chaos using microwave cavities: Results for the pseudo-integrable L-billiard," A. Kudrolli and S. Sridhar, Pramana, J. of Phys. **48**, 459 (1997).
39. "Patterns and spatiotemporal chaos in parametrically forced surface waves: Systematic survey at large aspect ratio," A. Kudrolli and J.P. Gollub, Physica D **97**, 133 (1996).
40. "Localized spatiotemporal chaos," A. Kudrolli and J.P. Gollub, Phys. Rev. E **54**, R1052 (1996).

41. "Comment on Gaussian orthogonal ensemble statistics," A. Kudrolli and S. Sridhar, Phys. Rev. Lett. **76**, 3036 (1996).
42. "Spatial correlation in quantum chaotic systems with time-reversal symmetry: Theory and experiment," V.N. Prigodin, N. Taniguchi, A. Kudrolli, V. Kidambi and S. Sridhar, Phys. Rev. Lett. **75**, 2392 (1995).
43. "Experiments on chaos and localization in quantum wavefunctions," A. Kudrolli, V. Kidambi and S. Sridhar, Phys. Rev. Lett. **75**, 822 (1995).
44. "Experiments on not hearing the shape of drums," S. Sridhar and A. Kudrolli, Phys. Rev. Lett. **72** 2175 (1994).
45. "Signatures of chaos in quantum billiards: Microwave experiments," A. Kudrolli, S. Sridhar, A. Pandey and R. Ramaswamy, Phys. Rev. E **49**, R11 (1994).

Invited, Conference Proceedings, and Preprints

1. "Granular Matter - Sticky Sand," News and Views, Nature Materials **7**, 174 (2008).
2. "Erosion of a granular bed driven by laminar fluid flow," A. Orpe, A. Lobkovsky, R. Molloy, A. Kudrolli, and D. Rothman, J. Fluid Mech. *accepted*.
3. "Introduction: Fourth Annual Gallery of Nonlinear Images (Denver, Colorado, 2007)," B. Schmittmann, M.C. Marchetti, S. Redner, and A. Kudrolli, Chaos **17**, 041101 (2007).
4. "Dynamics of a vibrated dimer," S. Dorbolo, N. Vandewalle, D. Volfson, L. Tsimring, and A. Kudrolli, in *Powders and Grains 2005* (Taylor and Francis, 2005).
5. "Magnetized granular materials," D.L. Blair and A. Kudrolli, in *The Physics of granular media*, H. Hinrichsen and D.E. Wolf (Editors), (Wiley-VCH publishers, 2004) 281-296. *Cover*.
6. "Clustering, jamming and segregation in cohesive granular materials," A. Samadani, D.L. Blair and A. Kudrolli, ASME International Mechanical Engineering Congress & Exposition, IMECE2002-32478 (2002).
7. "Segregation and layering in wet granular matter," A. Samadani and A. Kudrolli, in *Powders and Grains 01* (Balkema Publishers, 2001) 429.
8. "Visualization of segregation in granular flows inside silos," A. Samadani, A. Pradhan and A. Kudrolli, in *The Proceedings of The ITUAM Symposium on Segregation in Granular Flows*, (Kluwer Academic Publishers, 2000) 53.
9. "Sensitive force measurements in sheared granular flow with simultaneous imaging," S. Nasuno, A. Kudrolli and J. P. Gollub, in *Powders and Grains 97* (Balkema, 1997) 535.

10. "Studies of cluster formation due to collisions in granular material," A. Kudrolli and J. P. Gollub, in *Powders and Grains 97* (Balkema, 1997) 329.
11. "Microwave 2-disk scattering," A. Kudrolli and S. Sridhar, in *Proceedings of the 4th Drexel Conference on Nonintegrability*, (World Scientific, 1996).
12. "Experiments on quantum chaos using microwave cavities," A. Kudrolli and S. Sridhar, in *Proceedings of the 2nd Conference on Experimental Chaos*, editors W. Ditto, L. Pecora, S. Vohra, M. Shlesinger and M. Spano, (World Scientific, 1995) 184.
13. "Experimental eigenvalue spectra of rough and multiply-connected billiards," S. Sridhar, D. Hogenboom and A. Kudrolli, in *Quantum Dynamics of Chaotic Systems*, edited by J. M. Yuan, D. H. Feng and G. M. Zaslavsky, (Gordon and Breach, 1993) 297.

Advisees

Graduate: Toni Neicu, Ph.D. (Radiation Oncologist, Henry Ford Hospital, Detroit), Azadeh Samadani, Ph.D. (Assistant Professor of Physics, Brandeis University), Daniel Blair, Ph.D. (Assistant Professor of Physics, Georgetown University), Saloome Siavoshi, M.S. (Graduate Student, Northeastern), Qing Xu, M.S. (Graduate Student, Georgia State University), Kevin Safford (current), Andrea Panaitescu (current)

Undergraduate: Apurba Pradhan, Taimur Ellahi, Ryan O'Donnell, Eric Frederick, Ian Nagle, Sarah Shugars, Micah Veilleux, Ryan Molloy, Mike Robitaille

Post-doc/Visiting Scholar: Kristian Schaatt (NBI, Denmark), Olivier Brodier (ENS, France), Bill Jensen (UMass, Boston), Stephane Dorbolo (Liège), Geoffroy Lumay (Liège), Thomas Garnier (ENS-Lyons), Ashish Orpe (National Chemical Laboratory, Pune, India)

Teaching

Courses: Introductory Physics Calculus and Non-Calculus versions, Activity Based Introductory Physics (new course), Waves and Optics, Quantum Physics and Laboratory, Electrodynamics, Continuum Mechanics and Applications to Swimming and Flying (new course)

Professional Service

Clark Committee on Personnel, 9/07-present

Clark University Research Board, 10/02-present

Science Working Group 11/01 - present

Undergraduate physics advisor, 9/01-present

Information Technology Committee, 9/98-8/00, 9/01-8/02, 9/03-0/04.

Secretary-Treasurer, Topical Group on Statistical and Nonlinear Physics of the American Physical Society, 3/07-present.

Guest Editor, Gallery of nonlinear images, Chaos, 2007-present.

Organizer: 27th New England Complex Fluids Workshop, Annual Northeast Granular Materials Workshop

Organizer: Symposia on Locomotion in Complex Fluids, 2008 March American Physical Meeting, New Orleans

Referee

Journals: Physical Review Letters, Physical Review, Science, Nature, Proceedings of the National Academy of Science, Journal of Fluid Mechanics, Physics of Fluids, American Journal of Physics, Physica A, Chemical Engineering Sciences, Granular Matter, Powders and Grains 2005, Powder Technology

Funding Agencies: National Science Foundation, ACS/Petroleum Research Fund, Department of Energy, National Aeronautics and Space Administration, Research Corporation, Netherlands Foundation for Fundamental Research on Matter, Chile Science Foundation, Israel Science Foundation, INDO-US Science and Technology Forum

Invited Presentations

1. "Velocity correlations in dense granular flows," Workshop on granular fluids, Seville, Sept. 2007.
2. "Notions in Locomotion seminar," Aspen Institute of Physics, June 2007.
3. "Particle Shape and Dynamics of Granular Matter: Swarming to Swirling," Physics seminar, Trinity College, Apr. 2007.
4. "Particle Shape and Dynamics of Granular Matter: Swarming to Swirling," American Physical Society Meeting, Denver, Mar. 2007.
5. "Physics of Channelization: Theory, experiment, and observation," Workshop on Complex Geophysical Gravity Currents, Vancouver, Mar. 2007.
6. "Dense granular flows observed with internal imaging," Chemical Engineering seminar, IISc Bangalore, Jan 2007.
7. "Particle Shape and Dynamics of Granular Matter: Swarming to Swirling," Physics seminar, IISc Bangalore, Jan. 2007.
8. "Giant number fluctuations and cooperative phenomena in self propelled particles," Physics seminar, Brandeis University, Oct. 2006.
9. "Clustering and Dynamics of Granular Rods, Polymers and Magnets," Physics seminar, Boston University, Sept. 2006.
10. "Particle shape and dynamics of granular matter," Southern Workshop on Granular Matter, Vina del Mar, Chile, Sept. 2006.

11. "Particle shape and dynamics of granular matter," ESPCI, Paris, July 2006.
12. "Granular matter," Ecole Normale Sup'erieure, Paris, July 2006.
13. "Dynamics of anisotropic granular matter," Mechanical Engineering seminar, Yale University, Feb. 2006.
14. "Particle shape and dynamics of granular matter," Courant Institute seminar, New York University, Nov. 2005.
15. "Investigation of Dense Dry and Wet Granular Flows with Internal Imaging," Granular Matter Conference, KITP, Santa Barbara, June 2005.
16. "Self-organization in granular matter and noise driven motors," Granular Matter Seminar, KITP, Santa Barbara, April 2005.
17. "Self-organization in vibrated granular materials," NY-APS section meeting, Rochester, April 2005.
18. "Dynamics of granular materials," Physics colloquium, Georgia Tech, Dec. 2004.
19. "Anisotropic granular matter," 2nd Granular Materials Workshop, Yale University, New Haven, June 2004.
20. "Dynamics in granular materials," Physics Colloquium, Levih Institute, New York, May 2004.
21. "Dynamics in granular materials," Physics Colloquium, Emory University, Atlanta, April 2004.
22. "Granular Materials: Rock, Roll and Shake," Niels Bohr Seminar, Copenhagen, Mar. 2004.
23. "Self-organization in granular matter," Mechanical Engineering Seminar, WPI, Worcester, Dec. 2003.
24. "Self-Assembly in Magnetized Granular Materials," Workshop on Cooperative Grains: From Granular Matter to Nano Materials, Leiden, Netherlands, Sept. 2003.
25. "Self-Assembly in Magnetized Granular Materials," Workshop on Traffic and Granular Flow, Delft, Netherlands, Sept. 2003.
26. "Experiments on dry and wet granular materials," APCTP Winter School on Granular Material and Complex System, Phoenix Park, Korea, Feb. 2003.
27. "Granular materials: Shake, rattle and roll," Physics seminar, Korea University, Seoul, Feb. 2003.
28. "Granular materials: Shake, rattle and roll," Northeastern, Physics Colloquium, Boston, Jan. 2003.

29. "Clustering and jamming in cohesive granular materials," GLUE workshop, Argonne National Lab, Jan. 2003.
30. "Clustering, jamming and segregation in cohesive granular materials," ASME Meeting, New Orleans, Nov. 2002.
31. "Clustering, jamming and segregation in cohesive granular materials," Division of Engineering Seminar, Brown University, Providence, Oct. 2002.
32. "Clustering and segregation in dry and wet granular materials," Physics Colloquium, UMass, Lowell, Sept. 2002.
33. "Vortices, clustering and coarsening in granular materials," Workshop on the Formation of Structures in Granular Materials, Leiden, The Netherlands, Aug. 2002.
34. "Vortices in Vibrated Granular Materials," 50th Annual SIAM meeting, Philadelphia, July 2002.
35. "Cohesive Granular Matter," Gordon Research Conference, Plymouth, NH, June 2002.
36. "Vortices and clustering in anisotropic granular materials," Physics Colloquium, WPI, April 2002.
37. "Angle of Repose and segregation wet granular matter," American Physical Society Meeting, Indianapolis, Mar. 02.
38. "Vortices in vibrated granular matter, Physics Seminar," University of Maryland, College Park, Feb. 2002.
39. "Clustering and vortices in anisotropic granular materials," Nonlinear Science Seminar, Northwestern, Jan. 02.
40. "Experiments with cohesive granular matter," GBASM Workshop, Brandeis, Oct. 01.
41. "Granular matter with attraction," Physical Math Seminar, MIT, Oct. 01.
42. "Wet granular matter," Continuum Mechanics Workshop, Chicago, Aug. 01.
43. "Physics of granular and dipolar materials," Mechanical Engineering Dept Seminar, MIT, May 01.
44. "Clustering and segregation in granular matter," Mechanical Engineering Dept Seminar, NJIT, April 01.
45. "Instabilities in the flow of dry and wet granular matter," Workshop on Soft Matter as a Nonlinear System, Laguna Beach, Feb. 01.
46. "Physics of the sandbox," SPS seminar, Bridgewater State College, Dec. 00.
47. "Physics of granular flow," DEAPS seminar, MIT, Nov. 00.

48. "Clustering and segregation in the flow of granular matter," LASSP seminar, Cornell Univ., Sept. 00.
49. "Physics of the flow of granular matter," Workshop on Statistical Dynamics of Continuous Media, Aspen Center of Physics, June 00.
50. "Instabilities in the flow of granular matter," Applied Math Seminar, WPI, April 00.
51. "Flow and segregation in dry and wet granular matter," Meeting of the American Physical Society, Minneapolis, March 00.
52. "Segregation and clustering in granular matter," Physics Colloquium, Brandies University, Feb. 00.
53. "Instabilities in the flow of granular matter," Physical Math Seminar, MIT, Nov. 99.
54. "The physics of granular matter and the convection of life," Physics colloquium, Wesleyan University, April 99.
55. "The physics of granular flow," Condensed Matter Seminar, Brown University, Feb. 99.
56. "Physics of granular flow," Physics colloquium, University of Rhode Island, Sept. 98.
57. "Scarred patterns in surface waves," Seminar, Harvard University, June 98.
58. "Flow in granular matter: Clusters and precursors," Continuum Seminar Series, MIT, April 98.
59. "Physics of granular materials," Seminar, Northeastern University, Boston, Oct. 97.
60. "Physics of granular flow," University of Massachusetts, Amherst, Sept. 97.
61. "Scarred patterns in surface waves," Institute seminar, NEC Research Institute, Princeton, Aug. 97.
62. "Cluster formation in driven granular material," American Physical Society Meeting, Kansas City, Mar. 97.
63. "Physics of granular materials and surface waves," Clark University, Worcester, Feb. 97.
64. "Eigenvalues and Eigenfunctions of Microwave Cavities," Seminar, Bell Labs, Nov. 96.
65. "Chaos and disorder in quantum billiards: Microwave experiments," Condensed matter seminar, Rutgers University, Piscataway, Apr. 95.
66. "Chaos and disorder in quantum billiards: Microwave experiments," Institute seminar, Niels Bohr Institute, Copenhagen, Apr. 95.

67. “Experiments on quantum chaos using microwave techniques,” Quantum Chaos seminar, Harvard University, Cambridge, Dec. 94.

Research in the News

- “Sandcastle Stability Poet Triumph,” The mini-Annals of Improbable Research, December, 2007.
- “Nutty ideas spark Clark grain trust - Sand stirs new study,” Telegram and Gazette Newspaper, July 11, 2006.
- “Why do some sand castles stand firm until swallowed by the rising tide, while others fall over instantly?” Popular Science, Jan 2006.
- “The ascent of sand,” Seed Magazine, Oct 2005.
- “Recipe for a perfect sandcastle?” Reuter, CNN, Boston Globe, etc., Sept. 2005.
- “Surface wave patterns in a stadium,” Archimede, ARTE culture network TV in France and Germany, Jan. 2002.
- “Outa my way!” New Scientist, Oct 2001.
- “Ultraviolet and rings of bacteria,” The Boston Globe, Oct. 2001.
- “Ultraviolet prompts bacterial trek,” Physics News Update, Oct. 2001.
- “Swarming bacteria,” Physics News Graphics, Oct. 2001.
- “Novel wave symmetries in fluids,” Physics News Graphics, Jan. 1998.
- “Stick-slip friction,” Search and Discovery, Physics Today, Sept. 1997.
- “Cavities of chaos,” Science News, April 1995.
- “Beating a fractal drum,” Science News, Sept. 1994.
- “Why different drums can sound the same,” Physics World, Aug. 1994.