ROUSLAN KRECHETNIKOV

PERSONAL DATA

- Born in Siberia (Russia), on December 19, 1974
- Contact address:

Department of Mechanical Engineering
University of California, Santa Barbara, CA 93106
Ph: (805) 893-8501 / Fax: (805) 893-8651
E-mail: rkrechet@engineering.ucsb.edu

EDUCATION

- Moscow Institute of Physics and Technology (Phystech), Moscow, Russia

Ph.D. (January 2004) Applied Mathematics

- University of Notre Dame, Indiana, USA

M.S. (June 2000)/ **Ph.D.** (August 2002) Aerospace and Mechanical Engineering

- Moscow Institute of Physics and Technology (Phystech), Moscow, Russia

M.S. with honors (June 1998. GPA 5.0/5.0) Applied Mathematics and Theoretical Physics

B.S. with honors (June 1996. GPA 5.0/5.0) Applied Mathematics and Theoretical Physics

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RESEARCH EXPERIENCE

- Assistant Professor (tenure-track)

11/08 – present: Dept. of Mech. Engr., University of California, Santa Barbara, USA

07/07 – 10/08: Dept. of Math. & Stats. Sci., University of Alberta, Edmonton, Canada

08/06 – 06/07: School of Math. & Stats., Carleton University, Ottawa, Canada

- Postdoctoral Scholar

09/04 – 07/06: Research Group of Prof. Jerrold E. Marsden,
Control & Dyn. Systems/ Engng. Division, California Institute of Technology, Pasadena, USA

09/02 – 08/04: Research Group of Prof. George M. Homsy,
Mechanical & Environmental Engineering, University of California at Santa Barbara, USA

- Research assistant

09/98 – 05/02: Aerospace & Mechanical Engineering, University of Notre Dame, Indiana, USA

- Engineer & Research assistant

09/95 – 06/98: Research Group of Prof. Igor I. Lipatov,
Central Aero-Hydrodynamic Institute (TsAGI), Zhukovsky-3, Russia

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TEACHING EXPERIENCE

- Assistant Professor (University of California: Fall 2008 – present; University of Alberta: Fall 2007 – Fall 2008; Carleton University: 2006 - 2007)

Prepared and taught both graduate and undergraduate courses for mathematics and engineering students

- Lecturer (Caltech and University of Notre Dame)

Prepared and taught a lecture series on *Dissipation induced instability theory* (Caltech, Fall 2005)

Prepared and taught a graduate course *Symmetry Analysis of PDEs* (University of ND, Spring 2001)

CURRENT RESEARCH INTERESTS

- Mechanics and dynamical systems

  Effects of *dissipation* and various non-conservative forces in mechanical and fluids systems

  Modeling of *complex systems* lacking any 'first principles' description for the purpose of their control

- Fluid mechanics

  Interfacial fluid dynamics: instabilities, wetting and coating physics, surfactant and other Marangoni effects

  Separation phenomena and *control* of separated flows with application to aircrafts and biological systems

  Development of a rigorous *nonlinear* geometry-based *stability theory* of the transition to turbulence phenomena

MAIN SCIENTIFIC ACCOMPLISHMENTS

- Geometric mechanics (work with Jerrold E. Marsden)
  1) Developed a complete theory and a geometric picture of the fundamental dissipation-induced instabilities in the finite-dimensional systems.
  2) Extended the notion of the dissipation-induced instability onto infinite-dimensional systems and proved rigorously the first known example using baroclinic instability of Westerlies in mid-latitudes as a paradigm.
- Low Reynolds number fluid dynamics (work with George M. Homsy)
  1) Explained theoretically new hydrodynamic instability – surfactant driven fingering in a Hele-Shaw cell, and experimentally confirmed the theory.
  2) Explained and modeled new nonlinear Marangoni phenomena – chemically driven tip-streaming. In particular, new self-similar solution of Navier-Stokes equations is found and new exhibition of a long-range dipole-dipole type interaction is discovered.
  3) Demonstrated both numerically and experimentally that the film thickening in the Landau-Levich problem of dip-coating in the presence of surfactants is not due to Marangoni phenomena as commonly believed.
  4) Studied experimentally the problem of dip-coating of well-characterized rough surfaces.
  5) Discovered a fundamental instability responsible for the crown formation in the drop splash problem.
  6) Studied the effects of an interfacial curvature and a frame of reference on the evolution of the Richtmyer-Meshkov and the Rayleigh-Taylor instabilities.
- High Reynolds number fluid dynamics (Ph.D. work with Igor I. Lipatov)
  1) Exactly solved the Lighthill problem of upstream influence in super- and hypersonic boundary layer flows. As motivated by active control of separation, the study of the dependence of the upstream influence on physical conditions at the wall was performed and revealed nontrivial implications.
  2) Using analytical and numerical tools explained the dynamics of the oscillatory excitation type active control of separation based on fully nonlinear receptivity problem of unsteady Prandtl boundary layer equations. Both reattachment and re-separation when amplitude of excitation increases are accounted for.
  3) Determined hidden invariants in three-dimensional wall jets flows and thus found new self-similar solutions of Navier-Stokes equations.

HONORS AND ACTIVITIES

1. Fellow of the Center for Applied Mathematics of the University of Notre Dame, (09/99–07/01).
2. Chaplygin Fellowship (09/97-06/98).
3. Moscow Mayor Yuri Luzhkov Scholarship (09/95-06/96).
4. NSERC Discover Grant from Mechanical Engineering B GSC: 2007-2012
5. Referee for *Springer (Mathematics Section)*, *Physics of Fluids, Physical Review E*, *SIAM journal of Multi-scale modeling and Simulation, European Journal of Mechanics - B/Fluids, Foundations of Physics Letters*.

SELECTED PUBLICATIONS IN REFEREED JOURNALS

- High Reynolds number fluid dynamics (Ph.D. work with Igor I. Lipatov)

1 Krechetnikov R., Lipatov I.I., "**Disturbances propagation in three-dimensional viscous hypersonic boundary layers**," *Dynamics of continuous media (Transactions of Lavrentyev Institute for Hydrodynamics, Novosibirsk)* **113**, 93-98 (1998).

2 Krechetnikov R., Lipatov I.I., "**Disturbances propagation in three-dimensional supersonic boundary layers**", *Journal of Applied Mechanics and Technical Physics* **40**, 461-470 (1999).

3 Krechetnikov R., Lipatov I.I., "**Time-periodic boundary layer under conditions of the large amplitude external disturbances**," *Transactions of Central Aero-Hydrodynamics Institute* **31**, 27-40 (2000).

4 Krechetnikov R., Lipatov I.I., "**Hidden invariances in problems of 2D and 3D wall jets for Newtonian and non-Newtonian fluids**," *SIAM Journal on Applied Mathematics* **62**, 1837-1855 (2002).

5 Krechetnikov R., Lipatov I.I., "**On upstream influence in supersonic flows**," *Journal of Fluid Mechanics* **539**, 167-178 (2005).

- Low Reynolds number fluid dynamics (work with George M. Homsy)

6 Krechetnikov R., Homsy G.M., "**On a new surfactant-driven fingering phenomenon in a Hele-Shaw cell,**" *Journal of Fluid Mechanics* **509**, 103-124 (2004).

7 Krechetnikov R., Homsy G.M., "**On physical mechanisms in chemical reaction-driven tip-streaming**," *Physics of Fluids* **16**, 2556-2566 (2004).

8 Fernandez J., Krechetnikov R., Homsy G.M., "**Experimental study of a new surfactant-driven fingering phenomena in a Hele-Shaw cell***," Journal of Fluid Mechanics* **527**, 197-216 (2005).

9 Krechetnikov R., Homsy G.M., "**Dip coating in the presence of a substrate-liquid interaction potential,**" *Physics of Fluids* **17**, 102105 (2005).

10 Krechetnikov R., Homsy G.M., "**Experimental study of substrate roughness and surfactant effects on the Landau-Levich law**," *Physics of Fluids* **17**, 102108 (2005).

11 Krechetnikov R., Homsy G.M., "**Surfactant effects in the Landau-Levich problem,"** *Journal of Fluid Mechanics* **559**, 429-450 (2006).

- Geometric mechanics & Dynamical systems (work with Jerrold E. Marsden)

12 Krechetnikov R., Marsden J.E., "**A note on destabilizing effects of two fundamental non-conservative forces,**" *Physica D* **214**, 25-32 (2006).

13 Krechetnikov R., Marsden J.E., "**Dissipation-induced instabilities in finite dimensions,**" *Reviews of Modern Physics* **79**, 519-553 (2007).

14 Krechetnikov R., Marsden J.E., "**Dissipation-induced instability phenomena in infinite-dimensional systems,**" to appear in *Archive for Rational Mechanics and Analysis* (2009).

- Most recent works

15 Krechetnikov R., Homsy G.M., "**Crown-forming instability phenomena in the drop splash problem**," *Journal of Colloid and Interface Science* **331**, 555-559 (2009).

16 Krechetnikov R., "**Rayleigh-Taylor and Richtmyer-Meshkov instabilities of flat and curved interfaces**," to appear in *Journal of Fluid Mechanics* (2009)

17 Krechetnikov R., Marsden J.E., Nagib H.M., "**A mechanistic model of separation bubble**," submitted to *Physica D* (2007).

18 Krechetnikov R., "**Approaching reduced-order modeling in physics**," in preparation (2008).

19 Krechetnikov R., "**Stability theory for systems with inhomogeneous basic states**," in preparation (2008).

SEMINAR AND COLLOQUIUM PRESENTATIONS

1. "***Current mathematical problems of nonlinear stability-receptivity theory***"
   - Seminar of Applied Mathematics, *University of Colorado, Boulder*, March 9, 2000.
2. "***Hidden invariances in problems of 2D and 3D wall-adjacent jets for Newtonian and non-Newtonian fluids***"
   - Colloquium of Applied Mathematics, *University of Colorado, Boulder*, March 10, 2000,
   - *Computing Center of Russian Academy of Sciences*, Moscow, Russia, December 11, 2000.
   - *St. Petersburg State Technical University*, St. Petersburg, Russia, June 28, 2001.
3. "***Modern symmetry analysis of partial differential equations***"
   - TAM Graduate Students Seminar, *University of Illinois at Urbana-Champaign*, October 6, 2000.
4. "***On the linear and weakly nonlinear stability of non-parallel flows***"
   - Fluid Mechanics Seminar, *University of California, Santa Barbara*, March 12, 2003.
5. "***On new surfactant driven phenomena: a reversed Saffman-Taylor instability and Taylor cones without electric field***"
   - Colloquia in Applied Mathematics, *Northwestern University*, Evanston, August 11, 2003,
   - Special Seminar, Department of Chemical Engineering, *Princeton University*, August 14, 2003.
6. "***Some mathematical problems of the boundary layer theory***"
   - Department of Applied Mathematics and Physics, *Moscow Aviation Institute*, Moscow, September 16, 2003,
   - Department of Aerophysics and Space Research, *Moscow Institute of Physics & Technology*, Moscow, October 28, 2003.
7. "***On Marangoni effect which turned out to be not due to Marangoni***"
   - Department of Mathematics, *Southern Methodist University*, November 10, 2004.
8. "***On some problems from classical boundary layer theory***"
   - Department of Mathematics, *University of Louisiana at Lafayette*, November 11, 2004.
9. "***On new Marangoni effects and and new interpretation of old Marangoni effects in physics of interfaces***"
   - Control & Dynamical Systems, *Caltech*, February 24, 2005.
10. "***On novel Marangoni flows***"
    - Department of Mathematics, *Southern Methodist University*, February 2, 2006.
    - School of Natural Sciences, *University of California at Merced*, February 9, 2006.
    - School of Mathematics & Statistics, *Carleton University*, February 15, 2006.
    - Department of Mechanical & Aerospace Engineering, *Arizona State University*, February 20, 2006.
    - Department of Mechanical Engineering, *Stanford University*, February 28, 2006.
    - Department of Applied Mathematics, *University of Waterloo*, November 10, 2006.
    - Department of Mechanical, Aerospace, and Nuclear Engineering, *Rensselaer Polytechnic Institute*, January 30, 2008.
11. "***A mechanistic model of separation bubble***"
    - Fluid Dynamics Research Center, *Illinois Institute of Technology*, April 20, 2006.
    - Center for Flow Physics and Control, *University of Notre Dame*, April 21, 2006.

WORKSHOPS

1. "***Application of the Secondary Calculus to the paradoxes of hidden invariances,***" Graduate Students Workshop, Center for Applied Mathematics, Notre Dame, Indiana, March 31, 2000.
2. "***Coarsening of near critical evolution systems*,**" Graduate Students Workshop, Center for Applied Mathematics, Notre Dame, Indiana, April 6, 2001.
3. "***Center-Unstable manifolds for PDEs on infinite strips*,**" Workshop on "Dynamics and bifurcations of patterns in dissipative systems", Fort Collins, Colorado, May 19-22, 2003.

Recent conference reports

1. Krechetnikov R., "*The hidden invariances in problems of two and three-dimensional wall-adjacent jets*," TsAGI conference "Modern Problems of Aerospace Science," May 1998, Zhukovsky, Russia.
2. Krechetnikov R., Paolucci S., "*3D Rayleigh-Benard convection in a closed cavity at high Rayleigh numbers*," 52d Annual Meeting of the Division of Fluid Dynamics, November 21-23, 1999, New Orleans, Louisiana.
3. Krechetnikov R., "*Extension of nonlinear operators and application to problems with non-homogeneous boundary conditions*," AMS Meeting, April 8-9, 2000, Notre Dame, Indiana.
4. Krechetnikov R., Paolucci S., "*Low-dimensional modeling near the threshold of instabilities*," 53rd Annual Meeting of the Division of Fluid Dynamics, November 19-21, 2000, Washington DC.
5. Lipatov I.I., Krechetnikov R., "*Disturbances propagation in supersonic boundary layers*," 53rd Annual Meeting of the Division of Fluid Dynamics, November 19-21, 2000, Washington DC.
6. Krechetnikov R., Lipatov I.I., "*Hidden invariances in problems of 2D and 3D wall jets for Newtonian and non-Newtonian fluids*," XXIX Summer School "Advanced Problems in Mechanics", June 21-30, 2001, St. Petersburg, Russia.
7. Krechetnikov R., Paolucci S., "*On the mathematical theory of weakly nonlinear stability*," Progress in Nonlinear Science, July 2-6, 2001, Nyzhny Novgorod, Russia.
8. Krechetnikov R., Paolucci S., "*Linear and weakly nonlinear stability theory of nonparallel flows*," 54th Annual Meeting of the Division of Fluid Dynamics, November 18-20, 2001, San Diego, California.
9. Krechetnikov R., Paolucci S., "*On the singularity of the parallel flow limit on extended domains*," 55th Annual Meeting of the Division of Fluid Dynamics, November 24-26, 2002, Dallas, Texas.
10. Homsy G.M., Fernandez J., Krechetnikov R., "*The Amazing Drop: tip-streaming, four-roll mills, and Gary Leal*", AIChE Annual Meeting, November 16-21, 2003, San Francisco, California.
11. Krechetnikov R., Homsy G.M., "*A reversed Saffman-Taylor instability II: theory*", 56th Annual Meeting of the Division of Fluid Dynamics, November 23-25, 2003, NYC/New Jersey.
12. Homsy G.M., Krechetnikov R., Fernandez J., Ward T., "*Novel Marangoni flows*," American and Indian Institutes of Chemical Engineering, December 28-30, 2004, Santa Cruz (East)/ Mumbai, India.
13. Krechetnikov R., Cinque D., Homsy G.M., "*On the classical Landau-Levich problem*", 57th Annual Meeting of the Division of Fluid Dynamics, November 21-23, 2004, Seattle, Washington.
14. Marsden J.E., Krechetnikov R., "*On dissipation-induced instabilities in infinite-dimensional systems,*" Dynamical system methods in fluid dynamics, August 1-6, 2005, Oberwolfach, Germany.
15. Krechetnikov R., Marsden J.E., Nagib H.M., "*Mechanical model of separation phenomena*", 58th Annual Meeting of the Division of Fluid Dynamics, November 20-22, 2005, Chicago, Illinois.
16. Krechetnikov R., "*On the effect of large amplitude excitations on the boundary layer separation*", 59th Annual Meeting of the Division of Fluid Dynamics, November 19-21, 2006, Tampa Bay, Florida.
17. Krechetnikov R., Marsden J.E., "*Dissipation-induced instability phenomena,*" Geometric mechanics: continuous and discrete, finite and infinite-dimensional, August 12-17, 2007, Banff, Canada.
18. Krechetnikov R., Homsy G.M., "*On the nature of the crown forming instability in the drop splash problem,*" 60th Annual Meeting of the Division of Fluid Dynamics, November 18-20, 2007, Salt Lake City/Utah.
19. Krechetnikov R., Marsden J.E., *"On the transition to turbulence problem,"* 2nd Canada-France Congress 2008, June 2-5, Montreal, Canada.
20. Krechetnikov R., Marsden J.E., *"On unstable modes in plane Couette flow,"* 61st Annual Meeting of the Division of Fluid Dynamics, November 23-25, 2008, San Antonio, Texas.
21. Krechetnikov R., *"Rayleigh-Taylor and Richtmyer-Meshkov Instabilities of Flat and Curved Interfaces",* AIChE Annual Meeting 2008, November 15-21, Philadelphia, Pennsylvania.

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