

## Curriculum Vitae

Zoran Grujić

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### **Educational Summary**

University of Zagreb, Croatia (Undergraduate), B.S. in Applied Mathematics (1991)  
Indiana University, Bloomington (Graduate), Ph.D. in Mathematics (1998);  
advisor: Ciprian Foias

### **Research Interests**

Applied analysis and mathematical physics; nonlinear partial differential equations arising as models in fluid and plasma dynamics; mathematical theory of turbulence

### **Positions**

University of Virginia, Department of Mathematics, *Interim Chair* (2017-2018)  
University of Virginia, Department of Mathematics, *Professor* (2012-present)  
University of Virginia, Department of Mathematics, *Associate Professor* (2007-2012)  
University of Virginia, Department of Mathematics, *Assistant Professor* (2001-2007)  
The University of Texas at Austin, Department of Mathematics, *Instructor* (1998-2001)

### **Visiting Positions**

Princeton University, *Visiting Fellow* (Spring 2017)  
The University of Chicago, *Long Term Visitor* (Fall 2011)  
The University of Chicago, *Long Term Visitor* (Fall 2004)  
Los Alamos National Laboratory, CNLS, *Visiting Scientist* (Summer 1998)

### **Honors**

*Indiana University Board of Trustees Teaching Recognition Award*  
*Glenn Schober Award*

Plenary talk, *Anomalous dissipation as a trigger for the energy cascade*, RIMS Seminar on Modern Approach and Developments to Onsager's Theory on Statistical Vortices, Kyoto, Japan

## Major Research Funding

NSF DMS - 2009607, *Toward Criticality of the Navier-Stokes Regularity Problem*, 07/01/2020-06/30/2023, PI

NSF DMS - 1515805, *Turbulent Cascades and Dissipation in the 3D Navier-Stokes Model*, 09/01/2015-03/31/2019, PI; collaborative research with R. Dascaliuc, Oregon State University, PI

Lundbeckfonden R217-2016-446, *Gamification of Turbulent Flow*, 06/30/2016-07/01/2018, PI; collaborative research with R. Feidenhans'l, Niels Bohr Institute, PI (project manager), J. Sherson, Aarhus University, PI and R.S. Kjaergaard, Aarhus University, PI

The Research Council of Norway, Prosjekt 213474/F20 FRINATEK (Independent basic research projects in Mathematics, Physical Science and Technology), *Nonlinear PDE in Spaces of Analytic Functions*, 01/01/2012-12/31/2015, PI; collaborative research with H. Kalisch, University of Bergen, PI (project manager) and S. Selberg, Norwegian University of Science and Technology, PI

NSF DMS - 1212023, *Turbulent Cascades and Regularity Theory in Physical Scales of 3D Incompressible Fluid Flows*, 09/01/2012-8/31/2015, PI; collaborative research with R. Dascaliuc, Oregon State University, PI

## Major Lectures

*Mathematical Aspects of Hydrodynamics*, MFO, Oberwolfach, Germany (2019)

*Gran Sasso Science Institute Intensive Program on Fluids and Waves*, L'Aquila, Italy (2018)

*Niels Bohr Institute*, Copenhagen, Denmark (2016)

*The 11th Japanese-German International Workshop on Mathematical Fluid Dynamics*, Waseda University, Tokyo, Japan (2015)

*Mathematical Analysis of Turbulence*, IPAM/UCLA (2014)

*Recent Advances in PDEs and Applications*, a conference in honor of Hugo Beirao da Veiga's 70th birthday, CIRM, Levico, Italy (2014)

*Recent Advances in PDEs and Fluids*, Stanford (2013)

*International Winter School on Mathematical Fluid Dynamics*, CIRM, Levico, Italy (2012)

RIMS Seminar: *Modern Approach and Developments to Onsager's Theory on Statistical vortices*, Kyoto, Japan (2011)

*International Conference on PDEs Modeling Fluids and Complex Fluids*; Celebrating the 60th Birthday of Professor Peter Constantin, Xi'an, China (2011)

*Mathematical physics and PDEs*, CIRM, Levico, Italy (2009)

*Workshop on Fluids and PDE II*, Instituto de Matemática-UFRJ, Rio de Janeiro, Brazil (2008)

## Other Conference Presentations

*AMS Meeting*, Fayetteville, AR (2018)

*SIAM Conference on Analysis of Partial Differential Equations*, Baltimore, MD (2017)

*AMS Meeting*, Chicago, IL (2015)

*AMS Meeting*, Washington, DC (2015)  
*Joint Mathematics Meeting*, Baltimore, MD (2014)  
*SIAM Conference on Analysis of Partial Differential Equations*, Orlando, FL (2013)  
*Mathematical Congress of the Americas*, Guanajuato, Mexico (2013)  
*SIAM Conference on Analysis of Partial Differential Equations*, San Diego, CA (2011)  
*AMS Meeting*, Notre Dame, IN (2010)  
*New Trends in Harmonic and Complex Analysis*, Jacobs University, Bremen, Germany (2010)  
*AMS Meeting*, San Francisco, CA (2009)  
*AIMS Seventh International Conference on Dynamical Systems, Differential Equations and Applications*, Arlington, TX (2008)  
*AMS Meeting*, Chicago, IL (2007)  
*AMS Meeting*, Miami University, OH (2007)  
*AMS Meeting*, Notre Dame, IN (2006)  
*AMS Meeting*, Johnson City, TN (2005)  
*Joint AMS-IMS-SIAM Summer Research Conference—Control Methods in PDE-Dynamical Systems*, Snowbird, UT (2005)  
*AMS Meeting*, Los Angeles, CA (2004)  
*SIAM Conference on Applications of Dynamical Systems*, Snowbird, UT (2003)  
*AIMS Fourth International Conference on Dynamical Systems and Differential Equations*, University of North Carolina, Wilmington, NC (2002)  
*AMS Meeting*, Chattanooga, TN (2001)  
*Southwest Regional Workshop on New Directions in Dynamical Systems*, University of Southern California, Los Angeles, CA (2000)  
*Nonlinear Analysis 2000* →, Courant Institute, New York, NY (2000)  
*AMS Meeting*, Austin, TX (1999)  
 CNLS, Los Alamos National Laboratory (1999)  
*AMS Meeting*, Louisville, KY (1998)  
*SIAM Conference on Applications of Dynamical Systems*, Snowbird, UT (1997)

### **Colloquia and Seminar Talks**

University of Bordeaux, France; University of California, Riverside; University of California, San Diego; Carnegie Mellon University; The University of Chicago; Georgetown University; The University of Illinois at Chicago; Indiana University; Johns Hopkins University; University of Missouri; University of Nebraska; University of North Carolina, Wilmington; Northwestern University; University of Pittsburgh; Princeton University; Rice University, University of Southern California; Stanford University; The University of Texas at Austin; Texas A&M University; University of Trondheim, Norway; University of Virginia; University of Wisconsin; Aarhus University, Denmark; Duke University

**Postdocs (UVA)**

Radu Dascaliuc (AP at Oregon State University), Aseel Farhat (aP at Florida State University)

**Graduate Students (UVA)**

Amjad Tuffaha (AP at American University of Sharjah), Rafaela Guberović (Google), Zachary Bradshaw (aP at University of Arkansas), Keith Leitmeyer (NSA), Liaosha Xu (MSRI Postdoctoral Fellowship)

**Summer REU-type projects (UVA)**

Joseph Gallagher (2009)

Alexander Dementiev and Yang Liu (2010)

Yukun Liu (2011)

Jing Chen (2012)

Janet Rafner (2015)

Jiayi Wang (2018, 2019)

**Course Development (UVA)**

*Pavilion Seminar* entitled *Turbulence in Art and Math*, offered in Spring 2013; Pavilion Seminars are a new project at UVA's College of Arts and Sciences “..intended to bring together, in the context of the Lawn's Pavilions, a limited number of students from varied majors and intellectual backgrounds for stimulating discussion of vital questions of ethics, human nature, politics, aesthetics, nature, law, space, and survival..”

**Service to University (UVA)**

Institute of Mathematical Sciences Committee, P&T Committee, Third-Year Review Committee, Peer Review Committee, Hiring Committee, Whyburn Search Committee, Interim Chair Search Committee, Advisory Committee, External Chair/Marvin Rosenblum Professor of Mathematics Search Committee, Department Chair Search Committee, Governance Committee, Colloquium Chair, Graduate Committee, Lower Division Undergraduate Committee, Math Majors Advisor, Organizer of Harmonic Analysis and PDE Seminar

**Service to Profession**

Panelist and reviewer for *NASA, Heliophysics Division*

Panelist and reviewer for *NSF, Division of Mathematical Sciences*

Reviewer for *DOE*

Editorial Board of *Nonlinear Analysis: Real World Applications*

Evaluation letter-writer for external P&T cases

Referee for a variety of mathematics and physics journals

Reviewer for *Mathematical Reviews*

Co-organizer of the meeting *Reflections on mathematical fluid dynamics*, UVA (2019)

Co-organizer of the meeting *Essence of  $(u \cdot \nabla)u$ : reflections on mathematical fluid*

*dynamics*, UVA (2017)

Co-organizer of a session on *Nonlinear PDE in Spaces of Analytic Functions* at *The Sixth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena*, The University of Georgia (2009)

Co-organizer of a special session on *Harmonic analysis methods in mathematical fluid dynamics* at AMS meeting in Bloomington, IN (2008)

Mentor in Math Alliance, (2018-present)

Mentor in *Graduate Minority Achievers Program* (GMAP), Indiana University (1997)

### Professional Organizations

AMS (American Mathematical Society)

## Publications

### REFEREED BOOK CHAPTERS

1. *Fluid-Structure Interaction Model: Wellposedness, Regularity and Control* (with V. Barbu, I. Lasiecka and A. Tuffaha), *Advances in Dynamics and Control: Theory, Methods and Applications*. Chapter 2, 21-32. Cambridge Scientific Publishers, 2010.
2. *Vorticity Direction and Regularity of Solutions to the Navier-Stokes Equations* (with H. Beirao da Veiga and Y. Giga), *Handbook of Mathematical Analysis in Mechanics of Viscous Fluids*. Springer, 2016.

### REFEREED ARTICLES

1. *Space analyticity for the Navier–Stokes and related equations with initial data in  $L^p$*  (with I. Kukavica), *J. Funct. Anal.* **152** (1998) 447–466.
2. *The role of spatial analyticity in the local alignment of vorticity directions in 3D viscous fluids*, *Nonlinearity* **12** (1999) 1239–1246.
3. *Space analyticity for the nonlinear heat equation in a bounded domain* (with I. Kukavica), *J. Diff. Eq.* **154** (1999) 42–54.
4. *On the smallness of the (possible) singular set in space for 3D Navier-Stokes equations*, *Electronic J. Diff. Eq.* **1999** (1999) 1–8.
5. *Spatial analyticity on the global attractor for the Kuramoto-Sivashinsky equation*, *J. Dynam. Diff. Eq.* **12** (2000) 217–227.
6. *On the dynamics of complex singularities in 1D nonlinear parabolic PDE's*, *Studia Math.* **147** (2001) 183–195.
7. *The geometric structure of the super-level sets and regularity for 3D Navier-Stokes equations*, *Indiana Univ. Math. J.* **50** (2001) 1309–1317.
8. *A remark on time-analyticity for the Kuramoto-Sivashinsky equation* (with I. Kukavica), *Nonlinear Anal.* **52** (2002) 69–78.
9. *Local well-posedness for the generalized KdV equation in spaces of analytic functions* (with H. Kalisch), *Diff. Integral Eq.* **15** (2002) 1325–1334.

10. *Spatial analyticity properties of nonlinear waves* (with J.L. Bona), Math. Models & Methods Appl. Sci. **13** (2003) 1–15.
11. *The derivative nonlinear Schrödinger equation in analytic classes* (with H. Kalisch), J. Nonlinear Math. Physics **10** (2003) 1–10.
12. *Interpolation between algebraic and geometric conditions for smoothness of the vorticity in the 3D NSE* (with A. Ruzmaikina), Indiana Univ. Math. J. **53** (2004) 1073–1080.
13. *On depletion of the vortex-stretching term in the 3D Navier-Stokes equations* (with A. Ruzmaikina), Comm. Math. Phys. **247** (2004) 601–611.
14. *Algebraic lower bounds on the uniform radius of spatial analyticity for the generalized KdV equation* (with J.L. Bona and H. Kalisch), Ann. Inst. Henri Poincaré, Anal. Non Linéaire **22** (2005) 783–797.
15. *Regularity of forward-in-time self-similar solutions to the 3D NSE*, Discrete Cont. Dynamical Systems **14** (2006) 837–843.
16. *Space-time localization of a class of geometric conditions for preventing blow-up in the 3D NSE* (with Qi Zhang), Comm. Math. Phys. **262** (2006) 555–564.
17. *Global solutions of the derivative Schrödinger equation with analytic extension* (with J.L. Bona and H. Kalisch), J. Diff. Eq. **229** (2006) 186–203.
18. *Existence of the energy-level weak solutions for a nonlinear fluid-structure interaction model* (with V. Barbu, I. Lasiecka and A. Tuffaha), Contemporary Mathematics **440** (2007) 55–82.
19. *Smoothness of solutions to a nonlinear fluid-structure interaction model* (with V. Barbu, I. Lasiecka and A. Tuffaha), Indiana Univ. Math. J. **57** (2008) 1173–1207.
20. *Analytic solutions of a class of nonlinear dispersive wave equations* (with H. Kalisch), Nonlinear Anal. **71** (2009) 1160–1170.
21. *A bound on oscillations in an unsteady undular bore* (with H. Kalisch), Applicable Anal. **88** (2009) 1701–1712.
22. *Localization and geometric depletion of vortex-stretching in the 3D NSE*, Comm. Math. Phys. **290** (2009) 861–870.
23. *A KdV-type Boussinesq system in a scale of Bourgain-type spaces: from the energy level to analytic spaces* (with J.L. Bona and H. Kalisch), Discrete Cont. Dynamical Systems **26** (2010) 1121–1139.
24. *A family of regularity classes for the 3D NSE approximating a critical class*, Indiana Univ. Math. J. **59** (2010) 707–719.
25. *Localization of analytic regularity criteria on the vorticity and balance between the vorticity magnitude and coherence of the vorticity direction in the 3D NSE* (with R. Guberović), Comm. Math. Phys. **298** (2010) 407–418.
26. *A regularity criterion for the 3D NSE in a local version of the space of functions of bounded mean oscillations* (with R. Guberović), Ann. Inst. Henri Poincaré, Anal. Non Linéaire **27** (2010) 773–778.

27. *Energy cascades and flux locality in physical scales of the 3D NSE* (with R. Dascaliuc), *Comm. Math. Phys.* **305** (2011) 199–220.
28. *Anomalous dissipation and energy cascade in 3D inviscid flows* (with R. Dascaliuc), *Comm. Math. Phys.* **309** (2012) 757–770.
29. *Dissipation anomaly and energy cascade in 3D incompressible flows* (with R. Dascaliuc), *C. R. Math. Acad. Sci. Paris* **350** (2012) 199–202.
30. *Vortex stretching and criticality for the 3D NSE* (with R. Dascaliuc), *J. Math. Phys.* **53** (2012) 115613.
31. *Coherent vortex structures and 3D enstrophy cascade* (with R. Dascaliuc), *Comm. Math. Phys.* **317** (2013) 547–561.
32. *A geometric measure-type regularity criterion for solutions to the 3D Navier-Stokes equations*, *Nonlinearity* **26** (2013) 289–296.
33. *On the transport and concentration of enstrophy in 3D magnetohydrodynamic turbulence* (with Z. Bradshaw), *Nonlinearity* **26** (2013) 2373–2390.
34. *Energy cascades in physical scales of 3D incompressible magnetohydrodynamic turbulence* (with Z. Bradshaw), *J. Math. Phys.* **54** (2013) 093503.
35. *Blow-up scenarios for 3D NSE exhibiting sub-criticality with respect to the scaling of one-dimensional local sparseness* (with Z. Bradshaw), *J. Math. Fluid Mech.* **16** (2014) 321–334.
36. *A spatially localized  $L \log L$  estimate on the vorticity in the 3D NSE* (with Z. Bradshaw), *Indiana Univ. Math. J.* **64** (2015) 433–440.
37. *A note on the surface quasi-geostrophic temperature variance cascade* (with Z. Bradshaw), *Comm. Math. Sci.* **13** (2015) 557–564.
38. *Local analyticity radii of solutions to the Navier-Stokes equations with locally analytic forcing* (with Z. Bradshaw and I. Kukavica), *J. Diff. Eq.* **259** (2015), 3955–3975.
39. *Effect of vorticity coherence on energy-enstrophy bounds for the 3D Navier-Stokes equations* (with R. Dascaliuc and M. Jolly), *J. Math. Fluid Mech.* **17** (2015) 393–410.
40. *Vortex stretching and anisotropic diffusion in 3D Navier-Stokes equations*, *Contemporary Mathematics* **666** (2016) 239–251.
41. *Analyticity radii and the Navier-Stokes equations: recent results and applications* (with Z. Bradshaw and I. Kukavica), *Recent progress in the theory of the Euler and Navier-Stokes equations*, London Mathematical Society Lecture Note Series: 430. Cambridge University Press, 2016.
42. *On energy cascades in the forced 3D Navier-Stokes equations* (with R. Dascaliuc), *J. Nonlinear Sci.* **26** (2016) 683–715.
43. *The space  $B_{\infty,\infty}^{-1}$ , volumetric sparseness, and 3D NSE* (with A. Farhat and K. Leitmeyer), *J. Math. Fluid Mech.* **19** (2017) 515–523.
44. *Frequency localized criteria for the 3D Navier-Stokes equations* (with Z. Bradshaw), *Arch. Rational Mech. Anal.* **224** (2017) 125–133.

45. *Oscillations and integrability of the vorticity in the 3D NS flows* (with Y. Do, A. Farhat and L. Xu), *Indiana Univ. Math. J.* **69** (2020) 1559–1578.
46. *An algebraic reduction of the ‘scaling gap’ in the Navier-Stokes regularity problem* (with Z. Bradshaw and A. Farhat), *Arch. Rational Mech. Anal.* **231** (2018) 1983–2005.
47. *Local near-Beltrami structure and depletion of the nonlinearity in the 3D Navier-Stokes flows* (with A. Farhat), *J. Nonlinear Sci.* **29** (2019) 803–812.
48. *Toward criticality of the Navier-Stokes regularity problem*, to appear in the Special Issue of Pure and Applied Functional Analysis in memory of Ciprian Foias.
49. *A regularity criterion for solutions to the 3D NSE in ‘dynamically restricted’ local Morrey spaces* (with L. Xu), to appear in *Applicable Analysis*.
50. *Geometry of turbulent dissipation and the Navier-Stokes regularity problem* (with J. Rafner, C. Bach, J.A. Baerentzen, B. Gervang, R. Jia, S. Leinweber, M. Misztal, and J. Sherson), to appear in *Scientific Reports* (Springer Nature).

#### SUBMITTED

1. *Asymptotic criticality of the Navier-Stokes regularity problem* (with L. Xu)  
<https://arxiv.org/abs/1911.00974>
2. *Time-global regularity of the Navier-Stokes system with hyper-dissipation–turbulent scenario* (with L. Xu)  
<https://arxiv.org/abs/2012.05692>

#### NON-REFEREED BOOK CHAPTERS AND ARTICLES

1. *Boundary control model of fluid-structure interactions* (with V. Barbu, I. Lasiecka and A. Tuffaha), *Proceedings of the 12th IEEE International Conference on Methods and Models in Automation and Robotics*, 29th–31st August 2006, Miedzyzdroje, Poland.
2. *Turbulent cascades in physical scales of 3D incompressible fluid flows* (with R. Dascoliuc), *RIMS Kokyuroku* **1798** (2012) 107–120.

#### Citations

603 by 261 authors (MathSciNet)  
 987, h-index 19 (Google Scholar)