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Personal

Born in Zagreb, Croatia 1983.

Croatian Citizen.

Education

Massachusetts Institute of Technology, Ph.D. in Mathematics, June 2011.

Advisor: Gigliola Staffilani.

Thesis Title: *Bounds on the growth of high Sobolev norms of solutions to Nonlinear Schrödinger equations.*

University of California Berkeley, B.A. in Mathematics with Highest Honors, May 2006.

University of Zagreb, Mathematics Department, Fall 2002–Spring 2003.

Employment

Eidgenössische Technische Hochschule Zürich, from September 2014.

Advisor: Antti Knowles.

University of Pennsylvania, Simons Postdoctoral Fellow, 2011-2014.

Advisors: Philip Gressman and Robert Strain.

Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, visitor, January–February 2012.

Host: Felix Otto.

Publications

Thesis

Bounds on the growth of high Sobolev norms of solutions to nonlinear Schrödinger equations, Ph.D. Thesis, MIT (2011). Advisor: Gigliola Staffilani.

Published papers

Bounds on the growth of high Sobolev norms of solutions to Nonlinear Schrödinger equations on S^1 , Differential and Integral equations, **34** (2011), no. 7-8, 653–718.

Bounds on the growth of high Sobolev norms of solutions to Nonlinear Schrödinger equations on \mathbb{R} , Indiana University Mathematics Journal, **60** (2011), no. 5, 1487–1516.

Bounds on the growth of high Sobolev norms of solutions to 2D Hartree equations, Discrete and Continuous Dynamical Systems A, **32** (2012), no. 10, 3733–3771.

On the uniqueness of solutions to the 3D periodic Gross-Pitaevskii hierarchy (with Philip Gressman and Gigliola Staffilani), Journal of Functional Analysis **266** (2014), no. 7, 4705–4764.

Accepted papers

The Boltzmann equation, Besov spaces, and optimal time decay rates in the whole space (with Robert Strain), Volume **261**, no. 20 August 2014, Pages 274–332

Local existence of solutions to Randomized Gross-Pitaevskii hierarchies, to appear in Transactions of the American Mathematical Society.

Preprints

Randomization and the Gross-Pitaevskii hierarchy (with Gigliola Staffilani), preprint (2013), <http://arxiv.org/abs/1308.3714>, submitted. <http://arxiv.org/abs/1401.0326>, submitted.

A rigorous derivation of the defocusing nonlinear Schrödinger equation on \mathbb{T}^3 from the dynamics of many-body quantum systems, preprint (2014), <http://arxiv.org/abs/1405.3003>, submitted.

Research Reports

On the uniqueness of solutions to the periodic 3D Gross-Pitaevskii hierarchy (based on joint work with Gigliola Staffilani), Oberwolfach Reports, Vol. **9** (2012), no. 2, 1622–1644.

The Gross-Pitaevskii hierarchy on the three-dimensional torus (based on joint work with Philip Gressman and Gigliola Staffilani), Oberwolfach Reports, Report No. 41 (2013), 2360–2365.

Summer School Reports

Evolution Equations at the Swiss Federal Institute of Technology, Zürich, Switzerland (summer school report written jointly with Dean Baskin and Jacques Smulevici), in CMI Annual Report 2008, <http://www.claymath.org/library>.

Awards

Good Teaching Award, UPenn, Spring 2013.

Good Teaching Award, UPenn, Fall 2011.

Simons Postdoctoral Fellowship, UPenn, Fall 2011.-Spring 2014.

Charles and Jennifer Johnson Prize for a paper accepted for publication, MIT, Spring 2011.

MIT Presidential Fellowship, Fall 2006.

Valedictorian, UC Berkeley Mathematics Department, May 2006.

B.A. with Highest Honors, UC Berkeley, May 2006.

Phi Beta Kappa (Liberal Arts and Sciences), May 2006 to present.

Dorothea Klumpke Roberts Prize for Academic Excellence, UC Berkeley, May 2006.

Dean's Honor List, UC Berkeley.

International House Scholarship, UC Berkeley.

William Lowell Putnam Mathematical Competition 2005, Honorable Mention, Individual Rank 27th.

International Mathematical Olympiad 2001 and 2002, Bronze Medal.

Research

Research interests

Nonlinear Dispersive Equations, Harmonic Analysis, Kinetic Theory.

Present work

In my Ph.D. thesis, I studied the growth of high Sobolev norms of solutions of Nonlinear Schrödinger equations in 1 and 2 dimensions in periodic and non-periodic settings. This problem arises naturally in the physical context when one wants to estimate the *low-to-high frequency cascade* of solutions. The techniques that I have been using rely on appropriate frequency decomposition and the use of almost conserved quantities. The adaptation to high regularities of the *I-method* first used by Colliander-Keel-Staffilani-Takaoka-Tao has shown to be useful in our context. This approach allows us to improve existing polynomial bounds for certain equations.

In joint work with Philip Gressman and Gigliola Staffilani, we have been studying the question of uniqueness for the periodic 3D Gross-Pitaevskii hierarchy. In particular, we show a uniqueness result in a class of density matrices which contains the factorized solutions. Our result builds on the ideas from the work in 2D by Kirkpatrick, Schlein, and Staffilani, as well as the non-periodic 3D result of Klainerman and Machedon. One difference is that we have to use slightly more regular initial data as well as critical function spaces to compensate for the loss of derivatives in Strichartz estimates in the periodic setting.

In subsequent work joint with Gigliola Staffilani, we study the application of randomization techniques to this model. More precisely, we note that, by using an appropriate randomization of the Fourier coefficients in the collision operator, it is possible to extend the range of regularity exponents in the crucial estimate for the free evolution operator. Having proved this estimate, we can study randomized forms of the Gross-Pitaevskii hierarchy in low regularities. In further work, I show a local existence result for the randomized hierarchies. This is achieved by incorporating the truncation argument pioneered by T. Chen and Pavlović, which was developed in the deterministic setting.

I have recently obtained a rigorous derivation of the defocusing cubic nonlinear Schrödinger equation on \mathbb{T}^3 from the dynamics of many-body quantum systems. In this paper, I show that the proof of unconditional uniqueness for the Gross-Pitaevskii hierarchy by using the Quantum de Finetti theorem as in the

work of T. Chen, Hainzl, Pavlović, and Seiringer applies in the periodic setting. In doing so, one needs to recall the multilinear analysis of Herr, Tataru, and Tzvetkov. One can then combine this uniqueness result with the previous work of Elgart, Erdős, Schlein, and Yau in order to obtain the derivation of the defocusing cubic NLS on \mathbb{T}^3 .

My research interests also include problems from kinetic theory and the Boltzmann equation. In joint work with Robert Strain, we studied the convergence rates to the Maxwellian equilibrium for the non cut-off Boltzmann equation on the whole space in dimensions greater than or equal to three. The spaces in which we measure the convergence are L^2 -based Besov spaces, which contain L^1 by Sobolev embedding. This allows us to give a bound on the convergence rate to the Maxwellian equilibrium for L^1 initial data. Moreover, the estimates that we prove are optimal in the sense that they correspond to those one obtains for the linear Boltzmann equation. Our proof is based on the construction of appropriate Lyapunov functionals as in the previous work of Gressman and Strain, as well as the use of nonlinear estimates involving vector-valued functions. In order to resolve the latter difficulty, we use ideas from vector-valued Calderón-Zygmund theory.

Presentations

Invited Talks

University of Bielefeld, Bielefeld Stochastics Afternoon, April 16, 2014.

AMS Spring 2014 Sectional Meeting of the American Mathematical Society, Special Session on Stochastics and PDEs, Albuquerque, NM, April 6, 2014.

University of California Los Angeles, Analysis and PDE Seminar, February 21, 2014.

University of Rochester, Colloquium, February 11, 2014.

Eidgenössische Technische Hochschule Zürich, Postdoctoral Interview, January 23, 2014.

Joint Mathematics Meetings, AMS Special Session on Dispersive and Geometric Partial Differential Equations, Baltimore, MD, January 18, 2014.

University of Miami, Colloquium, January 16, 2014.

SIAM Conference on Analysis of Partial Differential Equations, section on Dynamics of Nonlinear Dispersive Wave Equations, Lake Buena Vista, FL, December 7, 2013.

University of Pennsylvania, Analysis Seminar, November 12, 2013.

Oberwolfach workshop on Nonlinear Waves and Dispersive Equations, August 15, 2013.

University of Zagreb, Probability Seminar, July 9, 2013.

Princeton University, Analysis Seminar, February 25, 2013.

University of Zagreb, Probability Seminar, December 18, 2012.

New York University, Analysis Seminar, November 29, 2012.

Massachusetts Institute of Technology, PDE/Analysis Seminar, October 23, 2012.

University of Pennsylvania, Analysis Seminar, October 2, 2012.

AMS 2012 Fall Eastern Sectional Meeting, Special Session on Microlocal Analysis and Nonlinear Evolution Equations, Rochester, NY, September 22, 2012.

UT Austin, 2012/13 Thematic Program on nonlinear Schrödinger equations and Bose gases from a multidisciplinary, integrative perspective, September 17 and September 19, 2012.

Conference in honor of Michael Taylor's 65th birthday, July 19, 2012.

Oberwolfach workshop on Nonlinear Evolution Equations, May 17, 2012.

Johns Hopkins Analysis Seminar, April 30, 2012.

Simons Postdoctoral Fellows Meeting, Stony Brook, April 11, 2012.

Drexel University, Applied Mathematics and PDE Seminar, March 20, 2012.

University of Pennsylvania, Analysis Seminar, March 13, 2012.

SIAM Conference on Analysis of Partial Differential Equations, section Recent Progress on Dispersive Partial Differential Equations, November 14, 2011.

AMS 2011 Fall Western Sectional Meeting, Special Session on Harmonic Analysis and Dispersive Partial Differential Equations, Salt Lake City, October 22, 2011.

Princeton University, Analysis Seminar, October 3, 2011.

SISSA trimester on Nonlinear Hyperbolic PDEs, Dispersive and Transport equations, Trieste, Italy, section on Dispersive equations, July 9, 2011.

University of Pennsylvania, Analysis Seminar, February 8, 2011.

Max Planck Institute for Mathematics in the Sciences, Leipzig, January 14, 2011.

Hausdorff Center for Mathematics, University of Bonn, January 11, 2011.

University of California Los Angeles, Analysis and PDE Seminar, October 22, 2010.

University of North Carolina Chapel Hill, Analysis/PDE Seminar, September 29, 2010.

University of Zagreb, Probability and Harmonic Analysis Seminar, June 15, 2010.

SIAM conference on Emerging Topics in Dynamical Systems and PDEs, Barcelona, June 3, 2010.

New York University Analysis Seminar, May 7, 2010.

Brown Department of Applied Mathematics PDE Seminar, March 19, 2010.

Expository Talks

UPenn Friday Pizza Seminar, "The nonlinear Schrödinger equation", Spring 2014.

MIT Pure Math Graduate Student Seminar, "Low regularity solutions of nonlinear dispersive equations", Spring 2010 .

MIT Pure Math Graduate Student Seminar, "Counting the number of lattice points in Euclidean balls", Fall 2008.

MIT Applied Math Student Seminar, "Solitary wave solutions to the Nonlinear Schrödinger equation", Spring 2008.

Undergraduate research

"Orbits under wreath products"

University of California Berkeley, Subfactor seminar, September 2005.

Conferences and Workshops

AMS 2014 Spring Western Sectional Meeting, University of New Mexico, Albuquerque, NM, April 5-6, 2014.

Joint Mathematics Meetings, Baltimore, MD, January 15-18, 2014.

SIAM Conference on Analysis of Partial Differential Equations, Lake Buena Vista, FL, December 7-10, 2013.

Oberwolfach workshop on Nonlinear Waves and Dispersive Equations, Oberwolfach, Germany, August 11-17, 2013.

The Global Behavior of Solutions to Critical Nonlinear Wave Equations: A conference in honor of Carlos Kenig, Kansas State University, Manhattan, KS, June 17-21, 2013.

The Sixteenth Rivière-Fabes Symposium on Analysis and PDE, University of Minnesota, April 19-21, 2013.

AMS 2012 Fall Eastern Sectional Meeting, Rochester Institute of Technology, Rochester, NY, September 22-23, 2012.

Partial Differential Equations: Analytic and Geometric Aspects, in honor of Michael Taylor's 65 Birthday, University of North Carolina, Chapel Hill, July 16-20, 2012.

Oberwolfach workshop on Nonlinear Evolution Equations, Oberwolfach, Germany, May 13-19, 2012.

Evolution Equations: A Workshop in Honor of Terence Tao, Northwestern University, May 4-6, 2012.

Simons Foundation Postdoctoral Fellows Meeting, Simons Center for Geometry and Physics, Stony Brook, NY, April 10-13, 2012.

SIAM Conference on Analysis of Partial Differential Equations, San Diego, CA, November 14-18, 2011.

ICERM conference on Boltzmann models in Kinetic theory, ICERM, Brown, Providence, RI, November 7-11, 2011.

AMS 2011 Fall Western Sectional Meeting, Salt Lake City, October 22-23, 2011.

SISSA trimester on Nonlinear Hyperbolic PDEs, Dispersive and Transport equations, Trieste, Italy, section on Dispersive equations, July 7-14, 2011.

The Fourteenth Rivière-Fabes Symposium on Analysis and PDE, University of Minnesota, April 15-17, 2011.

SIAM Conference: *Emerging Topics in Dynamical Systems and PDEs*, Barcelona, Spain, May 31-June 4, 2010.

The Thirteenth Rivière-Fabes Symposium on Analysis and PDE, University of Minnesota, April 23-25, 2010.

Workshop on Nonlinear dispersive and geometric evolution equations: *Singularities and Asymptotics*, Pacific Institute for the Mathematical Sciences, Vancouver, Canada, August 17-28, 2010

Conference *Ondes Non-linéaires et Dispersion*, Institut Henri Poincaré, Paris, France, June 22-26, 2009.

The power of Analysis, Birthday conference for Charles Fefferman, Princeton May 4-8, 2009.

Clay Mathematics Institute Summer School on Evolution Equations, ETH, Zurich, Switzerland June 23-July 18, 2008.

The Eighth International Conference on Harmonic Analysis and Partial Differential Equations, El Escorial, Spain, June 16-20, 2008.

Nonlinear Waves, Conference in honor of Walter Strauss, Brown University, May 8 - 11, 2008.

MIT Women in Mathematics: A Celebration, Massachusetts Institute of Technology, April 12-13, 2008.

References

Research references

Thomas Chen, University of Texas, Austin, tc@math.utexas.edu

Philip Gressman, University of Pennsylvania, gressman@math.upenn.edu

Herbert Koch, University of Bonn, koch@math.uni-bonn.de

Andrea Nahmod, University of Massachusetts, Amherst, nahmod@math.umass.edu

Felix Otto, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, otto@mis.mpg.de

Nataša Pavlović, University of Texas, Austin, natasa@math.utexas.edu

Gigliola Staffilani, Massachusetts Institute of Technology, gigliola@math.mit.edu

Robert Strain, University of Pennsylvania, strain@math.upenn.edu

Teaching reference

Robin Pemantle, University of Pennsylvania, pemantle@math.upenn.edu

Teaching

Courses

At UPenn:

Math 240: Calculus III, Fall 2013, instructor.

Math 425: Partial Differential Equations (Undergraduate Level), Spring 2013, instructor.

Math 644: Partial Differential Equations (Graduate Level), Fall 2011, instructor.

At MIT:

18.152: Introduction to PDE, Fall 2010, grader.

18.155: Differential Analysis, Fall 2010, grader.

18.03: Ordinary Differential Equations, Spring 2010, recitation instructor.

18.02: *Multivariable Calculus*, Fall 2009, recitation instructor.

18.06: *Linear Algebra*, Fall 2008, recitation instructor.

18.075: *Advanced Calculus for Engineering*, Spring 2008, grader.

18.101: *Analysis II*, Fall 2007, grader.

18.704: *Undergraduate Seminar in Algebra and Number Theory*, Spring 2007, grader.

Seminar Courses

Undergraduate seminar for Putnam Exam preparation, UPenn, Fall 2012.

Course on Nonlinear Dispersive Equations, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, January-February, 2012.

Reading Groups

Organizer of student reading group on the use of U and V function spaces in nonlinear dispersive equations, MIT, Spring 2011.

Organizer of student reading group on KAM Theory, MIT, Fall 2009.

High school teaching

Olympiad training for high school students in Croatia, Spring 2003 to present.

Committee Work

Chair of the Prize Committee at UPenn in the academic year 2012–2013.

Member of the Prize Committee at UPenn in the academic year 2013–2014.

Member of Ph. D. Thesis Defense Committee for Taisong Jing (UPenn), 2014.

Journals Refereed

Communications in Pure and Applied Analysis.

Physica D.

Proceedings of the American Mathematical Society.

Journal of Functional Analysis.

Journal of Mathematical Analysis and its Applications.

Discrete and Continuous Dynamical Systems, Series A.

Annales de l'Institut Henri Poincaré (C), Analyse Non Linéaire.

Membership

American Mathematical Society.

Croatian Mathematical Society.

Phi Beta Kappa.