Massimiliano Gubinelli

Academic career

1998	Diploma in Physics, University of Pisa, Italy
2001 - 2006	Ricercatore (Assistant Professor), Institute of Applied Mathematics, University of Pisa, Italy
2003	PhD in Theoretical Physics, University of Pisa, Italy
2006 - 2008	Maître de conférences, Paris-Sud University, Orsay, France
2008 - 2011	Professeur des Universités (2ème classe), Paris Dauphine University, Paris, France
2011 - 2015	Professeur des Universités (1ère classe), Paris Dauphine University, Paris, France
2012 - 2015	Part-time Professor, École Polytechnique, Palaiseau, France
Since 2015	Hausdorff Chair (W3), University of Bonn

Honours

2003	Invited professor, Institut E. Cartan, Université Nancy 1, France
2013 - 2018	Junior member of the Institute Universitaire de France

Invited Lectures

2009	Minicourse on “Rough Paths”, École Polytechnique, Palaiseau, France
2012	Minicourses in Marseille, Berlin and Rome
2014	Invited lecturer at Escola Brasileira de Probabilidade, Mambucaba, Brasil and at Centro Ennio de Giorgi, Pisa, Italy
2015	Winter school “Recent Breakthroughs in Singular SPDEs”, University of Milano-Bicocca, Italy
2016	CIME-EMS Summer school “Singular random dynamics”, Cetraro, Italy
2016	Minicourse at the school “Young women in probability”, Bonn
2018	Invited Section Lecture, International Congress of Mathematicians, Rio de Janeiro, Brasil

Research Projects and Activities

Project Blanc ANR ECRU “Explorations on rough paths”
Coordinator, 2009 - 2012
Projet Jeunes Chercheurs ANR MAGIX Mathématiques, Algèbre, Géométrie Exactes
Member, 2009 – 2012
Project B09 “Large scale modeling of non-linear microscopic dynamics via singular SPDEs” within DFG Collaborative Research Center SFB 1060 “The Mathematics of Emergent Effects”
Principal investigator

Research profile

I’m interested in problems of mathematical physics in connection with stochastic analysis. More generally in the description and analysis of random influences in evolutionary systems inspired by physics. In recent years I’ve been working in developing Rough Path Theory, which is a set of ideas and tools which allows a detailed analysis of irregular signals on non-linear systems. I’ve generalised the original theory, introduced by T. Lyons, to a wider class of signals, Branched Rough Paths and proposed various other theories in order to handle more complex dynamics like those underlying parabolic and hyperbolic PDEs. Rough paths and their generalisations have inspired the theory of Regularity Structures, invented by Hairer to describe the

local structure of solutions to singular PDEs of the kind appearing in mathematical physics: the Stochastic Quantisation Equation, the Kardar—Parisi—Zhang equation, the parabolic Anderson model. In a parallel development, in collaboration with Imkeller and Perkowski, I introduced tools of harmonic analysis also applicable to such singular SPDEs. In collaboration with Flandoli and Priola and subsequently with some PhD students we analysed the effect of random perturbation in non-linear infinite dimensional dynamics modelled by PDEs and we showed some situations where the presence of the noise improves the behaviour of solutions for hyperbolic and dispersive PDEs.

Editorships

- Electronic Journal of Probability (Associate Editor, since 2011)
- Electronic Communications in Probability (Associate Editor, since 2011)
- Discrete and Continuous Dynamical Systems A (2015 - 2017)
- Bernoulli Journal (Area Editor, since 2015)
- Annals of Applied Probability (since 2015)
- SIAM Journal of Mathematical Analysis (since 2015)

Research Area G My main research interest is the study of partial differential equations in presence of noise.
In collaboration with P. Imkeller and N. Perkowski we developed [6] a new method to define and analyze stochastic partial differential equation with quite singular non-linearities like the Kardar-Parisi-Zhang equation, the cubic reaction–diffusion model in three dimension with additive white noise and the parabolic Anderson model in two and three dimensions, among others. In the context of the KPZ equation together with N. Perkowski we proved [3] uniqueness of energy solutions [8] for the KPZ equation. Energy solutions is a flexible tool to prove universality of fluctuations in weakly asymmetric particle systems (see e.g. [1]).
Another line of research concerns the regularizing effects of the noise in the dynamics of partial differential equations. Together with F. Flandoli and E. Priola we gave one of the first examples of regularization by noise in the context of stochastic partial differential equations [9]. In collaboration with my former Ph.D. student Khalil Chouk [5] we proved regularization by stochastic modulation in nonlinear Schrödinger equations.

Research Area C I studied path integral techniques in the analysis of certain quantum systems.

In particular, in collaboration with F. Hiroshima and J. Lörinczi [7] we explicitly constructed a measure on path space for the ground state of the renormalized Nelson Hamiltonian. This Hamiltonian describes the interaction of a Boson field with a quantum non-relativistic particle. With J. Lörinczi [12] we constructed path integral representations for the interaction of particles with bosonic vector quantum fields, making a link with the theory of stochastic currents and rough paths.
With H. Koch and T. Oh we started the investigation of singular stochastic hyperbolic PDEs [2] which can be seen as simple models mimicking the behavior of the renormalization for quantum fields in Minkowski space or as large scale descriptions of fluctuations for nonlinear waves.

Supervised theses

PhD theses: 5, currently 3

Selected PhD students

Khalil Chouk (2013): “Trois chemins controlés”,
now Postdoc, TU Berlin
Rémi Catellier (2014): “Perturbations irrégulières et systèmes différentiels rugueux”,
now Maître de Conferences, Université Nice Sophia Antipolis, France

Selected publications

[1] Joscha Diehl, Massimiliano Gubinelli, and Nicolas Perkowski. The kardar-parisi-zhang equation as scaling limit of weakly asymmetric interacting brownian motions. *Comm. Math. Phys.*, 354(2):549–589, 2017.

[2] Massimiliano Gubinelli, Herbert Koch, and Tadahiro Oh. Renormalization of the two-dimensional stochastic nonlinear wave equation. *arXiv preprint arXiv:1703.05461, to appear in Trans. A.M.S.*, 2017.
[3] Massimiliano Gubinelli and Nicolas Perkowski. Energy solutions of kpz are unique. *Journal of the American Mathematical Society*, 2017.
[4] Massimiliano Gubinelli and Nicolas Perkowski. Kpz reloaded. *Comm. Math. Phys.*, 349(1):165–269, 2017.
[5] K. Chouk and M. Gubinelli. Nonlinear pdes with modulated dispersion i: Nonlinear schrödinger equations. *Comm. Partial Differential Equations*, 40(11):2047–2081, 2015.
[6] Massimiliano Gubinelli, Peter Imkeller, and Nicolas Perkowski. Paracontrolled distributions and singular pdes. *Forum Math. Pi*, 3:e6, 75, 2015.
[7] Massimiliano Gubinelli, Fumio Hiroshima, and J'ozsef Lörinczi. Ultraviolet renormalization of the nelson hamiltonian through functional integration. *J. Funct. Anal.*, 267(9):3125–3153, 2014.
[8] M. Gubinelli and M. Jara. Regularization by noise and stochastic burgers equations. *Stoch. Partial Differ. Equ. Anal. Comput.*, 1(2):325–350, 2013.
[9] F. Flandoli, M. Gubinelli, and E. Priola. Well-posedness of the transport equation by stochastic perturbation. *Invent. Math.*, 180(1):1–53, 2010.
[10] Massimiliano Gubinelli. Ramification of rough paths. *J. Differential Equations*, 248(4):693–721, 2010.
[11] Massimiliano Gubinelli and Samy Tindel. Rough evolution equations. *Ann. Probab.*, 38(1):1–75, 2010.
[12] Massimiliano Gubinelli and J'ozsef Lörinczi. Gibbs measures on brownian currents. *Comm. Pure Appl. Math.*, 62(1):1–56, 2009.
[13] M. Gubinelli. Controlling rough paths. *J. Funct. Anal.*, 216(1):86–140, 2004.