

# Curriculum Vitæ for David Barbato

Updated June 2017

## ADDRESS AND POSITIONS

---

### Address

- Department of Mathematics  
The University of Padua  
Via Trieste 63, 35121, Padova, Italy
- *Office: n.539, 5<sup>th</sup> floor*
- *Phone: +39 049 827 1471*
- *E-mail: barbato@math.unipd.it*
- *Web page: <http://www.math.unipd.it/barbato/>*

### Current Position

- (01/02/2015 – today) *Associate professor (SSC MAT/06)*, Department of Mathematics ,University of Padua.

### Previous Positions

- (Ott 2007 – Feb 2015) *Assistent professor (SSC MAT/06)*, Department of Mathematics ,University of Padua.
- (Sep 2005 – Jul 2007) Postdoc fellowship at Istituto Nazionale di Geofisica e Vulcanologia, Section of Pisa.
- (Jan 2004 – Aug 2005) Postdoc fellowship at Dipartimento di Matematica Applicata “U.Dini”, University of Pisa.

### Education

- (Jan 2001 – Dec 2003) PhD in Mathematics for Industry at the Scuola Normale Superiore of Pisa.
- November 23, 2000 Graduated cum Laude in Mathematics at the University of Pisa. Thesis on percolation.

## RESEARCH:

---

### Main research interests:

- Stochastic fluid dynamic models for energy cascade transfer.
- Girsanov transform of infinite differential systems.
- Stochastic Inequalities.

### Publications

- [1] Barbato D. *FKG inequality for brownian motion and stochastic differential equations* Elect. Comm. in Probab. Volume: 10 Pages: 7-16 Published: FEB 2005

- [2] Papale P, Moretti R, Barbato D. *The compositional dependence of the saturation surface of H<sub>2</sub>O + CO<sub>2</sub> fluids in silicate melts*. *Chemical Geology*, Volume 229 Issue 1-3 Pages: 78-95 Published: MAY 2006
- [3] Barbato D, Barsanti M, Bessayh H, Flandoli F. *Some Rigorous Results on a Stochastic GOY Model*. *Journal of Statistical Physics*, Volume: 9 Number: 1 Pages: 44-74 Published: NOV 2006
- [4] Barbato D, Berselli L, Grisanti C. *Analytical and numerical results for the Rational Large Eddy Simulation model*. *Journal of Mathematical Fluid Mechanics*, Volume: 125 Number: 3 Pages: 677-716 Published: 2007
- [5] Longo A, Barbato D, Papale P, Saccorotti G, Barsanti M. *Numerical simulation of the dynamics of fluid oscillations in a gravitationally unstable, compositionally stratified fissure*. Geological Society, London, Special Publications Volume: 307 Pages: 33-44 Published: 2008
- [6] Barsanti M, Papale P, Barbato D, Moretti R, Boschi E, Hauri E, Longo A. *Heterogeneous large total CO<sub>2</sub> abundance in the shallow magmatic system of Kilauea volcano, Hawaii*. *Geophysical Research. Solid Earth*, Volume 114, Published: DEC 2009
- [7] Barbato D, Flandoli F, Morandin F. *A theorem of uniqueness for an inviscid dyadic model*. *Comptes Rendus Mathematique* Volume: 348 Issue: 9-10 Pages: 525-528 Published: MAY 2010
- [8] Barbato D, Flandoli F, Morandin F. *Uniqueness for a stochastic inviscid dyadic model*. *Proceedings of the American Mathematical Society*, Volume: 138 Issue: 7 Pages: 2607-2617 Published: JUL 2010
- [9] Barbato D, Flandoli F, Morandin F. *Energy dissipation and self-similar solutions for an unforced inviscid dyadic model*. *Trans. Amer. Math. Soc.*, Volume: 363 Number: 4 Pages: 1925-1946 Published: APR 2011
- [10] Barbato D, Morandin F, Romito M. *Smooth solutions for the dyadic model*. *Nonlinearity*, Volume: 24 Pages: 3083-3097 Published: SEP 2011
- [11] Barbato D, Flandoli F, Morandin F. *Anomalous dissipation in a stochastic inviscid dyadic model*. *Ann. Appl. Probab.* Volume: 21 Number 6 Pages: 2424-2446 Published: 2011
- [12] Barbato D, Morandin F. *Positive and non-positive solutions for an inviscid dyadic model: well-posedness and regularity*. *Nonlinear Differ. Equ.* Volume: 20 Pages: 1105-1123 Published: 2013
- [13] Barbato D, Morandin F. *Stochastic inviscid shell models: well-posedness and anomalous dissipation*. *Nonlinearity*, Volume: 26 Pages: 1919-1943 Published: 2013
- [14] Barbato D, Bianchi L.A, Flandoli F, Morandin F. *A dyadic model on a tree*. *Journal of mathematical physics*, Volume: 54 Published: 2013
- [15] Barbato, D, Bessaih, H, Ferrario, B. *On a stochastic Leray- $\alpha$  model of Euler equations*. *Stochastic Processes and their Applications*, Volume: 124(1) Pages: 199-219 Published: 2014
- [16] Barbato D, Morandin F, Romito M. *Global regularity for a logarithmically supercritical hyperdissipative dyadic equation*. *Dynamics of PDE*, Volume: 11(1) Pages: 39-52 Published: 2014
- [17] Barbato D, Morandin F, Romito M. *Global regularity for a slightly supercritical hyperdissipative Navier-Stokes system*. *Analysis and PDE*, Volume: 7(8) Pages: 2009-2027 Published: 2014
- [18] Andreis L, Barbato D, Collet F, Formentin M, Provenzano L. *Strong existence and uniqueness of the stationary distribution for a stochastic inviscid dyadic model*. *Nonlinearity*, Volume: 29 Pages: 1156-1169 Published: 2016

## Seminari

- (20 June 2017) *Stationary distribution for stochastic inviscid shell models*, First Italian Meeting on Probability and Mathematical Statistics. Torino.
- (13 Lug 2010) *Girsanov transform on SPDE*, Scuola Estiva di Probabilità di St. Flour (F).
- (28 Maggio 2008) *An Introduction to Stochastic Fluid Dynamic Models*, Seminario dottorato. Padova

## Main research lines

### *State of the art:*

In recent years there has been a wide-spread interest in the study of qualitative properties of stochastic models of fluids. The most important challenge that still remains open is the well-posedness of the Stochastic Navier-Stokes equations. Many discretized models that preserve the energy properties of the fluid equations have been proposed and studied both by mathematicians and physicists. The study of these models is important for two reasons:

- 1) The study of simpler models allows to analyze and understand the problems related to the Navier-Stokes and Euler equations avoiding the excessive difficulty of the original.
- 2) The properties of these models are often interesting from the numerical point of view with possible applications in the industrial field.

### *Latest focus:*

- *Girsanov transform on stochastic differential equations in infinite dimension*. I have studied the method of linearization via the girsanov transformation introduced by Cruzeiro, Flandoli, Malliavin in 2007. This method has been successfully applied to the Dyadics models in [8] and then has been generalized to a more general class of models including GOY shell model of turbulence and SABRA shell model of turbulence in [13]. We have obtained weak existence and uniqueness both for dyadic, goy and sabra model, moreover for these models we have proved the anomalous dissipation of energy. The relevance of these results is given by the fact that the existence and uniqueness of solutions for the deterministic goy and sabra model is still a open problem.
- *Stochastic Leray- $\alpha$  model of Euler equation: well-posedness and anomalous energy dissipation*. The Leray  $\alpha$  model of Euler equations represents the inviscid version of the Leray  $\alpha$  model of Navier-Stokes equations introduced by Leray (1934) for the study of the Navier-Stokes equations. This model has a double interest, from a theoretical point of view the model is very close to the Navier-Stokes equation for the fluid dynamics (when the parameter  $\alpha$  tends to zero, the equations of the model tend to those of Navier-Stokes), while from the point of view of applications the Leray  $\alpha$  model successfully compares with empirical data, and has a great potential as a sub-grid scale model in large-eddy simulation of turbulence. Our line of research concerns the study of the inviscid model, for which most of the problems are still open. In [15] we have constructed a stochastic model of the Leray  $\alpha$  model of the Euler equation; we found a stochastic perturbation with multiplicative noise which is both conservative and formally compatible with a Girsanov transformation. The measure transformation has allowed us to obtain a result of well posedness, this result is relevant in view of the fact that the well posedness of the deterministic Leray  $\alpha$  model of the Euler equation is still open. A future development direction of this research line may be given by the studies of anomalous energy dissipation.
- *Slightly supercritical hyperdissipative Navier-Stokes system*. I, Francesco Morandin and Marco Romito have studied a conjecture of Terence Tao 2009 on “global regularity for a logarithmically supercritical hyperdissipative Navier-Stokes equation”. In [16] we have proved the global regularity for the solutions of a logarithmically supercritical hyperdissipative dyadic

system, that is the Tao conjecture on a simplified model of Navier-Stokes equations: the dyadic one. Whereas in [17] we have generalize that work to Navier-Stokes equations. The main idea is the reducing of the problem of smoothness of Navier-Stokes solutions to a problem of smoothness of a suitable shell model, obtained by averaging the energy of the solution over dyadic shells in Fourier space.

### Scientific research projects:

- 2017 GNAMPA *Understanding deep neural networks through randomness.*[Resp. Morandin F.]
- 2016 GNAMPA *Distribuzioni invariante in fluidodinamica.*[Resp. Barbato D.]
- 2015 PRIN *Deterministic and stochastic evolution equations.*
- 2014 GNAMPA *Regolarità e dissipazione in fluidodinamica.*[Resp. Ferrario B.]
- 2013 University of Padova. *Stochastic processes and applications to complex systems.*
- 2012 GNAMPA *Deterministic and stochastic shell models.*
- 2009 GNAMPA *Study of the singularities of some equations related to hydrodynamic models.*
- 2009 PRIN *Complex stochastic models, and their applications to physics and social sciences.*
- 2006 PRIN *Kolmogorov operator.*
- 2004 PRIN *Linear and nonlinear Kolmogorov equations: probabilistic and deterministic approach.*
- 2003 PRIN *Probabilistic models in fluid dynamics, in statistics, in mechanics and in information theory.*
- 2001 PRIN *Fluid dynamics stochastic processes and vortex structures.*

### THEACHING

---

- (2016/17) *Topics in linear algebra and geometry* (Course), Bachelor's Degree in engineering, University of Padova.
- (2016/17) *Probability theory* (Course), Bachelor's Degree in Mathematics, University of Padova.
- (2015/16) *Topics in linear algebra and geometry* (Course), Bachelor's Degree in engineering, University of Padova.
- (2015/16) *Probability theory* (Course), Bachelor's Degree in Mathematics, University of Padova.
- (2014/15) *Topics in linear algebra and geometry* (Course), Bachelor's Degree in engineering, University of Padova.
- (2014/15) *Probability and Statistics* (Course), Bachelor's Degree in Mathematics, University of Padova.
- (Spring 2014) *Random perturbation of differential equations*, Ph.D. in Mathematics, University of Padova [in collaboration with Paolo Dai Pra].
- (2013/14) *Probability and Statistics* (Course), Bachelor's Degree in Mathematics, University of Padova.
- (2012/13) *Introduction to probability* (Course), Bachelor's Degree in Statistics, University of Padova.
- (2012/13) *Mathematics with elements of statistics* (recitations), Bachelor's Degree in Natural Science, University of Padova.

- (2011/12) *Introduction to probability* (Course) Bachelor's Degree in Statistics, University of Padova.
- (2010/11) *Probability theory* (Course) Master's Degree in Statistics, University of Padova.
- (2010/11) *Introduction to probability* (recitations), Bachelor's Degree in Statistics, University of Padova.
- (2010/11) Course of mathematics for freshmen. (Course) Bachelor's Degree in Statistics, University of Padova.
- (2009/10) *Probability theory* (Course) Master's Degree in Statistics, University of Padova.
- (2009/10) *Introduction to probability* (recitations), Bachelor's Degree in Statistics, University of Padova.
- (2008/09) *Probability theory* (Course) Master's Degree in Statistics, University of Padova.
- (2008/09) *Introduction to probability* (recitations), Bachelor's Degree in Statistics, University of Padova.
- (2008) *Probability theory* (Course) Ph.D. in Statistics, University of Padova
- (2007/08) *Probability theory* (recitations), Master's Degree in Statistics, University of Padova.
- (2007/08) *Introduction to probability* (recitations), Bachelor's Degree in Statistics, University of Padova.

Padova, July 12 2017.

(David Barbato)