CURRICULUM – STEFANO BIANCHINI

CONTACT DETAILS

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ACADEMIC CURRICULUM

Born in Pavia, Italy, on May 13, 1970.
"Laurea" degree in Nuclear Engineering from the "Politecnico" of Milano, Italy, July 1995.
Ph.D. in Mathematics at the International School for Advanced Studies (S.I.S.S.A.), Trieste, October 2000.
From October 2001 to October 2004: Researcher at the "Instituto per le Applicazioni del Calcolo M. Picone", CNR Rome, Italy.
From November 2004 to October 2007: Associate Professor at the International School for Advanced Studies (S.I.S.S.A.), Trieste, Italy.
From November 2007 until present: Full Professor at the International School for Advanced Studies (S.I.S.S.A.), Trieste, Italy.

PRIZES

April 2004: Medal for Mathematics for the "Accademia dei XV" for the year 2003.
June 2004: EMS Prize for Mathematics for the year 2004.
September 2007: Vinti Prize of the Italian Mathematical Society.
December 2007: The SIAG/Analysis of Partial Differential Equations Prize.

MOST IMPORTANT INVITED LECTURES

Invited Speaker at HYP2002, Pasadena.
Plenary Speaker at EMS conference 2004, Stockholm.
Plenary Speaker at HYP2004, Osaka.
Plenary Speaker at "Giornata INDAM 2005", Napoli.
Invited speaker at "International Congress of Mathematics 2006", Madrid.
Plenary Speaker at SIAM Conference 2007, Mesa.
Invited Speaker at the "The Fifth International Conference on Differential and Functional Differential Equations" 2008, Moscow
Plenary Speaker at Hyp2010, Beijing.
Invited Speaker at the congress "Chocs et Oscillations" 2010, Bordeaux.
Invited Speaker at the "Conference on Hyperbolic Conservation Laws and Continuum Mechanics" 2011, Providence
Invited Speaker at the "The Sixth International Conference on Differential and Functional Differential Equations" 2011, Moscow
Invited Speaker at the "Geometry meets Transport" 2011, Nice
Invited speaker at the "Workshop on kinetic theory and fluid mechanics", 2012, Lyon
Invited speaker at the conference "Optimal Transportation and Differential Geometry", 2012, Banff
Invited speaker at the "International Workshop on Fluid and Kinetic Models", 2012, Daejong
Invited speaker at the "International Conference on Nonlinear PDE", 2012, Oxford
Invited speaker at the "International Conference on Nonlinear Analysis:Evolutionary P.D.E and Kinetic Theory", 2012, Taipei
Invited speaker at the "Trilateral Meeting Australia-Italia-Taiwan", 2012, Wollongong
Invited speaker at the "International Conference on Fluids and Variational Methods", 2013, Leipzig
Invited speaker at the "Conference on Conservation Laws and Applications", 2013, Bangalore
Plenary speaker at the "International Conference of Applied Mathematics", 2013, Heraklion

Invited speaker at the "International Conference on Nonlinear Analysis: Fluid Dynamics and Kinetic Theory", 2013, Taipei
Invited speaker at the "Recent developments of nonlinear PDEs", 2013, Canberra

COORDINATOR OF RESEARCH PROJECTS

Coordinator of the Trieste research group of the PRIN "Dinamica dei fluidi e leggi di conservazione" 2005-2007.
National Coordinator of the research group PRIN "Sistemi non lineari di Leggi di Conservazione e Fluidodinamica" 2008-2010.
Principal Investigator of the ERC-grant "Hyperbolic Systems of Conservation Laws: singular limits, properties of solutions and control problem" 2009-2013.
National Coordinator of the research group PRIN "Sistemi non lineari di Leggi di Conservazione e Fluidodinamica" 2011-2013.
National Coordinator of the research group PRIN "Nonlinear Hyperbolic Partial Differential Equations, Dispersive and Transport Equations: Theoretical and Applicative Aspects", 2013-2016.

MAIN ACHIEVEMENTS

Degree thesis (1995). During the degree thesis I studied an extended version of the Lorenz system. This system has a new type of homoclinic bifurcation, from which the chaotic dynamics appears. The homoclinics starting from this point can be directly related to the homoclinic bifurcation of the original Lorenz system.

Lyapunov theorem (1996). I worked on the Lypaunov theorem in my first year of PhD studies. The main results are a simple proof of the fact that in $\mathbb{R}^2$ every convex set is the range of a vector bounded measure (zonoid), and the characterization of strictly convex and of the faces of a zonoid in terms of the given measure.

Large data for hyperbolic systems (1998-2000, 2010) I generalized a previous result on hyperbolic systems with large data, showing that the convexity assumption on the flux function is not needed and that it is possible to pass to initial data in L^∞ at the price of requiring only a continuous dependence on the initial data instead of a Lipschitz one.
Another result is the simplification and extension of the Glimm-Lax results on existence of solutions for large data in the p-system.

Vanishing viscosity (1998-2001). During my PhD I worked principally on the vanishing viscosity limit to hyperbolic system. A part from special almost scalar systems, where the result can be obtained because the BV or L^∞ norm is naturally preserved and the presence of entropies, this question was an open problem since 1956. The importance of this problem relies on the fact that the hyperbolic systems are thought a the limiting equations for more complicate physical models where viscosity acts. Considering systems step by step more complicated, the general case has been completed during the first year after the doctorate.

Riemann problem (2002). The vanishing viscosity approach suggests a way to characterize the correct hyperbolic limiting solution from a given singular perturbation. In fact, the starting observation is that for BV solution it is enough to study the Riemann problem to single out the semigroup of solutions. I approached this problem in general for the most important singular perturbations: vanishing viscosity, relaxation and discrete-semidiscrete schemes.

Semidiscrete approximation (2002). While the vanishing viscosity result suggests a general philosophy to attack other singular limits (prove uniform BV estimate), in general every singular perturbation one add to the system requires its own ad-hoc technique. In the semidiscrete case the principal problem is that the source terms are not local, so that one has to adapt the techniques of the vanishing viscosity case to include and estimate non local interactions.

Relaxation approximation (2004). The study of relaxation approximation is definitely more complicated of the vanishing viscosity, because the interaction occurs among families of particles, instead that between macroscopic waves. This requires a quite different analysis than in the previous cases, which so far has been adapted to special relaxation models. The novelty here is the introduction of an interaction potential for BGK schemes, which to our knowledge was unknown.

Large time behavior for balance laws (2005). The analysis of large time behavior of solution is a classical topics in PDE. This works extends the Fourier analysis technique to linear balance laws, yields sharp estimates on the Green function and deduces sharp decay estimates for the nonlinear case.

Boundary conditions for hyperbolic systems (2003-2007). The techniques introduced for the study of singular perturbation allows the study of systems with boundary condition. The main achievement is that now there is a proof of convergence and a compatibility analysis. In particular it is possible to deduce the correct boundary conditions satisfied by the limiting solution as the viscosity converges to 0, without any assumption on the structure of the solution (only small BV).

Disintegration of measures along rays (2007). In a completely different direction, the problem of the regularity of the conditional probability of a given measure along a family of disjoint segments is addressed. If these segments correspond to optimal rays for the solution of a Hamilton-Jacobi equation, it is shown that the conditional probabilities are absolutely continuous w.r.t. the H^1 measure on the ray, if the disintegrated measure is absolutely continuous w.r.t. Legesbue. This fixes a 30 years proof of Sudakov.

Uniqueness, extremality and optimality conditions for transference plans (2009). The problem of uniqueness, extremality and optimality of transference plans for general Borel cost functions is considered from the point of view of measure theory. The main result is a general theorem of measure theory relating the uniqueness of transference plans and the fact that its carriage is the graph of a Borel linear preorder. The conclusion are probably optimal, further questions probably require additional set theory axioms.

Transport in metric measure space (2009-2010). We study the Monge transportation problem in general non branching metric measure space (e.g. Wiener spaces). The idea is to obtain the minimal conditions on the space in order to prove the existence of an optimal map. The results uses Descriptive Set Theory techniques.

SBV regularity for Hamilton-Jacobi and Conservation Laws (2009-2012). This is a natural question once the solution is known to be BV (conservation laws case) or semiconcave (Hamilton-Jacobi equations). Several cases of increasing generalities are solved.

Transport equation for Hamiltonian vector fields (2010-2012). The problem of transport equation for divergence free vector fields in 2d is solved completely. A Sard type condition on the vector field is proved to be necessary and sufficient for well posedness of the PDE, and this condition is checked on several classical functions spaces.

Sudakov's type decomposition for transference plans with norm costs (2013). The original strategy proposed by N.I. Sudakov for decomposing transference plans is fully implemented. The sets of the decomposition are locally affine sets (i.e. relatively open sets in their affine span), and the minimality condition characterizing them is that they are cyclically connected w.r.t. every optimal transference plans.

PUBLICATIONS

(1) Bianchini S., Modena S. On a quadratic functional for scalar conservation laws. JHDE, in press.
(2) G. Alberti, S. Bianchini, G. Crippa. A Uniqueness Result for the Continuity Equation in Two Dimensions. Journal EMS, in press.
(3) S. Bianchini, L. Yu. Global Structure of Solutions to Piecewise Genuinely Nonlinear Hyperbolic Conservation Laws in One Space Dimension. Comm. PDE, in press.
(4) G. Alberti, S. Bianchini, G. Crippa. On the L^p-differentiability of certain classes of functions. Revista Matematica Iberoamericana, in press.
(5) G. Alberti, S. Bianchini, G. Crippa. Structure of level sets and Sard-type properties of Lipschitz maps. Annali SNS, in press.
(6) Bianchini S., F. Cavalletti (2013). The Monge problem in metric spaces. Comm. Math. Physics, vol. 318, p. 615-673
(7) Bianchini S., L. Yu (2012). Regularity of solutions for general hyperbolic systems of conservation laws. Rendiconti Ist. Mat. Univ. Trieste, vol. 44, p. 1-34.
(8) Bianchini S., D. Tonon (2012). SBV regularity for Hamilton-Jacobi equations with Hamiltonian depending on (t, x). SIAM Math. Anal., vol. 44, p. 2179-2203.

(9) Bianchini S., L. Caravenna (2012). SBV regularity for genuinely nonlinear, strictly hyperbolic systems of conservation laws in one space dimension. Communications in Mathematical Physics, vol. 313, p. 1-33.
(10) Bianchini S., D. Tonon (2012). SBV-like regularity for Hamilton-Jacobi equations with convex Hamiltonian. Jour. Math. Anal. Appl., vol. 391, p. 190-208.
(11) Bianchini S., D. Tonon (2011). A decomposition theorem for BV functions. Communications on Pure and Applied Analysis, vol. 10, p. 1549-1566, ISSN: 1534-0392.
(12) Bianchini S., De Lellis C., Robyr R (2011). SBV regularity for Hamilton-Jacobi equations in R^n. Archive for Rational Mechanics and Analysis, vol 200, p. 1003-1021.
(13) Bianchini S., L.V. Spinolo (2011). Invariant manifolds for a singular ordinary differential equation. Journal of Differential Equations, vol. 250; p. 1788-1827, ISSN: 0022-0396
(14) Bianchini S., A. Brancolini (2010). Estimates on path functionals over Wasserstein spaces. SIAM Journal on Mathematical Analysis, vol. 42; p. 1179-1217, ISSN: 0036-1410
(15) Bianchini S., L. Caravenna (2010). On optimality of c-cyclically monotone transference plans. Comptes Rendus Mathematique, ISSN: 1631-073X, doi: 10.1016/j.crma.2010.03.022
(16) Bianchini S., M. Gloyer (2010). Transport equations with monotone vector fields. Communications in Partial Differential Equations, ISSN: 0360-5302
(17) Bianchini S., R.M. Colombo, F. Monti (2010). 2x2 systems of conservation laws with L^infty-data. Journal of Differential Equations, vol. 249; p. 3466-3488, ISSN: 0022-0396
(18) Bianchini S., L. Spinolo (2009). A connection between viscous profiles and singular ODEs. Rend. Ist. Mat. Univ. Trieste, vol. 41, p. 35-41.
(19) Bianchini S., Gloyer M. (2009). On the Euler-Lagrange equation for a variational problem: the general case II. Mathematische Zeitschrift, ISSN: 0025-5874, doi: 10.1007/s00209-009-0547-2
(20) Bianchini S., L. Caravenna (2009). On the extremality, uniqueness and optimality of transference plans. Bulletin of the Institute of Mathematics, Academia Sinica, vol. 4; p. 353-454, ISSN: 0304-9825
(21) Bianchini S., Spinolo L. V (2009). The boundary Riemann solver coming from the real vanishing viscosity approximation. Archive for Rational Mechanics and Analysis, vol. 191(1); p. 1-96, ISSN: 0003-9527
(22) Bianchini S. (2007). On the Euler-Lagrange equation for a variational problem. Discrete and Continuous Dynamical Systems, vol. 17(3); p. 449-480, ISSN: 1078-0947
(23) Bianchini S., Hanouzet B, Natalini R (2007). Asymptotic behavior of smooth solutions for partially dissipative hyperbolic systems with a convex entropy. Communications on Pure and Applied Mathematics, vol. 60; p. 1559-1622, ISSN: 0010-3640
(24) Bianchini S. (2006). On Bressan's conjecture on mixing properties of vector fields. Banach Center Publications, vol. 74; p. 13-31, ISSN: 0137-6934
(25) Bianchini S. (2006). Relaxation Limit of the Jin-Xin relaxation model. Communications on Pure and Applied Mathematics, vol. 59; p. 688-753, ISSN: 0010-3640
(26) Bianchini S., Bressan A. (2005). Vanishing viscosity solutions of nonlinear hyperbolic systems. Annals of Mathematics, vol. 161; p. 223-342, ISSN: 0003-486X
(27) Bianchini S. (2003). Interaction estimates and Glimm functional for general hyperbolic systems. Discrete and Continuous Dynamical Systems, ISSN: 1078-0947
(28) Bianchini S. (2003). BV solutions of the semidiscrete upwind scheme. Archive for Rational Mechanics and Analysis, ISSN: 0003-9527
(29) Bianchini S. (2003). A note on the Riemann problem for nonconservative hyperbolic systems. Archive for Rational Mechanics and Analysis, vol. 166; p. 1-26, ISSN: 0003-9527
(30) Bianchini S. (2003). A Note on Singular Limits to Hyperbolic Systems. Communications on Pure and Applied Analysis, vol. 2; p. 51-64, ISSN: 1534-0392
(31) Bianchini S., A. Bressan (2002). A Center Manifold Technique for tracing Viscous Waves. Communications on Pure and Applied Analysis, vol. 1; p. 161-190, ISSN: 1534-0392
(32) Bianchini S., A. Bressan (2002). On a Lyapunov Functional relating Shortening Curves and Viscous Conservation Laws. NONLINEAR ANALYSIS, vol. 51; p. 649-662, ISSN: 0362-546X
(33) Bianchini S., R.M. Colombo (2002). On the Stability of the Standard Riemann Semigroup. Proceedings of the American Mathematical Society, vol. 130; p. 1961-1973, ISSN: 0002-9939

(34) Bianchini S. (2001). A Glimm Type Functional for a Special Jin-Xin Relaxation Model. Annales de l'Institut Henri Poincar. Analyse non Linaire, vol. 18; p. 19-42, ISSN: 0294-1449
(35) Bianchini S. (2001). Stability of L^∞ solutions for hyperbolic systems with coinciding shocks and rarefactions. SIAM Journal on Mathematical Analysis, vol. 33; p. 959-981, ISSN: 0036-1410
(36) Bianchini S., A. Bressan (2001). A case study in vanishing viscosity. Discrete and Continuous Dynamical Systems, vol. 7; p. 449-476, ISSN: 1078-0947
(37) Bianchini S. (2000). On the shift dierentiability of the flow generated by a hyperbolic system of conservation laws. Discrete and Continuous Dynamical Systems, vol. 6; p. 329-350, ISSN: 1078-0947
(38) Bianchini S. (2000). The Semigroup generated by a Temple Class System with Non Convex Flux Function. Differential and Integral Equations, vol. 13; p. 1529-1550, ISSN: 0893-4983
(39) Bianchini S., A. Bressan (2000). BV Solutions for a Class of Viscous Hyperbolic Systems,. Indiana University Mathematics Journal, vol. 49; p. 1673-1713, ISSN: 0022-2518
(40) Bianchini S. (1999). Extremal Faces of the Range of a Vector Measure and a Theorem of Lyapunov. Journal of Mathematical Analysis and Applications, vol. 231; p. 301-318, ISSN: 0022-247X
(41) Bianchini S., C. Mariconda (1999). The Vector Measures whose Range is strictly convex: some Characterizations and Applications. Journal of Mathematical Analysis and Applications, vol. 232; p. 1-19, ISSN: 0022-247X
(42) Bianchini S., C. Mariconda, R. Cerf (1998). Chebyshev Measures and the Vector Measures whose Range is Strictly Convex. Atti del Seminario Matematico e Fisico dell'Universita' di Modena, vol. 46; p. 525-534, ISSN: 0041-8986
(43) Bianchini S., C. Mariconda, R. Cerf (1997). Two Dimensional Zonoids and Chebyshev Measures. Journal of Mathematical Analysis and Applications, vol. 211; p. 512-526, ISSN: 0022-247X

PROCEEDINGS

(1) Bianchini S., M. Gloyer (2011). Transport rays and applications to Hamilton-Jacobi equations. In: Nonlinear PDEs and Applications. Lecture Notes in Mathematics 2028 (2011), p. 1-16.
(2) Bianchini S. (2010). SBV regularity of Genuinely Nonlinear Hyperbolic Systems of Conservation Laws in One Space Dimension. In: 13th conference on Hyperbolic Problems: Theory, Numerics and Applications, Acta Math. Scientia, vol. 32, p. 380-388
(3) Bianchini S. (2006). Glimm interaction functional for BGK schemes. In: Hyperbolic Problems: theory, numerics, applications, vol. I, p. 1-13
(4) Bianchini S. (2006). Vanishing Viscosity Solutions of Hyperbolic Systems of Conservation Laws with Boundary. In: Waves and Stability in continuous media, pag. 13-22.
(5) Bianchini S. (2006). On Bressan conjecture on mixing properties of vector fields. In: Banach Center Publications, vol. 74, 13-31.
(6) Bianchini S (2006). Vanishing Viscosity Solutions of Hyperbolic Systems of Conservation Laws with Boundary. In: Waves and Stability in continuous media. p. 13-22.
(7) Bianchini S., A. Bressan (2001). Viscosity Solutions for Hyperbolic Systems where Shock curves are Straight lines. In: International Series of Numerical Mathematics, vol. 140, p. 159-167

UNPUBLISHED

(1) Bianchini S., Dabrowski A. (2014). Existence and uniqueness of the gradient flow of the Entropy in the space of probability measures.
(2) Bianchini S., Yu L. (2014). Structure of entropy solutions to general scalar conservation laws in one space dimension.
(3) Bianchini S., Modena S. (2013). Quadratic interaction functional for systems of conservation laws: a case study.
(4) Alberti G., Bianchini S., Caravenna L. (2013). Reduction on characteristics for continuous solutions of a scalar balance law.
(5) Bianchini S. (2008). The Euler Lagrange equation for a variational problem: the general case.
(6) Bianchini S., L.V. Spinolo (2007). Perturbation techniques applied to the real vanishing viscosity approximation of an initial boundary value problem.

(7) Ancona F., Bianchini S. (2003). Vanishing Viscosity Solutions for general Hyperbolic Systems with Boundary.