

Sandro Salsa

Born in Novara (Italy) the 11th January 1950.

Laurea degree in Mathematics in 1972 at the University of Milan.

Relevant academic positions

Researcher (with tenor) at the University of Milan from 1981 to 1986.

Full Professor in Mathematical Analysis since 1987 at the Department of Mathematics, Politecnico di Milano.

Main institutional activities and appointments

- Chairman of the Department of Mathematics from November 1999 until December 2008.
- Co-founder of the Educational program in Mathematical Engineering at the Politecnico (1999-2001).
- President of the program in Mathematical Engineering in the years 2001/2002, and from January 2010 until December 2015.
- Co-founder of the Lab in Modelling and Scientific Computing (MOX) at the Mathematics Department (1999-2002).

Major fields of past and current research interest.

Nonlinear, nonlocal, singular or degenerate Partial Differential Equation of elliptic and parabolic type. In particular, free boundary problems with sharp interphase, obstacle problems for the fractional Laplacian, free boundary problems from Finance, boundary behaviour of solutions to degenerate and singular type operators.

Other scientific activities

- Director of the local research group in Mathematical Models and Dynamical Systems, from 1996 to 1998.
- Advisor of 5 PhD theses in Mathematics.
- Visiting professor in several periods during the indicated years at the *Department of Mathematics* in Minneapolis (1978-1988) at the *Institute for Advanced Study* in Princeton (1990-1996), at the *Courant Institute* of Mathematical Sciences in New York (1997-2000) and at the *Department of Mathematics* in Austin, Texas (2000-2010).
- Associate Editor of *Nonlinear Analysis*.
- Co-editor in chief of The Bocconi-Springer Series in Mathematics, Statistics, Finance and Economics
- From 2008 to 2017 member of the scientific committee of the INDAM group G.n.a.m.p.a.
- From 2015 to 2018, Director of the Scuola Matematica Interuniversitaria.

Selected monographs and Scientific Textbooks

- A Geometric Approach to Free Boundary Problems, (with L. A. Caffarelli), *Graduate Studies in Mathematics*, American Math. Society, Providence RI, (2005), vol. 68, pp 270.
- Partial Differential equations: from modelling to theory. *Springer-Verlag*, third edition (2016), pp 688.
- A Primer on PDEs - Models, Methods, Simulations, (with F. Vegni, A.Zaretti, P.Zunino), *Springer-Verlag* (2012), pp 482.

Selected research Papers

- Regularity of higher order in two-phase free boundary problems. (with D. De Silva, F. Ferrari), *Transaction of American Mathematical Society*, 2019, vol. 371 (5), 3691-3720
- A saddle point approach to an optimal boundary control problem for steady Navier-Stokes equations (with A. Manzoni, A. Quarteroni), *Mathematics in Engineering*, vol. 1 (2), 2019, pp.252-280.
- Solution Map Analysis of a Multiscale Drift-Diffusion Model for Organic Solar Cells (with Verri, M.; Porro, M.; Sacco, R.), *Computer Methods in Applied Mechanics and Engineering*, 2018, vol. 331, pp 281-308
- Existence of viscosity solutions to two-phase problems for fully nonlinear equations with distributed sources. (with F. Tulone, G. Verzini), *Mathematics in Engineering*, vol. 1 (1), 2018, pp.147-173.
- Obstacle Problems Involving the Fractional Laplacian.(with D. Danielli), *Recent Developments in Nonlocal Theory* 2018, De Gruyter, pp.81-164
- Boundary estimates for certain degenerate and singular parabolic equations, (with B Avelin, U. Gianazza), *Journal of European Mathematical Society*, 18, 2016, 381-424.
- Regularity of the free boundary for two-phase problems governed by divergence form equations and applications (with D. De Silva, F. Ferrari), *Nonlinear Analysis* 138, 2016, 3-30.
- Free boundary regularity for fully nonlinear non-homogeneous two-phase problems, (with D. De Silva, F. Ferrari), *Journal de Mathématiques Pures et Appliquées* 103 (3), 2015, 658-694.
- Perron solutions for two phase free boundary problems with distributed sources (with D. De Silva, F. Ferrari), *Nonlinear Analysis* 121, 2015, 382-402.
- Two-phase problems with distributed source: regularity of the free boundary, (with D. De Silva, F. Ferrari), *Analysis & PDE* 7 (2), 2014, 267-310.
- Shape optimization by free-form deformation: existence results and numerical solution for Stokes flows, (with F. Ballarin, A. Manzoni, G. Rozza), *Journal of Scientific Computing* 60 (3), 2014, 537-563.
- Two-Phase Free Boundary Problems for Parabolic Operators: Smoothness of the Front, (with F. Ferrari), *Communications on Pure and Applied Mathematics*, 2014, vol. 67, 1–39. doi: 10.1002/cpa.
- The problem of the obstacle in lower dimension and for the fractional Laplacian, *Lecture Notes on Regularity estimates for nonlinear elliptic and parabolic problems*, Springer-Verlag, 2012, 153-244.
- Regularity of the Solution for Parabolic Two-Phase Free Boundary Problems, (with F. Ferrari), *Comm. in P.D.E.*, 2010, vol. 35, 1095-1129.
- Regularity of the free boundary of an American Option on several assets, (with P. Laurence), *Communications on Pure and Applied Mathematics*, 2009, vol. 62, 969-994.

- Regularity estimates for the solution and the free boundary of the obstacle problem for the fractional Laplacian, (with L.A. Caffarelli, L. Silvestre), *Inventiones Mathematicae*, 2008, vol. 171, 425-461.
- The structure of the free boundary for lower dimensional obstacle problems, (with I. Athanasopoulos, L. A. Caffarelli), *American Journal of mathematics*, 2008, vol. 130, 485-498.
- Regularity of the free boundary in two-phase problems for linear elliptic equations, *Advances in Mathematics*, (with F. Ferrari), 2007, vol. 214, 288-322.
- Two-phase problems for linear elliptic operators with variable coefficients: Lipschitz free boundaries are $C^{1,\alpha}$, (with M.C Cerutti, F. Ferrari), *Archive for Rational Mechanics and Analysis*, 2004. 171, 329-348.
- Stefan like problems with curvature, (with I. Athanasopoulos, L. A. Caffarelli) *The Journal of Geometric Analysis*, 2003, vol. 13, p. 21-27, 1050-6926
- Variational inequalities with lack of ellipticity. Part I: Optimal interior regularity and non degeneracy of the free-boundary, (with D. Danielli, N. Garofalo), *Indiana University Journal*, 2003, vol. 52, 361-398.
- The free boundary in an inverse conductivity problem, (with I. Athanasopoulos, L. A. Caffarelli), *Journal für die Reine und angewandte Mathematik*, 2001, vol. 534, 1-31.
- An Area-Dirichlet integral Minimization Problem, (with I. Athanasopoulos, L. A. Caffarelli, C. Kenig), *Communications on Pure and Applied Mathematics*, 2001, vol. 54, 479-499.
- Phase Transition problems of parabolic type: Flat free boundaries are smooth, (with I. Athanasopoulos, L. A. Caffarelli), *Communications on Pure and Applied Mathematics*, 1998, vol. 51, 77-112.
- Regularity in parabolic phase transition problems, *Journal of Fourier Analysis and applications*, 1998, vol. 4, 549-564.
- Caloric Functions in Lipschitz Domains and the Regularity of Solutions to Phase Transition Problems, (with I. Athanasopoulos, L. A. Caffarelli), *Annals of Mathematics*, 1996, vol. 143, 413-434.
- Regularity of the free boundary in parabolic phase-transition problems, (with I. Athanasopoulos, L. A. Caffarelli), *Acta Mathematica*, 1996, vol. 176, 245-282.
- Quasilinear elliptic equations with quadratic growth in the gradient, (with C. Maderna, C. Pagani), *Journal of Differential Equations*, 1992, vol 1, 54-70.
- An application of a parabolic comparison principle to free boundary problems, (with I. Athanasopoulos), *Indiana University Journal*, 1991, vol. 40, 29-32.
- Fatou theorems for some nonlinear elliptic equations, (with E. Fabes, N. Garofalo, S. Marin-Malave), *Revista matematica Iberoamericana*, 1988 vol. 4, 227-251.
- A backward Harnack inequality and Fatou theorem for nonnegative solutions of parabolic equations, (with E. B. Fabes, N. Garofalo), *Illinois Journal of mathematics*, 1986, vol. 30, 536-565.

- Existence results for an inverse problem in potential theory, (with C. Maderna, C. Pagani), *Nonlinear Analysis T.M.A.* 1986, vol. 10 (3), 277-298.
- Estimates of caloric measure and the initial-Dirichlet problem for the heat equation in Lipschitz cylinders, (with E. Fabes), *Transactions of the American Math. Society*, (1983), vol. 279, p. 635-650.
- A nonvariational second order elliptic operator with singular elliptic measure, (with L. Modica, S. Mortola), *Proceedings of the American Math. Society* 1983, vol. 84.
- Boundary behavior of nonnegative solutions of elliptic operators in divergence form, (with L. A. Caffarelli, E. Fabes, S. Mortola), *Indiana University Journal*, (1981), vol. 30, 621-640.
- Some properties of nonnegative solutions of parabolic differential operators, *Annali di Matematica Pura e Applicata*, 1981, vol. 128, 193-206.