Curriculum Vitae

INFORMAZIONI PERSONALI

Nome MARCO MARIA LUIGI

Cognome SAMMARTINO

Recapiti Dipartimento di Matematica ed Informatica, Via Archirafi 34 90123

Telefono 091-23891089

E-mail marcomarialuigi.sammartino@unipa.it
marco.sammartino@math.unipa.it

FORMAZIONE TITOLI

Appointments held

University of Palermo Full Professor 2002-present
University of Palermo Associate Professor 1999-2002
University of Palermo Ricercatore 1993-1999
Math Dept, UCLA Visiting Assisting Researcher 1992-1993
Mech. Aerosp. Nucl. Engng Dept, UCLA Visiting Researcher 1991-1992

Awards and Honors

Agostinelli Prize for Pure and Applied Mechanics and Mathematical Physics, Italian National Academy, 2015
Plenary lecture at the XX Congress of the Italian Mathematical Association Siena September 2015

Education

University of Catania PhD in Mathematics (Program in Mathematical Physics) 1991
Advisor: Prof. A.M. Anile
Thesis: Mathematical Foundations of Radiation Hydrodynamics

University of Catania Laurea, Mathematics, Cum Laude 1986
Supervised by Prof. A.M. Anile
Thesis: Dynamical Systems and Cosmological Solutions of
Einstein's Equations

Visiting Positions

Institute for Pure and Applied Mathematics, Los Angeles, August-December 2016, Visiting Researcher
Institute for Pure and Applied Mathematics, Los Angeles, September-December 2015, Visiting Researcher
University of Southern California, Los Angeles, August 2014-January 2015, Visiting Professor
Institute for Pure and Applied Mathematics, Los Angeles, August-October 2013, Visiting Professor
Math Dept University of California at Los Angeles, September-November 2003 Visiting Professor
Universite de Marne-la-Vallee January-February 2002 Professeur invite
Universite de Paris VII May-June 2000 Professeur invite
Math Dept Univ. of Arizona February 1999 Visiting Professor
Math Dept University of California at Los Angeles, July-September 1997 Visiting Faculty
Math Dept University of California at Los Angeles, July-September 1996 Visiting Faculty
Math Dept University of California at Los Angeles, July-September 1995 Visiting Faculty
Math Dept University of California at Los Angeles, July-September 1994 Visiting Faculty
Math Dept University of California at Los Angeles, July-October 1993 Visiting Faculty

Invited talks and lectures

1. invited at the *BIRS Workshop Recent Advances in Hydrodynamics*, Banff, Canada, June 5-10 2016.
2. invited at the *Workshop on Complex systems of reaction-diusion*, Paris, March 11-14 2016.
3. invited talk at the conference *Couches limites et Interactions Fluide/Structure, Bordeaux*, January 11-14, 2016.
4. Plenary lecture at the *XX Congress of Italian Mathematical Association*, Siena, September 7-12 2015.
5. invited talk at the *XVIII International conference on Waves and Stability in Continuous Media*, Cetraro(CZ), June 1-5, 2015.
6. invited talk at the *Seventh China-Italy Colloquium on Applied Mathematics*, Cinisi (PA), September 8-11, 2014.

7. invited talk at the International Conference *Advances in Mathematical Fluid Mechanics*, *Stochastic & Deterministic Methods*, Lisbon June 30-July 5 2014.
8. invited talk at the *Fourth Workshop on Fluids and PDE*, Rio de Janeiro, IMPA, 26-30 May 2014.
9. invited talk at the *XVII International conference on Waves and Stability in Continuous Media*, Levico, June 17-21 2013.
10. invited talk at the *Sixth China-Italy Colloquium on Applied Mathematics*, Shanghai, October 22-27, 2012.
11. invited talk at the Minisymposium on *Infinite Dimensional Dynamics and Applications*, *9th AIMS Conference on on Dynamical Systems, Differential Equations and Applications* Orlando, Florida, July 1 - 5, 2012.
12. invited talk at the Minisymposium on *Singular Perturbations and Boundary Layer Theory, 9th AIMS Conference on on Dynamical Systems, Dierential Equations and Applications* Orlando, Florida, July 1 - 5, 2012.
13. invited talk at the Minisymposium on *The many aspects of Fluids and Harmonic Analysis, SIAM Conference on Analysis of PDE*, San Diego, November 14-17, 2011.
14. invited talk at the workshop *Stability and Qualitative Analysis of Dynamical Systems*, Levico, October 4-5 2011.
15. invited talk at the INDAM workshop *Nonlinear Hyperbolic Systems of Balance Laws in Extended Thermodynamics and Kinetic Theory* Cortona (Italy), September 4-10 2011.
16. plenary talk at *XVI International conference on Waves and Stability in Continuous Media*, Brindisi June 12-18 2011.
17. plenary talk at *Fifth China-Italy Colloquium on Applied Mathematics*, Acireale, September 27-30, 2010.
18. invited talk at the Minisymposium on *Fluids and Harmonic Analysis, SIAM Conference on Dynamical systems and PDE*, Barcelona May 31-July 4, 2010.
19. plenary talk at *IPERBA, 13th Meeting on Hyperbolic Equations*, Bari 11-13 Feb. 2009.
20. invited talk at *New Trends in Industrial and Applied Mathematics*, Catania November 10-13. 2008.
21. plenary talk at the International conference on *New Trends in Fluid and Solid Models*, Vietri, February 28- March 1 2008.

ATTIVITA' DIDATTICA

I Have been teaching the following courses:

Undergraduate courses
Theoretical Mechanics, Dynamical Systems, Finance Math, Introductory courses in PDE, Introductory courses in numerical Analysis.

Graduate courses
Advanced courses in PDE, Advanced Numerical Mathematics, General Relativity, Mathematical Methods for Physicists.

RICERCHE FINANZIATE

Galileo Project
Italy-France Project in collaboration with the University of Marne-la-Vallee; Principal Investigator for the Italian part, 2002

GNFM Project
A project funded by the ITALIAN National Institute for Higher Mathematics, in collaboration with the Universities of Naples and Catania, Principal Investigator, 2004.

INCARICHI / CONSULENZE

Member of the Scientific Committee of the Italian National Mathematical Phisics Group (INDAM) 2013-2017

PUBBLICAZIONI

Papers appeared on refereed journals

1. M.C.Lombardo, R. Barresi , E. Bilotta, F. Gargano, P. Pantano, M. Sammartino, *Demyelination patterns in a mathematical model of multiple sclerosis,* Journal of Mathematical Biology, in press.
2. I.Kukavica, M.C.Lombardo, M.Sammartino, *Zero viscosity limit for analytic solutions of the Primitive Equations*, Archive for Rational Mechanics and Analysis, 222 (1), pp. 15-45, (2016).

3. G. Gambino, M. C. Lombardo, S. Lupo, M. Sammartino , *Super-critical and sub-critical bifurcations in a reaction-diffusion Schnakenberg model with linear cross-diffusion*, Ricerche di Matematica, 65 (2), pp. 449-467 (2016)..
4. R. Barresi , E. Bilotta, F. Gargano, M. C. Lombardo, P. Pantano, M. Sammartino, *Wavefront invasion for a chemotaxis model of Multiple Sclerosis*, Ricerche di Matematica, 65 (2), pp. 423-434 (2016).
5. F. Gargano, G. Ponetti, M. Sammartino, V. Sciacca, *Complex singularities in KdV solutions*, Ricerche di Matematica, 65 (2) , pp. 479-490 (2016).
6. B.Bozzini, G.Gambino, D.Lacitignola, S.Lupo, M.Sammartino, I.Sgura, *Weakly nonlinear analysis of Turing patterns in a morphochemical model for metal growth*, Computers and Mathematics with Applications, vol.70(8), 1948-1969 (2015).
7. R.E.Caflisch, G.Gambino, M.Sammartino, C.Sgarra, *European option pricing with transaction costs and stochastic volatility: An asymptotic analysis*, IMA Journal of Applied Mathematics, vol.80(4), 981-1008 (2015).
8. R.Caflisch, F.Gargano, M.Sammartino, V.Sciacca, *Complex singularities and PDEs*, Rivista di Matematica della Universita di Parma, Vol.6(1) 69-133 (2015)
9. E.Tulumello, M.C.Lombardo, M.Sammartino, *Cross-Diusion Driven Instability in a Predator-Prey System with Cross-Diusion*, Acta Applicandae Mathematicae, vol.132(1),621-633 (2014).
10. G.Ponetti, M.Sammartino, V.Sciacca, *Formation of Coherent Structures in Kolmogorov Flow with Stratication and Drag*, Acta Applicandae Mathematicae, vol.132(1), 483-492 (2014).
11. F.Gargano, M.Sammartino, V.Sciacca, K.Cassel, *Complex singularities for high Reynolds number Navier-Stokes solutions* . Journal of Fluid Mechanics, vol.747, 381{421 (2014).
12. G.Gambino, M.C.Lombardo, M.Sammartino, V.Sciacca, \Turing pattern formation in the Brusselator system with nonlinear diusion" Physical Review E , vol.88(4), 042925 (2013).
13. M.Cannone, M.C.Lombardo, M.Sammartino, \Well-posedness of Prandtl equations with non-compatible data" Nonlinearity, vol.26(12), 3077{3100 (2013).
14. G.Gambino, M.C.Lombardo, M.Sammartino, \Pattern formation driven by cross-diffusion in a 2D domain" Nonlinear analysis B: Real Worls Applications, vol.14(3), 1755{1779 (2013).
15. G.Gambino, M.C.Lombardo, M.Sammartino, \Turing instability and traveling fronts for a nonlinear reaction-diusion system with cross-diusion," Mathematics and Computers in Simulations, vol.82(6), 1112{1132 (2012).
16. F.Gargano, M.Sammartino, V.Sciacca, \High Reynolds number Navier-Stokes solutions and boundary layer separation induced by a rectilinear vortex," Computers and Fluids, vol.52, 73-92 (2011).
17. R.Caflisch, M.C.Lombardo, M.Sammartino, \Asymptotic Analysis of a Slightly Rarefied Gas with Nonlocal Boundary Conditions," Journal of Statistical Physics, vol.143(4), 725{739 (2011).
18. G.Gambino, M.C.Lombardo, M.Sammartino, \Adaptive control of a seven mode truncation of the Kolmogorov ow with drag." Chaos, Solitons and Fractals, vol.41(1), 47{59 (2009).
19. G.Gambino, M.C.Lombardo, M.Sammartino, \A velocity{diusion method for a Lotka-Volterra system with cross and self{diusion." Applied Numerical Mathematics, vol.59(5), 1059{1074 (2009).
20. F.Gargano, M.Sammartino, V.Sciacca, \Singularity formation for Prandtls equations," Physica D-Nonlinear Phenomena, vol.238, 1975{1991 (2009).
21. M.C.Lombardo, R.Caisch, M.Sammartino, *Non-Local Scattering Kernel and the Hydrodynamic Limit*, Journal of Statistical Physics, vol.130, 69{82(2008).
22. G.Della Rocca, M.C.Lombardo, M.Sammartino, V.Sciacca, *Singularity tracking for Camassa-Holm and Prandtl's equations*. Applied Numerical Mathematics, vol. 56, 1108-1122 (2006).
23. G.Gambino, M.C.Lombardo , M.Sammartino, \Global linear feedback control for the generalized Lorenz system," Chaos, Solitons and Fractals, vol.29, 829{837 (2006).
24. G.Della Rocca, M.Sammartino, L.Seta, \A mathematical model for the therapy of the HIV infection," Ricerche di Matematica, vol. 54, 313{327 (2005).
25. M.C.Lombardo , M.Sammartino, V.Sciacca, \A note on the analytic solutions of the Camassa-Holm equation," Comptes Rendus Mathematique, vol. 341/11, 659-664 (2005).
26. M.Cannone, M.C.Lombardo, M.Sammartino, \Well-posedness of the boundary layer equations with a non-analyticity hypothesis," SIAM Journal on Mathematical Analysis, vol.35; 987-1004 (2003).
27. C.D.Levermore, M.Sammartino, \A shallow water model in a basin with varying bottom topography and eddy viscosity," Nonlinearity, Vol.14, n.6, 1493-1515 (2001).
28. M.C.Lombardo, M.Sammartino, \Zero viscosity limit of the Oseen equations in a channnel," SIAM Journal on Mathematical Analysis, Vol.33(2), 390-410, (2001).
29. M.Cannone, M.C.Lombardo, M.Sammartino, \Existence and uniqueness for Prandtl equations with non-analytic initial data," Comptes Rendu de l'Academie des Sciences de Paris, Vol.332, 441-446, (2001).
30. M.C.Lombardo, R.E.Caisch, M.Sammartino, \Asymptotic analysis of the linearized Navier-Stokes equation on an exterior circular domain : explicit solution and the zero viscosity limit," Communications in Partial Dierential Equations, Vol.26, n. 1&2, 131-150, (2001).
31. R.E.Caflisch, M.Sammartino, \Existence and Singularities for the Prandtl Boundary Layer Equations," Z. Angew. Math. Mech., Vol.80, 733{744, (2000).
32. A.G.Ramm, M.Sammartino, \Existence and uniqueness of the scattering solutions in the exterior of rough domains," Fields Institute Communications, Operator Theory and its Applications, Amer.Math.Soc., Providence RI, 457-471, (2000).
33. M.Sammartino, R.E.Caflisch, \Zero viscosity limit for analytic solutions of the Navier- Stokes equations on a half space II: Construction of the Navier-Stokes solution," Communications in Mathematical Physics, vol.192, 463-491, (1998).
34. M.Sammartino, R.E.Caflisch, \Zero viscosity limit for analytic solutions of the Navier-Stokes equations on a half space I: Existence for Euler and Prandtl equations," Communications in Mathematical Physics, vol.192, 433-461, (1998).
35. R.E.Caisch, M.Sammartino, \Navier-Stokes equations on an exterior circular domain: construction of the solution and the zero viscosity limit," Comptes Rendu de l'Academie des Sciences de Paris, t.324 , Serie I, 861-866, (1997) .
36. M.Sammartino, \The boundary layer analysis for Stokes equations on a half space," Communications in Partial Dierential Equations, vol.22, n.5&6, 749-771, (1997).
37. M.Sammartino, \Zero viscosity limit for Stokes equations on a half space," Comptes Rendu de l'Academie des Sciences de Paris, t. 324, Serie I, 129-134, (1996).
38. M.Sammartino, F.Malvagi, G.C.Pomraning, \Diusive Limits for Particle transport in Stochastic Mixtures," J. Math. Phys., vol.33, (4), 1480-501 (1992).

39. F.Malvagi, G.C.Pomraning, M.Sammartino, \Asymptotic Diusive Limits for Transport in Markovian Mixtures," Nucl. Sci. Eng., vol. 112, (3), 199-214 (1992).
40. F.Malvagi, M.Sammartino, G.C.Pomraning, \ Asymptotically Exact Diusive Boundary Conditions in Linear Kinetic Theory," J. Math. Phys., vol.33, (7), 2639-47 (1992).
41. M.Sammartino, G.C.Pomraning, \Flux-Limiting in Stochastic Transport," J. Quant. Spectrosc. Radiat. Transfer, vol.46, 237-249 (1991).
42. A.M.Anile, S.Pennisi, M.Sammartino, \Covariant Radiation Hydrodynamics," Annales de l'Inst. H.Poincare, vol.56, (1):48-74 (1992).
43. A.M.Anile, S.Pennisi, M.Sammartino, \Eddington factors for particle transport: applications," Ricerche di Matematica, vol.XLI Supplemento, 39-52, (1992).
44. S.Pennisi, M.Sammartino, \Hyperbolic Models for Linear Transport Theory," J. Math. Phys., vol.33, (9), 3229-39 (1992).
45. A.M.Anile, S.Pennisi, M.Sammartino, A Thermodynamical Approach to Eddington Factors," J. Math. Phys., vol.32, 544 (1991).
46. S.Pennisi, M.Sammartino, \A Mathematical Model for Radiation Hydrodynamics," Le Matematiche, vol XLV (2), (1990).
47. A.M.Anile, M.Sammartino, Relativistic Causality and Dissipative Fluids: a Case from Radiation Hydrodynamics,"Annales de Physique, vol.14, 1 (1989).

ATTIVITA' SCIENTIFICHE

CURRENT RESEARCH INTERESTS AND PLANS

1. Zero viscosity limit of the Navier-Stokes equations.
   a) High Reynolds number fluids interacting with a boundary, Prandtl equations
   b) Vortex sheets and vortex layers
2. Pattern formation for Reaction-Diffusion equations.
3. Modeling of the gas-surface interaction.
4. Finite-dimensional approximations of the Fluid Dynamics equations and control theory.

1.a High Reynolds number fluids interacting with a boundary

It is well known that Prandtl's equations can be obtained as a formal asymptotic limit of the Navier-Stokes equations for infinite Reynolds number. A very important problem in the mathematical theory of fluid dynamics is to prove the well posedness of Prandtl's equations when the initial data have a Sobolev like regularity (or to disprove this showing they are ill posed in some Sobolev space). Related to this, there is the long standing problem of the convergence of the Navier-Stokes solutions to the solutions of Euler equations away from a physical boundary. These problem, beside their intrinsic mathematical interest, are also important because they are related to relevant phenomena like boundary layer separation and transition to turbulence.
During the last four-five years I have been involved, together with my co-workers, in an extensive numerical exploration of the limit of the available theory. In particular:
a) we have studied the behavior of the complex singularities of the Prandtl equation giving numerical evidence of the ill-posedness in $\mathbf{H}_1$;
b) we have seen that the ultimate failure of the Prandtl solution to describe the behavior of the flow inside of the boundary layer is due to the interaction (large scale interactions followed by small scale interactions) with the outer Euler flow;
c) we have shown that the Navier-Stokes solutions have complex singularities.

Plan

The long term goal is to to study the convergence of the Navier-Stokes solutions to Euler solutions (or solutions of modications, in a sense to be understood, of the Euler equations). To do this it is clear that one has to get a clear understanding of the phenomena occurring in the boundary layer. As a short term goal it is my intention to clarify the role of the Navier-Stokes complex singularities in the separation and transition phenomena. I am also investigating whether the tracking of the complex singularities can be used as a tool for control of the separation of the boundary layer and of the subsequent transition.

1.b Vortex sheets and vortex layers

A vortex sheet is a plane curve on which vorticity is concentrated as a function. The motion (for an inviscid flow) of this curve on the plane is ruled by the celebrated Birkhoff-Rott equation; this equation has been proved to be well-posed in analytic function spaces, while it is ill-posed in Sobolev spaces, due to Kelvin-Helmholtz instability. Together with R.Caisch, starting from the Navier-Stokes equations and through a formal asymptotic analysis, I have derived the equations ruling the flow close to a vortex layer of small thickness in the limit of small viscosity and proved that these equations are well posed in an analytic function space. Moreover I have recently proved that the dynamics of a layer of small thickness (when ruled by the Euler equations) converge to the dynamics predicted by the Birkhoff-Rott equation.

Plan

The goal of this research is to justify the Birkhoff-Rott solution as the zero viscosity limit of the Navier-Stokes solutions when the initial datum has vorticity concentrated on a layer whose thickness is the square-root of the viscosity.

2. Pattern formation for Reaction-Diusion equations

It is well known that reaction-diffusion systems can admit the formation, via a destabilization of the uniform equilibrium, of coherent structures. In recent years I have been interested in the destabilizing properties of non-linear cross diusion. We have shown that, even when the kinetics is trivializing like the competitive Lotka-Volterra kinetics, cross-diffusion is able, via Turing bifurcation, to lead to the formation of patterns. The amplitude of the patterns (close to bifurcation) is ruled by the cubic (or quintic, in the sub-critical case) Ginzburg-Landau equation. We have also developed a particle method numerical scheme which can be used for reaction-diffusion equation.

Plan

To study the patterns far from equilibrium.
To explore the role of the non linear diffusion for systems admitting Hopf bifurcation.
To develop a high precision numerical scheme based on particle methods (the scheme we have developed, based on particle approximation, being only first order accurate).

3. Modeling of the gas-surface interaction

Together with R.Caisch and M.C.Lombardo we have proposed two models for the interaction of a gas with a solid boundary. These models, based on scattering kernels that are generalizations of the classical Maxwell scattering kernel , take into account the possibility of a particle being re-emitted, after the interaction with the wall, from a location dierent from where it impinged on the wall. In the uid dynamic limit, these scattering kernels give rise to non local boundary conditions for the Navier-Stokes equations.
The original goal of this research was to justify, starting from the Boltzmann equation, the boundary condition usually employed to model, in the Large Eddy simulation context, the interaction of a turbulent fluid with a wall. The goal has been achieved. However we believe that the scattering kernels we have proposed are of independent interest; in particular we believe they could be of relevance for flows on a micro scale.

Plan

We are planning to begin a numerical exploration of the proposed models. The goals being both the validation of the models and a better understanding of the interaction between micro ows and walls.

4. Finite-dimensional approximations of the Fluid Dynamics equations and control

I have been interested in the design of a feed-back control for the generalized Lorenz system and of an adaptive control of a finite-dimensional approximation of the Kolmogorov flow. The long term plan behind these warm up investigations is to see if it is possible to achieve, using finite-dimensional approximations, control of phenomena like the formation of the recirculation region, separation and transition to turbulence for flows interacting with boundaries.

AMBITI DI RICERCA

I have been working in the following fields

1. Mathematical fluid dynamics, boundary layer theory
2. Computational fluid dynamics, singularities for PDE
3. Reaction-diffusion equations, pattern formation
4. Kinetic theory, hydrodynamic limits
5. Linear transport theory, radiation hydrodynamics