CURRICULUM VITAE ET STUDIORUM

FRANCESCO DEMONTIS
—
Department of Matematics and Computer Science
University of Cagliari
Viale Merello 92, 09123 Cagliari
web: http://tex.unica.it/~francesco/

Personal Data

Place and date of birth: Carbonia (CI, Italy), 31 March 1976
Address: via San Sebastiano n° 34, 09030 Elmas (CA)
Phone: +39 335 6899272 (mobile)
+39 070 675 5611 (office)
Fax: +39 070 675 5601
WWW: http://tex.unica.it/ francesco/
E-mail: fdemontis@unica.it
Citizenship: Italian

Education

Master Degree in Mathematics on a thesis entitled "Exact Macroscopic Approach to Extended Thermodynamics for an ultrarelativistic gas. The case of arbitrarily many moments", with the degree awarded on 28/04/2003 (voto 110/110 lode). Thesis advisor: **S. Pennisi**, University of Cagliari.

Ph.D. Degree in Mathematics on a thesis entitled "Direct and Inverse Scattering of the Matrix Zakharov-Shabat System", with the degree awarded on February 19, 2007. Thesis advisor: **C. van der Mee**, University of Cagliari.

High school teaching license (Abilitazione all'insegnamento per le classi di concorso A042-Informatica) in Computer Science awarded on May 2008 (voto 80/80 SSIS Cagliari).

High school teaching license (Abilitazione all'insegnamento per la classe di concorso A049-Matematica e Fisica) in Mathematics and Physics awarded on May 2009 (voto 80/80 SSIS Cagliari).

Current Position

Researcher (assistant professor) in Mathematical Physics at the Department of Mathematics of the University of Cagliari, from 29/12/2011.

Visits to other Universities:

- Visit to the Department of Mathematics of the University of Texas at Arlington for scientific collaboration with Prof. T. Aktosun **from 07-05-2008 to 23-05-2008** and **from 15-04-2013 to 21-04-2013**.

- Visit to the Department of Mathematics of the University of Colorado at Colorado Springs for scientific collaboration with Prof. B. Prinari **from 29-10-2011 to 14-11-2011**, **from 28/03/2013 to 13/04/2013** and **from 15/08/2016 to 13/12/2016**.

- Visit to the Department of Mathematics of the Northumbria University (Newcastle upon Tyne (U.K.)) for scientific collaboration with Dr. M. Sommacal **from 25-04-2013 to 27-04-2013**.

- Visit to the Department of Mathematics of the University of Milano Bicocca **from 16/10/2013 to 19/10/2013** and **from 19/03/2014 to 22/03/2014** for scientific collaboration with Dr. G. Ortenzi.

- Visit to the Department of Mathematics of the College of Charleston (Charleston, USA) for scientific collaboration with Prof. A. Calini **from 25-04-2013 to 27-04-2013**.

Teaching:

D1: Various teaching experiences in public highschools in the years 2003-2009.

D2: Tutor of "Mathematics and Computer skills" for the Pharmacological Science degree of the University of Cagliari (Academic year 2003-2004).

D3: Tutor of "Rational Mechanics 1" for the Mathematics degree of the University of Cagliari (Academic year 2004-2005 : graduate students teaching activity).

D4: Tutor of "Mathematical Analysis 4" for the Mathematics degree of the University of Cagliari (Academic year 2005-2006: graduate students teaching activity).

D5: Lectures and problem sessions of Rational Mechanics 1 for mathematics students (Spring Semester 2010).

D6: Lectures and problem sessions of Rational Mechanics 1 for mathematics students and problem sessions of Rational Mechanics for physics students (Spring Semester 2012).

D7: Instructor of Rational Mechanics 2 for mathematics students (Fall Semester 2012).

D8: Instructor of Rational Mechanics 1 for mathematics students (Spring Semester 2014).

D9: Instructor of Rational Mechanics 1 for mathematics students (Spring Semester 2015).

D10: Instructor of Rational Mechanics 2 for mathematics students (Fall Semester 2015).

D11: Instructor of Calculus 1 for chemistry students (Fall Semester 2015).

D12: Instructor of Math 3400: Introduction to Differential Equations. (Fall Semester 2016, University of Colorado at Colorado Springs).

D13: Instructor of Rational Mechanics 1 for mathematics students (Spring Semester 2016).

D14: Instructor of Calculus 2 for chemistry students (Spring Semester 2016).

Advisor for four (bachelor) theses in mathematics and one master thesis in mathematics.

Participation in research projects:

P1: **PRIN 2006** (Principal Investigator: D.Bini). Cagliari research unit: "Equazioni integrali con nuclei strutturati e applicazioni". Cagliari unit coordinator: S. Seatzu.

P2: **PRIN 2008** (Principal Investigator: D.Bini). Cagliari research unit: "Structured integral equation and linear systems". Cagliari unit coordinator: S. Seatzu.

P3: **Scholarship for young reseacher, Legge Regionale 7 Agosto 2007, n.7 "Promozione alla ricerca scientifica e dell'innovazione tecnologica in Sardegna"**, main investigator F. Demontis. Title of the project: *Modelli Matematici in Ottica Nonlineare: principi, analisi e applicazioni*, (15/01/2010-14/01/2012).

P4: **Progetto di ricerca fondamentale o di base, legge regionale 7 Agosto 2007, n. 7, Bando 2008**, main investigator C. van der Mee. Title of the project: *Modelli matematici in ottica nonlineare e nel design dei dispositivi fotonici*. (01/12/2010-31/12/2012).

P5: **Progetto Giovani GNFM 2013** (Project proposed by F. Demontis and G. Ortenzi, main investigator: G. Ortenzi). Title of the project: *Exact solutions of the Hirota equation and applications to the vortex filaments theory.* (2013-2014).

P6: **Progetto Research in pairs supported by London Mathematical Society**, Investigators: M. Sommacal e F. Demontis. Title of the project: *Propagating, localised waves in ferromagnetic nanowires,* (November 2016-July 2017).

Research contracts:

B1: Research contract from 03/09/07 to 03/03/08 (six months) in the context of the project "Numerical methods in linear algebra and applications".

B2: Research scolarship for young researcher from January 2010 to January 2012 (Legge Regionale 7 agosto 2007, n. 7 "Promozione della ricerca scientifica e dell'innovazione tecnologica in Sardegna". Title of the Project: *Mathematical models in nonlinear optics: principles, analysis and applications*. The corresponding scientific activity has carried out at the Department of the Matemathics and Computer Science of University of Cagliari).

List of publications

Book PhD thesis: Francesco Demontis, *Matrix Zakharov-Shabat system and Inverse Scattering Transform*, Lambert Academic Publishing, 2012, ISBN: 978-3-659-24838-2

Publications in Refereed Journals

[1] F. Borghero, F. Demontis,
A 3-Dimensional Inverse Problem of Geometrical Optics: a Mathematical Comparison Between Fermat's Principle and the Eikonal Equation. **Journal of the Optical Society of America. A, Optics, Image Science, and Vision**, **33** (9), 1710–1722, (2016), DOI: 10.1364/JOSAA.33.001710.

[2] F. Demontis, F. Vargiu, and C. van der Mee,
Nonsmooth Spin Densities for Continuous Heisenberg Spin Chains. **Ricerche di Matematica**, **65**(2), 469–478 DOI:10.1007/s11587-016-0268-x, (2016).

[3] F. Demontis, G. Ortenzi, C. van der Mee,
Exact Solutions of the Hirota Equation and Vortex Filaments Motion. **Physica D**, **313** (2015), 61-80

[4] F. Demontis, B. Prinari, C. van der Mee, and F. Vitale,
The inverse scattering transform for the focusing nonlinear Schrödinger equation with asymmetric boundary conditions. **J. Math. Phys.**, **55**: 40 pages, 101505 (2014); doi: 10.1063/1.489876 (online first)

[5] F. Demontis and C. van der Mee,
Characterization of Scattering Data for the Matrix Zakharov-Shabat System. **Acta Applicandae Mathematicae**, **131**: 29–47 DOI 10.1007/ s10440-013-9848-x

[6] F. Borghero, F. Demontis and S. Pennisi,
Wave Speeds in the Macroscopic Extended Model for Ultrarelativistic Gases.
J. Math. Phys. 54, 113101 (2013); doi: 10.1063/1.4829365

[7] F. Demontis and C. van der Mee,
An Alternative Approach to Integrable Discrete Nonlinear Schrödinger Equations.
Acta Applicandae Mathematicae, **127**, 169–191 (2013). doi: 10.1007/s10440-012-9797-9: 10.1007/s10440-012-9797-9

[8] F. Demontis, B. Prinari, C. van der Mee, and F. Vitale
The inverse scattering transform for the defocusing nonlinear Schrödinger equation with nonzero boundary conditions.,
Studies in Applied Mathematics, **131**(1), 1-40 (2013), DOI:10.1111/j.1467-9590.2012.00572.x.

[9] F. Borghero, F. Demontis, S. Pennisi
On the Hyperbolicity of a Model with 30 Moments for Ultrarelativistic Gases,
Meccanica, **48**(3): 585-600 (2013), DOI: 10.1007/s11012-012-9617-3.

[10] F. Demontis and C. van der Mee,
Closed Form Solutions to the integrable discrete nonlinear Schrödinger equation,
Journal of Nonlinear Mathematical Physics, **19**, (2012) ISSN: 1402-9251, doi: 10.1142/S1402925112500106

[11] F. Demontis and C. van der Mee,
Closed Form Solutions to the Matrix Sine-Gordon Equation,
IMA Journal of Applied Mathematics 77, 308-315 (2012); doi: 10.1093/imamat/hxs029

[12] F. Demontis,
Exact solutions to the modified Korteweg-de Vries equation,
Theoretical and Mathematical Physics, **168**(1): 886–897 (2011).

[13] F. Demontis and Cornelis van der Mee,
Exact Solutions to the Integrable Discrete Nonlinear Schrödinger Equation under a Quasiscalarity Condition,
Communications in Applied and Industrial Mathematics, **2** (2011)

[14] T. Aktosun, F. Demontis, and C. van der Mee,
Exact solutions to the focusing nonlinear Schrödinger equation,
Inverse Problems, **23**, 2171-2195 (2007).

[15] F. Demontis and C. van der Mee,
Explicit solutions of the cubic matrix nonlinear Schrödinger equation,
Inverse Problems, **24**, 02520 (2008), 16 pp. DOI: 10.1088/0266-5611/24/2/02520.

[16] T. Aktosun, T. Busse, F. Demontis, and C. van der Mee,
Symmetries for exact solutions to the nonlinear Schr"odinger equation,
Journal of Physics A, **43**, 025202 (2010).

[17] F. Demontis and C. van der Mee,
Marchenko equations and norming constants of the matrix Zakharov-Shabat systems,
Operators and Matrices, **2**, 79-113 (2008).

[18] F. Demontis and C. van der Mee,
Scattering operators for matrix Zakharov-Shabat systems,
Integral Equations and Operator Theory, **62**(4), 517-540 (2008).

[19] T. Aktosun, F. Demontis, and C. van der Mee,
Exact solutions to the Sine-Gordon Equation,
Journal of Mathematical Physics, **51**, 123521 (2010).

[20] F. Demontis and C. van der Mee,
Wave Operators for Defocusing Matrix Zakharov-Shabat Systems with Potentials Nonvanishingat Infinity, **Serdica Mathematical Journal**, **36** (2010), 265–284.

[21] F. Demontis and S. Pennisi,
On a further condition in the macroscopic extended model for ultrarelativistic gases,
Ann. Univ. Ferrara Sez. VII Sci. Mat., **53**, no. 1, 51-64 (2007).

[22] M.C. Carrisi, F. Demontis, and A. Scanu,
A kinetic type extended model for dense gases and macromolecular fuids,
Le Matematiche, **60**, no. 1, 181-188 (2006).

Book Chapters

[23] F. Demontis, C. van der Mee and F. Vitale
On the Location of the Discrete Eigenvalues for Defocusing Zakharov-Shabat Systems having Potentials with Nonvanishing Boundary Conditions,
Contemporary Mathematics, 635 13–24 (2015). In: Anton Dzhamay, Willy A. Hereman, and B. Prinari (eds.), Nonlinear Wave Equations: Analytic and Computational Techniques, Contemporary Mathematics **635**, Amer. Math. Soc., Providence, RI, 2015.

[24] Tuncay Aktosun, Theresa Busse, Francesco Demontis, and Cornelis van der Mee,
Exact solutions to the nonlinear Schrödinger equation,
in: Joseph A. Ball, Vladimir Bolotnikov, J. William Helton, Leiba Rodman, and Ilya Spitkovsky (eds.) **Topics in Operator Theory**, Vol. 2, Systems and Mathematical Phisics, Birkhäuser OR 203, Basel and Boston, 2010, pp. 1-12.

[25] M.C. Carrisi, F. Demontis, S. Pennisi, and A. Scanu,
A kinetic type extended model for polarizable and magnetizable fluids,
in: A.M. Anile, G. Alì, and G. Mascali (eds.), **Scientific Computing in Electrical Engineering, Mathematics in Industry**, Vol. 9, Springer, Berlin, 2006, pp. 295-300. ISBN 978-3-642-06941-3.

Proceedings

[26] F. Demontis and C. van der Mee,
Novel Formulation of Inverse Scattering and Characterization of Scattering Data,
in: Wei Feng, Zhaosheng Feng, Maurizio Grasselli, Akif Ibragimov, Xin Lu, Stefan Siegmund and

Jürgen Voigt (eds.), Dynamical Systems and Differential Equations, DCDS Supplement 2011, Proceedings of the 8th AIMS International Conference (Dresden, Germany) pp. 343-350, september 2011, Clothcover, 1476 pages.

[27] F. Demontis, S. Pennisi, and F. Rundo,
Some further considerations on the Galileian relativity principle in extended thermodynamics,
in: WASCOM 2005, 13th Conference on Waves and Stability in Continuous Media, pp. 176-181, World Sci. Publ., Hackensack, NJ, 2006.

[28] F. Borghero, F. Demontis, and S. Pennisi,
The non-relativistic limit of relativistic extended thermodynamics with many moments. I. The balance equations,
in: WASCOM 2005, 13th Conference on Waves and Stability in Continuous Media, pp. 47-52, World Sci. Publ., Hackensack, NJ, 2006.

[29] M.C. Carrisi, F. Demontis, and S. Pennisi,
The non-relativistic limit of relativistic extended thermodynamics with many moments. II. How it includes the mass, momentum and energy conservation,
in: WASCOM 2005, 13th Conference on Waves and Stability in Continuous Media, pp. 95-100, World Sci. Publ., Hackensack, NJ, 2006

[30] F. Borghero, F. Demontis, and S. Pennisi,
An exact macroscopic extended model with many moments for ultrarelativistic gases,
in: WASCOM 2003, 12th Conference on Waves and Stability in Continuous Media, pp. 94-101, World Sci. Publ., River Edge, NJ, 2004.

Conferences:

Member of the organizing committee of the International Conferences:

1) "International Conference on Scientific Computing SC2011". Santa Margherita di Pula (Cagliari), October 10-14, 2011.

2) "Nonlinear Evolution Equations and Linear Algebra". Cagliari, September 2-15, 2013.

3) "Nonlinear Evolution Equations and Dynamical Systems". Santa Margherita di Pula (Cagliari), May 24-31, 2015.

He has organized (with G. Rodriguez (Università di Cagliari) and C. van der Mee (Università di Cagliari)) the miniworkshop

i) "Two Days on Applied Mathematics in Cagliari". Cagliari, April 9-10, 2015.

Moreover, he has organized the following special sessions:

a) "Nonlinear evolution equations: analytical and geometrical methods" held at the Conference "Convegno Nazionale Simai 2012," Turin (IT), June 25-28, 2012 [organized together with G. Ortenzi (University of Bergamo, IT)]

b) "Nonlinear phenomena: Theory and applications" held at the Conference "The 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications," Madrid (SP), July 07-13, 2014 [organized together with S. Lombardo (Northumbria University, UK), G. Ortenzi (University of Bergamo, IT) and M. Sommacal (Northumbria University, UK)].

c) "Connections between nonlinear wave equations and geometry" held at the Conference "SIAM Conference on Nonlinear Waves and Coherent Structures," Cambridge (UK), August 11-14 2014 [organized together with A. Calini (College of Charleston, USA) and G. Ortenzi (University of Bergamo, IT)].

Participation as a speaker at the following International Conferences:

C1: "Wascom 2003" 12th Conference on Waves and Stability in Continuous Media. Villasimius (Cagliari), 1-7 June, 2003. Title of the talk: *An exact macroscopic extended model with many moments for ultrarelativistic gases*;

C2: "Wascom 2005" 13th Conference on Waves and Stability in Continuous Media. Acireale (Catania), 19-25 June, 2005. Title of the talk: *Some further considerations on the Galileian relativity principle in extended thermodynamics*;

C3: 7th AIMS International Conference Dynamical Systems, Differential Equations and Applications. Arlington, Texas-U.S.A., 18-21 May, 2008. Title of the talk: *Explicit Solutions of the Cubic Matrix Nonlinear Schrödinger Equations (Invited Speaker)*;

C4: 8th AIMS International Conference Dynamical Systems, Differential Equations and Applications. Dresden, Germany, 25-28 May, 2010. Title of the talk: *An explicit formula for exact solutions to the focusing NLS Equation*;

C5: "SIMAI 2010", Cagliari, June 21-25, 2010. Title of the talk: *Exact Solutions to the Sine-Gordon Equation (Invited Speaker)*;

C6: "Nonlinear Physics", Gallipoli (Lecce), June 23-July 3, 2010. Title of the talk: *Exact Solutions to the Sine-Gordon Equation*;

C7: "Global Analysis and PDE on Manifolds", Sofia(Bulgaria), September 6-8, 2010. Title of the talk: *(A,B,C) formulas for some evolution equations (Invited Speaker)*;

C8: "The Seventh Imacs International Conference on Nonlinear Evolutions Equations and Wave Phenomena: Computation and Theory", Athens, Georgia (USA), April 3-7, 2011. Title of the talk: *Exact Solutions to the Focusing Discrete Nonlinear Schödinger Equation (Invited Speaker)*;

C9: "Wascom 2011" 16th Conference on Waves and Stability in Continuous Media. Brindisi, 12-16 June, 2011. Title of the talk: *Exact Solutions to the modified Korteveg de-Vries equation*;

C10: "IMA Conference in Nonlinearity and Coherent Structures", Reading (UK), July 6-8, 2011. Title of the talk: *Exact Solutions to the sine-Gordon equation*;

C11: "International Conference on Scientific Computing SC2011", Pula (Cagliari), October 10-14, 2011. Title of the talk: *Closed Form Solutions to the Integrable Discrete Nonlinear Schrödinger Equations (Invited Speaker)*;

C12: "AGMP-7 Algebra Geometry Mathematical Physics", Mulhouse (France), October 24-26, 2011. Title of the talk: *Closed Form Solutions to the Integrable Discrete Nonlinear Schrödinger Equations (Invited Speaker)*;

C13: "AGMP-8 Algebra Geometry Mathematical Physics", Brno (Rep. Ceca), September 12-14, 2012. Title of the talk: *The inverse scattering transform for the defocusing nonlinear Schrödinger equation with nonzero boundary conditions (Invited Speaker)*;

C14: "Assemblea Scientifica G.N.F.M"., Montecatini (Italy), 04-06 October, 2012. Title of the talk: *The inverse scattering transform for the defocusing nonlinear Schrödinger equation with nonzero boundary conditions*;

C15: "The Eigth Imacs International Conference on Nonlinear Evolutions Equations and Wave Phenomena: Computation and Theory", Athens, Georgia (USA), March 25-28, 2013. Title of the talk: *Direct Scattering Problem for AKNS system: characterization of scattering data (Invited Speaker)*;

C16: AMS Sectional Meeting, Boulder, Colorado (USA), April 13-14, 2013. Title of the talk: *Direct Scattering Problem for AKNS system: characterization of scattering data (Invited Speaker)*;

C17: "Wascom 2013" 17th Conference on Waves and Stability in Continuous Media. Levico Terme, 17-21 June, 2013. Title of the talk: *Direct Scattering Problem for AKNS system: characterization of scattering data*;

C18: "Assemblea Scientifica G.N.F.M"., Montecatini (Italy), 14-17 May, 2014. Title of the talk: *Soluzioni esatte per l'equazione di Hirota e loro applicazioni alla teoria dei filetti vorticosi*.

C19: "Workshop on Nonlinear Waves ad Integrable Systems in Sicily", Taormina (Italy), June 9-12, 2014. Title of the talk: *Exact Solution and Vortex Filament for the Hirota Equation (Invited Speaker)*

C20: "2dAMC" Two Days on Applied Mathematics in Cagliari. Cagliari, April 9-10 , 2015. Title of the talk: *Hirota Equation and Vortex Filaments*;

C21: "Wascom 2015" 18th Conference on Waves and Stability in Continuous Media. Cetraro, June 1-6, 2015. Title of the talk: *Soliton Solutions of the Heisenberg Ferromagnetic Equation*;

C22: "Second Workshop on Trends in Nonlinear Analysis Cagliari". Cagliari, September 24-26, 2015. Title of the talk: *Closed-form soliton solutions for the Heisenberg Ferromagnetic Chain Equation (Invited Speaker)*.

He gave the following seminars (colloquium):

- *Solitoni e trasformata inversa spettrale: una breve introduzione*, held at University of Cagliari on 20/11/2012.
- *Inverse Scattering Transform and triplets method: a brief introduction*, held at College of Charkleston (Charleston, USA), on 21/10/2016.

Research activity

The actual research activity is the natural continuation of the studies started during the PhD period and continued until now.

In my PhD thesis I studied the matrix Nonlinear Schrödinger equation (mNLS) equation. Initially this equation was introduced to describe the wave propagation in nonlinear isotropic media and then generalized as to feature wave propagation in nonisotropic media. Its importance in applied contexts derives, mainly, from the fact that lossless signal propagation along an optical fiber satisfies this equation.

More precisely, in my PhD thesis, I have analyzed the following:

(a) The direct and inverse scattering theory of a suitable system of linear ordinary differential equations (LODE) associated with the mNLS (the so-called matrix Zakharov-Shabat system);

(b) The inverse scattering transform (IST) which plays an important role in solving the initial value problem of the mNLS equation.

The basic idea behind the IST is to find the time evolution of the scattering data of the matrix Zakharov-Shabat system allowing the solution of the initial value problem of the mNLS equation by using direct and inverse scattering theory. The techniques of direct and inverse scattering are important, because they allow one to move the mathematical difficulties from finding the solution of the initial value problem to the much easier problem of formulating the time evolution of the scattering data. For this reason it is usually said that the IST is the analog for nonlinear problems of the Fourier transform for linear problems.

It is well known that the IST can be formulated in terms of a Lax pair which consists of two (pseudo)differential operators. In my PhD thesis the Lax pair for the mNLS equation is explicitly found, so it was possible to get the following results:

a. The direct and inverse scattering theory are developed by removing the usual assumption that the poles of the transmission coefficient are simple. In this way it was possible to generalize many results established before for simple poles to the case of multiple poles.

b. The inverse scattering theory of the Zakharov-Shabat system is formulated in terms of a system of integral equations known as the Marchenko integral equations. Their solution is related in an algebraic way to the solution of the initial value problem of the mNLS equation. We have also proved the unique solvability of the Marchenko equations.

c. When the kernel of the Marchenko equation is written in separated form, a huge class of exact solutions of the mNLS equation was produced. It is interesting to observe that the set of these exact solutions can be expressed in compact form by using a triplet of matrices and the matrix exponential. It is remarkable that the solution formula obtained gives a unified representation of the exact solution of the mNLS equation in the following sense: choosing the matrix triplet in an appropriate way, it is possible to reproduce many of the solutions known in the literature as well as the so-called multipole soliton solutions (because they are obtained when the poles of the transmission coefficient are not simple). Moreover, the method developed for the representation in a unified form of the solutions of the mNLS equation can also be adopted to get the solutions of other integrable systems of nonlinear evolution equations.

The continuation of the research activity after the PhD period allowed me to obtain the various results contained in the articles [3], [4], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [8], [7], [5], [23], [3] listed in the "List of Publications."

Before doing research on integrable nonlinear evolution equations, I have worked in Extended Thermodynamics. In my masters thesis, after a description of the state of the art in relativistic extended thermodynamics, the particular case of ultrarelativistic gases is treated, leading to a system of 14 thermodynamic equations in 14 independent variables. This has led to a generalization of well-known results in the literature. In fact, the model of an ultrarelativistic gas with many moments is considered by using a macroscopic approach. Then, in [30], by following a macroscopic approach, the general solution for this model is given and the fact that the results obtained with the kinetic approach are particular cases of those found by the macroscopic approach is established. In the paper [21] the model of an ultrarelativistic gases with many moments in the case where the influence of an electromagnetic field acts as external force is analyzed. Also in this case, with a macroscopic approach, a family of solutions satisfying this further conditions is furnished. The papers [27], [28], [29], [25], [22] can be seen in the context of the so-called Constitutive Thermodynamic. The object of the Constitutive Thermodynamic is to impose the principles of entropy, relativity and causality and convessity on the constitutive functions, i.e, the functions which depend on the principal field appearing in the balance equations, in such a way to get a system having the same number of unknowns (the principal fields) and number of equations. Recently, interesting results on the determination of the wave speed for a model with 30 moments describing an ultrarelativistic gases were presented in [9] and, for whatever moments in [6].

Actual Research Activity

Actually my research actvity concerns:

- **NLS equation and AKNS systems:** Development of the theory "time dependent scattering" for the matrix Zakharov-Shabat system with respect to the time evolution of the wave operators and to the scattering operators which characterize this theory. In this way it is possible to give a rigorous theoretical basis on which to put the method of Lax pairs and this method, as it is known, allows us to determine the integrable nonlinear evolution equations. Recently, my research has also been devoted to NLS equation with nonvanishing boundary conditions.
- **Integrable Discrete Nonlinear Schrödinger System (IDNLS):** Direct and inverse scattering theory for the matrix discrete Zakharov-Shabat system and the IST for IDNLS system. The principal result of this research consists of obtaining explicit solutions to the IDNLS by using the method of the matrix exponential used succesfully in the continuous case. Moreover, since the IDNLS system can be thought as the discretization of the mNLS system, it will be interesting to investigate what happens to the solution formulas to the IDNLS when the step size goes to zero.
- **Hierarchies of nonlinear evolution equations:** The method of the matrix exponential can be used to derive explicit solutions to other nonlinear evolution equations which appear in a hierarchy of integrable-solvable by IST- equations, with the objective to characterize the evolution of the scattering data in terms of the hierarchy to which they belong.
- **Landau-Lifshitz equation:** Development of the scattering theory of the linear eigenvalue problems associated to the Landau-Lifshitz (LL) equation in ferromagnetism. In particular, I am interested in finding explicit solutions of the LL equation in terms of elementary functions.

Affiliations

Member of: GNFM (Gruppo Nazionale per la Fisica Matematica) since 2004, Unione Matematica Italiana (UMI) since 2010 and Societá Italiana Matematica Applicata Industriale (SIMAI) since May 2011.

Cagliari, 28 dicembre 2016 Demontis Francesco