CURRICULUM VITAE AND LIST OF PUBLICATIONS

of

Paolo Maria Santini

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Personal Data

Name: Paolo Maria Santini

Place and date of birth: Bologna, Italy. 28/05/1954

Education

Laurea in Physics, 110/110 cum laude, December 1977. Supervisor: Prof. F. Calogero. Department of Physics, University of Roma "La Sapienza".

PhD in Mathematics, May 1984. Supervisor: Prof. M. J. Ablowitz. Department of Mathematics, Clarkson University, Potsdam, N.Y., USA.

Hobbies: Drawing, painting, playing guitar and listening music, dancing tango, reading books and watching movies.

Academic Positions

November 2000 - present. Ordinary Professor of Theoretical Physics, Fis 02, Department of Physics, University of Roma "La Sapienza".

November 1998 - October 2000. Associate Professor of Physics; Department of Physics, University of Roma "La Sapienza".

November 1994 - October 1998. Associate Professor of Theoretical Physics; Department of Physics, University of Catania.

Academic years: 1986 - 87 and 1987 - 88. Visiting Professor; Department of Mathematics, Clarkson University, Potsdam, N.Y., USA.

September 1981 - October 1994. Tenur Researcher in Theoretical Physics, Department of Physics, University of Roma "La Sapienza".

June 1978 - September 1981. Fellow in Mathematical Physics of the Italian National Council of Research (CNR). Supervisor: Prof. F.Calogero. Department of Physics, University of Roma "La Sapienza".

Editorial Positions

Editorial Board of Inverse Problems. 1992 - 1996.
Editorial Board of Journal of Nonlinear Mathematical Physics. 2015 -

International Programs and Workshops organized

"NEEDS - Nonlinear Evolution Equations and Dynamical Systems"; Chania, Creta, 20/06-05/07 1985.

6 Month Programme "Integrable Systems" at the Newton Institute, Cambridge (UK). July - December 2001.

Euro-Conference:"NEEDS - Nonlinear Evolution Equations and Dynamical Systems"; Cambridge (UK). 24/07 - 31/07 2001.

Euro-Workshop: "Discrete Systems"; Cambridge (UK). 03/09 - 14/09 2001.

International Congress: "Integrability and Physics"; Dept. of Physics, Univ. "La Sapienza". 25/03/2011.

International Congress: "Three days on Painlevé equations and their applications"; Dept. of Physics, Univ. of Roma 3, December 18-20 2014.

Scientific gathering: "Integrable and quasi-integrable systems"; Centro Internacional de Ciencias (CIC), Cuernavaca, Mexico, November 14 - December 09, 2016

Associations in scientific groups

· INFN associate, and national and local coordinator of the INFN research network Mathematical Methods of Nonlinear Physics (MMNLP).
· Associate in the Mathematical Physics branch of the INDAM (Istituto Nazionale della Matematica Italiana) group.

Activity as commission member in competitions for university positions

· Commission member in the competition for 1 position of university researcher FIS02, University of Torino, 1999.
· Commission member in the competition for 2 transfering positions of university researcher in the Macroarea A, University La Sapienza, 2011.
· Commission member in the competition for 72 positions of associate pro-

fessor in the area CUN 02, University of Roma La Sapienza, 2012.
· Commission member in the competition for 1 position of associate professor FIS02, University of Catania, 2014.
· President of the committee for the competition for two positions of associate professor FIS02, 02/A2, University of Roma La Sapienza, 2015.
· Since 2011 he is President of the examining committee in the competition for fellowships to support the visit of young people possessing a Laurea Magistrale obtained in the University la Sapienza, to foreign scientific institutions.

Participation in scientific university committees

Member of the "Giunta" of the Dept. of Physics, University La Sapienza, period 2010-12.
Member of the "Commissione di Valutazione passaggi", Dept. of Physics, University La Sapienza, period 2009-11.
President of the "commissione di valutazione dei risultati della ricerca svolta da titolari di assegni di ricerca", Dept. of Physics, University La Sapienza, period 2016 -

Publications

More than 100 papers. 20 in Conference and School Proceedings, or in Special Issues Volumes; the rest on international journals. One book, co-authored with C. Bernardini and O. Ragnisco, on Mathematical Methods of Physics. 3 co-edited special issues scientific volumes.

Research Interests

The theory of nonlinear (algebraic, differential, partial differential, integro-differential, difference, functional) equations treatable by spectral means. In particular,

1. the study of the rich mathematical aspects of such a theory, involving several branches of Mathematics: Algebra, Complex Analysis, Differential Geometry, Discrete Geometry, and Algebraic Geometry;

2. the study of the interesting applications to the Natural Sciences.

The scientific production can be grouped into the following research fields.

1. Longtime behaviour of solutions of nonlinear evolutionary systems, like the Kadomtsev-Petviashvili (KP) equation [4], describing the evolution

of two-dimensional waves in shallow water; its x-dispersionless version [95], describing such evolution near the shore, when the wave breaks; the "heavenly" equation of Plebanski [88], describing self-dual Einstein fields.

2. Multiple scale expansions for integrable and non integrable PDEs, carried, in principle, to all orders, and the nonlinear Schrödinger hierarchy [55, 57, 58]. Application to the study of partial difference equations (PΔEs) in the small lattice spacing regime, as i) a vicinity test between the PΔE and its continuous limit and ii) integrability test for the PΔE [100].

3. Use of the Inverse spectral transform for soliton equations in 1+1 and 2+1 dimensions, to solve the Cauchy problem for distinguished soliton equations, like the sine-Hilbert equation [10, 12, 13] and the Davey-Stewartson equation [38, 39, 40, 41, 42, 43], a universal model in the description of the amplitude modulation of strongly dispersive two-dimensional waves in a weakly nonlinear medium, with the spectral characterization of the dromions, novel coherent structures on the plane.

4. Construction of the theory of recursion operators and bi - Hamiltonian structures for integrable PDEs in multidimensions [16, 17, 18, 19, 20, 21].

5. Construction of a theory of integrable discrete geometries based on the geometric notion of quadrilateral lattice [60, 62, 63, 64, 65, 66, 67, 68, 69].

6. Search and construction of novel and distinguished nonlinear integrable systems: algebraic and functional equations [34, 50], cellular automata [47, 51], integrable multidimensional PDEs with constraints [48], the so-called Sine-Hilbert equation [10, 12], integrable discrete geometries and several integrable generalizations of the Toda law on the square, triangular and honeycomb lattices [78, 94], a general matrix PDE in arbitrary dimensions integrable by the method of characteristics [91].

7. Development of variants of the Dressing method, to construct and solve integrable or quasi - integrable PDEs in multidimensions. In particular,

the construction of nonlinear PDEs in (n) dimensions possessing an analytic solution space of dimension $(n-2)$ [86].

8. Development of spectral methods to solve initial - boundary value problems for integrable PDE's [71, 72, 82].

9. Study of the transition from integrable to chaotic behavior of dynamical systems on the plane, explained as travel on Riemann surfaces [84, 97].

10. Development, at a formal level, of the Inverse Spectral Transform for integrable multidimensional PDEs arising from the commutation of one parameter families of multidimensional vector fields [85, 87, 88]. Applications of this theory to the heavenly equation of Plebanski (exact reduction of the Einstein equations) [85, 88, 99], to the dispersionless KP equation [87, 95, 101, 102, 106, 107], with the analytic description of the gradient catastrophe of two-dimensional shallow water waves near the shore [95], to the Pavlov equation [90, 99], and to the so-called dispersionless Toda equation in 2+1 dimensions, relevant in field theory and in the study of ideal Hele-Shaw flows [98]. Study of the universal way in which weakly nonlinear quasi onedimensional waves break in Nature [101]. Study of the rigorous aspects of this theory in [109, 112].

11. An analytic approach to rogue (anomalous) waves (RWs) in Nature. The periodic Cauchy problem for the focusing nonlinear Schrödinger equation (NLS) $iu_t+u_{xx}+2|u|^2u=0$, for initial data describing generic perturbations of the unstable background solution $u_0=exp(2it)$, is the prototype mathematical problem giving rise to the formation of RWs, through the physical mechanism of modulation instability (MI) of the amplitude of quasi monochromatic waves. In collaboration with P. G. Grinevich, such a Cauchy problem has been solved, in the case of a finite number of unstable modes, obtaining the analytic description the first appearance and recursion of RWs through elementary functions [116],[117],[118].

PUBLICATIONS

Books

C. Bernardini, O. Ragnisco e P. M. Santini: "Metodi Matematici della Fisica"; La Nuova Italia Scientifica, 1993.

Edited volumes

A.V. Mikhailov and P.M. Santini, "Nonlinear Evolution Equations and Dynamical Systems", guest editors of a special issue, Theoretical and Mathematical Physics 134 No 1, pp. 1-140, 2003.

A.V. Mikhailov and P.M. Santini, "Nonlinear Evolution Equations and Dynamical Systems", guest editors of a special issue, Theoretical and Mathematical Physics 133 No 2, pp. 1443-1606, 2002.

A.V. Mikhailov and P.M. Santini, "Nonlinear Evolution Equations and Dynamical Systems", guest editors of a special issue, Theoretical and Mathematical Physics 133 No 3, pp. 1607-1756, 2002.

References

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[2] P. M. Santini: "Asymptotic behaviour (in t) of solutions of the cylindrical KdV equation. I"; Il Nuovo Cimento 54A. 241 (1979).

[3] P. M. Santini: "Asymptotic behaviour (in t) of solutions of the cylindrical KdV equation. II"; Il Nuovo Cimento 57A, 387 (1980).

[4] S. V. Manakov, P. M. Santini and L. A. Takhtajan: "Asymptotic behaviour of the solutions of the Kadomtsev-Petviashvili equation (two dimensional Korteweg-de Vries equation)."; Phys.Lett.75A, 451 (1980).

[5] L. Martina and P. M. Santini: "Propagation of ion acoustic waves in cold inhomogeneous plasmas." Lettere al Nuovo Cimento 29, 513 (1980).

[6] P. M. Santini: "On the evolution of two dimensional packets of water waves over an uneven bottom."; Lettere al Nuovo Cimento 30, 236 (1981).

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