

# Short Curriculum of Marco Modugno

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## 1 Life and academic data

### 1.1 Date and place of born

Born in Bari (Italy) on 13.04.1943.

### 1.2 Current address

Marco Modugno  
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### 1.3 Academic studies

Degree in Physics at University of Florence on 07.03.1966.

### 1.4 Positions

Assistant Professor of Mathematics:

- at University of Florence from 1972 to 1975.

Professor of Mathematics:

- at University of Florence from 1969 to 1975.

Full Professor of Mathematical Physics:

- at University of Lecce from 1975 to 1979,

- at University of Florence from 1979 to 2013.

Emeritus Professor of Mathematical Physics 03-02-2015

- at University of Florence.

### 1.5 Academic responsibilities and activities

- Dean of the Faculty of “Sciences” at University of Lecce from 1976 to 1979.

- Head of the Institute of “Applied Mathematics” at University of Florence from 1980 to 1982.

- Head of the Department of “Applied Mathematics” at University of Florence from 1993 to 1996.

### 1.6 Research responsibilities and activities

- Founder of the “Journal of Geometry and Physics” and Editor in Chief of this journal from 1982 to 2003; Editor of this journal from 2003 to 2017.

- Editor of “Differential Geometry and its Applications” from 1992 to 2016.

- Referee of several journals of differential geometry and mathematical physics.

- Member of “Unione Matematica Italiana”, “American Mathematical Society”, “European Mathematical Society”, “International Society of General Relativity and Gravitation”, Società Italiana di Relatività Generale e Fisica della Gravitazione”.

- Organiser or co-organiser of the following meetings: international meeting “Geometry and Physics”, Florence 1982; Italian National Conference on “General relativity and Gravitation”, Florence 1984; International Conference of the “International Society of General Relativity and Gravitation”, Florence 1995.

- Coordinator of the research group “Geometry and Physics” at University of Florence, which has been supported by international, national and local funds from 1980 to 2013.

- Visited several Universities and delivered talks at several meetings: in Belgium, China, Czech Republic, England, Finland, France, Germany, Hungary, Israel, Netherlands, Poland, Portugal, Spain, Switzerland and USA.

- Cooperated with several coauthors: D. Canarutto (Italy), C.T.J. Dodson (England), J. Janyška (Czech Republic), I. Kolář (Czech Republic), L. Mangiarotti (Italy), K.B. Marathe (USA), D. Saller (Germany), C. Tejero Prieto (Spain), J. Tolksdorf (Germany), A. Vinogradov (Russia, Italy), R. Vitolo (Italy).

## 2 Research

### 2.1 Research area

Research field concerning “Differential Geometry”, “Mathematical Physics” and their interactions.

Research in “Differential Geometry” dealing mainly with fibred manifolds, jet spaces, graded Lie algebras of tangent valued forms, general connections, systems of connections, lagrangian theories, cosymplectic manifolds, smooth manifolds (in the sense of A. Frölicher).

Research in “Mathematical Physics” dealing mainly with general relativity, analytical mechanics, gauge theories and relativistic quantum theories.

Currently, the main research area deals with a geometric approach to “Covariant Quantum Mechanics”.

### 2.2 Research contributions

Main contributions in “Differential Geometry” dealing with:

- structured bundles [13, 14],
- geometric structures on odd dimensional manifolds [41],
- geometric structures in the theory of jets [6, 7, 11, 15, 16, 20, 27],
- introduction of a new approach to the graded Lie algebra of tangent valued forms [7, 8],
- introduction of a new calculus for general connections, including generalised curvature, torsion, Ricci tensor, Bianchi identities [7, 17, 18, 19, 24],
- introduction of a new concept of finite and infinite dimensional systems of general connections and the related calculus as a generalisation of concepts existing for principal connections [45, 7, 12, 29, 45, 46],
- extension to any system of connections of the concepts of universal connection and curvature, originally introduced by P. L. Garcia for principal connections [45, 7, 19, 45, 46],
- introduction of a new Lie algebra of special quadratic functions on a cosymplectic phase space in the Galilei and Einstein general relativities [22, 23, 25, 31, 35, 36, 39].

Main contributions in “Mathematical Physics” concerning the general relativistic formulation of quantum mechanics on a curved spacetime and, in particular, it dealing with:

- geometric approach to classical mechanics [38, 44],
- geometric topics in general relativity [1, 2, 3, 4],
- geometric approach to lagrangian theory [28],
- geometric approach to gauge theories [5, 9],
- formulation of general relativistic classical mechanics on a curved Galilei and Einstein spacetime through a cosymplectic structure on the jet space [21, 22, 26, 37, 43, 44],
- formulation of a general relativistic quantum mechanics on a curved Galilei spacetime through a quantum bundle equipped with a Hermitian product with values in the space of spacelike volume forms and a universal, Hermitian connection whose curvature is proportional to the cosymplectic form; in this contest the dynamics arises functorially from a covariant quantum Lagrangian and a covariant isomorphism between the classical Lie algebra of quantisable functions and the Lie algebra of Hermitian vector fields [21, 22, 25, 30, 31, 32, 33, 34, 35, 36, 39, 42, 43, 44, 44, 47],

- extension of the above techniques to a Lorentzian spacetime for the formulation of a general relativistic pre-quantum theory [27, 35, 36, 40].

### 2.3 Current research

Current research dealing mainly with the refinement and extension of the above geometric approach to the covariant formulation of quantum mechanics.

## 3 A few selected works

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- [2] M. MODUGNO: *Formulation of analytical mechanics in general relativity*, Ann. Inst. H. Poinc., **21**, 2 (1974), 147–174.
- [3] M. MODUGNO, G. STEFANI: *On gravitational and electromagnetic shock waves and their detection*, Ann. Inst. H. Poinc., **25**, 1 (1976), 91–104.
- [4] M. MODUGNO, G. STEFANI: *On the geometrical structure of shock waves in general relativity*, Ann. Inst. H. Poinc., **30**, 1 (1979), 27–50.
- [5] L. MANGIAROTTI, M. MODUGNO: *Some results on calculus of variations on jet spaces*, Inst. H. Poinc., **39**, 1 (1983), 29–43.
- [6] L. MANGIAROTTI, M. MODUGNO: *New operators on jet spaces*, Ann. Fac. Scien. Toulouse, **2**, 5 (1983), 171–198.
- [7] L. MANGIAROTTI, M. MODUGNO: *Fibred spaces, jet spaces and connections for field theories*, in “Geometry and Physics”, Edr.: M. Modugno, Proc. Intern. Meet., Florence 12-15 October 1982, Pitagora Editrice, Bologna, 1983, 135–165.
- [8] L. MANGIAROTTI, M. MODUGNO: *Graded Lie algebras and connections on a fibred space*, Journ. Math. Pur. et Applic., **63**, (1984), 111–120.
- [9] L. MANGIAROTTI, M. MODUGNO: *On the geometric structure of gauge theories*, J. Math. Phys., **26**, 6 (1985), 1373–1379.
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- [12] M. MODUGNO: *Systems of vector valued forms on a fibred manifold and applications to gauge theories*, in ‘Differential Geometric Methods in Mathematical Physics’, Eds.: P. L. García, A. Pérez-Rendón, Proc. of the XIV Int. Conf., Salamanca 24-29 June 1985, Lect. Notes Math. **1251**, Springer-Verlag, 1987, 238-264.

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- [15] I. KOLÁŘ, M. MODUGNO: *On the algebraic structure on the jet prolongation of fibred manifolds*, Czech. Math. Jour., **40**, 115 (1990), 601–611.
- [16] I. KOLÁŘ, M. MODUGNO: *Natural maps on the iterated jet prolongation of a fibred manifold*, Ann. Mat. Pura ed Appl., IV, **68** (1991), 151–165.
- [17] M. MODUGNO: *Torsion and Ricci tensor for non linear connections*, Diff. Geom. Appl., **1**, 2 (1991), 177–192.
- [18] I. KOLÁŘ, M. MODUGNO: *Torsions and connections on some natural bundles*, Diff. Geom. and Appl. **2**, 1 (1992), 1–16.
- [19] K. B. MARATHE, M. MODUGNO: *Polynomial connections on affine bundles*, Tensor N. S. **50**, 1 (1991), 35–49.
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