

## Curriculum vitae et studiorum

**Professor ALBERTO CAVICCHIOLI**

Born on 25/4/1955, he graduated in Mathematics with a grade of 110/110 cum laude at the Faculty of Mathematical, Physical and Natural Sciences of the University of Modena during the summer exam session (28/6/1978).

The main results obtained in the degree thesis are shown in work 1 of the list of publications.

From 15/3/1978 to 23/10/1978 he benefited from a scholarship for graduates of the C.N.R. at the Department of Mathematics of the University of Modena.

From 23/10/1978 to 23/10/1981 (with suspension of the C.N. R. grant from 11/12/1979 to 3/12/1980 for military service) he was the holder of a scholarship for graduates of the C.N.R., Geometry--Algebra group at the Department of Mathematics of the University of Modena.

From 1/8/80 (for legal purposes) and from 1/11/81 (for economic purposes) until 10/6/87 he held the role of confirmed researcher for the discipline group n.89 Geometry--Algebra at the Faculty of Sciences of the University of Modena. On 10/6/87 he was appointed Associate Professor of Differential Topology at the Faculty of Mathematical, Physical and Natural Sciences of the University of Basilicata (Potenza).

From 1/11/1990 to 31/10/1994 he was extraordinary professor and then full professor of Geometry at the Faculty of Engineering of the University of Modena.

He was a member of the Unione Matematica Italiana, the American Math. Society and the Society of Mathematicians and Naturalists of Modena. He is a member of the G.N.S.A.G.A. of the C.N.R. (Italian National Research Council).

Since 1/11/1994 he has been full professor of Institutions of Superior Geometry at the Faculty of Mathematical, Physical and Natural Sciences of the University of Modena.

In 1978 and 1979 he attended the courses of: Algebraic Topology, Complex Analysis, Introduction to Differential Geometry and Introduction to Probability Calculus at the Interuniversity Mathematics School of Perugia.

From 1/11/1990 to 1/11/1994 he was secretary of the Council of Professors of the Faculty of Engineering of the University of Modena.

From 1/11/1994 to 1/12/2002 he was the president of the Library Commission of the Department of Mathematics of the University of Modena.

From 1995 to 2002 he was first a member of the University Commission for the organization of the Interdepartmental Scientific Library (BSI) of the University Campus of Via Campi and then vice-director of the BSI.

From 1998 to 2004 he was a member of the Board of the Department of Mathematics of the University of Modena. Since 1998 he has been for several periods the local coordinator of the ex 40% funds of the MIUR (Ministry of Education, University and Research--formerly MURST) within the national project "Geometric Properties of Real and Complex Varieties".

He was a member of the Scientific Committee of the Mathematics Journal "Atti Sem. Mat. Fis. Univ. Modena". He was an associate editor of the International Journal of Mathematics "International Journal of Mathematics and Mathematical Sciences" IJMMS. He is an honorary member of the International Journals of

Mathematics "Pure Mathematical Sciences" and "International Mathematical Forum". He was a member of the Editorial Board of the international mathematics journal "Journal of Mathematics".

From January 2000 to February 2012 he was the Coordinator of the PhD in Mathematics at the University of Modena and Reggio Emilia. From September 2012 to October 2018 he was the scientific manager for the Mathematics Area in the agreement University of Modena and Reggio E.-INDAM.

Since 2020 he has been Dean of the University of Modena and Reggio E. and Dean of the Department of Physical, Computer and Mathematical Sciences (FIM).

Since 2022 he is the President of the Ethics Committee of the University of Modena and Reggio E. (Three-year period 2022-2025).

### **Teaching Activities**

In the academic years from 1978/79 to 1986/87 he held the exercises in the courses of **Geometry I** and **Geometry II** (in alternate years) for the Degree Course in Mathematics at the Faculty of Mathematical, Physical and Natural Sciences of the University of Modena, also collaborating in the drafting of handouts for the students.

He also collaborated, in the same years, in the holding of the courses of **Differential Geometry** and **Algebraic Topology**, supporting the holders of the courses with seminars, complements and collaborating in the drafting of theses and dissertations.

During the academic year 1983/84 he also held the exercises in the course of **Mathematical Institutions** at the School for Systems and Procedure Analysts of the University of Modena.

In the academic year 1987/88 he taught the course of **Geometry I**, with related exercises, for the Degree Course in Mathematics at the Faculty of Mathematical, Physical and Natural Sciences of the University of Basilicata (Potenza) and, as a substitute professor, he taught the course of **Algebraic Topology** for the Degree Course in Mathematics at the Faculty of Mathematical, Physical and Natural Sciences of the University of Modena.

In the academic years 1988/89 and 1989/90 he taught the courses of **Geometry I** (Degree Course in Mathematics Univ. Basilicata) and **Algebraic Topology** (Degree Course in Mathematics Univ. Modena, substitute).

In the academic year 1990/91 he taught the course of **Geometry** for the Degree Course in Computer Engineering at the Faculty of Engineering of the University of Modena and, as a substitute professor, he taught the course of **Institutions of Higher Geometry** for the Degree Course in Mathematics at the Faculty of Mathematical, Physical and Natural Sciences of the University of Modena.

In the academic years 1991/92, 1992/93 and 1993/94 he taught the course of **Geometry** for the Degree Course in Computer Engineering at the Faculty of Engineering of the University of Modena and, as a substitute professor, he taught the Course of **Higher Geometry** for the Degree Course in Mathematics at the Faculty of Mathematical, Physical and Natural Sciences of the University of Modena.

In the academic year 1992/93 he also taught the course of **Geometry** for the Diploma in Mechanical Engineering at the Faculty of Engineering of the University of Modena.

In the academic year 1994/95 he taught the course of **Institutions of Higher Geometry** for the Degree Course in Mathematics at the Faculty of Sciences of the

University of Modena and, as a substitute professor, he taught the course of **Geometry** for the Degree Course in Computer Engineering at the Faculty of Engineering of the University of Modena.

In the academic years 1995/96, 1996/97, 1997/98 and 1998/1999 he taught the courses of **Institutions of Higher Geometry** for the Degree Course in Mathematics at the Faculty of Sciences of the University of Modena and of **Geometry** for the Degree Course in Computer Engineering at the Faculty of Engineering of the University of Modena.

In the academic year 1999/2000 he taught the course of **Institutions of Higher Geometry** for the Degree Course in Mathematics at the Faculty of Science of the University of Modena, the course of **Geometry** for the Degree Course in Computer Engineering at the Faculty of Engineering of the University of Modena and the extensive (annual) integrated teaching of **Geometry** for the 181st Course of Studies in Engineering, devoted to the training of Officers of the Corps of Engineers of the Italian Army.

In the academic year 2000/2001 he taught the course of **Institutions of Higher Geometry I/II** for the Degree Course in Mathematics and the course of **Geometry** for the Degree Course in Physics at the Faculty of Science of the University of Modena and Reggio Emilia and the extensive (annual) integrated teaching of **Geometry** for the 182nd Course of Studies in Engineering, devoted to the training of Officers of the Corps of Engineers of the Italian Army.

In the academic year 2001/2002 he taught the course of **Institutions of Higher Geometry I/II** for the Degree Course in Mathematics, the course of **Geometry** for the Degree Course in Physics at the Faculty of Science of the University of Modena and Reggio Emilia and the course of **Differential Geometry** for the Research Doctorate in Mathematics of the University of Modena and Reggio Emilia.

In the academic year 2002/2003 he taught the courses **Geometry of Curves** and **Institutions of Higher Geometry I/II** for the Degree Course in Mathematics and the course **Geometry** for the Degree Course in Physics at the Faculty of Science of the University of Modena and Reggio Emilia. In addition, he taught the course **Fundamentals of Geometry** for the Degree Course in Environmental Engineering at the Faculty of Engineering of the University of Modena and Reggio E. and the course **Geometry of Varieties** for the PhD in Mathematics at the University of Modena and Reggio Emilia.

In the academic year 2003/2004 he taught the course **Geometry of Curves** for the Bachelor's Degree Course in Mathematics and the course **Institutions of Higher Geometry** for the Master's Degree Course in Mathematics at the Faculty of Science of the University of Modena and Reggio Emilia. Furthermore, he taught the course of **Fundamentals of Geometry** for the Degree Course in Environmental Engineering at the Faculty of Engineering of the University of Modena and Reggio Emilia and the course of **Hyperbolic Geometry** for the PhD in Mathematics at the University of Modena and Reggio Emilia.

In the academic year 2004/2005 he taught the course of **Geometry of Curves** for the Bachelor's Degree Course in Mathematics and the course of **Institutions of Higher Geometry** for the Master's Degree Course in Mathematics at the Faculty of Sciences of the University of Modena and Reggio Emilia. Furthermore, he taught the course of **Geometry A** for the Degree Course in Telecommunications Engineering at the Faculty of Engineering of the University of Modena and Reggio Emilia and the course of **Differential Geometry** for the PhD in Mathematics at the University of Modena and Reggio Emilia.

In the academic years 2005/2006 and 2006/2007 he taught the course **Geometry of Curves** for the Bachelor's Degree in Mathematics and the course **Institutions of Higher Geometry** for the Master's Degree in Mathematics at the Faculty of Science of the University of Modena and Reggio Emilia. Furthermore, he taught the course

**Differential Geometry** for the PhD in Mathematics at the University of Modena and Reggio Emilia.

In the academic year 2007/2008 he taught the course **Geometry of Curves** for the Bachelor's Degree in Mathematics and the course **Institutions of Higher Geometry** for the Master's Degree in Mathematics at the Faculty of Science of the University of Modena and Reggio Emilia. Furthermore, he taught the courses **Theory of Graphs** and **Homological Algebra** for the PhD in Mathematics at the University of Modena and Reggio Emilia.

In the academic year 2008/2009 he taught the course **Geometry of Curves** for the Bachelor's Degree in Mathematics and the course **Institutions of Higher Geometry** for the Master's Degree in Mathematics at the Faculty of Science of the University of Modena and Reggio Emilia. In addition, he taught the courses **Theory of Knots** and **Surgery and Geometric Varieties** for the PhD in Mathematics at the University of Modena and Reggio Emilia.

In the academic year 2009/2010 he taught the course **Geometry of Curves** for the Bachelor's Degree in Mathematics and the course **Institutions of Higher Geometry** for the Master's Degree in Mathematics at the Faculty of Science of the University of Modena and Reggio Emilia. Furthermore, he taught the course of **Geometry and Linear Algebra** for the Bachelor's Degree in Mechanical Engineering and Materials Engineering at the Faculty of Engineering of the University of Modena and Reggio Emilia.

In the academic years 2010/2011 and 2011/2012 he taught the course of **Geometry of Curves** for the Bachelor's Degree in Mathematics and the course of **Institutions of Higher Geometry** for the Master's Degree in Mathematics at the Faculty of Sciences of the University of Modena and Reggio Emilia.

In the academic year 2012/2013 he taught the course of **Geometry of Curves** and **Foundations of Mathematics I** for the Bachelor's Degree in Mathematics and the courses of **Geometry of Surfaces**, **Differential Geometry** and **Geometric Optimization Methods** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia.

In the academic year 2013/2014 he taught the course **Geometry of Curves** and **Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics and the course **Geometry of Surfaces** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course **Geometry and Linear Algebra** (II group letter L-Z) for the Bachelor's Degree in Mechanical Engineering and Environmental Engineering at the University of Modena and Reggio Emilia (Modena campus). He taught the course **Mathematical Analysis** (II group) for the Bachelor's Degree in Strategic Sciences at the Military Academy of Modena.

In the academic year 2014/2015 he taught the course **Geometry of Curves** and **Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics. He taught the course of **Geometry and Linear Algebra** (II group letter L-Z) for the degree courses in Mechanical Engineering and Environmental Engineering at the University of Modena and Reggio Emilia (Modena campus). He taught the course of **Mathematical Analysis** (II group) for the degree course in Strategic Sciences at the Military Academy of Modena.

In the academic year 2015/2016 he taught the course of **Geometry of Curves** and **Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics and the course of **Geometry of Surfaces** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course of **Geometry and Linear Algebra** (II group letter L-Z) for the degree courses in Mechanical Engineering and Environmental Engineering at the University of Modena and Reggio Emilia (Modena campus).

campus). He taught the course of **Mathematical Analysis** (II group) for the degree course in Strategic Sciences at the Military Academy of Modena.

In the academic year 2016/2017 he taught the course of **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics. He taught the course of **Geometry and Linear Algebra** (II group letter L-Z) for the degree courses in Mechanical Engineering and Environmental Engineering at the University of Modena and Reggio E. (Modena campus). He taught the course of **Mathematical Analysis** (II group) for the degree course in Strategic Sciences at the Military Academy of Modena.

In the academic year 2017/2018 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics and the course **Geometry of Surfaces** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course **Geometry and Linear Algebra** for the Bachelor's Degree in Vehicle Engineering at the University of Modena and Reggio Emilia (Modena campus). He taught the course **Mathematics I** (II group) for the Bachelor's Degree in Strategic Sciences at the Military Academy of Modena.

In the academic year 2018/2019 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics. He taught the course **Geometry and Linear Algebra** for the Bachelor's Degree in Mechanical Engineering at the University of Modena and Reggio Emilia (Modena campus). He taught the course **Mathematical Analysis** (II group) for the Bachelor's Degree in Strategic Sciences at the Military Academy of Modena.

In the academic year 2019/2020 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics and the course **Geometry of Surfaces** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course of **Geometry and Linear Algebra** for the degree course in Mechanical Engineering at the University of Modena and Reggio E. (Modena campus). He taught the course of **Mathematics I** (II group) for the degree course in Strategic Sciences at the Military Academy of Modena.

In the academic year 2020/2021 he taught the course of **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics. He taught the course of **Geometry and Linear Algebra** for the degree course in Mechanical Engineering at the University of Modena and Reggio E. (Modena campus). He taught the course of **Mathematics I** (II group) for the degree course in Strategic Sciences at the Military Academy of Modena.

In the academic year 2021/2022 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics and the course **Geometry of Surfaces** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course **Geometry and Linear Algebra** for the Bachelor's Degree in Mechanical Engineering at the University of Modena and Reggio Emilia (Modena campus). He taught the course **Geometry and Linear Algebra** (I group) for the Bachelor's Degree in Strategic Sciences at the Military Academy of Modena.

In the academic year 2022/2023 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course **Geometry and Linear Algebra** for the Bachelor's Degree in Mechanical Engineering at the University of Modena and Reggio E. (Modena campus). He taught the course **Geometry and Linear Algebra** (I group) for the Bachelor's Degree in Strategic Sciences at the Military Academy of Modena.

In the academic year 2023/2024 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics and the course **Superior Geometry** for the Master's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course of **Geometry and Linear Algebra** for the degree course in Mechanical Engineering at the University of Modena and Reggio Emilia (Modena campus). He taught the course of **Geometry and Linear Algebra** (I group) for the degree course in Strategic Sciences at the Military Academy of Modena.

In the academic year 2024/2025 he taught the course **Geometry of Curves and Fundamentals of Mathematics I** for the Bachelor's Degree in Mathematics at the Department of Physical, Computer and Mathematical Sciences of the University of Modena and Reggio Emilia. He taught the course **Geometry and Linear Algebra** for the Bachelor's Degree in Mechanical Engineering at the University of Modena and Reggio E. (Modena campus). He taught the course **Geometry and Linear Algebra** (I group) for the Bachelor's Degree in Strategic Sciences at the Military Academy of Modena.

In the same years he was the supervisor of numerous theses on the topics of Algebraic and Geometric Topology, Differential Geometry, Graph Theory and Computational Geometry. He was the supervisor of the doctoral thesis in Mathematics of Dr. Elena Barbieri (17th Cycle of the Doctorate in Research in Mathematics of the University of Modena and Reggio Emilia) entitled *On the Topology of Some Families of Closed 3-Manifolds* (Final Examination Session for the award of the title of Doctor of Research, February 25, 2005). He was the supervisor of the PhD thesis in Mathematics of Dr. Agnese Iliaria Telloni (23rd Cycle of the PhD in Mathematics of the University of Modena and Reggio Emilia) entitled *Groups and Manifolds from Triangulated Polyhedra* (Final Examination Session for the award of the title of Doctor of Research, 10 February 2012).

### Conference participations

- 1) Conference of ``Topology'' (Perugia, from 1/5/1980 to 3/5/1980) during a leave from military service.
- 2) Conference of the G.N.S.A.G.A. group (Modena, from 30/9/1981 to 2/10/1981) where he gave a talk entitled ``A topological invariant of 3-manifolds independent of the homotopy type''.
- 3) Conference of ``Topology'' (L'Aquila, from 27/3/1983 to 29/3/1983) where he gave a talk entitled ``A representation of 3-manifolds by means of properly discontinuous transformation groups''.
- 4) Conference ``Colloquium on Topology'' (Eger--Hungary, from 9/8/1983 to 13/8/1983).
- 5) XII U.M.I. Congress (Perugia, from 2/9/1983 to 7/9/1983) where he gave a talk entitled ``Three dimensional manifolds as quotients of bodies of handles''.
- 6) Conference of ``Topology'' (Taormina, from 2/4/1984 to 7/4/1984) where he gave a talk entitled ``On a Lins--Mandel conjecture''.
- 7) Conference--study on the ``Geometry of differentiable varieties'' (Rome, from 17/9/1984 to 21/9/1984).
- 8) Conference of the G.N.S.A.G.A. group (Turin, from 4/10/1984 to 6/10/1984) where he gave a talk entitled ``Handles and factorizations of varieties''.
- 9) VII congress of mathematicians of Latin expression (Coimbra, Portugal, from 9/9/1985 to 14/9/1985) where he gave a communication entitled ``Fibered homological spheres''.

- 10) III National Conference of ``Topology'' (Trieste, from 9/6/1986 to 12/6/1986) where he gave a talk entitled ``A genus for n-dimensional links''.
- 11) Conference of ``Differential Geometry'' (Bari, from 26/2/1987 to 28/2/1987).
- 12) National Conference ``Pietro Riccardi and the historiography of Mathematics in Italy'' (Modena, from 16/3/1987 to 18/3/1987).
- 13) XIII U.M.I. Congress (Turin, from 3/9/1987 to 9/9/1987) where he gave a talk entitled ``Numbers of covering of varieties''.
- 14) IV National Conference of ``Topology'' (Sorrento, from 14/9/1988 to 17/9/1988) where he gave a talk entitled ``4-dimensional manifolds and symmetric forms''.
- 15) Conference of the G.N.S.A.G.A. group of the C. N. R. (Trieste, from 6/10/1988 to 8/10/1988) where he gave a talk entitled ``Some recent results on 4-dimensional manifolds''.
- 16) Conference ``Geometry and Complex variables'' (Bologna, from 8/2/1989 to 11/2/1989).
- 17) Conference of ``Topology'' (Padua, from 2/6/1989 to 3/6/1989) where he gave a talk entitled ``Some results on 4-dimensional non-simply connected varieties''.
- 18) Conference ``Study days on Differential Geometry and Topology'' (Lecce, from 21/6/1989 to 23/6/1989).
- 19) Second International Catania Combinatorial Conference ``Graphs, designs and Combinatorial Geometries'' (Santa Tecla, Acireale (CT), from 4/9/1989 to 9/9/1989) where he gave a talk entitled ``Heegaard diagrams and colourings of graphs''.
- 20) 1990 Barcelona Conference on Algebraic Topology (S. Feliu de Guixols, Barcelona, from 6/6/1990 to 12/6/1990).
- 21) V International Conference on ``Topology'' (Otranto, Lecce, from 17/9/1990 to 21/9/1990).
- 22) CIRM Conference "Complex Analysis and Geometry--X" (Trento, 5/27/1991 to 5/31/1991).
- 23) Conference "International Conference on Graphs and Hypergraphs" (Varenna, Como, Villa Cipressi, 6/17/1991 to 6/20/1991), where he gave a talk entitled "Homology for colored graphs".
- 24) X National Conference of Topology (Turin, from 23/1/1992 to 25/1/1992).
- 25) "Seminar of Algebraic Topology" (Milan, 27/5/1992), where he held a conference entitled "Surgery on Manifolds".
- 26) Conference "Days of Differential Geometry" (Turin, from 29/5/1992 to 30/5/1992).
- 27) Conference "Homotopy Theory Conference" (Palazzo Feltrinelli, Gargnano (BS), from 4/9/1992 to 9/9/1992).
- 28) Conference of Geometry (Milan, from 21/9/1992 to 23/9/1992).
- 29) Conference on "Topological Theory of Fixed Points" (Cortona, from 21/6/1993 to 25/6/1993).

- 30) Conference "Eleventh International Conference on Topology" (Trieste, from 6/9/1993 to 11/9/1993).
- 31) Conference on "Combinatorial Algebra and Geometry" (Modena, from 16/9/1993 to 17/9/1993).
- 32) Conference of the G.N.S.A.G.A. group. (Lecce, from 21/10/1993 to 23/10/1993) where he held a general conference entitled "On the topological classification of manifolds"
- 33) Conference on "Differential Geometry and Complex Analysis" (Parma, from 19/5/1994 to 20/5/1994).
- 34) 1994 Barcelona Conference on Algebraic Topology (S. Feliu de Guixols, Barcelona, Spain, 1/6/1994 to 7/6/1994)
- 35) Visiting Professor at the University of Ljubljana (Slovenia), 20/11/1994 to 27/11/1994 for scientific research in collaboration with Prof. Dusan Repovs and where he gave two general conferences entitled "Manifolds with highly connected universal covers" and "On the homotopy type of closed 4-manifolds".
- 36) Conference "Research Activities in the Faculty of Science of the University of Modena" (National Academy of Letters, Sciences and Arts of Modena, 22-2-1995), where he held a conference entitled "Topology of Varieties: Problems and Results".
- 37) Visiting Professor at the Universidad Central del Ecuador from 17/3/1995 to 5/4/1995 for scientific research in collaboration with Prof. Hernan Leon Velasco and where he held a series of seminars entitled "Variedades y Teoria de Grafos: Problemas Computacionales".
- 38) Conference "Giornate di Geometria Algebrica ed Analitica" (Florence, 4-6 September 1995).
- 39) XV Congress U.M.I. (Padova, September 11-16, 1995) where he gave a lecture entitled "Homotopy type and stable classification of 4-manifolds".
- 40) Visiting Professor at the University of Ljubljana (Slovenia) from November 5, 1995 to November 12, 1995 for scientific research in collaboration with Prof. Dusan Repovs and where he gave a lecture entitled "Spines of 3-manifolds".
- 41) "Seminar of Algebraic Topology" (Milan, April 29, 1996), where he gave a lecture entitled "Cyclic Presentations and Branched Coverings".
- 42) Conference "Federigo Enriques: maestro a Bologna" (Bologna, November 22 and 29, 1996).
- 43) "Seminar of Geometry and Topology" (Trieste, 23-24 April 1997), where he held two lectures entitled "Surgery and Branched Coverings" and "Homotopy Type and Cobordism of 4-dimensional Manifolds".
- 44) Visiting Professor at the University of Ljubljana (Slovenia), from 26/5/1997 to 30/5/1997 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled "4-manifolds with surface fundamental groups".
- 45) Conference of the G.N.S.A.G.A Group (Perugia, from 6 to 9 November 1997) where he held a communication entitled "Surgery sequence and Cobordism of 4-dimensional Manifolds".
- 46) "Seminar of Geometry and Topology" (Trieste, 26-27 November 1997) where he held a conference entitled "Special Spines and Invariants of Three-dimensional Manifolds".

- 47) "Cultura e Vita" (Science Course) (Modena, February 27, 1998 and March 6, 1998) where he held two conferences entitled "Introduction to Algebraic Topology Methods: first and second part".
- 48) International Conference "Mathematics towards the third millennium" (Rome, May 27--29, 1999).
- 49) Visiting Professor at the University of Ljubljana (Slovenia) from June 24, 1999 to July 7, 1999 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled "Branched Coverings of Hyperbolic Links".
- 50) XVI Congress of the Italian Mathematical Union (Naples, September 13-18, 1999), where he gave a talk entitled ``Surgery, L-groups and Decompositions of 4-Manifolds''.
- 51) Seminars in Geometry (Univ. Bologna, December 15, 1999), where he gave a talk entitled ``Homotopy, Cobordism and Decompositions of 4-Manifolds''.
- 52) Seminars in Geometry (Univ. Milan, May 26, 2000), where he gave a talk entitled ``Manifolds of dimension 4 with special homotopy groups''.
- 53) Visiting professor at the University of Ljubljana (Slovenia), from 26/6/2000 to 2/7/2000 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled ``Differentiable 4-manifolds with vanishing second homology''.
- 54) Seminars in Geometry (Univ. Trento, January 24, 2001), where he held a conference entitled ``Differentiable structures on 4-dimensional manifolds''.
- 55) Visiting professor at the University of Ljubljana (Slovenia), from 2/9/2001 to 9/9/2001 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled ``Topological Properties of Cyclically Presented Groups''.
- 56) Visiting professor at the University of Ljubljana (Slovenia), from 2/9/2002 to 9/9/2002 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled ``On certain classes of hyperbolic 3-manifolds''.
- 57) Visiting professor at the University of Ljubljana (Slovenia), from 26/5/2003 to 31/5/2003 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled ``Asphericity and Atoricity of Symmetric Presentations''.
- 58) XVII Congress of the Italian Mathematical Union (Milan, from 8 to 13 September 2003).
- 59) VIII Conference of the Austrian Mathematical Society (Bolzano, 22-26 September 2003), where he gave a talk entitled ``Connected Sum Decompositions of Four-Manifolds''
- 60) Workshop ``New Perspectives on Holonomy and Submanifolds'' (Turin, 23-24 April 2004)
- 61) International Conference ``Trends in Geometry- In memory of Beniamino Segre'' (Rome, 7-9 June 2004)
- 62) International Colloquium on Singularities and Low-dimensional Topology- In honour of Bernard Perron (Dijon, France, 14-18 June 2004)

63) International Conference ``Geometrical Topology, Discrete Geometry and Set Theory'' - In commemoration of the Centennial of Ljudmila Vsevolodovna Keldysh (Moscow, Russia, 24-28 August 2004), where he held a general conference entitled "Group Presentations and Topology of 3-Manifolds".

64) 9th International Conference on Differential Geometry and its Applications (Prague, Czech Republic, from August 30 to September 3, 2004), where he gave a talk entitled *Volumes of some hyperbolic 3-manifolds*.

65) International Conference COMBINATORICS '04 (Capomulini, Catania, September 12-18, 2004), where he gave a talk entitled *SL(2, C)-representations of knot groups*.

66) Visiting professor at the University of Ljubljana (Slovenia), from November 12, 2004 to November 18, 2004 for scientific research in collaboration with Prof. Dusan Repovs and where he gave a talk entitled ``On the classification of Kim and Kostrikin manifolds''.

67) Visiting professor at the University of Ljubljana (Slovenia), from 04/06/2005 to 13/06/2005 for scientific research in collaboration with Prof. Dusan Repovs and where he held a conference entitled ``Palindrome presentations of knot groups''.

68) International Conference on Differential Geometry and Physics (Budapest, Hungary, from 29 August to 2 September 2005).

69) International Conference COMBINATORICS 2006 (Ischia, Naples, 25 June-1 July 2006), where he held a communication entitled ``Poly-surface groups and manifolds''

70) International Congress of Mathematicians ICM 2006 (Madrid, Spain, 22-30 August 2006).

71) Visiting professor at the University of Gothenburg (Sweden), from 16/12/2006 to 31/12/2006 for scientific research in collaboration with Prof. Niklas Eriksen and where he held a conference entitled ``Combinatorics of Piecewise Linear Manifolds''.

72) International Conference COMBINATORICS 2008 (Costermano, Verona, 22 June-28 June 2008).

73) Day in honor of Mario Marchi (for his 70th birthday) (Brescia, 30 January 2010).

74) Cycle "Teaching Mathematics: Geometric Aspects and more" (in memory of Prof. Carlo Felice Manara) Academy of Letters, Sciences and Arts, Modena, 21 March 2012, where he held a conference entitled "Euler and the Classification of Platonic Solids".

75) Scientific Degrees Project. He held two conferences entitled *Non-Euclidean Geometries: the historical-axiomatic path* and *Non-Euclidean Geometries: Gauss and the differential method* at the State Scientific High School "Rinaldo Corso" of Correggio (RE), 2 May 2013, and at the State Scientific-Technological High School "Alessandro Volta" of Sassuolo (MO), 13 March 2014, 12 March 2015 and 11 February 2016 and 2018.

### **Scientific activity**

The scientific activity mainly concerns problems related to topological and differentiable manifolds addressed by means of techniques of Algebraic, geometric and differential topology, combinatorial group theory, graph theory and homological algebra.

The obtained results can be divided into the following sections:

### **Sec. 1. Topology and Geometry of Manifolds**

The starting point is to consider a combinatorial representation of manifolds and their generalizations (homological manifolds, quasi-varieties, pseudo-varieties) by means of Heegaard diagrams, P-graphs, RR-systems, standard spines, branched coverings, surgery on numbered links and special classes of colored graphs called *crystallizations*. In this way, combinatorial methods are available to describe large classes of polyhedra and to calculate their main algebraic invariants.

In the field of the theory of manifolds, the following problems have been solved:

Determination of a presentation of the fundamental group of a manifold. Combinatorial characterizations of the crystallizations of manifolds between classes of colored graphs on the edges. Search for minimal atlases of manifolds. Definition and study of new topological invariants of manifolds independent of the homotopy type. Representations of manifolds by a positive integer  $n$  and an involutory permutation without fixed points on  $Z_n \times Z_6$  or by a finite number of arcs on surfaces. Construction of infinite classes of non-homeomorphic homological spheres with Heegaard genus two. Factorizations of manifolds (that is, varieties) and recognition of handles in connected sum decompositions of reducible varieties. Construction of special classes of varieties that generalize lenticular spaces or that extend Lins-Mandel varieties. Combinatorial description of the orientability of a variety. Connections between the theory of crystallizations and the theory of Heegaard splittings. Representation of varieties as coverings of the 3-sphere ramified on nodes and links. Combinatorial characterizations of  $S^1 \times S^3$ , of the complex projective plane  $CP^2$  and of the real projective space  $RP^4$  in the framework of closed manifolds of dimension 4. Determination of automorphism groups of colored graphs associated with manifolds. Normal forms of links and  $n$ -bridge nodes and associated covering spaces. Construction of 3-manifolds that are not homeomorphic but admit isomorphic spines. Cyclic presentations of fundamental groups and classification of 3-manifolds represented by symmetric Heegaard diagrams. Proof of the validity of a Dunwoody conjecture. Classification of the topological and geometric structure of notable families of 3-manifolds (e.g. Fibonacci Manifolds, Sieradski Manifolds, Kim-Vesnina Manifolds, Takahashi Manifolds, Kim-Kostrikin Manifolds, etc.). Study of branched coverings on toric knots and 2-bridge knots. Construction of infinite families of hyperbolic 3-manifolds. Topological and geometric classification of manifolds represented by link surgery, branched coverings, Heegaard diagrams, RR-systems, spines and polyhedral schemes. Palindromic presentations of knots and recursive description of their character varieties. Topological and geometric classification of 3-manifolds obtained from Platonic solids and various Archimedean solids. Dehn surgery on twisted Whitehead links. Hyperbolic manifolds with few generators and their geometric representations. Tetrahedral manifolds with hyperbolic structure. Representation of manifolds obtained by Whitehead link surgery as tetrahedral manifolds. Exceptional surgeries on classes of (1,1)-hyperbolic knots. Families of hyperbolic knots admitting the standard 3-sphere or lenticular spaces as surgeries. Spines and surgery descriptions of graph manifolds. Classification of exceptional surgeries on the Motegi and Song link. Isometry groups and volumes of hyperbolic manifolds. Description by surgery of Cube Manifolds reducible to two generators. Character varieties of cusped surgery manifolds. Complexity and arithmetic invariants of combinatorial manifolds.

### **Sec. 2. Homological Algebra and Combinatorial Group Theory**

Using techniques of homological algebra and combinatorial group theory, results and applications have been obtained regarding questions of the theory of surgery on varieties and knot theory.

In particular, the following problems have been solved:

Study of the algebraic properties of the Poincaré groups of closed 3-manifolds. Calculation of the homology groups of notable classes of manifolds. Covering numbers of manifolds (i.e., varieties) and study of the critical points (resp. values) of Morse functions. Transversality in the polyhedral category and geometric description of cohomological products by geometric cocycles. Representation of 3-manifolds by properly discontinuous groups of covering homographic transformations. Geometric description of the fundamental group of surfaces by complex Möbius transformations. Genus of knots and links in dimension  $n$ . Embeddings of polyhedra in 3-manifolds. Methods for the construction of manifolds from lower-dimensional complexes and characterization of the complements of notable nodes in the 3-sphere. Extensions of cyclically presented groups and links with groups of high-dimensional knots. Homology groups for colored graphs and their topological interpretation. Study and topological classification of Neuwirth manifolds and interpretation of cyclically presented groups (e.g. Fibonacci groups, Sieradski groups, etc.) as fundamental groups of closed 3-manifolds. Classification of idempotent comultiplications on graded algebras (e.g. the cohomology algebra of a manifold) and of idempotent multiplications on Lie groups.

### **Sec. 3. Algebraic Topology and L-theory**

In this area, the homotopy type, the topological type and the cobordism class of topological or differentiable manifolds of dimension 4 with a special fundamental group (e.g. free groups, surface groups, polycyclic groups, fundamental groups of aspheric varieties) have been studied. Using methods of algebraic L-theory and surgery theory, theorems on the classification (modulo equivalences of homotopy and, in various cases, modulo homeomorphisms) of the aforementioned manifolds have been proved. In particular, it has been proved that the homotopy type of a closed 4-manifold  $TOP$  ( $PL = DIFF$ )  $M$  with a free fundamental group is completely determined by the isomorphism class of the intersection form on the second homotopy group. A generalization of a theorem of Montesinos on the decomposition into handles of a 4-dimensional manifold for higher-dimensional manifolds is obtained. As a consequence, it is proved that  $S^1 \times S^n$  is the unique closed  $(n+1)$ -manifold of genus one. The  $C(p,q)$ -varieties introduced by Ykeda and Yamashita have been classified. Study of the algebraic properties of symmetric intersection forms on 4-varieties and applications to the topological structure of complex algebraic surfaces. Algebraic characterizations of varieties with highly connected universal covering and of 4-varieties admitting a fibered space structure on a surface. Study of the algebraic properties of obstruction groups for surgery and construction of various spectral sequences in the algebraic K-theory of quadratic extensions. A complete description of the pseudo-isotopy classes of homeomorphisms on handle bodies is obtained. Decompositions of 4-dimensional manifolds modulo homotopy equivalences. Extension of the Bolsinov-Fomenko theorem on the classification of Hamiltonian integral systems. Study of the Lagrangian and the associated equation of motion for Yang-Mills fields defined on differentiable 4-manifolds. Families of structures on spherical fibrations. Approximations (modulo homotopies) of homotopy equivalences between differentiable 4-manifolds by means of topological homeomorphisms (Borel problem in dimension 4). Algebraic characterization of the homotopy type of Poincaré spaces with finitely presented fundamental group. In particular, the connection between the polarized homotopy type over a Postnikov tower and the concept of CW-tower category due to J. H. Baues is described. Regular embeddings of 4-manifolds with zero second homology group in Euclidean spaces. Varieties of algebras from Fibonacci groups. Resolution of generalized manifolds and their construction by controlled surgery techniques. Obstruction groups for surgery on compact manifolds and construction of various spectral sequences in K- and L-theory. Topology of cell-like maps and

construction of homological manifolds in high dimension. Assembly maps and construction of obstructions for splitting in surgery theory. Surgery on pairs of closed manifolds. Browder-Quinn L-groups for manifolds with filtrations. Topology and cobordism classes of 4-manifolds with special homotopy groups. Geometry of minimal Poincaré Complexes. Cobordism and signature of Poincaré Complexes in dimension 4. Cobordism groups of Poincaré Complexes and closed 4-manifolds. Intersection forms, k-invariants and homotopy type classification of differentiable 4-manifolds. Poincaré complexes with fundamental class.

#### **Sec. 4. Graph Theory and Computational Geometry**

In this field, algorithms have been developed, implemented on personal computers in C language, for the automatic computation of the (co)homological characters of a compact polyhedron. These algorithms are based on a combinatorial representation of compact polyhedra by means of colored graphs. Study and computational analysis of some classical conjectures of Graph Theory and subsequent classification, modulo isomorphisms, of cubic graphs with chromatic index 4 (snarks) and fixed order. Classification, modulo isomorphisms, of special classes of cubic graphs (quasi-Hamiltonian, hypoHamiltonian and (co)critical). Homology groups for colored graphs and their topological interpretation. Study of combinatorial invariants of PL varieties by means of automatic computation. Classification of combinatorial manifolds by means of regular genus, complexity and/or average order. Colored graphs of closed 3-manifolds of genus 2.

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