Ludovico Battista

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Nationality Italian

Birth 10/04/1994, in Campobasso (CB), Italy

Positions

Feb 2023 - current **Post-doc**, *FBK - Fondazione Bruno Kessler*, ES - Embedded Systems, Trento.

Mar 2022 - Jan 2023 **Post-doc**, *Alma Mater Studiorum - University of Bologna*, Department of Mathematics, Bologna.

Education

2018/2019 - 2021/2022 **Ph.D. in Pure Mathematics**, *Università di Pisa*, Pisa, Defense date: 08/04/2022, cum laude.

PhD Thesis: "Hyperbolic 4-manifolds, perfect circle-valued Morse functions and infinitesimal rigidity"

Research topic: During my PhD I worked with my advisor to find examples of (compact and cusped) finite-volume hyperbolic 4-manifolds M with perfect circle-valued Morse functions, that is circle-valued Morse functions $f\colon M \to S^1$ with only index 2 critical points. We used this examples to better undestand the topology of hyperbolic 4-manifolds.

We also have developed a general strategy to study the infinitesimal rigidity of cyclic coverings of manifolds obtained by colouring right-angled polytopes. In this way we proved the infinitesimal rigidity of some geometrically infinite hyperbolic 4- and 5-manifolds. These are the first examples of geometrically infinite hyperbolic manifolds that are infinitesimally rigid.

Supervisor: Prof. Bruno Martelli.

2016/2017 - 2017/2018 **Graduate Student in Pure Mathematics**, *Università di Pisa*, Pisa, Master Degree in Mathematics, 110/110 cum laude, 26/10/2018.

Master Thesis: "Principal congruence Link complements"

Dissertation Topic: The topic is the study of hyperbolic manifolds that are both principal congruence manifolds and link complements in S^3, which were classified by Baker, Goerner and Reid in the article "All pincipal congruence link complements". After a brief introduction to the basic results in hyperbolic geometry, we exhibit the two main results that prove that there exists only a finite number of such manifolds. We show the main algorithm that allow to prove that a principal congruence manifold is indeed a link complement and several methods to prove the opposite. At the end, we follow a construction due to Goerner that allows to obtain explicitly a link whose complement is a specific principal congruence manifold.

Advisor: Prof. Bruno Martelli.

Reward: As a winner of the *Scolarship for Mathematics Master students* by the *Istituto Nazionale di Alta Matematica*, I had the opportunity to obtain a final prize based on the evaluation of my master thesis. I was rewarded with the maximum possible final prize.

2013/14 - 2015/16 **Bachelor Student in Pure Mathematics**, *Università di Pisa*, Pisa, Bachelor Degree in Mathematics, 110/110 cum laude, 13/05/2016.

Bachelor Dissertation: "Crescita di gruppi: un gruppo con crescita intermedia" (Group growth: a group with intermediate growth).

Dissertation Topic: The topic is the existance of a group with intermediate growth. At the beginning there are the definitions of group growth and the exposition of some of its proprieties. Then some connections with the fundamental group of Riemannian manifold are studied: the main results in this section are two Milnor's theorems that link the growth of the volume of universal cover's balls with the growth of the fundamental group of a manifold. At the end, we show a group with intermediate growth, following a Grigorchuk's example.

Advisor: Prof. Roberto Frigerio.

2008/09 - 2012/13 **High School Student**, *Classical Lyceum "Mario Pagano"*, Campobasso (CB), High School Diploma, 100/100, July 2013.

Publications

4 **SMT-Based Stability Verification of an Industrial Switched PI Control Systems**, *j.w. with S. Basagiannis, A. Becchi, A. Cimatti, G. Giantamidis, S. Mover, A. Tacchella, S. Tonetta, V. A. Tsachouridis*, 53rd Annual IEEE/IFIP International Conference on Dependable Systems and Networks, DSN Workshop VERDI, 2023.
arXiv

4 **Bounded Cohomology Classes of Exact Forms**, *j.w. with S. Francaviglia, M. Moraschini, F. Sarti, A. Savini*, Proceedings of the American Mathematical Society, 2022.
arXiv

3 **Dodecahedral L-spaces and hyperbolic 4-manifolds**, *j.w. with Leonardo Ferrari and Diego Santoro*, Accepted in Communications in Analysis and Geometry, 2022.
arXiv

2 **Infinitesimal Rigidity for Cubulated Manifolds**, Geom Dedicata 217, 33, 2023.
arXiv Journal

1 **Hyperbolic 4-manifolds with perfect circle-valued Morse functions**, *j.w. with Martelli, B.*, Transactions of the American Mathematical Society 375.04: 2597-2625, 2022.
arXiv Journal

Talks

22 November 2022 **Geometry seminars, Luxembourg**, *Hyperbolic 4-manifolds, perfect circle-valued Morse functions and infinitesimal rigidity*.

04 October 2022 **Geometry seminars, Neuchâtel**, *Dodecahedral L-spaces and Hyperbolic 4-manifolds*.

12 April 2022 **Seminario di Algebra e Geometria, Bologna**, *Hyperbolic 4-manifolds, perfect circle valued Morse functions and infinitesimal rigidity*.

01 April 2022 **TGV: Seminari di Topologia e Geometria delle Varietà, Bologna**, *Funzioni di Morse perfette a valori in S^1 su 4-varietà iperboliche, parte 2*.

25 March 2022 **TGV: Seminari di Topologia e Geometria delle Varietà, Bologna**, *Funzioni di Morse perfette a valori in S^1 su 4-varietà iperboliche, parte 1*.

16 June 2021 **Informal seminar at the Department of Mathematics, Pisa**, *Infinitesimal Deformations of Hyperbolic Manifolds*.

16 Nov 2020 **Exotic LS: informal online seminars**, *Building exotic manifolds*, with Diego Santoro.

29 Oct 2020 **GT GAPS**, *A Hyperbolic 4-Manifold with a Perfect Circle-Valued Morse Function*.

30 Sep 2020 **Seminar of Geometry group, Pisa**, *A Hyperbolic 4-manifold with a perfect circle valued Morse function*.

Organized activities

24 March 2023 **Non-positive curvature in manifolds and groups**, *Math Day funded by INdAM*.
Link

22-23 March 2023 **Manifolds and groups in Bologna**, *Workshop funded by GNSAGA (INdAM)*.
Link

Second semester 2021/2022 **TGV: Seminari di Topologia e Geometria delle Varietà**, *Department of Mathematics, Bologna*, with Stefano Francaviglia, Marco Moraschini e Stefano Riolo, We organized a weekly meeting with master students to introduce them to some research topics in differential topology.

Scholarships

2016/17 - 2017/18 **Scolarship for Mathematics Master students**, *Istituto Nazionale di Alta Matematica*.
I ranked first in the national test for this scolarship. It consisted in a written exam with several problems about Analysis, Probability, Geometry and Algebra.

2013/14 - 2015/16 **Scolarship for Mathematics students**, *Istituto Nazionale di Alta Matematica*.
I won this scolarship for academic achievement, and I succeeded in renewing it for the whole duration of my Bachelor's Degree.

Invitations

21-25/11/2022 **Research visit**, *University of Luxembourg*.
During my visit a gave a talk in the framework of the research seminars of the geometry group, and I collaborated with prof. Jean-Marc Schlenker and his research team.

03-08/10/2022 **Research visit**, *University of Neuchâtel*.
During my visit a gave a talk in the framework of the research seminars of the geometry group, and I collaborated with prof. Aleksandr Kolpakov and his research team.

Work and teaching experience

October 2021 - February 2022 **Support to teaching for the course *Differential Geometry* - Department of Physics, Pisa**.
I won a competition announcement to begin this collaboration. My job was to correct some exercises made by the students during the course and to attend the oral examinations.

February 2021 - May 2021 **Support to teaching for the course *Geometria e algebra lineare -modulo Geometria* - Department of Civil and Industrial Engineering, Pisa**.
I won a competition announcement to begin this collaboration. My job was to help in the preparation of the written exams and in the evaluation of the oral exams.

February 2019 - July 2019 **Support to teaching for the course *Principles of Geometry* - Department of Mathematics, Pisa**.
I won a competition announcement to begin this collaboration. My job was to correct some exercises made by the students during the course.

February 2018 - July 2018 **Semestral course in Arithmetic to reduce early university leaving - Department of Mathematics, Pisa**.
I won a competition announcement to begin a collaboration with the university. This was really different from my other jobs in the Department: I taught a class in collaboration with another Master student in order to help first year students who couldn't pass the Arithmetic exam in January-February. I had the chance to focus on an argument which is not too wide and to take care of a limited number of students. This experience helped me a lot in understanding the problems of teaching and gave me motivation to improve both as a student and as a teacher.

September 2017 - February 2018 **Part-time Counseling (Counseling) - Department of Mathematics, Pisa**.
I won a competition announcement to begin a collaboration with the university. My job was to conceive and write a brochure to promote the university's educational offer to high-school students. I also held a lecture where I introduced the graph theory.

June 2016 - July 2017 **Part-time Tutoring (Tutorato alla Pari) - Department of Mathematics, Pisa**.
I won a competition announcement to begin a collaboration with the university, and I succeded in renewing it for the second half of the year. My job was to tutor other students, assisting them with their queries and problems: for example, how to draft a study plan, the documents necessary to enroll in the faculty and helping (especially first-year students) with problems in mathematics.

Academic positions

31/05/2019 - 31/05/2020 **Expert on the subject for the course *Geometria e Algebra Lineare***, *Department of Mathematics, Pisa*.

28/12/2018 - 28/12/2021 **Expert on the subject for the course *Geometry and Differential Topology***, *Department of Mathematics, Pisa*.

19/06/2019 - 19/06/2021 **Expert on the subject for the course *Principles of geometry***, *Department of Mathematics, Pisa*.

Schools and Conferences

26-30/09/2022 **Conference**, *Recent Advances in Bounded Cohomology*, Regensburg.

12-16/09/2022 **Conference**, *4-Manifolds: From Above and Below*, Marseille, **Flash talk given**.

29/06-01/07/2022 **Conference**, *Geometry and Dynamics of Moduli Spaces*, Bologna.

16-20/05/2022 **Conference**, *Arithmetic Groups and 3-Manifolds*, Bonn.

13-16/12/2021 **Conference**, *Winter Braids XI*, Dijon, **Flash talk given, poster presented**.

6-11/09/2021 **Conference**, *Counting problems*, Ventotene, **Flash talk given**.

6-9/07/2021 **Conference**, *Swiss Knots 2021*, Fribourg.

31/05-4/06/2021 **Conference**, *Trisections and the Thom conjecture*, Matemale.

17-21/02/2020 **Conference**, *Winter Braids X*, Pisa.

9-14/09/2019 **Conference**, *Of coarse! Quasi-isometries and groups: rigidity and classification*, Ventotene.

24-28/06/2019 **School**, *Géométrie, topologie et arithmétique de façon hyperbolique*, Les Diablerets.

17-21/06/2019 **Conference**, *Knot concordance and low-dimensional manifolds*, Le Croisic.

6-10/05/2019 **School**, *Trisections of smooth 4-manifolds*, Matemale.

17-22/02/2019 **School**, *Geometry, Algebra and Combinatorics of Moduli Spaces and Configurations III*, Dobbiaco.

14-18/01/2019 **Conference**, *Conference on Geometric Structures in Nice*, Nice.

7-11/01/2019 **School**, *Winter School on Geometric Structures in Nice*, Nice.

28-30/11/2018 **Workshop**, *Workshop on Topology and Neuroscience*, Lausanne.
I attended this workshop during which several connections between the Topology (in particular Topological Data Analysis) and Neuroscience were presented.

11-15/06/2018 **Research school**, *3-Manifolds and Geometric Group Theory*, Marseille.
I had the chance to take part in this school during which I attended some mini-courses about 3-Manifolds, Cube Complexes, Relatively Hyperbolic Groups and Boundary of CAT(0) spaces.

Skills

Language skills

Italian	Mother tongue
English	Intermediate
French	Basic, A1

Computer skills

Python	Intermediate
Sage	Intermediate

Matlab	Intermediate
LaTeX	Intermediate
C Language	Basic