Curriculum vitae et studiorum
Maria Chiara Brambilla

Name: Maria Chiara Brambilla
Date of birth: March 28th, 1977
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Education

- July 1996: High school degree (Classics), Liceo Ginnasio "Alessandro Manzoni" of Lecco. Final marks 60/60.
- September 1996-February 2001: Undergraduate studies in Mathematics at University of Milan.
- February 2001: "Laurea" in Matemathics at University of Milan.
  Tesi di Laurea (Dissertation): "*Sul comportamento osculatorio di superfici speciali e una congettura di Piene-Tai* " ("*On the osculating behaviour of special surfaces and a conjecture of Piene-Tai* ").
  Supervisor Prof. Antonio Lanteri. Final marks: 110/110 summa cum laude.
- March 2001-September 2004: PhD studies in Mathematics at University of Florence.
- September 28, 2004: PhD degree in Mathematics at University of Florence.
  Thesis: "*Simplicity of vector bundles on $\mathbb{P}^n$ and exceptional bundles*".
  Supervisor Prof. Giorgio Ottaviani.

Grants

- July 2004- June 2007: Postdoc grant (assegnista di ricerca) in Algebraic Geometry, at "Dipartimento di Matematica e Applicazioni per l'Architettura", University of Florence.
- April-October 2005: fellowship CNR-NATO, spent in Warsaw at the Instytut Matematyki, University of Warsaw, supervisors J. Wisniewski and A. Langer.
- From January 2008: Postdoc grant (assegnista di ricerca) at "Dipartimento di Matematica Castelnuovo" , University of Rome La Sapienza.

Seminars and teaching activities

- 2001/2003: Organizer of *Informal geometry seminars*, University of Florence.
- 2002/2003: Teaching assistantship for the course Mathematical Methods, Faculty of Engineering, University of Florence.
- 2004/2005: Teaching assistantship for the course Mathematics I, Faculty of Architecture, University of Florence.
- 2004/2005: Teaching assistantship for the course Mathematics II, Faculty of Architecture, University of Florence.
- 2004/2005: Teaching assistantship for the course Geometry, Faculty of Engineering, University of Florence.
- 2006/2007: Teaching assistantship for the course Mathematics I, Faculty of Architecture, University of Florence.
- 2006/2007: Teacher of the course of Geometry, Faculty of Engineering, University of Florence.
- 2007/2008: Teaching assistantship for the course Mathematics I, Faculty of Architecture, University of Florence.
- 2007/2008: Teaching assistantship for the course Geometry, Faculty of Engineering, University of Florence.

Talks

- March 2002, Florence: "Kempf-Ness theory and stability of homogeneous bundles".
- July 2003, Cortona: "Simplicity of generic Steiner bundles".
- May 2004, Rimini: "Steiner bundles and Fibonacci numbers".
- September 2004, Levico Terme: "Simplicity of bundles on projective spaces",
- March 2004, Salamanca (Spain): "Fibonacci numbers and bundles on projective spaces".
- May 2005, Warsaw: "Steiner and Fibonacci bundles on Pn".
- October 2005, Warsaw: "Stability of vector bundles".
- February 2006, Pisa: "Steiner and Fibonacci bundles".
- October 2006, Levico Terme: "Moduli of bundles on Fano threefold of genus 7 and Brill-Noether on curves of genus 7".
- March 2007, Barcelona: "Vector bundles on Fano threefolds of genus 7 and Brill-Noether loci".
- June 2007, Istanbul (Turkey), GAEL conference, "Vector bundles on Fano threefolds of genus 7".

- September 2007, Trento: "Secant varieties and polynomial interpolation", in the workshop "The Geometry of Special Varieties".
- September 2007, Bari: "Secant spaces and polynomial interpolation" in the conference "XVIII Congresso UMI".
- December 2007, Trieste (SISSA): "Moduli of Vector Bundles and Brill-Noether loci"
- January 2008, San Diego (California): "Secant varieties and polynomial interpolation" invited speaker in the *"AMS Special Session on Secant Varieties and Related Topics"*, *Joint Mathematics Meetings.*
- January 2008, Moscow (Idaho): "Vector bundles on Fano threefolds and Brill-Nother loci", Colloquium talk at the Department of Mathematics, University of Idaho.
- February 2008, Rome: *"Fibrati senza coomologia intermedia su varieta' di Fano tridimensionali"*, Department of Mathematics, University of Roma I.
- March 2008, Barcelona: *"Moduli spaces of bundles without intermediate cohomology on anticanonical threefolds."*, workshop "Moduli spaces of vector bundles: algebro-geometric aspects".
- May 2008, *"Spazi di secanti e interpolazione polinomiale"*, Department of Mathematics, University of Roma III.
- May 2008, *"Moduli di fibrati vettoriali su Fano threefold di genere 7 e luoghi di Brill-Noether su curve di genere 7"*, Department of Mathematics, University of Milan.
- May 2008, *"Variétés de sécants et interpolation polynomiale"*, Department of Mathematics, University of Pau.

Schools and conferences

- July-August 2000, Perugia: Summer course of the "Scuola Matematica Interuniversitaria", Prof. Mercuri and Barth.
- May-June 2001 Rome: School of Computational Algebrai Geometry, Prof. Wolfram Decker.
- September 2001, Ferrara: Conference AG.a.Fe., lecturers: A. Corti, N. Shepherd-Barron, F.L. Zak.
- September 2001, Wykno (Poland): EAGER School in Algebraic Geometry, lecturers: G. Ottaviani and J. Valles.
- April 2002, Florence: Workshop "Proiezioni di varieta' proiettive, secanti, algebre di Jordan".
- May 2002, Florence: Conference in memory of Fabio Bardelli on "Algebraic Varieties".
- September 2002, Catania: "P.R.A.G.MAT.I.C. 2002", School in Algebraic Geometry, Prof. F. Zak and M. Mella.
- December 2002, Madrid: Workshop on "Global Geometry of Algebraic Varieties".

- June 2003, Trento: School in Algebraic Geometry on "Algebraic surfaces", Prof. M. Andreatta and F. Catanese.
- June-July 2003, Cortona: Summer course of the "Scuola Matematica Interuniversitaria" on "Representation theory and projective geometry", Prof. L. Manivel and J. Landsberg.
- September 2003, Torino: "School and workshop on polynomial interpolation and projective embeddings", lecturers L. Chiantini and R. Miranda.
- May 2004, Rimini: Conference "Giornate di geometria algebrica e argomenti correlati VII", invited speaker.
- June 2004. Siena: Conference "Projective varieties with unexpected properties", presented a poster on "Steiner bundles and Fibonacci numbers".
- September-October 2004, Levico Terme: "Progressi Recenti in Geometria Reale e Complessa", invited speaker.
- April-May 2005, Banach Center, Warsaw school on "Moduli spaces", lecturers J.-M. Drezet, T. Gomez, A. Schmitt, N. D. Tuan.
- June 2005, Ferrara: conference AG.a.Fe. Geometry of Algebraic Varieties.
- August 2005, Cortona: summer school on "Algebraic Geometry", lecturers Chris Peterson (Colorado State University) and Alessio Corti (Uni. Cambridge, UK).
- September 2005: Lukecin (Poland), school on "Equivariant intersection theory", lecturers Andrew Kresch (Warwick, UK) and Angelo Vistoli (Bologna);
- May 2006, Pisa: conference on "Birational Geometry of Varieties".
- September 2006, Povo (Trento): "School (and Workshop) on Vector Bundles and Low Codimensional Subvarieties", lecturers Ph. Ellia (Ferrara), R.M. Miro-Roig (Barcellona).
- April 2007, Gargnano: school on "Projective and birational geometry of algebraic varieties".
- June 2007, Levico Terme (Trento): conference Algebraic Geometry in Higher Dimensions.
- June 2007, Instanbul (Turkey): GAEL XV conference.
- September 2007, Povo (Trento): workshop "The Geometry of Special Varieties".
- September 2007, Bari: Conference "XVIII Congresso UMI".
- January 6-9, 2008, San Diego (California): *Joint Mathematics Meetings*, as invited speaker in the *"AMS Special Session on Secant Varieties and Related Topics"*, organized by Peterson (Colorado State University), Abo (University of Idaho), Geramita (Queen's University and University of Genoa).
- February 2008: school on "Moduli spaces in geometry, topology and physics" Castro Urdiales (Cantabria, Spagna) organized by Luis Alvarez-Consul (CSIC, Madrid).

Visiting positions

- May-June 2002: visiting student at the University of Madrid (Departamento de Algebra, Facultad de Ciencias Matematicas, Universidad Complutense de Madrid), supervisor Prof. E. Arrondo.
- March 2005: visit to the University of Salamanca (Spain). Invited by Beatriz Grana and Daniel Hernandez Ruiperez.
- April - October 2005: visiting student at University of Warsaw (Poland). Supervisors: Jaroslaw Wiśniewski and Adrian Langer.
- January 2008: visit to the University of Idaho. Invited by Hirotachi Abo.
- February - March 2008: visiting position for the *"Semester on Moduli Spaces"* at University of Barcelona, invited by Rosa Maria Miró-Roig and Laura Costa.
- May - June 2008: visiting position at Department of Mathematics of University of Pau (France). Invited by Daniele Faenzi.

Research interests

My research field is Algebraic Geometry. I have been working on different problems related to vector bundles on complex projective algebraic varieties, moduli spaces of semistable bundles, and classical projective geometry. More precisely my research concerns the following topics:

- **Vector bundles on complex projective spaces.** Starting from the case of *Steiner bundles*, we study bundles with given resolutions on complex projective spaces. Our main results in this framework provide criteria for simplicity and (semi)-stability. As an application we prove the semistability of some vector bundles connected to a question posed by the physicists Douglas and Zhou, in the setting of String Theory. Then we find a canonical decomposition of decomposable bundles in terms of *exceptional bundles*. These are crucial objects introduced by Drézet and Le Potier and developed in the context of derived category (Rudakov, etc.). We succeed to prove the stability of Steiner exceptional bundles on $\mathbb{P}^n$ for any $n \geq 2$, while in general the stability of exceptional bundles on $\mathbb{P}^n$ for $n \geq 4$ is an open problem. In this setting another interesting open problem is *Tyurin's conjecture* on the unicity of exceptional bundles of fixed rank on the projective plane. Moreover we define and investigate a suitable generalization of exceptional bundles, called *Fibonacci bundles*, for which we give an explicit construction in terms of mutations.
- **Geometry of moduli spaces of semistable sheaves on a projective threefold X.** We focus on the case of Fano threefolds, considered by several authors (Barth, Clemens-Griffiths, Iliev, Manivel, Markushevich, etc.). Some important tools used to study moduli spaces are the Abel-Jacobi map and Serre's correspondence between rank 2 bundles and curves contained in X. Recently, in collaboration with Daniele Faenzi, we describe some moduli spaces of rank 2 bundles in the case of smooth prime Fano threefolds. We make use of cohomological methods based on the *semiorthogonal decomposition* of the derived category of X, provided by Kuznetsov, and the corresponding integral functor. Via Kuznetsov's Homological Projective Duality, the geometry of such moduli spaces turns out to be related to the geometry of suitable moduli spaces on a dual variety of X (e.g. the Brill-Noether varieties of a curve). This duality involves homogeneous vector bundles on symmetric spaces (see Mukai's results on Fano 3-folds). Furthermore, our results allow us to complete the classification of the aCM rank 2 bundles on generic Fano threefolds.

- **Higher secant spaces to projective varieties and polynomial interpolation.** The celebrated Alexander-Hirschowitz theorem solved the classical problem of classifying all the k-defective Veronese varieties. This theorem has an interpretation in terms of Waring problem for polynomials and of *Polynomial Interpolation*. Indeed it describes the cases in which a collection of k double points in $\mathbb{P}^n$ imposes independent conditions to homogeneous polynomials of degree d. The proof of Alexander and Hirschowitz is based on zero dimensional Scheme Theory, cohomological methods, and the so-called Horace differential method. Jointly with Giorgio Ottaviani, we obtain a simplified proof in the case of cubic polynomials. This allows us to generalize the Alexander-Hirschowitz theorem, classifying all the subschemes of a general collection of double points in $\mathbb{P}^n$ which impose independent conditions to homogeneous polynomials of degree d. This field offers several interesting open problems, which in turns are strongly connected to questions in representation theory, coding theory and algebraic complexity theory.

Publications and preprints

- M.C.Brambilla, *Sul comportamento osculatorio di superfici speciali e una congettura di Piene-Tai.* Master thesis 2001, University of Milan.
- M.C.Brambilla, *Simplicity of vector bundles on $\mathbb{P}^n$ and exceptional bundles.* PhD Thesis 2004, University of Florence.
- M.C. Brambilla, *Simplicity of generic Steiner bundles.* **Boll. Unione Mat. Ital.** Sez. B, Artic. Ric. Mat.(8), vol. 8 (2005), n. 3, 723–735.
- M.C.Brambilla, *O pewnym równaniu diofantycznym (A nice diophantine equation).* Delta (journal of the University of Warsaw), 10 (2006), 10-12. Translated in Polish by Marcin Hauzer.
- M.C. Brambilla, *Cokernel bundles and Fibonacci bundles.* **Mathematische Nachrichten**, vol. 281 (2008), n. 4, 499–516.
- M.C. Brambilla, *Semistability of certain bundles on a quintic Calabi-Yau threefold.* To appear in **Revista Matematica Complutense** (ArXiV: math.AG/0509599)
- M.C. Brambilla and G. Ottaviani, *On the Alexander-Hirschowitz theorem.* **Journal of Pure and Applied Algebra**, Vol. 212 (2008), n. 5, 1229–1251.
- M.C. Brambilla and D. Faenzi, *Vector bundles on Fano threefolds of genus 7 and Brill-Noether loci.* Preprint 2007.
- M.C. Brambilla and G. Ottaviani, *On partial polynomial interpolation.* Preprint 2007. (ArXiV: math.AG/0705.4448)
- E. Ballico and M.C. Brambilla, *Postulation of general quartuple fat point schemes in $\mathbb{P}^3$.* Preprint 2008. To appear in **Journal of Pure and Applied Algebra**
- M.C. Brambilla and D. Faenzi, *Moduli spaces of rank 2 ACM bundles on prime Fano threefolds.* Preprint 2008. (ArXiV:0806.2265)
- M.C. Brambilla and D. Faenzi, *Rank 2 bundles with trivial determinant on prime Fano threefolds of genus 7.* Preprint 2008.

- M.C. Brambilla e D. Faenzi, *Rank 2 stable sheaves with odd determinant on Fano threefolds of genus 9.* Preprint 2008.
- M.C. Brambilla and D. Faenzi, *Spazi di moduli di fasci aritmeticamente Cohen-Macaulay su varietà di Fano della serie principale.* To appear in **Boll. Unione Mat. Ital.**
- M.C. Brambilla and L. Costa, *G-exceptional vector bundles on* $\mathbb{P}^2$ *and representations of quiver.* Preprint 2008.
- H. Abo e M.C. Brambilla, *Secant varieties of Segre-Veronese varieties* $\mathbb{P}^m \times \mathbb{P}^n$ *embedded by* $\mathcal{O}(1,2)$. Preprint 2008.

Other information

- 2006/2007: Cooperation with high schools in the project "Orientamento e Lauree scientifiche", University of Florence.
- Languages: Italian, English, French.