

# Lucy Liuxuan Zhang

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Toronto, ON, M5S 2B4, Canada.

**Birth Date:** November 9, 1983      **Birth Place:** Guangzhou, China

**Citizenship:** Canadian

## Education:

2007-      Ph.D. at Department of Mathematics, University of Toronto, Canada.  
2006-2007      M.Sc. at Department of Physics, University of Toronto, Canada.  
2003-2006      B.Sc. at Department of Mathematics, University of Toronto, Canada;  
Specialist program: Mathematics and Physics.  
2002-2003      B.Mus. at Department of Music, McGill University, Quebec, Canada;  
Major program: Violin Performance (withdrew after transferring to U of T).  
1999-2002      Clarkson Secondary School, Mississauga, Canada.

## Research Interests:

Primary      Topological quantum computation, topological phases, Kitaev's model;  
Modular tensor categories, topological quantum field theories, modular functors.  
Secondary      Categorification of knot invariants and quantum groups;  
Quantum error correction and fault tolerance.

## Papers:

2007      M.Sc. Project, "Fate of entanglement in surface codes";  
supervised by Dr. Robert Raussendorf and Prof. Daniel James.  
2006      Marcos Curty, Lucy-Liuxuan Zhang, Hoi-Kwong Lo, "Sequential attacks against  
differential-phase-shift quantum key distribution with weak coherent states",  
Quantum Information & Computation Vol. 7 (2007) 665-688, quant-ph/0609094.  
2005      Lucy Liuxuan Zhang and Ue-Li Pen, "Fast n-point correlation functions and  
three-point lensing application", New Astron. 10 (2005) 569-590, astro-ph/0305447.

## Academic Awards and Honours:

2011-2012      Queen Elizabeth II Graduate Scholarships in Science and Technology, \$15,000.  
2010-2011      Faculty of Arts and Science Blyth Fellowship, \$16,039.  
2007-2010      U of Toronto Fellowships (for Mathematics Ph.D.), around \$15,000.  
2007-2008      Helen Sawyer Hogg Graduate Admission Award, \$2,850.  
Fall 2007      Perimeter Institute Graduate Scholarship, \$2,293.  
2006-2007      U of Toronto Fellowships (for Physics M.Sc.), around \$21,000.  
Summer 2006      NSERC Undergraduate Student Research Award, Mathematics, \$6,000.

2005-2006 Galois OSOTF Award, \$2,000.  
 Summer 2004 NSERC Undergraduate Student Research Award, Astronomy & Astrophysics, \$8,000.  
 2002 Member of the Chair's Circle of Excellence in the Department of Computer Science, Faculty of Arts and Science, U of Toronto.  
 2001-2002 Selected participant in U of T Mentorship Program for high school students.  
 2000-2001, 2001-2002 Participated in the Physics Olympiad Preparation Programme run by the U of T, and was invited to the Invitational Weekend Training & Selection Camp both years (among top 20 in Ontario).  
 2000-2001, 2001-2002 Winner at International Mathematics Tournament of Towns at Toronto (sponsored by U of Toronto).  
 2000-2001 Canadian Open Mathematics Challenge (U of Waterloo math contest): Ontario Central Gold Medalist, top 4% nationally.  
 2000-2001 Fermat (U of Waterloo Gr. 11 math contest): top 1% nationally, invitee to Invitational Mathematics Challenge Grade 11.  
 2000-2001 Euclid (U of Waterloo Gr. 12 math contest): first place at Clarkson S. S., top 4% nationally.  
 2000-2001 Descartes (U of Waterloo OAC math contest): first place at Clarkson S. S., top 3% nationally.  
 1999-2000 AMC 12 (American Mathematics Contest 12): top 2% internationally, invitee to AIME (American Invitational Mathematics Examination).  
 1999-2000 Fermat: School Champion Medal.  
 1999-2000 Avogadro Examination (U of Waterloo Gr. 11 chemistry contest): first at Clarkson S. S., top 5% nationally.  
 1999 Municipal Environmental Protection Design Project Competition: I designed a garbage collection system for classroom use which was awarded 1st prize in the city of Guangzhou, China; my high school received a cash prize equivalent to CAD\$1000 for a trial of my design; more money was to be awarded to my school for implementation if trial was successful.

#### TA/Teaching Experiences:

2011- Private violin teaching.  
 2011-2012 Fall & Winter: TA for MAT135Y (Calculus for Life Science I).  
 Winter 2011 U of T Mentorship Program: Mentor for 3 high school students in project "Towards TQFTs: topology, categories and algebra".  
 2010-2011 Fall & Winter: TA for MAT135Y (Calculus for Life Science I);  
 Fall & Winter: Marker for MAT235Y (Calculus for Life Science II);  
 Fall: Marker for MAT237Y (Multivariable Calculus);  
 Winter: TA for MAT157Y (Analysis I).  
 Summer 2010 Full-summer: Marker and Math Aid for MAT237Y (Multivariable Calculus).  
 2009-2010 Fall & Winter: TA for MAT135Y (Calculus for Life Sciences I);  
 Fall & Winter: Marker for MAT237Y (Multivariable Calculus).  
 2008-2009 Fall & Winter: TA for MAT135Y (Calculus for Life Science I);  
 Fall: Marker for MAT301F (Groups and Symmetries).  
 Winter 2009 Grad Talk series, Perimeter Institute: I gave a "Mini-course on Quantum Groups"

(consisting of a series of 9 one-hour lectures; for course information, see [http://www.math.toronto.edu/lzhang/Teaching/quantum\\_groups2009W.html](http://www.math.toronto.edu/lzhang/Teaching/quantum_groups2009W.html)).

2007-2008 Winter: TA for MAT185S (Linear Algebra for Engineering Science I).  
 2006-2007 Fall & Winter: TA for PHY138Y (Physics for the Life Sciences I).  
 2000-2002 Private math tutoring.

### Research Positions and Projects:

2008- Ph.D. advisor: Prof. Joel Kamnitzer, Mathematics, U of Toronto.  
 2007-2008 Ph.D. co-advisor: Prof. Joe Repka, Mathematics, U of Toronto.  
 Fall 2007 Ph.D. co-advisor: Prof. Daniel Gottesman, Perimeter Institute, Waterloo.  
 2006-2007 Master advisor: Prof. Daniel James, Physics, U of Toronto.  
 a) Undergraduate research course PHY479Y: theory of cluster-state quantum computation and trapped ion implementation;  
 b) Master: theory of fault-tolerant cluster-state quantum computation (in collaboration with Dr. Robert Raussendorf).  
 Summer 2006 Supervised by Prof. Joe Repka, Mathematics, U of Toronto.  
 NSERC USRA 2006 (paid): representation of the symmetric groups.  
 Fall 2005 Supervised by Prof. Hoi-Kwong Lo, Physics & ECE, U of Toronto.  
 Undergraduate research course PHY478H: security of differential-phase-shift quantum key distribution.  
 2003-2005 Supervised by Prof. Chris Matzner, Astronomy and Astrophysics, U of Toronto.  
 a) Summer student 2003: developed efficient compressible isothermal MHD code to study turbulence in molecular clouds;  
 b) Research assistant under the U of T Work-Study Program 2003-04 (paid): developed Message-Passing-Interface version of the code to simultaneously utilize 540 CPUs;  
 c) NSERC USRA 2004 (paid): analyzed energetics and power spectra of high-Mach number astrophysical turbulence, studied implications on star formation rate; learnt about astrophysical dynamo;  
 d) Informal 2004-05: computed decomposed power spectra to understand the nature of turbulence and transitions between modes; studied the theory of MHD turbulence.  
 2001-2002 Supervised by Prof. Ue-Li Pen, CITA, U of Toronto.  
 a) U of T Mentorship Program for high school students: data analysis for gravitational lensing;  
 b) Summer research assistant 2002 (paid): wrote fast library subroutines for  $N$ -body simulations using Intel assembly language.  
 Spring 2002 High School Co-op program: microscopy lab assistant;  
 Xerox Research Centre of Canada, Mississauga.

### Talks:

Aug. 1, 2011 JCHS 2011: Categories, Geometry and Physics, Universidad Sergio Arboleda (Colombia):  
 “Kitaev’s quantum double models as extended topological quantum field theories”.  
 Jul. 20, 2011 Women in Physics Canada, Perimeter Institute:  
 “Mathematics and Topological Quantum Computation”.  
 Jun. 17, 2011 8th Canadian Student Conference on Quantum Information, Quebec:

“Kitaev’s quantum double models and (2+1)-dimensional extended topological quantum field theories”.  
 Apr. 22, 2011 Institute for Quantum Information, Caltech:  
 Introductory talk on “(2+1)D extended TQFTs and doubled topological phases”.  
 Apr. 6, 2011 Math Graduate Student Seminar, U of Toronto:  
 “Kitaev’s quantum double model for topological quantum computation: representations, higher categories and extended TQFTs”.  
 Mar. 31, 2011 Khovanov-Lauda Categorification Learning Seminar, U of Toronto:  
 “Quantum groups and the Grothendieck ring of  $\mathbb{R}$ ”.  
 Oct. 6, 2010 Bakalov-Kirillov Learning Seminar, U of Toronto:  
 “Modular Tensor Categories and Quantum Double of a Finite Group”.  
 Jun. 7, 2010 Quantum Information group meeting, Perimeter Institute:  
 “Ribbon operators in 2D lattice anyon models”.  
 Jun. 11, 2009 Quantum Groups and Representations Learning Seminar, U of Toronto:  
 “Existence and uniqueness of universal enveloping algebras for semisimple Lie algebras using cohomology arguments”.  
 Jan. 21, 2009 Math Graduate Student Seminar, U of Toronto:  
 “Introduction to quantum groups”.  
 Oct. 26, 2008 2nd Pure and Applied Mathematics Graduate Student Conference, McMaster U:  
 “Hopf algebras and quantum computation”.  
 Jun. 23, 2008 Quantum Information group meeting, Perimeter Institute:  
 “Colour codes”.  
 Jun. 17, 2008 Math Graduate Student Seminar, U of Toronto:  
 “Introduction to topological quantum computation”.  
 Nov. 2007 Prof. Daniel James’ group meeting, Dept. of Physics, U of Toronto:  
 “Introduction to stabilizer formalism”.  
 Oct. 9, 2007 Math group meeting, Institute for Quantum Computing, Waterloo:  
 “Minimum-weight perfect matching in surface code recovery”.  
 Sep. 8, 2007 Perimeter Institute’s Budding Minds Conference:  
 “Learning about topological quantum memory” (Version II).  
 Jun. 4, 2007 4th Canadian Quantum Information Students’ Conference, Perimeter Institute:  
 “Learning about topological quantum memory”.  
 Mar. 2007 Institute for Quantum Optics and Quantum Information, Innsbruck:  
 “Fault-tolerant cluster-state quantum computation”.  
 Mar. 2007 Quantum Optics group meeting, U of Toronto:  
 “Introduction to cluster-state quantum computation”.  
 Dec. 11, 2006 Quantum Computation and Quantum Information (the book by Nielsen and Chuang) Learning Seminar, U of Toronto:  
 “On measurements”.  
 Jul. 2006 Canadian Undergraduate Mathematics Conference 2006, McGill U:  
 “Attacking a new quantum communication protocol”.  
 Oct. 2005 Canadian Undergraduate Physics Conference 2005, U of Western Ontario:  
 “USD Attack on Differential Phase Shift QKD”.  
 Mar. 2004 Toronto Astrophysical Gas Dynamics Group meeting, U of Toronto:  
 “MHD turbulence: direct simulations”.

- Mar. 2004 University of Toronto Undergraduate Math Seminar:  
“Physics & Astrophysics of Magnetohydrodynamical Turbulence”.
- Nov. 2003 Canadian Undergraduate Physics Conference 2003, McGill U:  
“Compressible magnetohydrodynamic turbulence in molecular clouds”.
- Aug. 2003 National Astronomical Observatories of China, Beijing, China:  
“Fast n-point correlation functions and the application of three-point  
function on weak lensing”.
- Jul. 2003 Canadian Undergraduate Mathematics Conference 2003, York U:  
“Fast n-point correlation functions”.

**Posters:**

- Jan. 2011 QIP 2011 (14th Workshop on Quantum Information Processing), Singapore:  
“Twists arising from group automorphisms in the Kitaev model”.
- Aug. 2005 International Conference on The Origin and Evolution of Cosmic Magnetism,  
Bologna, Italy:  
“Simulations of MHD Turbulence in ISM”.
- Aug. 2005 Open Questions in Cosmology: the First Billion Years, Garching, Germany:  
“Fast Three-point Correlation Function Algorithm for Weak Lensing”.
- Aug. 2004 International Conference on Cosmic Rays and Magnetic Fields in Large  
Scale Structure, Busan, Korea:  
“Compressible Magnetohydrodynamic Turbulence in Molecular Clouds”.
- Jun. 2003 Canadian Astronomical Society Annual Meeting 2003, U of Waterloo:  
“Fast n-point correlation functions and three-point lensing application”.
- Jun. 2002 University of Toronto Mentorship Program poster session:  
“Study of weak gravitational lensing effect”.

**Contributions to Academic Community:**

- Summer 2011- Founder and organizer of the Women-in-Math Seminar series at U of T.
- Aug. 16, 2011 Invited speaker at the Classroom Adventures in Mathematics Summer Institute, Toronto:  
“Challenges faced by young women in mathematics and how teachers can help”.
- Winter 2011 Volunteer mentor for U of T Mentorship Program.
- 2010-11 Secretary and Social Committee member of the Math Graduate Students  
Association at U of T; supporting fellow student organizers and fought hard  
on student issues.
- Oct. 2009 Volunteer presenter for Quantum to Cosmos Festival, Perimeter Institute, Waterloo.
- 2008-09 President, Social Committee, Departmental Council and Graduate Planning  
Committee member of the Math Graduate Students Association at U of T.
- 2007-08 Vice President and Secretary of the Math Graduate Students Association.
- 2005-07 Involvement in local practices for the Association for Computing Machinery  
International Collegiate Programming Contest.
- 2005-06 VP Social of the (Undergraduate) Math Union at U of T.
- 2001-03 Organized reunions for POPTOR alumni.
- 2001-02 Minister of Finance for the Peel Region Student Presidents’ Council.
- 2000-01 Executive of the Student Activities Council at Clarkson Secondary School.

### **Hobbies Past and Present:**

Artistic	Violin, voice, ballet.
Intellectual	Languages, bridge, chess, programming.
Relaxation	Horse riding, swimming, juggling, yoga.

### **Selected musical deeds (A bit out of date):**

#### **VOICE**

2008-10, 11- Aug. 6, 2010	Studied voice with Inna Golsband. (Previous teachers not listed.) Performed Cherubino's aria "Non so piu cosa son" from Mozart's Marriage of Figaro, as part of Atelier Ballet Summer Program.
2009-10	Chorus member of Opera Kitchener: productions include Mozart's Marriage of Figaro and Pucini's Madama Butterfly.
Jul. 31, 2008	Performed the role of Catherine in Offenbach's operetta Le Mariage aux Lanternes, with the Royal Conservatory of Music Opera Scene Study Program.
Jul. 5, 2008	Performed the role of Amore in Gluck's opera Orfeo e Euridice, with Opera by Request.
Feb. 2008	Intermediate Voice Trophy Finalist at Kiwanis Music Festival of Greater Toronto.
Jul. 20, 2007	Received full scholarship to sing in the Atelier Ballet Summer Program production of Handel's Fairy Queen.
Jan. 27, 2007	Performed the role of Hero in excerpts from Berlioz's opera Beatrice et Benedict, with the Royal Conservatory of Music Opera Scene Study Program, supported by the Morris Katz Opera Scene Study Bursary.

#### **VIOLIN**

2000-02, 03, 06, 09- 2010-2011	Studied violin with Alec Hou. (Other teachers not listed.) Member of the Mississauga Symphony Orchestra.
2003-04, 05-07, 09-11	Member of the Hart House Orchestra.
Dec. 2 2009	Delivered voice-violin recital at the Hart House Midday Mosaic Series, U of T.
May 2007	1st in class for String Quartets at Toronto Music Festival.
2002	Member of the McGill Symphony Orchestra.
2002	a) 1st in class for String Quartet (Age 18 & Under) at the Greater Toronto; Kiwanis Music Festival b) 1st in class for String Quartet (any age) at Peel Music Festival, winning the Hilda Kirton Memorial Scholarship; c) 2nd in class for Concerto for Violin and Orchestra (Open) at Peel Music Festival.
2001	Senior scholarship recipient at Mississauga Music Festival (for solo violin).
Summer 2001	Member of the National Youth Orchestra of Canada, selected based on highly competitive national auditions.
2000-02	Concertmaster of Mississauga Youth Orchestra.
1998	Gr. 9 Violin (Guangzhou, China).

#### **BALLET**

2009-2011	Studied ballet at the Contemporary School of Dance, Waterloo.
Winter 07	Studied ballet at the School of Atelier Ballet, Toronto.
Summer & Fall 2006	Studied ballet at the National Ballet School, Adult Ballet Program.
Summer 04, Winter 06	Studied ballet at Hart House, U of Toronto.

#### **MUSIC THEORY**

May 2010 RCM Exam: Advanced Rudiments 99%, First Class Honours with Distinction.  
Dec. 2010 RCM Exam: Basic Harmony 88%, First Class Honours.

**Progress on bridge:**

2010 Obtained the title of Junior Master from American Contract Bridge League.

**Language Proficiencies:**

Fluent English, Mandarin and Cantonese.  
Intermediate Italian, German, French.  
Basic Spanish.