

VITA¹

Domenico D'Alessandro

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Professional Experience

August 2009-Today, Professor, Department of Mathematics, Iowa State University.

August 2004-August 2009, Associate Professor, Department of Mathematics, Iowa State University.

August 1999-August 2004, Assistant Professor, Department of Mathematics, Iowa State University.

September 1996-June 1999, Ph.D. Student and Research Assistant or Teaching Assistant, Department of Mechanical and Environmental Engineering, University of California, Santa Barbara.

Education

(1991) "Laurea in Ingegneria Elettronica" (5-years undergraduate program in Electrical Engineering) Università degli Studi di Roma "La Sapienza", Italy, (Grade: 110/110 magna cum laudem).

(1996) Ph.D. in Electrical Engineering, Università degli Studi di Padova, Italy; Graduate Advisor: Prof. Michele Pavon.

(1999) Ph.D. in Mechanical Engineering, University of California at Santa Barbara; Graduate Advisor: Prof. Mohammed Dahleh.

Citizenship:

Italy, United States of America.

Languages: Italian (mother tongue), English (fluent), working knowledge of Spanish.

Research interests

- Mathematical Physics.
- Systems and Control Theory.
- Quantum Theory and Quantum Information.
- Differential Geometry and Lie Groups
- Application of Control Theory to Bio-Medical Science

¹Updated on October, 2020

Honors and Awards

- *Iowa State University Foundation Award for Early Achievement in Research* (2004).
- *National Science Foundation CAREER Award* (2003).
- *George S. Axelby Outstanding Paper Award* of the IEEE Control Systems Society, (year 2000), for work on control and quantification of mixing using entropy.²
- *Education Abroad Program (EAP) Scholarship*, University of Padova-University of California, 1995.

Grants

[1] National Science Foundation, Individual Research Grant, Principal Investigator, “Geometric Analysis and Optimal Control of Quantum Systems in the KP Configuration; Generalizations to Nonlinear Systems with Symmetries”, (292,004 Dollars for three years (August 2017-July 2020), extended through July 2021).

[2] Foreign Travel Grant, Iowa State University 1,185 Dollars (Summer 2015).

[3] Department of Defense, MURI Research Grant, ‘Control of Quantum Open Systems: Theory and Experiments’, Collaborative Proposal with University of Southern California, Princeton University, University of California Riverside, University of Massachusetts Boston, Griffith University Australia, 3+2 years proposal, October 2011-November 2016, (Originally awarded total budget for Iowa State 429,844 dollars)

[4] National Science Foundation, Individual Research Grant, Principal Investigator, “Control Theory for Quantum Walks on Graphs and its Applications to Quantum Algorithms”, (246,109 Dollars). Three years grant (extended by two more years). Starting date, 8/15/2008, expired 7/31/2013.

[5] National Science Foundation *CAREER* Grant, 2003, Individual Research Grant, Principal Investigator, “A Methodology for Control of Finite Dimensional Quantum Mechanical Systems”. (400,000 Dollars, Expired March 2009)

[6] Iowa State University, Seed Grant for Nanotechnology-Related Research, “Analysis and Control of Quantum Dynamics: A Magnetic Force Microscopy Study of Magnetic Molecular Nanomagnets at low Temperature”, together with F. Borsa and L. Miller (Department of Physics) and M. Salapaka (Department of Electrical Engineering), (29,000 Dollars).

[7] Iowa State University, Faculty Development Grant, Individual Research Grant, Principal Investigator, “System Theoretic Analysis and Control of Quantum Mechanical Systems with Applications to Quantum Computing”, 1999, (7,500 Dollars)

²D. D’Alessandro, M. Dahleh and I. Mezić, Control of mixing in fluid flow: A maximum entropy approach, *IEEE Trans. on Automatic Control*, (1999) Vol. 44. No. 10, pp. 1852-1863.

Publications

Book

[1] D. D'Alessandro, *Introduction to Quantum Control and Dynamics*, CRC Press, Boca Raton FL, August 2007.

Ph.D. Thesis

[1] D. D'Alessandro, Optimal control techniques with applications (Tecniche di controllo ottimo e loro applicazioni), Ph.D. Thesis, Department of Electrical Engineering, Universita' degli Studi di Padova, Italy, 1996 (in Italian).

[2] D. D'Alessandro, Ergodic Theory and the Control of Mixing in Fluid Flows, Ph. D. Thesis, Department of Mechanical and Environmental Engineering, University of California at Santa Barbara, 1999 (Available at <http://www.public.iastate.edu/~daless/>).

Book Chapters

[1] F. Albertini and D. D'Alessandro, Remarks on the observability of nonlinear discrete time systems, *System Modeling and Optimization (Prague 1995)*, J. Dolezal & al. eds. 155-162, Chapman & Hall, London, 1996.

[2] D. D'Alessandro and M. Dahleh, Geometric control of quantum mechanical systems, in *Lagrangian and Hamiltonian Methods for Nonlinear Control 2000, (IFAC workshop)*, N.E. Leonard and R. Ortega, eds. 45-49 Pergamon Press, 2000.

[3] D. D'Alessandro, Directions in the theory of quantum control, in *Multidisciplinary Research in Control: The Mohammed Dahleh Legacy* (Santa Barbara CA 2002) 72-80, L. Giarre' and B. Bamieh eds., *Lecture Notes in Control and Information Sciences* 289, Springer Verlag, Berlin, 2003.

[4] D. D'Alessandro and M. Dahleh, Optimal control of two-level quantum systems, Russian translation of journal paper³, in the volume "Control of Molecular and Quantum Systems" (in Russian: "Upravlenie molekulyarnymi i kvantovymi sistemami"), Ed. A. L. Fradkov, O. A. Yakubovskii, Translated by I. A. Makarov, Moscow-Izhevsk, Institute for Computer Studies, 2003, pp. 245-276.

Journal Papers

[1] D. D'Alessandro, B. Sheller and Z. Zhu, Time-optimal control of quantum Lambda systems in the KP configuration, *Journal of Mathematical Physics*, 61, 052107 (2020) .

[2] D. D'Alessandro and J. Hartwig, Dynamical Decomposition of Bilinear Control Systems subject to Symmetries, *Journal of Dynamical and Control Systems* (2020).

[3] F. Albertini, D. D'Alessandro and B. Sheller, Sub-Riemannian geodesics on $SU(n)/S(U(n-1) \times U(1))$ and optimal control of three level quantum systems, *IEEE Transactions on Automatic Control*, **65**, Vol. 3, 1176-1191 (2020).

³D. D'Alessandro and M. Dahleh, Optimal control of two-level quantum systems, *IEEE Transactions on Automatic Control*, Vol. 46, June 2001, no. 6, pg. 866-876.

- [4] F. Albertini and D. D'Alessandro, Subspace controllability of bipartite symmetric spin networks, *Linear Algebra Appl.* 585 (2020), 1-23. Corrigendum in *Linear Algebra Appl* Volume 603, 15 October 2020, Pages 508-510.
- [5] D. D'Alessandro and B. Sheller, Algorithms for Quantum Control without Discontinuities; Application to the Simultaneous Control of two Qubits, *J. Math. Phys.* 60 (2019), no. 9, 092101
- [6] Y. Ji, J. Bian, M. Jiang, D. D'Alessandro and X. Peng, Time-optimal control of independent spin-1/2 systems under simultaneous control, *Physical Review A* 98, 062108 December 2018.
- [7] F. Albertini and D. D'Alessandro, Controllability of Symmetric Spin Networks, *Journal of Mathematical Physics*, 59, 052102, (2018)
- [8] F. Albertini and D. D'Alessandro, The $K - P$ problem on tensor products of Lie groups and time-optimal control of n quantum bits with a bounded field, *IEEE Transactions on Automatic Control*, Vol 63, No. 2, February 2018, pp. 518-524.
- [9] F. Albertini and D. D'Alessandro, On symmetries in time optimal control, sub-Riemannian geometries and the $K - P$ problem, *J. Dyn. Control Syst.* 24 (2018), no. 1, pp. 13-38
- [10] R. Romano and D. D'Alessandro, Minimum time control of a pair of two-level quantum systems with opposite drifts, *Journal of Physics A, Mathematical and Theoretical*, Volume 49, No. 34, (2016).
- [11] F. Albertini and D. D'Alessandro, Time optimal simultaneous control of two level quantum systems, *Automatica*, Volume 74, December 2016, Pages 55-62
- [12] D. D'Alessandro, F. Albertini and R. Romano, Exact algebraic conditions for indirect controllability in quantum coherent feedback schemes, *SIAM J. Control Optim.* 53-3 (2015), pp. 1509-1542.
- [13] B. Sheller and D.D'Alessandro, Analysis of a Cancer Dormancy Model and Control of Immunotherapy, *Mathematical Biosciences and Engineering*, Vol. 12 No. 5, 1037-1053, (2015).
- [14] F. Albertini and D. D'Alessandro, Minimum Time Optimal Synthesis for a Control System on $SU(2)$, *Journal of Mathematical Physics* 56, 012106 (2015);
- [15] F. Albertini and D. D'Alessandro, Time-optimal control of a two level quantum system via interaction with an auxiliary system, *IEEE Transactions on Automatic Control*, Vol. 59, No. 11, pg. 3026-3032, Nov. 2014.
- [16] D. Burgarth, D. D'Alessandro, L.Hogben, S. Severini and M. Young, Zero forcing, linear and quantum controllability for systems evolving on networks, *IEEE Transactions on Automatic Control*, Vol. 58, No. 9, September 2013.
- [17] D. D'Alessandro, Equivalence between indirect controllability and complete controllability for quantum systems, *Systems & Control Letters* 62 (2013) 188-193.
- [18] F. Albertini and D. D'Alessandro, Control of a two level quantum system in a coherent feedback scheme, *Journal of Physics A, Mathematical and Theoretical*, 2013 46 045301, 2013.

- [19] D. D'Alessandro and S. Simsek, Controllability of System Dynamics on Networks, Quantum Walks and Random Walks, *Automatica* 49 (2013), pp. 1358-1364
- [20] F. Albertini and D. D'Alessandro, Controllability of quantum walks on graphs, *Mathematics of Control Signals and Systems*, Volume 24, Number 3 (2012), 321-349.
- [21] D. D'Alessandro and R. Romano, Indirect Controllability of Quantum Systems; A Study of two Interacting Quantum Bits, *IEEE Transactions on Automatic Control*, Vol. 57, No. 8, August 2012, pp. 2009-2020.
- [22] D. D'Alessandro and R. Romano, A method for exact simulation of quantum dynamics, *Journal of Physics A: Mathematical and Theoretical*, **45**, 025308, (2012).
- [23] D. D'Alessandro, Connection between continuous and discrete time quantum walks; From d dimensional lattices to general graphs, *Reports on Mathematical Physics*. Vol. 66. pp. 85-102, (2010).
- [24] D. D'Alessandro, Constructive decomposition of the controllability Lie algebra for Quantum systems, *IEEE Transactions on Automatic Control* June 2010, 1416-1421.
- [25] F. Albertini and D. D'Alessandro, Analysis of quantum walks with time-varying coins on d -dimensional lattices, *Journal of Mathematical Physics*, **50**, 122106 (2009).
- [26] D. D'Alessandro, General methods to control right-invariant systems on compact Lie groups and multilevel quantum systems, 2009 *J. Phys. A: Math. Theor.* **42**, 395301.
- [27] L. Cattaneo and D. D'Alessandro, Generalized concurrences do not provide necessary and sufficient conditions for entanglement detection, *Quantum Information and Computation*, Vol. 9, No. 1 and 2, pp. 0166-0180, (2009)
- [28] F. Albertini and D. D'Alessandro, Input-Output model equivalence of spin systems; A characterization using Lie algebra homomorphisms, *SIAM Journal on Control and Optimization*, Volume 47, Issue 4, pp. 2016-2043 (2008).
- [29] M. D'Agli, D. D'Alessandro and J. Smith, A general framework for recursive decompositions of unitary quantum evolutions, *Journal of Physics A, Mathematical and Theoretical*, **41**, 2008, 155302.
- [30] D. D'Alessandro, G. Parlangeli and F. Albertini, Nonstationary quantum walks on the cycle, *J. Phys. A Math. Theor.* (2007) **40**, 14447-14455.
- [31] D. D'Alessandro and F. Albertini, Quantum symmetries and Cartan decompositions in arbitrary dimensions, *J. Phys. A Math. Theor.* 40 (2007), no. 10, 2439-2453.
- [32] D. D'Alessandro and R. Romano, Decomposition of Unitary Evolutions and entanglement dynamics of bipartite quantum systems, *Journal of Mathematical Physics* 47 082109 (2006)
- [33] R. Romano and D. D'Alessandro, Environment-mediated control of a quantum system, *Physical Review Letters*, 97, 080402 (2006).

- [34] G. Giedke, J. M. Taylor, D. D'Alessandro, M. D. Lukin, A. Imamoglu, Quantum measurement of the nuclear spin polarization in quantum dots, *Physical Review A*, 74 032316 (2006) quant-ph/0508144.
- [35] D. D'Alessandro and R. Romano, Further results on the observability of quantum systems under general measurement, *Quantum Information Processing*, Vol. 5, No. 3. (June 2006), pp. 139-160.
- [36] R. Romano and D. D'Alessandro, Incoherent control and entanglement for two-dimensional coupled systems, also xxx.lanl.gov, quant-ph/0510020, *Physical Review A* 73 022323 (2006).
- [37] D. D'Alessandro, Controllability, observability and parameter identification for two coupled spin 1's, *IEEE Transactions on Automatic Control*, Vol. 50, No. 7, July 2005.
- [38] F. Albertini and D. D'Alessandro, Input-Output equivalence of spin networks under multiple measurements, *Mathematics of Control, Signals and Systems*, Vol. 17, No. 1, Pages 1-13, 2005.
- [39] F. Albertini and D. D'Alessandro, Control of the evolution of Heisenberg spin systems, *European Journal of Control*, Special issue on Lagrangian and Hamiltonian Methods for Nonlinear Control, January 2005.
- [40] F. Albertini and D. D'Alessandro, Model identification for spin networks, *Linear Algebra and its Applications*, 394, (2005), 237-256.
- [41] D. D'Alessandro, Optimal evaluation of generalized Euler angles with applications to control, *Automatica*, 40 (2004) 1997-2002.
- [42] D. D'Alessandro, On quantum state observability and measurement, *Journal of Physics A: Mathematical and General* 36 (2003) 9721-9735
- [43] F. Albertini and D. D'Alessandro, Notions of controllability for multilevel bilinear quantum mechanical systems, *IEEE Transactions on Automatic Control*, Vol. 48, No. 8 (2003), pg. 1399-1403.
- [44] D. D'Alessandro, Controllability of one spin and two interacting spins, *Mathematics of Control, Signals and Systems*, (2003) 16:1-25.
- [45] F. Albertini and D. D'Alessandro, Observability and forward-backward observability of discrete time nonlinear systems, *Mathematics of Control, Signals and Systems*, Vol. 15 (2002), pg. 275-290.
- [46] D. D'Alessandro, Uniform finite generation of compact Lie groups, *Systems and Control Letters* 47 (2002) 87-90.
- [47] F. Albertini and D. D'Alessandro, The Lie algebra structure and controllability of spin systems, *Linear Algebra and its Applications*. Volume 350, Issues 1-3, 15 July 2002, Pages 213-235.
- [48] D. D'Alessandro, The optimal control problem on $SO(4)$ and its applications to quantum control, *IEEE Transactions on Automatic Control*, Vol. 47, No. 1. January 2002.
- [49] D. D'Alessandro, I. Mezić and M. Dahleh, Statistical properties of controlled fluid flows with applications to control of mixing, *Systems and Control Letters*, 45 (2002), 249-256.
- [50] D. D'Alessandro, Small time controllability of systems on compact Lie groups and spin angular momentum, *Journal of Mathematical Physics*, Vol.42, No. 9, 4488-4496, September 2001.

- [51] D. D'Alessandro and M. Dahleh, Optimal control of two-level quantum systems, *IEEE Transactions on Automatic Control*, Vol. 46, June 2001, no. 6, pg. 866-876.
- [52] D. D'Alessandro, Topological properties of reachable sets and the control of quantum bits, *Systems and Control Letters*, **41** (2000), pg. 213-221.
- [53] F. Albertini, D. D'Alessandro and A. D. B. Paice, Further conditions on the stability of continuous time systems with saturation, *IEEE Trans. on Circuits and Systems I, Fundamental Theory and Applications*, (2000) Vol. 47. No. 10, pp. 723-729.
- [54] D. D'Alessandro, M. Dahleh and I. Mezić, Control of mixing in fluid flow: A maximum entropy approach, *IEEE Trans. on Automatic Control*, (1999) Vol. 44. No. 10, pp. 1852-1863.
- [55] D. D'Alessandro, Invariant manifolds and projective combinations of solutions of the Riccati differential equations, *Linear Algebra and Its Applications*, 279 (1998) no. 1-3, 181-193.
- [56] A. Beghi and D. D'Alessandro, Discrete time optimal control with control-dependent noise and generalized Riccati difference equations, *Automatica*, 34 (1998), no. 8, 1031-4.
- [57] D. D'Alessandro, A superposition theorem for solutions of the Riccati difference equation, *Journal of Mathematical Systems Estimation and Control*, 8 (1998), no. 1.
- [58] D. D'Alessandro, A parametrization of the nonnegative definite solutions of the algebraic Riccati equation, *Automatica*, 34 (1998), no. 3, 385-388.
- [59] D. D'Alessandro, Geometric aspects of the Riccati difference equation in the nonsymmetric case, *Linear Algebra Appl.*, 255 (1997), 1-18.
- [60] M. Pavon and D. D'Alessandro, Families of solutions of matrix Riccati differential equations, *SIAM J. Control Optim.*, 35 (1997), no. 1, 194-204.
- [61] D. D'Alessandro and A. Ferrante, Optimal steering for an extended class of nonholonomic systems using Lagrange functionals, *Automatica*, 33 (1997), no. 9, 1635-1646.
- [62] F. Albertini and D. D'Alessandro, Asymptotic stability of continuous-time systems with saturation nonlinearities, *Systems Control Lett.*, 29 (1996), no. 3, 175-180.
- [63] D. D'Alessandro, On passivity and adaptive stabilization of nonlinear systems, *IEEE Trans. Automat. Control*, 41 (1996), no. 7, 1083-1086.

Refereed Conference Papers

- [1] F. Albertini and D. D'Alessandro, Subspace controllability of quantum Ising spin networks with a central spin, in *Proceedings European Control Conference*, 2019.
- [2] D. D'Alessandro and B. Sheller, On K-P sub-Riemannian problems and their cut locus, in *Proceedings European Control Conference*, 2019.
- [3] F. Albertini and D. D'Alessandro, The minimum time function for a control system on $SU(2)$, in the proceedings of the International Symposium on *Mathematical Theory of Networks and Systems*, Minneapolis, July 2016.

- [4] D. D'Alessandro, E. Jonckheere and R. Romano, Control of open quantum systems in a bosonic bath, in the *Proceedings of the 54-th Conference on Decision and Control*, Osaka, Japan, Dec. 2015.
- [5] D. D'Alessandro, E. Jonckheere and R. Romano, On the Control of Open Quantum Systems in the Weak Coupling Limit, in *Proceedings of Mathematical Theory of Networks and Systems (2014)*, pages 1677-1684.
- [6] F. Albertini and D. D'Alessandro, Algebraic Conditions for Indirect Controllability in Quantum Coherent Feedback Schemes, in *Proceedings of the European Control Conference 2013*
- [7] D. D'Alessandro and R. Romano, Indirect Controllability and Indirect Observability of Quantum Mechanical Systems, in *Proceedings Conference on Decision and Control 2012*.
- [8] F. Albertini and D. D'Alessandro, Methods of Control Theory for the Analysis of Quantum Walks on Graphs, Proceedings of the 19th International Symposium on Mathematical Theory of Networks and Systems MTNS 2010 5-9 July, 2010 Budapest, Hungary, pp. 2035-2038.
- [9] M. Dagli and D. D'Alessandro, Recursive decompositions of quantum dynamics, in *Proceedings of conference on Mathematical Theory of Networks and Systems*, MTNS, 2008.
- [10] F. Albertini and D. D'Alessandro, Lagrangian Formulation and Geometric Control of Switching LC Electrical Networks, in *Proceedings of the 45-th conference on Decision and Control*, San Diego CA, Dec. 2006.
- [11] D. D'Alessandro and R. Romano, Decompositions of unitary evolutions and entanglement dynamics of bipartite quantum systems, in *Proceedings of the 45-th conference on Decision and Control*, San Diego CA, Dec. 2006.
- [12] R. Romano and D. D'Alessandro, Incoherent controllability and entanglement of quantum systems, in the *Proceedings of the 45-th conference on Decision and Control*, San Diego CA, Dec. 2006.
- [13] D. D'Alessandro and R. Romano, Further results on the observability of quantum mechanical systems under general measurement, in *Proceedings of the 44-th Conference on Decision and Control*, Seville, Spain, Dec. 2005.
- [14] D. D'Alessandro, On the observability and state determination of quantum mechanical systems, in *Proceedings of the 43-rd Conference on Decision and Control*, Paradise Island, Bahamas, Dec. 2004.
- [15] U. G. Vaidya, D. D'Alessandro and I. Mezić, Control of Heisenberg spin systems; Lie algebraic decompositions and action-angle variables. in *Proceedings of the 42-nd Conference on Decision and Control*, Maui, Hawaii, Dec. 2003.
- [16] F. Albertini and D. D'Alessandro, Observability, measurement and parameter identification of quantum mechanical systems, in *Proceedings of the 42-nd Conference on Decision and Control*, Maui, Hawaii, Dec. 2003.
- [17] D. D'Alessandro and V. Dobrovitski, Control of a two level open quantum system, *Proceedings 41st Conference on Decision and Control*, Las Vegas, Nevada, Dec.2002.
- [18] D. D'Alessandro, Contributions of control theory to fundamental quantum mechanics and its applications, *Proceedings 41-st Conference on Decision and Control*, Las Vegas, Nevada, Dec.2002.

- [19] F. Borsa, D. D'Alessandro, L. Miller and M. Salapaka, Quantum control of molecular magnets using atomic force microscopy, *Proceedings 40 – th Conference on Decision and Control*, Orlando, FL, Dec. 2001.
- [20] F. Albertini and D. D'Alessandro, Notions of controllability for quantum mechanical systems, *Proceedings 40 – th Conference on Decision and Control*, Orlando, FL, Dec. 2001.
- [21] F. Albertini and D. D'Alessandro, The Lie algebra structure of spin systems and their controllability properties, in *Proceedings 40 – th Conference on Decision and Control*, Orlando, FL, Dec. 2001.
- [22] D. D'Alessandro, Constructive controllability of one and two spin $\frac{1}{2}$ particles, in *Proceedings 2001 American Control Conference*, Arlington, Virginia, June 2001.
- [23] D. D'Alessandro, On the controllability of systems on compact Lie groups and quantum mechanical systems, in *Proceedings 39-th Conference on Decision and Control*, Sydney, Australia, Dec. 2000.
- [24] D. D'Alessandro, Algorithms for quantum control based on decompositions of Lie groups, in *Proceedings 39-th Conference on Decision and Control*, Sydney, Australia, Dec. 2000.
- [25] D. D'Alessandro and M. Dahleh, Optimal control of two-level quantum systems, *Proceedings American Control Conference*, Chicago, IL, June 2000.
- [26] D. D'Alessandro, I. Mezić and M. Dahleh, On the existence of time averages for time varying dynamical systems, in *Proceedings Conference on Decision and Control*, pp. 2065-2070, Tampa (Florida), December 1998.
- [27] D. D'Alessandro, M. Dahleh and I. Mezić, Control of fluid mixing using entropy methods, in *Proceedings American Control Conference*, pp. 838-843, Philadelphia (Pennsylvania), June 1998.
- [28] D. D'Alessandro, M. Dahleh and I. Mezić, Maximum entropy approach to the control of mixing, in *Proceedings American Control Conference*, pp. 160-161, Albuquerque (New Mexico), June 1997.
- [29] A. Beghi and D. D'Alessandro, Some remarks on FSN models and generalized Riccati equations, in *Proceedings of the 4-th European Control Conference*, paper number 662, Brussels (Belgium), July 1997.

Preprints

- [1] F. Albertini and D. D'Alessandro, Dynamics and control theory of quantum walks on graphs, IMA Preprint Series No. 2324, June 2010.
- [2] D. D'Alessandro, The Lie algebra rank condition for non bilinear quantum systems, xxx.ArXiv, No. quant-ph:0301144

[1] F. Albertini and D. D'Alessandro, Subspace controllability of multi-partite spin networks, submitted to *Systems and Control Letters*, available at xxx.arXiv:2006.11402.

Teaching Experience⁴

Fall 2020 Linear Algebra; Spring 2020 Undergraduate Mathematics Seminar; Fall 2019 Linear Algebra, Mathematical Topics in Quantum Physics*; Spring 2019 Differential Equations and Transforms (Large lecture), Elementary differential equations; Fall 2018 Differential Equations and Transforms (recitations); Spring 2018: Differential Equations and Transforms (Large Lectures); Fall 2017: Differential Equations and Transforms (Large Lectures); Spring 2017: Differential Geometry*; Fall 2016: Differential Equations and Transforms (Large Lectures); Elementary Linear Algebra Spring 2016: Differential Equations and Transforms (Large Lectures) Spring 2015 Differential Geometry*, Fall 2014 Differential Equations and Transforms (Large Lectures), Spring 2014 Differential Equations and Transforms, Fall 2013 Differential Equations and Transforms, Calculus II (Honors), Spring 2013: Differential Equations and Transforms, Fall 2012: Calculus II, Fall 2011: Differential Equations and Transforms, Spring 2010: Undergraduate Seminar, Laplace Transforms Fall 2009: Calculus III, Differential Equations* Fall 2008: Calculus II; Spring 2008: Theory of Matrices; Fall 2007: Theory of Linear Algebra; Spring 2007: Elementary Differential Equations and Transforms; Spring 2006: Multivariable Calculus; Fall 2005: Theory of Linear Algebra; Spring 2005: Elementary Differential Equations and Transforms; Spring 2004: Control of Quantum Systems*; Fall 2003: Multivariable Calculus; Spring 2003: Calculus and differential equations for the Life Sciences (Math 182); Fall 2002–Two courses: a) Multivariable Calculus and b) Calculus for the Life Sciences (Math 181); Spring 2002: Differential Geometry*; Fall 2001: Calculus I; Spring 2001: Multivariable Calculus; Fall 2000: Multivariable Calculus; Spring 2000: Optimal Control*; Fall 1999: Calculus I; (Fall 1996– Spring 1999) Teaching assistant, Department of Mechanical Engineering, University of California, Santa Barbara, for the following courses: Numerical Analysis, Robust Control*, Linear Systems Theory*, Fundamentals of Fluids.

Students Advised

Ruchira Majumdar, Ph.D. in Applied Mathematics. Graduated April 2001. Ph. D Thesis: ‘On Relationships between Lyapunov Spectrum and Morse Spectrum’. (Co-advised with Wolfgang Kliemann).

Kenneth Rubenstein, Master in Mathematics. Graduated June 2002. Final Project: ‘Generators of Classical Lie Algebras of Type A_n ’.

Mehmet Dagli, Master in Mathematics. Graduated April 2004. Final Project: ‘Levi Decomposition of Lie Algebras and Algorithms for its Computation’. Ph.D. in Mathematics, final dissertation successfully defended in April 2008. Dissertation title: Lie Algebra Decompositions with Applications to Quantum Dynamics.

⁴Courses followed by an asterisk are graduate courses.

Haseena Ahmed, Master in Applied Mathematics. Graduated November 2005, Final Project: ‘A feedback control strategy using the Lyapunov method for quantum systems’.

Benjamin Sheller, Ph. D. in Mathematics, 2016-2019, Graduated in March 2019. Dissertation title: ‘Symmetry reduction in KP systems’.

Postdoctoral Fellows Advised

Dr. James Taylor, August 2003-May 2004.

Dr. Raffaele Romano, January 2004-May 2004, January 2005-July 2006, August 2012-May 2015.

Dr. Laura Cattaneo, August 2007-May 2008.

Dr. Zhifei Zhu, August 2019-Today.

Scientific Visits⁵

June 2004-December 2004, Faculty Professional Development Program), Institute of Quantum Electronics, Quantum Photonics Group, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland.

May 2005-June 2005 and June 2008, Department of Mathematics, Universita’ di Padova, Italy.

October 2006-December 2006, Department of Physics, Universita’ del Salento, Lecce, Italy.

April 2010- July 2010, Institute for Mathematics and its Applications, (IMA), Minneapolis, MN.

September 2010 - December 2010, Faculty Professional Development Program, Department of Mathematics, University of Minnesota, Minneapolis, MN.

February 2012-April 2012, Quantum Information Science and Technology Research Center, Tsinghua University, Beijing, China.

June-July 2014, Dipartimento di Matematica, Universita’ di Padova, Italy.

September 1, 2015-December 15, 2015, Institute of Mathematics and Applications, Minneapolis, MN.

Invited talks and courses:

1. December 2018, Department of Physics, Universita’ del Salento, Lecce, Italy, ‘Geometric Optimal Control of a Class of Quantum Systems’.
2. December 2017, Department of Physics, Delft University of Technology, The Netherlands, Title: ‘Optimal Control of a Class of Quantum Systems’.
3. July 2017, Talk at the ‘Second international conference on Quantum Information, Spacetime and Topological Matter (QuIST)’, ZhangJiajie (Hunan, China) July 3-7, 2017, Title: ‘Optimal Control of A Class of Quantum Systems and the Reduction of Symmetry’.
4. June 2017, 16 hours mini-course on ‘Geometric Quantum Control Theory’ University of Science and Technology of China, Hefei, China.

⁵Only visits of 1 month or more are reported. More scientific visits are included in the invited talks

5. June 2016, Department of Physics, University of Science and Technology of China (USTC), Hefei, China.
6. May 2016, Department of Physics, Shanghai University, China.
7. May 2016, Workshop on Quantum Control and Dynamics, Institute Henri Poincaré, Paris, France, Talk: 'On Symmetries in Optimal Control; the K-P Problem and Applications to Quantum Systems'.
8. May 2016, Department of Mathematics, University of Padova Italy.
9. October 2015, Institute of Mathematics and Applications, Minneapolis, MN.
10. August 2015, Conference on Nonlinear Control and Geometry, Banach Center, Bedlewo Poland, Talk: 'Mathematical Methods and Problems in the Control of Quantum Mechanical Systems'
11. July 2015, Dipartimento di Matematica, Università di Trento, Italy, Talk: 'Lie algebraic and geometric methods in the control of quantum systems; Indirect and optimal control'.
12. June 2014, Quantum Information Science and Technology Research Center, Tsinghua University, Beijing, China, Talk: 'Indirect Controllability of Quantum Systems: Lie Algebraic Techniques and Constructive Control'.
13. June 2013, Department of Electronics and Informatics, University of Padua, Italy, *Workshop on Mathematical Aspects of Quantum Modeling, Estimation and Control*, giving the talk: Indirect Controllability of Quantum Systems: Lie Algebraic Techniques and Constructive Control.
14. July 2012, Department of Physics, University College London, Talk on 'Lie Algebraic Approach to the Control of Classical and Quantum Systems'.
15. May 2012, Department of Physics, Kinki University, Osaka Japan, Giving a series of three talks on Lie Algebraic Control of Quantum Systems.
16. March 2012, Automation Student Workshop, Tsinghua, Beijing, Talk on 'Control of Quantum Mechanical Systems'.
17. February 2012, Quantum Information Science and Technology Research Center, Tsinghua University, Short Course on Quantum Control, February-April, 2012.
18. February 2011, International Center for Theoretical Physics, Miramare-Trieste, Italy, Workshop on New Trends in Quantum Dynamics and Quantum Entanglement, 'Lie Algebraic Methods for the Analysis and Control of Quantum Systems; Applications to Quantum Walks'.

19. February 2011, Laboratory of Signals and Systems-SUPELEC, Gif sur Yvette, France, Lie Algebraic Methods for the Analysis and Control of Quantum Systems; Applications to Quantum Walks.
20. September 2010, Department of Physics and Astronomy, University College London, Talk: ‘Controllability of Quantum Random Walks on Graphs’.
21. September 2010, Department of Physics, University of Trieste, Italy, ‘Controllability of Quantum Random Walks on Graphs’.
22. May 2009, Conference ”Concepts and Methods in Quantum Control: Theory and Experiment”, Kavli Institute for Theoretical Physics in Santa Barbara, ‘The constructive Lie Algebra Rank Condition and its Applications in Quantum Control’.
23. November 2008, Workshop on ”Open Quantum Systems: De-coherence and Control” , Harvard University, November 2008, ‘Lie Algebraic Analysis and Control of Quantum Dynamics’.
24. June 2008, Graduate School in Information Engineering, Department of Information Engineering, University of Padova, ‘Introduction to Quantum Control Theory’, graduate course (10 lectures of two hours each).
25. November 2007, Department of Mathematics, University of Minnesota, Minneapolis, ‘Control theory of quantum mechanical systems with Lie algebras and Lie groups’.
26. July 2007, Systems and Control Laboratory, Hungarian Academy of Sciences, Budapest, Decompositions of Unitary Evolutions and Dynamics of Quantum Systems.
27. June 2007, Research Center for Quantum Information, Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovakia, Decompositions of Unitary Evolutions and Dynamics of Quantum Systems.
28. June 2007, Department of Mathematics, Universita’ di Padova Italy, Decompositions of Unitary Evolutions and Dynamics of Quantum Systems.
29. October-December 2006, Dipartimento di Fisica, Universita’ di Lecce, Italy, Invited series of 5 lectures ‘Lie Group Decompositions, Quantum Entanglement and Dynamics’.
30. June 2006, Department of Mathematics, University of Szczecin, Poland, Introduction to control of quantum systems.
31. December 2005, Department of Electrical Engineering, University of Michigan Ann Arbor, ‘Quantum symmetries, Cartan decompositions and Quantum system identification in arbitrary dimensions’.
32. October 2004, Quantum Photonics Group, Institute of Quantum Electronics, ETH, Zurich, ‘Observability in Classical and Quantum Systems’.
33. June 2003, University of Minnesota, Minneapolis, Department of Electrical Engineering, ‘An introduction to quantum control theory with some new results’.
34. June 2002, University of California Santa Barbara, Department of Mathematics, ‘A survey on control theory of quantum mechanical systems’
35. February 2002, University of California Santa Barbara, Mohammed Dahleh Symposium, ‘A survey on geometric control theory of quantum mechanical systems’

36. March 2001, University of Illinois at Urbana Champaign, Decision, Control, and Optimization Seminar: ‘Algorithms for quantum control based on decompositions of Lie groups’.
37. May 2001, University of Padova, Italy, Department of Mathematics Seminar, ‘Ergodic theory and the control of mixing in fluid flows’.
38. June 2001, University of California at Santa Barbara, Department of Electrical Engineering, ‘Notions of controllability for quantum mechanical systems’.

Conferences Attended and Contributed Talks

1. June 2019, European Control Conference, Naples, Italy, presenting the talk: ‘On KP sub-Riemannian problems and their cut locus’.
2. October 2018, American Mathematical Society (Fall Central Sectional Meeting), presenting the talk: ‘Geometric Optimal Control of a Class of Quantum Systems’.
3. November 2016, MURI Review, Washington DC, presenting the talk ‘On Symmetries in Optimal Control the K-P Problem and Applications to Quantum Systems’.
4. July 2016, International Symposium on Mathematical Theory of Network and Systems, Minneapolis, MN, presenting the talk ‘The Minimum Time function for a Control System on $SU(2)$ ’.
5. December 2015, MURI Review, Washington DC, presenting the talk ‘Control of Quantum Mechanical Systems from a Geometric Perspective: MURI Research at Iowa State University’.
6. February 2015, MURI retreat, Huntington Beach, California, presenting the talk ‘Explicit solutions of time optimal control problems for quantum systems’.
7. October 2014, MURI Annual meeting, Los Angeles California, presenting the talk ‘Control of Open Quantum Systems; Master Equations and Time Optimal Control’
8. July 2014, Quantum Mechanics and Applications, Dipartimento di Fisica ‘M.Merlin’, Bari, Italy.
9. February 2014, MURI Retreat, Laguna Beach, California.
10. December 2013, MURI Annual meeting, Los Angeles California, presenting the talk ‘Rigorous Models and New Mathematical Tools for Quantum Decoherence Control’.
11. April 2013, American Mathematical Society, 2013 Spring Central Section Meeting, Ames, IA, Exact Lie algebraic conditions for the indirect controllability of quantum mechanical systems.
12. April 2013, Center for Control, Dynamical Systems, and Computation, UCSB, talk “An introduction to the Lie algebraic approach for the control of Quantum systems”.
13. April 2013, MURI retreat, Santa Barbara, California, giving the talk “Indirect Controllability of Quantum Systems: Lie Algebraic Techniques and Constructive Control”.
14. December 2012, 51-st IEEE Conference on Decision and Control, Maui, Hawaii, presenting the talk: ‘Algebraic Conditions for Indirect Controllability of Quantum Systems’.
15. November 2012, MURI Annual meeting, Los Angeles California, presenting the talk ‘Algebraic Conditions for Indirect Controllability in Coherent Quantum Feedback Schemes’.

16. January 2012, Joint Mathematics Meeting, Boston Massachusetts, presenting the talk: ‘Indirect controllability of quantum systems; General Lie algebraic conditions and some special cases’.
17. November 2011, MURI Kickoff meeting, Los Angeles California, presenting the talk ‘Lie algebraic structures and Hamiltonian engineering in quantum control’.
18. September 2010, University of Hradec Kralove, Czechia, QMath11 Mathematical Results in Quantum Physics, presenting the talk: ‘Controllability of Quantum Walks on Graphs’ (joint work with F. Albertini).
19. July 2010, 10-th Canadian School on Quantum Information and Workshop on Quantum Algorithms, Computational Models and Foundations of Quantum Mechanics, University of British Columbia, Canada, presenting the talk: ‘Dynamical and Combinatorial Analysis of Quantum Walks on Graphs’ (joint work with F. Albertini).
20. June 2009, School on Applied Algebraic Topology, Institute for Mathematics and Applications, Minneapolis, Minnesota.
21. March 2009 IMA Annual Program Year Workshop, Coherence, Control, and Dissipation March 2-6, 2009
22. June 2008, 40-th Symposium on Mathematical Physics, Geometry and Quanta, Torun, Poland, presenting the following talk
‘The Lie Algebraic Approach to Control and Analysis of Quantum Dynamics, Applications to Quantum Walks’.
23. July 2006, Quantum Probability, Information and Control Symposium Nottingham U.K., presenting the following talk:
‘Decompositions of Unitary Evolutions and Entanglement Dynamics of Quantum Systems’, (joint work with R. Romano)
24. June 2006, 38-th Symposium on Mathematical Physics, Quantum Entanglement and Geometry, Torun Poland, presenting the following talk:
‘Decompositions of Unitary Evolutions and Entanglement Dynamics of Quantum Systems’, (joint work with R. Romano)
25. December 2005, 44-th Conference on Decision and Control, Seville, Spain, Presenting the following talk:
‘Further results on the observability of quantum systems under general measurement’, (joint work with R. Romano)
26. December 2003, 42-nd Conference on Decision and Control, Maui, Hawaii, Presenting the following talk:
‘Observability, measurement and parameter identification of quantum mechanical system’, (joint work with F. Albertini).
27. December 2002, 41-st Conference on Decision and Control, Las Vegas Nevada, Presenting the following two talks:
 - (a) ‘Control of a two level open quantum system’, (joint work with V. Dobrovitski)(Invited Talk),

- (b) ‘Contributions of control theory to fundamental quantum mechanics and its applications’(Invited Talk).
28. October 2002, 50-th Midwest Solid State Conference and Workshop on Solid State Quantum Computation, University of Illinois at Urbana-Champaign, presenting the talk: ‘Parameter sensitivity and control of open quantum systems’ (joint work with V. Dobrovitskii).
 29. August 2002, Mathematical Theory of Networks and Systems, University of Notre Dame, Indiana, presenting the following two talks:
 - (a) ‘Geometric control of quantum mechanical systems in a noisy environment’ (Invited Talk).
 - (b) ‘Control of quantum mechanical systems with minimum number of switches’(Invited Talk).
 30. December 2001, 40-th Conference on Decision and Control, Orlando Florida, Presenting the following three talks:
 - (a) ‘Notions of controllability for quantum mechanical systems’, (joint work with F. Albertini),
 - (b) ‘The Lie algebra structure and controllability properties of spin systems’, (joint work with F. Albertini),
 - (c) ‘Control of molecular magnets using magnetic force microscopy’, (joint work with M. Salapaka, L. Miller and F. Borsa).
 31. July 2001, SIAM Conference on Control and Applications, San Diego CA, Presenting the talk :‘Notions of controllability for quantum mechanical systems’, (joint work with F. Albertini).
 32. December 2000, 39-th Conference on Decision and Control, Sydney, Australia, presenting the talks:
 - (a) ‘On the controllability of systems on compact Lie groups and quantum mechanical systems’
 - (b) ‘Algorithms for quantum control based on decompositions of Lie groups’.
 33. June 1999, American Control Conference, Chicago, IL, U.S.A., presenting the talk: ‘Optimal control of two-level quantum systems’, (joint work with M. Dahleh).
 34. July 1998, ‘Mathematical Theory of Networks and Systems’, Padova, Italy, presenting the talk: ‘Control of fluid mixing using entropy methods’, (joint work with M. Dahleh and I. Mezic).
 35. June 1998, American Control Conference, Philadelphia PA, U.S.A. presenting the talk: ‘Control of fluid mixing using entropy methods’ (joint work with M. Dahleh and I. Mezic).
 36. June 1997, American Control Conference, Albuquerque NM, U.S.A. presenting the talk: ‘Maximum entropy approach to the control of mixing’, (joint work with M. Dahleh and I. Mezic).
 37. June 1996, Mathematical Theory of Networks and Systems, St. Louis Missouri, U.S.A., presenting the following three talks:
 - (a) ‘Projective superposition laws for Riccati equations’ (joint work with M. Pavon),

- (b) ‘Stability of continuous time systems with saturations’ (joint work with F. Albertini and A. Paice).
- (c) ‘Optimization using Lagrange functionals: minimum energy steering for an enlarged class of nonholonomic systems’ (joint work with A. Ferrante)

Editorships

Associate Editor *SIAM Journal on Control and Optimization* January 2012-2019.

Service⁶

1. Reviewer for the following scientific journals, conferences, funding agencies and publishers: 1) Journal of Physics B, Atomic and Molecular Physics, 2) Communications in Mathematics, 3) EuroPhysics Letters, 4) CRC Press, 5) SIAM Journal on Control and Optimization, 6) INRIA (France) 7) International Journal of Robust and Nonlinear Control, 8) Systems and Control Letters, 9) ESAIM: Control, Optimization and Calculus of Variations, 10) Journal of Mathematical Physics, 11) European Journal of Control, 12) IEEE Transactions on Automatic Control, 13) Physics Letters A, 14) Automatica, 15) Physical Review A, 16) European Physical Journal - Plus, 17) Science, 18) Journal of Optimization Theory and Applications, 19) Physics of Fluids, 20) Physica D, 21) Encyclopedia for Life Support Systems (UNESCO-EOLSS), 22) Journal of Guidance, Control, and Dynamics 23) U.S. Army Research Office, 24) IFAC Congress, 25) IEEE Conference on Decision and Control, 26) American Control Conference, 27) Journal of Physics A: Mathematical and Theoretical, 28) Reports on Mathematical Physics, 29) European Physics Journal Plus, 30) NCN (National Research Center of Poland) 31) INRIA (France) 32) International Journal of Quantum Information.
2. Panelist for the Evaluation of NSF Proposals.
3. Research Assessor for the Australian National University.
4. Organizer and Chair of the Invited Session: ‘Theory and Experiments in Quantum Control’ for the *40-th Conference on Decision and Control*. December 2001.
5. Chair and co-chair of several sessions at the *Conference on Decision and Control*.
6. Organizer of a special session on Quantum Control at the AMS Joint meeting held in Boston in January 2012.

⁶It includes only activity after becoming a faculty member at Iowa State