

# Sergio H. Cantu

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## EDUCATION

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### Massachusetts Institute of Technology

- Thesis : ‘*Quantum Light Engineering via Rydberg Polaritons.*’  
Advisor : Vladan Vuletić, Co-advisor : Mikhail Lukin
- *National Science Foundation Graduate Research Fellow (NSF-GRFP 2014)*

### Physics Ph.D. Candidate

Sep. 2014 – Present  
GPA = 4.1/5.0

### The University of Texas at Brownsville

- *Magna Cum Laude*
- *Center for Gravitational Wave Astronomy - NASA scholar*
- *Arecibo Remote Command Center (ARCC) scholar*

### B.S. in Physics and B.S. in Mathematics

Sep. 2007 – May 2012  
GPA = 3.813/4.0

## EXPERIENCE

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### Massachusetts Institute of Technology

NSF Graduate Research Fellow at the Center of Ultra-cold atoms and Teaching Assistant

Cambridge, MA

Sept 2014 - Present

#### • **Experimental Research:**

Atomic optical spectroscopy techniques. Design of laser frequency and intensity stabilization systems. Circuit design for stabilization systems of electric and magnetic fields. Optical- and radio-frequency control. Single photon detection and photon counting modules for data acquisition. Ultra-High Vacuum environments to work with alkali atoms and Rydberg excitation production in optical tweezer arrays. Laser control for atomic absorption imaging.

#### • **Theoretical and Numerical Methods:**

Development of python libraries for the simulation of quantum theories for: photon-photon interactions, Rydberg dipole-dipole Interactions and photon propagation through quantum nonlinear mediums. For data analysis, developed numerical libraries for statistical correlations of photon numbers and photonic nonlinear phases using Numpy and Pandas optimized for paralleled computing.

- **Teaching Assistant - Atomic Physics I and II (Graduate):** Design and development of two online courses on the *MITx* platform. Class has about 300 students on average each semester. Course covers standard atomic physics methods and state of the art atomic physics research highlights.

### Massachusetts Institute of Technology

Visiting Student. Bridge to Ph.D. program

Cambridge, MA

Sept 2012 - Sept 2014

- **Research Assistant - Laser Trapping and Cooling of atoms:** Studied and implemented optical lattices for application in laser trapping and cooling of Rb atoms. Characterized and optimized optical systems of a dipole trap of Rb atoms to improve the measurement of quantum nonlinearities at the single photon level of the atomic Rydberg states.

### University of Texas at Brownsville

Undergraduate CGWA-NASA Research Scholar and Teaching Assistant

Brownsville, TX

May 2008 - July 2012

- **Research Assistant - Optical Mode Cleaners:** Conditioned a classroom into a optics lab, setup a computer cluster for theoretical experiments. Developed matlab library to simulate the resonance stability of triangular ring resonators using novel ray tracing and Gaussian propagation techniques. Studied and modeled photonic crystal structures and related phenomena (i.e. Negative Index of refraction, Perfect mirrors, and silicon ring resonators).

### Massachusetts Institute of Technology

Undergraduate Summer Intern. Space Propulsion Laboratory

Cambridge, MA

Jun-Aug 2011

- **Research Assistant:** Development of an electrochemistry-free ionic liquid ion source (ILIS) for applications in space propulsion devices. Research involved the construction of super-critical dryers for the production of silica aerogel.

Undergraduate Summer Intern. Laser Interferometer Gravitational-Wave Observatory

Jun-Aug 2010

- **Research Assistant:** Constructed a prototype interferometer displacement sensor using frequency and intensity stabilization techniques. Project entailed design of both the optical configuration of my experiment as well as the control system of opto-mechanical components to achieve the desired stabilization results.

### Laser Interferometer Gravitational-Wave Observatory

Undergraduate Research Staff

Hanford, WA

Jun 2008 - Dec 2009

- **Research Assistant:** Characterization and fabrication of triangular Fabry-Perot resonators. Design of optical mechanical components for optical setup. Characterization of 500 mW 1064nm Nd:YAG laser. Worked and studied the Pound-Drever-Hall technique for phase stabilization in a laser system.

## PUBLICATIONS

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- **Sergio H. Cantu**, Aditya V. Venkatramani, Wenchao Xu, Leo Zhou, Brana Jelenković Mikhail D. Lukin & Vladan Vuletić *Repulsive photons in a quantum nonlinear medium*. arXiv:1911.02586 (2019) - Accepted in Nature Physics.
- Qi-Yu Liang, Aditya V. Venkatramani, **Sergio H. Cantu**, Travis L. Nicholson, Michael J. Gullans, Alexey V. Gorshkov, Jeff D. Thompson, Cheng Chin, Mikhail D. Lukin & Vladan Vuletić *Observation of three-photon bound states in a quantum nonlinear medium*. Science 359, 783-786 (2018).
- Jeff D. Thompson, Travis L. Nicholson, Qi-Yu Liang, **Sergio H. Cantu**, Aditya V. Venkatramani, Soonwon Choi, Ilya A. Fedorov, Daniel Viscor, Thomas Pohl, Mikhail D. Lukin & Vladan Vuletić *Symmetry-protected collisions between strongly interacting photons*. Nature 542, 206–209 (2017).
- Soumya D Mohanty & **Sergio Cantu** *Teaching introductory undergraduate physics using commercial video games*. Phys. Educ. 46 570 (2011).

## SELECTED PRESENTATIONS

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- Repulsive Photon-Photon Interactions mediated by Rydberg atoms*. Quantum Fluids of Light and Matter 2018. Ecole de Physique des Houches, 2018.
- Three-photon interactions and spin exchange in a quantum nonlinear medium*. 47th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, May 23–27, 2016. Providence, Rhode Island.
- Low-Loss Optical Resonator for Laser Interferometer Gravitational-Wave Observatory*. The National Society of Hispanic Physicists and The National Society of Black Physicists (NSBP-NSHP) joint annual meeting, February 2009. Undergraduate Poster Award, sponsored by OSA/SPIE, for Best Poster in Optics and Photonics.
- Laser Stabilization Techniques for Gravitational Wave Detectors*. The American Physical Society Texas Section Meeting, 2010.
- Interferometric Displacement Sensor for Advanced LIGO*. The Society for the Advancement of Chicanos and Native Americans in the Sciences (SACNAS) 2010 annual meeting.
- Dynamic Response and Locking of Optical Resonators for LIGO*. APS Texas Section meeting, October 2009.
- Characterization of Optical Resonators for LIGO*. Annual Review Meeting for the Consortium for Nanomaterials for Aerospace Commerce and Technology (CONTACT), UTPA, Edinburg, TX, September 2009.
- Development of an electrochemistry-free Ionic Liquid Ion Source*. NSBP-NSHP Annual Joint Conference, September 2011, Austin TX.

## ACTIVITIES

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- Elected President - *Mexican Student Association* MITMEX  
Elected Treasurer - *Academy of Courageous Minority Engineers*  
Instructor - *Clubes de Ciencia México*, 2015.

## AWARDS

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- MIT Service Award - Sergio Vazquez Prize (2018)  
El Mundo Boston's 30 under 30 Most Influential Latino Leaders (2018)  
NSF Graduate Research Fellow (2014-2019)  
Center for Gravitational-Wave Astronomy (CGWA)-NASA Scholarship (2007-2012)  
Arecibo Remote Command Center Scholarship(2008)  
Sydney V. Neely Mathematics Scholarship (2008).