

CHANGHAO LI

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EDUCATION

Massachusetts Institute of Technology Cambridge, MA Sept. 2017 - Sept. 2022 (*Anticipated*)
Ph.D. candidate, Quantum Engineering Group, Research Laboratory of Electronics and Department
of Nuclear Science and Engineering. **Supervisor: Prof. Paola Cappellaro**

Profile article in MIT news.

Xi'an Jiaotong University Xi'an, Shaanxi, China Sept. 2013 - June 2017
B.S., Physics Elite Class in School of Science Cumulative GPA: 3.8/4.0 Overall Ranking: 2/29

University of California, Berkeley Berkeley, CA Aug. 2015 - May 2016
Exchange student, Department of Physics and Astronomy

University of Notre Dame South Bend, IN May 2015 - Aug. 2015
Undergraduate researcher, Department of Physics

RESEARCH INTEREST

Quantum computation and simulation, quantum control, quantum sensing and magnetic resonance
imaging, nitrogen-vacancy (NV) centers in diamond, superconducting circuits, quantum network.

SELECTED JOURNAL PUBLICATIONS

Changhao Li, Mo Chen and Paola Cappellaro, "A geometric perspective: experimental evaluation
of the quantum Cramer-Rao bound.", arXiv 2204.13777.

Mo Chen*, **Changhao Li***, Giandomenico Palumbo, Yan-Qing Zhu, Nathan Goldman and Paola
Cappellaro, "Experimental characterization of the 4D tensor monopole and topological nodal rings.",
Science 375, 1017-1020 (2022) (*equal contribution).

Changhao Li, Rouhollah Soleyman, Mohammad Kohandel and Paola Cappellaro, "SARS-CoV-2
quantum sensor based on nitrogen-vacancy centers in diamond.", Nano Letters 22 (1), 43-49 (2022).
Highlighted in MIT news, APS Press Release.

Guoqing Wang*, **Changhao Li*** and Paola Cappellaro, "Observation of symmetry-protected selec-
tion rules in periodically driven qubits.", Phys. Rev. Lett. 127, 140604 (2021), *Editor's Suggestions*.
(*equal contribution). Highlighted in MIT news.

Changhao Li, Tianyi Li, Yi-Xiang Liu and Paola Cappellaro, "Effective routing design for remote
entanglement generation on quantum networks.", npj Quantum Information 7, 10 (2021).

Changhao Li, Mo Chen, Dominika Lyzwa and Paola Cappellaro, "All-optical quantum sensing of
rotational Brownian motion of magnetic molecules.", Nano Letters 19 (10), 7342-7348 (2019).

Changhao Li and Paola Cappellaro, "Telecom photon interface of solid-state quantum nodes.",
Journal of Physics Communications 3, 095016 (2019).

Changhao Li and Pengbo Li, "Coupling a single nitrogen-vacancy center with a superconducting
qubit via the electro-optic effect." Phys. Rev. A 97, 052319 (2018).

Gangqin Liu, Jian Xing, Wenlong Ma, Ping Wang, **Changhao Li**, Hoi Chun Po, Renbao Liu and
Xinxu Pan, "Single-Shot Readout of a Nuclear Spin Weakly Coupled to a Nitrogen-Vacancy Center."
Phys. Rev. Lett. 118, 150504 (2017).

RESEARCH EXPERIENCE

Quantum Engineering Group in MIT

Advisor: Prof. Paola Cappellaro

Sep 2017 - Present

- Exploring experimental simulation of exotic gauge fields and topological phases using spin defects.
- Working on bio-sensing based on NV centers in nanodiamonds. Developing hybrid sensors based on NV center and magnetic molecules that is capable of sensing and diagnosing virus.
- Proposing optimal protocols of managing entanglement generation in quantum networks.
- Implementing hardware-efficient quantum error correction codes using nuclear spins in diamond.

Quantum Optics Group in Xi'an Jiaotong University (XJTU)

Advisor: Prof. Pengbo Li

Feb 2017 - July 2017

- Theoretically proposed a hybrid coupling system which involves the coupling between a single NV center and a superconducting qubit via electro-optics effect. Demonstrated its capacity in achieving high fidelity quantum state transfer as well as highly entangled quantum states.

Quantum Information Group in Beijing National Lab, Chinese Academy of Sciences

Advisor: Prof. Xinyu Pan

July 2016 - Oct 2016

- Investigated single-shot readout of a nuclear spin via manipulating a weakly-coupled electron spin at room temperature. Successfully demonstrated a novel readout scheme with a high signal-to-noise ratio using dynamical decoupling sequences;

UC Berkeley AMO Physics Group

Advisor: Prof. Dmitry Budker

Aug. 2015 - May 2016

- Investigated the spatial distributions of NV centers in a diamond irradiated by electrons via a transmission electron microscope. Built the experiment setups for scanning control and data analysis;
- Measured longitudinal spin relaxation and vapor density as a function of temperature in antirelaxation-coated cesium vapor cells (Observed merit improvement at temperatures over 100 °C);

FELLOWSHIPS AND HONORS

Students Awards — Xi'an Jiaotong University

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| Outstanding Students Union Executive Award (Percentage: 4.0%) | May 2014 |
| · Sakura Festival Outstanding Volunteer | June 2014 |
| · National Encouragement Scholarship (Percentage: 3.2%) | Sept. 2014 |
| · Mount Everest First Prize Scholarship (Percentage: 5.6%) | Nov. 2014, Mar. 2016 |
| · Pengkang Scholarship (Percentage: 1.1%) | Sept. 2015 |
| · Siyuan Scholarship | Oct. 2016 |
| · Outstanding Student Award | Sept. 2014, Sept. 2015, Oct. 2016 |
| · Best Undergraduate Thesis Award (Percentage: 0.3%) | June 2017 |

Competition Awards

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| · Second Prize of the University Mathematical Contest in Modeling | June 2014 |
| · Second Prize of the 5th China Undergraduate Physics Tournament | Aug. 2014 |
| · Third Prize of the China Undergraduate Mathematical Competition | May 2015 |
| · Technical Merit Award in MIT Quantum Hackathon | Jan. 2020 |

PRESENTATIONS AND CONFERENCES

C.Li, "A geometric perspective: experimental evaluation of the quantum Cramer-Rao bound", APS DAMOP Meeting 2022.

C. Li, “Virus quantum sensor based on nitrogen-vacancy centers in diamond”, APS March Meeting 2022.

Session Chair of the 1st Quantum Science and Engineering Consortium (QSEC) Annual Research Conference in Cambridge, MA, Feb. 2022

C. Li, “SARS-CoV-2 quantum sensor based on nitrogen-vacancy centers in diamond”, SIQSE Invited talk, SUSTech, Dec. 2021

C. Li, “Building quantum ion sensors based on solid-state defects in nanodiamond”, OPTICA QIM VI conference, Nov. 2021

C. Li, “Experimental characterization of the 4D tensor monopole and topological nodal rings”, APS March Meeting, Mar. 2021

C. Li “Quantum dots: from fundamental science to applications”, iCAN-X talk, X challenger, Mar. 2021

C. Li, “Experimental characterization of the tensor monopole in synthetic 4D space”, MIT-Harvard CUA seminar, Nov. 2020

C. Li “SARS-CoV-2 quantum sensor based on spin defect in nanodiamonds”, seminar of Department of Nuclear Science and Engineering at MIT, Sep. 2020

C. Li, “Quantum sensing of rotational Brownian motion of magnetic molecules”, seminar of Department of Nuclear Science and Engineering at MIT, Sep. 2019

Program committee member of the 1st Student Conference on Quantum Computing in Shenzhen, China, Aug. 2019.

C Li, T. Li, Y Liu, P. Cappellaro, “Routing protocol of purified entanglement in quantum repeater networks.” CQIQC-VIII conference poster, Aug. 2019.

C. Li, D. Lyzwa, M. Kohandel, P. Cappellaro, “Optical sensing of biological processes with nitrogen-vacancy centers in nanodiamonds.” APS March Meeting 2019.

C. Li, “Resolution and Stability Analysis of the ATF2 Straightness Monitor”. University of Notre Dame Summer Research Program Final Presentation, July 2015.

C. Li, “Investigation of the Formation and Evolution of Bubble Crystals”. The 5th China Undergraduate Physics Tournament, Huazhong University of Science and Technology, Aug. 2014.

SKILLS

Languages	Mandarin (native), English (fluent: TOEFL iBT 106; GRE General 326+3.0)
Programming	Python, C++
Scripting/Analysis	Matlab, Mathematica, ROOT, LabView, Origin, L ^A T _E X, JavaScript, HTML

PEDAGOGICAL TRAINING

TA Days Training – MIT Teaching + Learning Lab Feb 2022
Workshop series introducing evidence-based teaching practices for TAs

Explored how to engage students and lead discussions in general teaching settings; Studied strategies to lead a problem-solving session, implement in Course 22.51; Learned to provide effective feedback on reports, proposals, and essays to students from a variety of disciplines.

PUBLIC WELFARE

Participating in a non-profitable global program “Project Access” aiming to help under-represented students with advanced education.

Writing popular science articles in Chinese social media platforms which has over 6 million reads and with over 40 thousands followers.

Performed scientific demos to elementary schoolers during Science Festival in 2018