

Contact Information

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Google Scholar : scholar.google.com/citations?user=s0cbKvYAAAAJ&hl=en&authuser=2

Web : thecolombolab.com/

Research Positions

Assistant Professor - University of Connecticut (UConn)

Department of Physics, School of Liberal Arts and Sciences

Aug 2023 – current

- Experimental AMO Physics and Quantum Science

Research Scientist - MIT

MIT-Harvard CUA, RLE @ MIT

2022 – 2023

Postdoctoral researcher -MIT

MIT-Harvard CUA, RLE @ MIT

PI: Prof. Vladan Vuletić.

2017 – 2022

Postdoctoral researcher

Department of Physics – Fribourg Atomic Physics

PI: Prof. Antoine Weis.

2017

Ph.D. Candidate

Department of Physics – Fribourg Atomic Physics

Advisor: Prof. Antoine Weis.

2013 - 2017

Education and Training

Postdoc - Massachusetts Institute of Technology (MIT)

Cambridge, MA, USA

MIT-Harvard Center for Ultracold Atoms (CUA)

2017 - 2022

Research Laboratory of Electronics (RLE)

PI: Prof. Vladan Vuletić

Senior Postdoctoral Associate since September 2021.

Postdoc - University of Fribourg

Fribourg, Switzerland

Department of Physics – Fribourg Atomic Physics (FRAP)

2017

PI: Prof. Antoine Weis

Ph.D. in Physics - University of Fribourg

Fribourg, Switzerland

Department of Physics – Fribourg Atomic Physics (FRAP)

2013 - 2017

Supervisor: Prof. Antoine Weis

Thesis title: A magnetic particle imaging scanner based on atomic magnetometry.

M.Sc. in Physics - University of Fribourg

Fribourg, Switzerland

Department of Physics – Soft Matter Theory

2011 - 2013

Supervisor: Prof. Joseph Brader

Dissertation title: Wetting of a colloidal rod-sphere mixture

GPA: 5.7/6

Awards and grants

- MIT- MISTI Global Seed Funds (30'000 USD grant for global collaboration) 2022
- Postdoc.Mobility Fellowship from Swiss National Science Foundation (SNSF) 2019
- Early Postdoc.Mobility Fellowship from Swiss National Science Foundation (SNSF) 2017
- Swiss finalists “Ma thèse en 180 secondes” (MT180) - EPF Lausanne 2016
- Switzerland 3rd in regional “Ma thèse en 180 secondes” (MT180) - Fribourg, Switzerland 2016

Publications

Peer reviewed:

20. C. Shu*, **S. Colombo***, Z. Li*, A. Adiyatullin, E. Mendez, E. Pedrozo-Peñafiel, and V. Vuletić. Increased Atom-Cavity Coupling through Cooling-Induced Atomic Reorganization. **Physical Review Research**, 6(3), L032049 (2024)
*equal contribution
19. W. Xu, T. Sumarać, E. Qiu, M. L. Peters, Z. Li, S. H. Cantú, A. Menssen, M. Lukin, **S. Colombo**, and V. Vuletić. Bose-Einstein condensation by polarization gradient laser cooling. **Physical Review Letters**, 132(23), 233401 (2024).
18. **S. Colombo**. Parallel quantum control meets optical atomic clocks. **Nature Physics**. 20, 177–178 (2024).
→ Invited Article. News and Views
17. Z. Li, **S. Colombo**, C. Shu, G. Velez, S. Pilatowsky-Cameo, R. Schmied, S. Choi, M. Lukin, E. Pedrozo-Peñafiel, and V. Vuletić. Improving Metrology with Quantum Scrambling. **Science**, 380(6652), 1381-1384 (2023)
16. **S. Colombo**, E. Pedrozo-Peñafiel, and V. Vuletić. Entanglement-enhanced optical atomic clocks. **Applied Physics Letters**, 121, 210502 (2022)
→ **Featured Article**
→ **Invited Article**
→ **Cover of the 21 November 2022 issue of Applied Physics Letters**
15. **S. Colombo**, E. Pedrozo-Peñafiel, A. Adiyatullin, Z. Li, C. Shu, E. Mendez, and V. Vuletić. Time-Reversal-Based Quantum Metrology with Many-Body Entangled States. **Nature Physics**, 18(8), 925-930 (2022)
Altmetric: 199 (98th percentile, 90th percentile in Nature Physics)
14. S.C. Carrasco, M.H. Goerz, Z. Li, **S. Colombo**, V. Vuletić, and V.S. Malinovsky. Extreme Spin Squeezing via Optimized One-Axis Twisting and Rotations. **Physical Review Applied**, 17, 064050 (2022)
13. Z. Li, B. Braverman, **S. Colombo**, A. Kawasaki, C. Shu, E. Pedrozo-Peñafiel, E. Mendez, and V. Vuletić. Collective spin-light and light-mediated spin-spin interactions in an optical cavity. **PRX Quantum**, 3(2), 020308 (2022)
12. E. Pedrozo-Peñafiel*, **S. Colombo***, C. Shu*, A. Adiyatullin, Z. Li, E. Mendes, B. Braverman, A. Kawasaki, D. Akamatsu, Y. Xiao, and V. Vuletić. Entanglement on an

Optical Atomic-Clock Transition. **Nature**, 588, 414–418 (2020).

*equal contribution

→ **Nature News and Views**: Quantum Engineering for optical clocks

11. A. Kawasaki, B. Braverman, E. Pedrozo-Peñafiel, C. Shu, **S. Colombo**, Z. Li, and V. Vuletić. Trapping ^{171}Yb atoms into a one-dimensional optical lattice with small waist. **Physical Review A**, 102, 013114 (2020)
10. **Simone Colombo**, V. Lebedev, A. Tonyushkin, S. Pengue, and A. Weis. Imaging Magnetic Nanoparticle Distributions by Atomic Magnetometry-Based Susceptometry. **IEEE Transactions on Medical Imaging**, 39, 4 (2020)
9. B. Braverman, A. Kawasaki, E. Pedrozo-Peñafiel, **S. Colombo**, C. Shu, Z. Li, E. Mendez, M. Yamoah, L. Salvi, D. Akamatsu, Y. Xiao, and V. Vuletić. Near Unitary Spin Squeezing in ^{171}Yb . **Physical Review Letters**, 122, 223203 (2019)
8. A. Kawasaki, B. Braverman, E. Pedrozo-Peñafiel, C. Shu, **S. Colombo**, Z. Li., O. Ozel, W. Chen, L. Salvi, A. Heinz, D. Levonian, D. Akamatsu, Y. Xiao, and V. Vuletić. Geometrically asymmetric optical cavity for strong atom-photon coupling. **Physical Review A**, 99(1), 013437 (2019)
- **Editor's suggestion**
7. **S. Colombo**, V. Dolgovskiy, T. Scholtes, Z. D. Grujić, V. Lebedev, and A. Weis. Orientational dependence of optically detected magnetic resonance signals in laser-driven atomic magnetometers. **Applied Physics B** 123, 35 (2017).
6. A. Weis, **S. Colombo**, S., V. Dolgovskiy, Z. D. Grujić, V. Lebedev, and J. Zhang. Characterizing and imaging magnetic nanoparticles by optical magnetometry. **Journal of Physics: Conference Series**, 793(1), 012032, (2017)
5. **S. Colombo**, V. Lebedev, A. Tonyushkin, Z. D. Grujić, V. Dolgovskiy, and A. Weis. Towards a mechanical MPI scanner based on atomic magnetometry. **International Journal on Magnetic Particle Imaging**, 3(1), (2017)
4. **S. Colombo**, V. Lebedev, Z. D. Grujić, V. Dolgovskiy, and A. Weis. MPS and ACS with an atomic magnetometer. **International Journal on Magnetic Particle Imaging**, 2(1), 1604002 (2016)
3. **S. Colombo**, V. Lebedev, Z. D. Grujić, V. Dolgovskiy, and A. Weis. M (H) dependence and size distribution of SPIONs measured by atomic magnetometry. **International Journal on Magnetic Particle Imaging**, 2(1), 1604001 (2016)
2. V. Dolgovskiy, I. Fescenko, N. Sekiguchi, **S. Colombo**, V. Lebedev, J. Zhang, and A. Weis. A magnetic source imaging camera. **Applied Physics Letters**, v. 109, 2, 023505 (2016)
1. V. Dolgovskiy, V. Lebedev, **S. Colombo**, A. Weis, B. Michen, L. Ackermann-Hirschi, and A. Petri-Fink. A quantitative study of particle size effects in the magnetorelaxometry of magnetic nanoparticles using atomic magnetometry. **Journal of Magnetism and Magnetic Materials**, 379, 137-150 (2015)

In Preparation:

2. S. C. Carrasco, M. H. Goerz, Z. Li, **S. Colombo**, V. Vuletić, W. Schleich, and V. S. Malinovsky. Cat state generation and generalized Ramsey interferometry.
1. C. Hotter, K. Giekta, L. Zaporski, Q. Liu, V. Vuletić, **S. Colombo** and H. Ritsch. Continuous Antiresonance-based Optical Atomic Clock

Press publications:

1. Vladan Vuletić, **Simone Colombo**, and Edwin Pedrozo-Peñafiel. Keeping Better Time Through Entanglement. **physics@mit**, No. 34 (2021)

Invited Seminar/Colloquium

22. Engineering of Kerr-Hamiltonians in a cavity QED system Jan. 2025
Workshop on Quantum Information Science on the Intersections of Nuclear and AMO Physics, UMass Boston, Boston MA (USA)
21. Observing our Universe using Quantum/Atomic Sensors Nov. 2024
University of Florida Condensed Matter/Biophysics Seminar, Gainesville FL (USA)
20. Observing our Universe using Quantum Sensors Nov. 2024
Wesleyan University Physics Colloquium, Middletown CT (USA)
19. Observing our Universe with Quantum Sensors Oct. 2024
University of Rhode Island Physics Colloquium, Kingston RI (USA)
18. Observing our Universe with Atomic Sensors Oct. 2024
Quantum Sensors UConn Workshop, Storrs CT (USA)
17. Observing our Universe with Quantum Sensors Sep. 2024
Central Connecticut State University Physics Colloquium, New Britain CT (USA)
16. Entanglement-Enhanced Quantum Metrology in Atomic Sensors May 2024
Bose.X webinar, online
15. Enhancing atom-cavity coupling through Raman sideband cooling Jan. 2024
SPIE Quantum West, San Francisco CA (USA)
14. Quantum Metrology with Ultracold Atoms (and Optical Cavities) Oct. 2023
UConn Physics Colloquium, Storrs CT (USA)
13. Light-induced all-to-all Interactions for Quantum Metrology with Atoms May 2023
ITAMP Workshop – Harvard, Cambridge MA (USA)
12. Entanglement-Enhanced Quantum Metrology in Atomic Sensors Apr. 2023
Seminar JPL NASA - Caltech, Pasadena CA (USA)
11. Entanglement-Enhanced Quantum Metrology in Atomic Sensors Mar. 2023
Symposium on Quantum Gravity - IQOQI, Vienna (Austria)
10. Quantum-Enhanced Metrology in Atomic Sensors Feb. 2023
Physics Seminar UConn, Storrs CT (USA)

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| 9. Time-reversal Protocols for Quantum-Enhanced Metrology
<i>SPIE Quantum West</i> , San Francisco CA (USA) | Feb. 2023 |
| 8. Keeping Better Time through Entanglement
<i>University of Basel</i> , Basel (Switzerland) | 2021 |
| 7. Quantum Metrology in Optical Lattice Clocks.
<i>EPFL</i> , Lausanne, (Switzerland) | 2021 |
| 6. Approaching the Heisenberg Limit with a time-reversal Hamiltonian.
<i>Old Dominion University Physics Colloquium</i> . Norfolk VA (USA) | 2021 |
| 5. Approaching the Heisenberg Limit with a time-reversal Hamiltonian.
<i>MIT-Harvard CUA virtual seminar</i> . Cambridge MA (USA) | 2021 |
| 4. Squeezing in an Optical Clock Transition: Motivations and Methods.
<i>UMass Boston Physics Colloquium</i> . Boston MA (USA) | 2019 |
| 3. Spin Squeezing in Ytterbium-171 (and the beauty of unitarity).
<i>QSIT Seminar (ETH Zürich)</i> , Zürich (Switzerland) | 2019 |
| 2. Near-Unitary Spin Squeezing.
<i>University of Basel</i> , Basel (Switzerland) | 2019 |
| 1. Near-Unitary Spin Squeezing in ytterbium 171.
<i>ITAMP-Harvard lunch seminar</i> . Cambridge MA (USA) | 2019 |

Selected Contributions to conferences

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| 8. Towards cavity QED in a tweezers-array of Sr atoms (Poster)
<i>International Conference in Atomic Physics (ICAP 2024)</i> ,
London (UK) | 2024 |
| 7. Connecting Quantum Information Scrambling with
Entanglement Enhanced Metrology (Poster).
<i>International Conference in Atomic Physics (ICAP 2022)</i> ,
Toronto (Canada) | 2022 |
| 6. Connecting Quantum Information Scrambling with
Entanglement Enhanced Metrology (Poster).
<i>Gordon Research Conferences (GRC) Quantum Science</i> ,
Stonehill College, Easton MA (USA) | 2022 |
| 5. Approaching the Heisenberg limit in a many-spin system (Oral).
<i>Photonica 2021</i> . Belgrade (Serbia), hybrid event | 2021 |
| 4. Two-photon Resolved-Sideband Raman Cooling of ^{171}Yb in an optical cavity.
<i>DAMOP 2021</i> . online | 2021 |
| 3. Demonstration of spin Squeezing in an Optical Clock Transition (Oral).
<i>QTech 2020</i> . Barcelona (Spain), online | 2020 |
| 2. Near-Unitary Spin-Squeezing (Oral).
<i>MIT-Harvard Center for Ultracold Atoms (CUA) retreat</i> ,
Plymouth NH (USA) | 2019 |

1. Near-Unitary Spin-Squeezing for Optical Clocks (Poster). 2018
International Conference in Atomic Physics (ICAP 2018),
 Barcelona (Spain)

Mentorship and Teaching

Advisor or co-advisor

4 Graduate students – University of Connecticut (UConn), USA 2023 - current

Students' supervision and mentoring:

9 Undergraduate students – University of Connecticut (UConn), USA 2023 - current

8 Graduate students - Massachusetts Institute of Technology (MIT), USA 2017 - 2023

2 Graduate students - Harvard University and MIT, USA 2017 - 2023

1 M.Sc. student - University of Fribourg, Switzerland 2016 – 2017

Teaching

Development of Quantum Mechanics (PHYS2300), Undergrad level – UConn 2024, 2025

Physics for Engineers (1501Q), Undergrad level – UConn 2023

Lecturer

Quantum Mechanics (8.04), Undergrad level - MIT 2023
 (replaced Prof. Vladan Vuletić and Prof. Will Detmold when absent)

Modern Physics, B.Sc. level - University of Fribourg, Switzerland 2016
 (replaced Prof. Antoine Weis when absent)

Teaching Assistant

Modern Physics, B.Sc. level - University of Fribourg, Switzerland 2015 - 2017

Modern Optics, M.Sc. level - University of Fribourg, Switzerland 2015 - 2017

Physics Lab, B.Sc. level - University of Fribourg, Switzerland 2011 - 2015

Physics I and II, B.Sc. level - University of Fribourg, Switzerland 2011 - 2013

Outreach

Committees

MIT-Harvard Engage CUA committee 2020 –2023

Public presentations

STEM Career Showcase – CT Science Center [link](#) Hartford, CT, USA – 12/2024

CUA Cambridge Science Festival Workshop – MIT Cambridge, MA, USA – 04/2021

CUA Cambridge Science Festival Workshop – MIT [link](#) Cambridge, MA, USA – 04/2019

Trois minutes pour la science – TV broadcast (french), RTS [link](#) Switzerland – 2016

In the news (selected)

“Da Gordola al Connecticut, per misurare il tempo con una precisione "atomica”
 Simone Pengue, *Ticino Scienza*, [link](#) 02/2025

“How quantum physics is revolutionising the measurement of time”
 Lionel Pousaz, *Horizons (The Swiss research magazine)*, [link](#) 09/2022

- “Physicists harness quantum “time reversal” to measure vibrating atoms”
Jennifer Chu, *MIT News*, [link](#) 07/2022
- “Des chercheurs créent l'horloge la plus précise du monde (grâce à l'intrication quantique)”
Roman Ikonikoff, *Science et Vie*, [link](#) 07/2021
- “Unraveling The Mysteries Of Time With Scientists From MIT”
Cole Pennington, *Hodinkee*, [link](#) 01/2021
- “New Type of Atomic Clock keeps time even more precisely”
Jennifer Chu, *MIT News*, [link](#) 12/2021

Scientific Societies and other organizations

Member of Swiss Physical Society (SPS), European Physical Society (EPS),
American Physical Society (APS).

Committee member Fribourg Physics Fachschaft (2010-2013, vice-pres. 2011-2013),
MIT-Harvard Engage CUA committee (2020 – 2023).

Professional Activities

Referee for Nature, Nature Physics, Nature Photonics, Physical Review Letters, Physical Review A,
Optics Communications, IEEE Transaction on Medical Imaging, Photonic Sensors, International
Journal on Magnetic Particle Imaging.

Initiatives Quantum Initiative (UConn), QuantumCT (State of Connecticut, UConn and Yale)

Institutional Service AMO seminar coordinator

Events Organization

- Conferences for Undergraduate Women and Gender Minorities in Physics (CU*iP)** 2025
Organizing Committee, UConn
- Quantum Sensors UConn Workshop** Oct. 2024
Co-organizer, UConn Storrs CT (USA)
- 5th Workshop on Optically Pumped Magnetometers** 2017
Local Organizing Committee, University of Fribourg, (Switzerland)

Languages

English (fluent), French (fluent), Italian (Native), German (Initiated), Spanish (Basic)