USC Dornsife College of Letters, Arts and Sciences
Department of Physics and Astronomy

Ming Hsieh Institute - Physics

Joint Seminar Series

USC Viterbi School of Engineering
Ming Hsieh Department of Electrical and Computer Engineering

Enhanced Trapped-Ion Quantum Control with Integrated Photonics

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Friday, December 13, 2024
SSL 202
2:00 pm

Abstract:
Practical quantum information processing requires significant advances over current systems in error and robustness of basic operations, and in scale. Despite the fundamental promise of trapped atomic ion qubits, the optics required pose a major challenge in scaling. Interfacing low-noise atomic qubits with scalable integrated photonics [1] offers a route to scale, enabling extensibility while simultaneously lending robustness to noise in sensitive quantum operations [2]. Beyond scaling, though, such techniques further allow generation of optical field profiles enabling improvements to coherent and incoherent processes [3]. I will discuss modeling work from our group predicting substantially increased cooling rates as well as motional mode bandwidths for ground-state laser cooling in structured light fields [4], routes to quantum logic leveraging related ideas, and early results from recent foundry-fabricated trap devices with fully integrated delivery to realize these schemes. I will also touch on challenges and opportunities for novel photonic materials and devices motivated by atomic quantum systems. [1] K.K. Mehta, C.D. Bruzewicz, R. McConnell, R.J. Ram, J.M. Sage, and J. Chiaverini. "Integrated optical addressing of an ion qubit." *Nature Nanotechnology* **11**, 1066-1070 (2016). [2] K.K. Mehta, C. Zhang, M. Malinowski, T.-L. Nguyen, M. Stadler, and J.P. Home. "Integrated optical multi-ion quantum logic." *Nature* **586**, 533-537 (2020). [3] A. Ricci Vasquez, et al. "Control of an atomic quadrupole transition in a phase-stable standing wave." PRL 130, 133201 (2023). [4] Z. Xing and K.K. Mehta. "Trapped-ion laser cooling in structured light fields." arXiv: 2411.08844 (2024).

Bio: Karan Mehta received BS. Degrees from UCLA in Electrical Engineering and Physics in 2010 and completed his PhD in Electrical Engineering and Computer Science at MIT in 2017, with the support of a DOE Science Graduate Fellowship. From 2017 to 2021 he was an ETH Postdoctoral Fellow and subsequently senior scientist at ETH Zurich. He joined Cornell ECE in January of 2022 where he leads the Photonics and Quantum Electronics group. He is recipient of an NSF CAREER award and a Sloan Research Fellowship in Physics.

Hosted by
Quntao Zhuang, Eli Levinson-Falk, Jonathan Habif, Daniel Lidar, Kelly Luo, Todd Brun, Tony Levi, Stephan Haas