UTC Research Institute

"Advancing Quantum Information Science and Technologies with Single Photons and Neutral Atoms"

given by **Jianming Wen**

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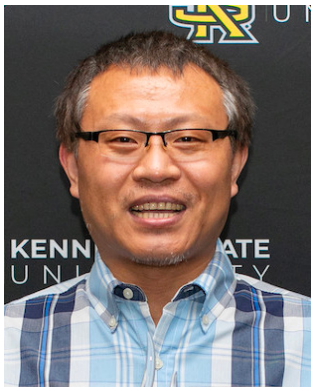
Wednesday, January 10, 1:30 p.m., ECS 426 (Maytag Room)*

Public Invited



Quantum information science stands at a transformative crossroads, poised to revolutionize diverse fields such as computing, cryptography, communication, networks, metrology, sensing, and imaging. Among various quantum systems, photonic qubits and neutral atoms shine as pivotal catalysts for this quantum revolution. This presentation explores the synergistic convergence of these platforms, with a central focus on pioneering narrowband entangled biphoton sources via spontaneous four-wave mixing (SFWM) in coherent atomic ensembles [1,2]. Notably, we've recently achieved the unique feat of creating a reliable genuine W-class triphoton source through spontaneous six-wave mixing (SSWM) in hot atomic vapor [3] with an unprecedented generation rate for the first time. Of importance, this breakthrough has inadvertently unveiled profound connections with the renowned three-body problem in mathematics and celestial mechanics for centuries. Our journey commences with foundational quantum concepts, surveys alternative qubit platforms, and dives into conventional biphoton generation methods like spontaneous parametric down-conversion (SPDC) and SFWM in solid materials. We unveil our recent breakthroughs in narrowband bi- and tri-photon generation within coherent atoms, promising long-distance quantum information processing and networking. Single photons, embodying unshakeable quantum properties, serve as versatile information carriers, while neutral atoms offer an ideal setting for nurturing long-lived qubits and quantum memory. We demystify the intricate mechanisms underlying entanglement generation with neutral atoms, shedding light on SFWM and SSWM principles. The talk concludes by showcasing our latest advancements, highlighting our capacity to generate unparalleled coherence and tunability in narrowband entangled photons. These attributes propel scalable quantum networks, connecting quantum processors and enabling secure global information exchange. As we embark on this enlightening journey, we illuminate the pivotal roles of single photons and neutral atoms in advancing quantum information science and technologies, inspiring fresh research avenues toward a quantum-enabled future.

References:

[1] S. Du, J. Wen and M. H. Rubin, J. Opt. Soc. Am. B 25, C98-C108 (2008). (invited review)
[2] S. Du, J. Wen, M. H. Rubin and G. Y. Yin, Phys. Rev. Lett. 98, 053601 (2007).
[3] K. Li, J. Wen, Y. Cai, S. V. Ghamsari, C. Li, F. Li, Z. Zhang, Y. Zhang and M. Xiao, arXiv:2303.07977 (to appear in Nature Photonics).

Jianming Wen is an associate professor in the Physics Department at Kennesaw State University (KSU). He earned his PhD in physics from the University of Maryland in 2007, specializing in quantum optics within a cornerstone research group. So far, he has authored 49 peer-reviewed publications in renowned journals, including *Nat. Phys., Nat. Photon., Nat. Commun., PRL, Adv. Opt. Photon.*, among others. His pioneering contributions span diverse fields, notably narrowband entangled photon generation, non-Hermitian physics, self-imaging, and integrated photonics. His research expertise resides at the nexus of fundamental physics and real applications, bridging AMO physics, photonics, optical imaging, condensed matter physics, and quantum information science and technologies. His commitment to advancing scientific knowledge extends to active roles as a dedicated reviewer for over 85 major peer-reviewed journals, encompassing reputable publishers like APS, Optica, Nature, Wiley, ACS, IEEE, IOP, Springer, AIP, MDPI, Frontiers, and Elsevier. His exceptional service has garnered numerous Outstanding Reviewer awards from these publishers. In addition to his prolific research and reviewing contributions, he holds key editorial responsibilities as an Editorial Board member or Editor for several esteemed journals. His expertise is often sought by renowned funding agencies, including NSF, DoE, AFOSR, ANR, RGC, ISF, MIUR, Gordon and Betty Moore Foundation, and others. His exceptional scholarly contributions were duly recognized when he received the prestigious KSU *Outstanding Research and Creative Activity Award* in 2021. Since joining KSU in 2017, he has demonstrated his research acumen by successfully securing over $1 million in research funds from NSF and DoE.

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