

# Prof. Michael E. Flatté

*University of Iowa*  
*IEEE Magnetics 2022 Distinguished Lecturer*

**Friday, October 21, 11:00 am. Osborne A204**

## **Coherent magnonics for quantum information science**



The current revolution in quantum technologies relies on coherently linking quantum objects like quantum bits (“qubits”). Coherent magnonic excitations of low-loss magnetic materials can wire together these qubits for sensing, memory, and computing. Coherent magnonics may reduce the size of superconducting qubits (which otherwise struggle with the large scale of microwave excitations) and may increase the size of spin-based qubit networks (which otherwise contend with the very short distances of dipolar or exchange interactions). Compared to photonic devices, these magnonic devices require minimal energy and space. However, efforts to exploit coherent magnonic systems for quantum information science will require a new understanding of the linewidths of low-loss magnonic

materials shaped into novel structures and operating at dilution-refrigerator temperatures.

This lecture will introduce the fundamental requirements for practically linking quantum objects into large-scale coherent quantum systems as well as the advantages of coherent magnonics for next-generation quantum coherent systems (i.e., spin-entangling quantum gates [1]). Other critical challenges for quantum information science then will motivate the development of coherent magnonics for quantum transduction from “stationary” spin systems to “flying” magnons and for quantum memory [2]–[4]. Finally, the advantages of all-magnon quantum information technologies that rely on manipulating and encoding quantum information in superpositions of fixed magnon number states will highlight the potential of new magnetic materials, devices, and systems.

### Key publications:

[1] M. Fukami, D. R. Candido, D. D. Awschalom, and M. E. Flatté, “Opportunities for long-range magnon-mediated entanglement of spin qubits via on and off-resonant coupling,” *PRX Quantum*, vol. 2, Oct. 2021, Art. no. 040314.

[2] D. R. Candido, G. D. Fuchs, E. Johnston-Halperin, and M. E. Flatté, “Predicted strong coupling of solid-state spins via a single magnon mode,” *Mater. Quantum Technol.*, vol. 1, Dec. 2021,

Art. no. 011001.

[3] Ö. O. Soykal and M. E. Flatté, "Strong field interactions between a nanomagnet and a photonic cavity," *Phys. Rev. Lett.*, vol. 104, Feb. 2010, Art. no. 077202.

[4] T. Liu, X. Zhang, H. X. Tang, and M. E. Flatté, "Optomagnonics in magnetic solids," *Phys. Rev. B, Condens. Matter*, vol. 94, Aug. 2016, Art. no. 060405(R).

## **Biography**

Michael E. Flatté (Member, IEEE) received the A.B. degree in physics from Harvard University, Cambridge, MA, USA, in 1988, and the Ph.D. degree in physics from the University of California at Santa Barbara, Santa Barbara, CA, USA, in 1992. He is a Professor at the Department of Physics and Astronomy, The University of Iowa (UI), Iowa City, IA, USA. After his post-doctoral work at the Institute for Theoretical Physics, University of California at Santa Barbara, and the Division of Applied Sciences, Harvard University, he joined the faculty at UI in 1995. He has over 270 publications and ten patents. He has an adjunct appointment as a Professor at the Department of Applied Physics, Eindhoven University of Technology, Eindhoven, The Netherlands. His research interests include optical and electrical control of spin dynamics in materials, novel spintronic devices, quantum sensors, and solid-state realizations of quantum computation. Dr. Flatté is a fellow of the American Association for the Advancement of Science and the American Physical Society.