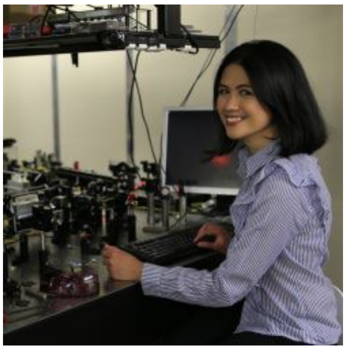
Light Shapes: Quantum Entanglement Levels Up

2025 AIP Einstein Lecture

MACQUARIE University

Speaker

Associate Professor Jacqueline Romero



Associate Professor Jacqueline Romero is an expert in experimental photonic quantum information. Her research focuses on using higher-dimensional systems for exploring curious quantum physics phenomena and developing future quantum technologies. She is the group leader of the research team Qudits@UQ.

Born and raised in Manila, Philippines, Jacq googled “quantum physics” after overhearing the term from her high school physics teacher — and has been hooked ever since. She holds a PhD from the University of Glasgow where she was a researcher for seven years, moving to the University of Queensland in 2015, where she is currently an Associate Professor.

Her many prestigious awards and fellowships include a 2016 ARC DECRA, a 2019 Westpac Research Fellowship, the 2019 L'Oreal-UNESCO for Women in Science International Rising Talent Award and the Ruby Payne-Scott Medal from the Australian Institute of Physics in 2018 for excellence in early-career research.

Associate Professor Romero is a Chief Investigator at the ARC Centre of Excellence for Engineered Quantum Systems (EQUS) and Deputy Director of the ARC Industrial Transformation Training Centre on Current and Emergent Quantum Technologies (CEQuTech). Outside work, she is a busy mum to three boys, and an occasional painter.

Abstract

Quantum entanglement has been called “the quintessential quantum phenomenon,” and it involves a fascinating connection between particles that exists only in the quantum world, between the tiniest, sub-atomic building-block particles of matter, energy and light. Einstein famously called quantum entanglement ‘spooky action at a distance.’

This talk is an introduction to quantum entanglement, its importance and implications. Photons - single particles of light - have played a crucial role in experiments that proved entanglement is real.

Most quantum computing focuses on photons as simple binary units called qubits (quantum bits). However, photons are not limited to representing the ubiquitous qubit; photons are rich physical systems that are naturally high-dimensional.

When photons form shape patterns (called transverse modes), they can carry more complex information in the form of Qudits. These qudits are higher-dimensional quantum information carriers that open up exciting, expanded new possibilities for quantum technologies.

In this presentation, we’ll explore these higher-dimensional quantum systems, how they become entangled with each other, and the promising ways they might transform future technologies - from ultra-secure communications to more powerful quantum computers.