Researchers make leap in measuring quantum states

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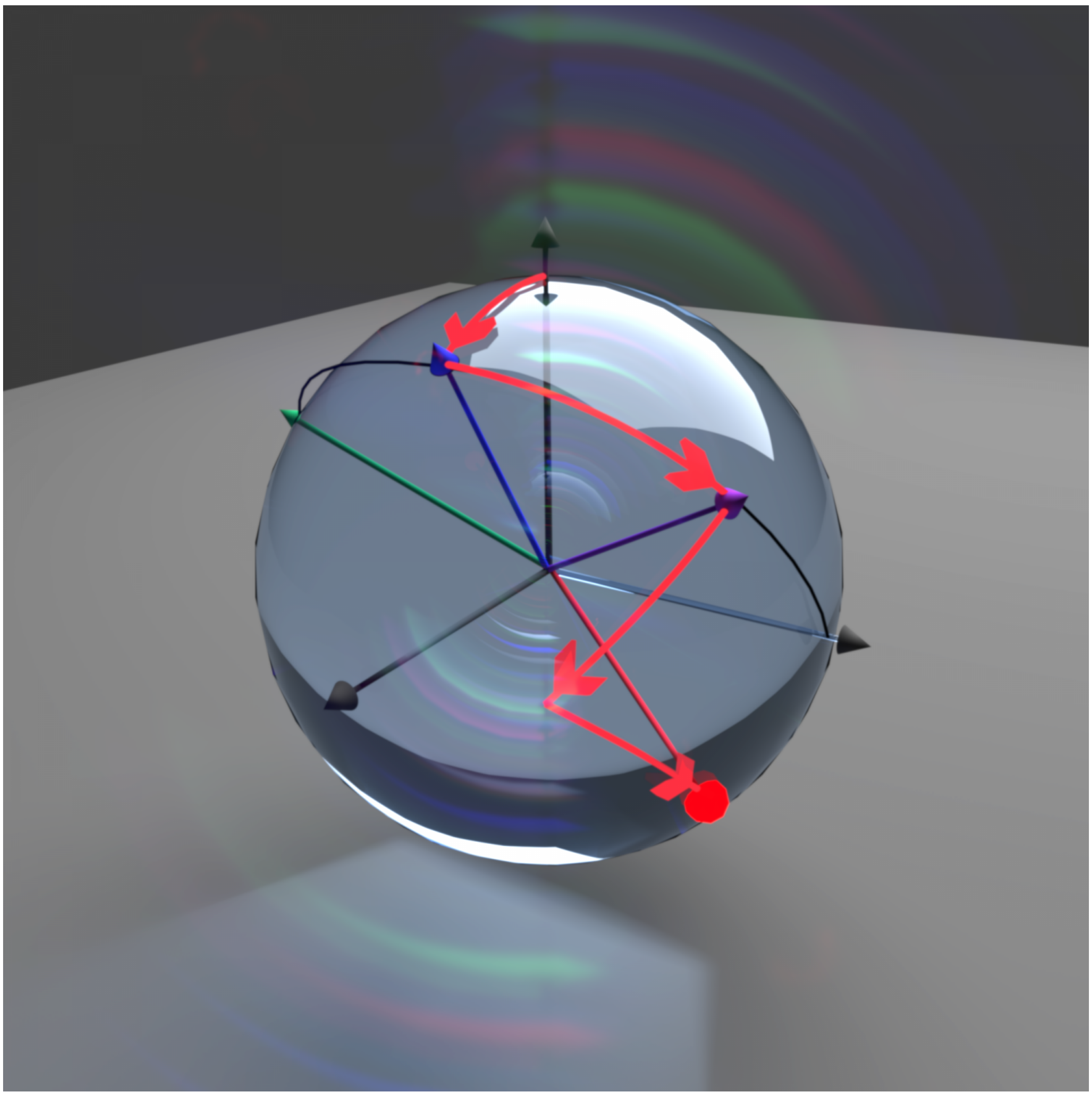

The unknown quantum state is shown as a red dot on the Bloch sphere. The algorithm estimates the gradient performing measurements with the green and purple projectors, updates the current estimate of the state (red line), and repeats until the desired accuracy is achieved. Credit: RMIT University

A breakthrough into the full characterisation of quantum states has been published today as a prestigious Editors' Suggestion in the journal *Physical Review Letters*.

The full characterisation (tomography) of quantum states is a necessity for future quantum computing. However, standard techniques are inadequate for the large quantum bit-strings necessary in full scale quantum computers.

A research team from the Quantum Photonics Laboratory at RMIT University and EQuS at the University of Sydney has demonstrated a new technique for quantum tomography—self-guided quantum tomography—which opens future pathways for characterisation of large quantum states and provides robustness against inevitable system noise.

Dr Alberto Peruzzo, Director of the Quantum Photonics Laboratory, said: "This is a big step forward in quantum tomography. Our technique can be applied to all quantum computing architectures in laboratories around the world."

"Characterising quantum states is a serious bottleneck in quantum information science. Self-guided quantum tomography uses a search algorithm to iteratively 'find' the quantum state.

"This technique significantly reduces the necessary resources by removing the need for any data storage or post-processing."

Robert Chapman, lead author and RMIT PhD student, said the technique employed was far more robust against inevitable noise and experimental errors than standard techniques.

"We experimentally characterise quantum states encoded in single photons—single particles of light.

"Photons are a strong candidate for future quantum computing, however, our method can be applied to other quantum computing architectures, such as ion traps and superconducting qubits.

"Any experiment suffers from measurement noise which degrades results. In our experiment, we engineer the level of noise up to extreme levels to test the performance of our algorithm. We show that self-guided quantum tomography is significantly more robust against noise than standard tomography.

"We hope research groups can employ our technique as a tool for characterising large quantum states and benefit future quantum technologies."

The research, "Experimental demonstration of self-guided quantum tomography", has been published in *Physical Review Letters* and can be accessed online.

Provided by RMIT University