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Mile Gu is New Zealand physicist conducting research on interfacing aspects of quantum and complexity science. He obtained a PhD in quantum computing at the University of Queensland, where he pioneered analytical evidence of emergence – the idea that certain properties of macroscopic systems cannot be computed directly from microscopic laws. Gu then conducted research at the Centre for Quantum Technologies, where his work in identifying quantum resources beyond entanglement was named research highlight of the month at the National University of Singapore. Gu subsequently joined the Institute for Interdisciplinary Information Sciences at Tsinghua University under the China One Thousand Talents Program. His other notable scientific contributions include joint connecting quantum complexity to paths of free fall in general relativity, and identifying quantum phases with different computational power and joint proposal of a new model of quantum computation that is now employed to build ultra-large entangled states of light.

In 2016, Gu returned in Singapore as a National Research Foundation Fellow, and works jointly at the Complexity Institute and the School of Physical and Mathematical Sciences at Nanyang Technological University, and the Centre for Quantum Technologies. He currently heads the quantum and complexity science initiative - which seeks to explore how complexity science generalizes in a quantum world (www.quantumcomplexity.org).

Quantum simplicity: Can quantum mechanics better isolate the causes of natural things?

Quantitative science relies on mathematical abstraction – the capacity to infer patterns from observational statistics, and thereby build causal models that describe how past observations affect future expectations. In the spirit of Occam's razor, the better we isolate the potential causes of future behaviour, the greater our understanding. This privileges simpler models. Should two models make identical predictions, the one that requires less input information is preferred.

Yet, for almost all processes, even the provably simplest classical models remain wasteful. They demand extraneous input information that is uncorrelated with future observations. In this presentation, I outline how we can harness the unique quantum effects to reduce this waste beyond classical limits. I describe quantum models make equally accurate predictions while requiring less information about the past than any classical counterpart, and recent efforts to realize these models in the laboratory conditions.

I discuss how these advances may fundamentally change what we consider in nature of be complex. Certain observed phenomena may appear to require tracking immense amounts of information to model classically, and yet remarkably little information quantum mechanically. Thus, existing notions of structure, complexity, and exactly what is difficult to model may change drastically in the advent of quantum technology.