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A Snapshot of Mathematics in the Second Quantum Revolution

We are in the midst of an exciting revolution in quantum science and technology, comparable in ways to the first one that occurred about 100 years ago. One of the most tantalizing and potentially disruptive innovations to emerge from this second revolution is the prospect of quantum computing. Serious attempts in both academia and industry to design practical quantum computers are pushing physical materials to their extremes. The rise of quantum materials, influenced in part by these attempts, has involved new perspectives and tools not only from physics, chemistry, and material science, but also from mathematics — and not only applied mathematics, but also pure mathematics. I will discuss my work over the past half decade in using ideas from pure mathematics — especially from complex algebraic geometry and Riemann surfaces — to anticipate new models of quantum materials as well as new paradigms for programming quantum devices that would result from these materials. I will explain, with lots of pictures, not only the mathematical and scientific ideas here, but also how the path to fabrication and actualization has led to exciting interdisciplinary collaborations between mathematics and other sciences and between academia and industry.