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Cleaning up a Quantum Material: from Quantum Enigma to Quantum Oscillations

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Sr_2RuO_4 is the most disorder-sensitive superconductor known. It has also been a leading candidate for a novel type of quantum computer that would enable calculations to occur over much longer time scales before suffering decoherence than is the case for today's superconductor-based quantum computers. Establishing whether Sr_2RuO_4 is viable for such applications would be aided by the ability to make structures containing superconducting Sr_2RuO_4 films.

Achieving superconducting Sr_2RuO_4 films was an enigma for over 15 years. PARADIM's in-house research team recently became the only group in the United States to synthesize superconducting thin films of Sr_2RuO_4. The temperature at which PARADIM's Sr_2RuO_4 films superconduct is nearly twice as high as the best prior superconducting Sr_2RuO_4 films and is comparable to the best Sr_2RuO_4 single crystals.

To get an idea of whether the relatively high T_c observed in PARADIM's Sr_2RuO_4 thin films can be attributed to film cleanliness or something else, quantum oscillation measurements were made. The electronic structure of Sr_2RuO_4 films and single crystals were found to be nearly identical, but important differences arise from the types of defects in thin films (out-of-phase boundaries) versus in single crystals (point defects).

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