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Are High-Temperature Quantum Materials Possible? Lesson Learned from Room Temperature Superfluorescence in Perovskites

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As the demand for quantum approaches in computing, communication and cryptology is increasing, the need for discovering new "**quantum materials**" is at an unprecedented level. Quantum materials is a term that is used to describe matters exhibiting quantum properties suitable for a target application. While for most applications the required quantum properties are known, the designer rules for producing these materials are not clear and quantum materials functioning at room temperature is almost non-existent. Quantum coherence, i.e., the phase stability of a superposition state, is the fundamental requirement for quantum applications. For instance, a key requirement for quantum materials for quantum computing applications is a long-lived coherence, i.e., long dephasing times, which can currently only be achieved at mK temperatures, limiting the use of these materials to cryogenic conditions. In fact, coherence is one of the most important requirements for observing quantum phenomena. For example, superconducting materials used for quantum computers require an extremely low temperature operation, and superconductivity, similar to other macroscopic phase transitions, such as superfluorescence and Bose-Einstein condensation, is a symmetry breaking process that requires a collective phase in an ensemble. Therefore, these phenomena are only observed at cryogenic conditions.

Since quantum phase is extremely fragile due to thermal scattering events, we have the following fundamental questions: Are thermal processes really a fundamental roadblock for designing quantum materials with extended coherence? Is there a way to protect quantum coherence in spite of thermal scattering? Based on our recent discovery of high temperature superfluorescence in hybrid perovskites, we believe that it is possible to protect the quantum phase of a quantum system by isolating it from ambient thermal interactions by using a mechanism similar to vibrational isolation in classical mechanical systems. I will present our model using our recent experimental results on room temperature superfluorescence in hybrid perovskite thin films, and my perspective for designing quantum materials at high temperatures.

Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

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