Toward Realization of Novel Quantum Materials via Magneto-Synthesis

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It has been widely recognized that whoever controls the development of novel materials controls technologies that evolve from them. The science and technology of materials synthesis are at the heart of the discovery, design, and realization of novel quantum materials that underpin quantum technologies. The current lack of clear-cut material realizations of many long-sought quantum materials expected to underpin novel technologies strongly suggests that daunting materials challenges will hinder advances in the development of quantum technologies, such as realistic quantum computers in future decades. There is a clear indication that existing synthesis techniques are inadequate. Left unaddressed, these urgent material challenges will hinder the advancements of revolutionary new quantum technologies. New synthesis technologies capable of producing novel materials are urgently needed. This project offers a timely response to the materials challenges by advancing the science and technology of materials fabrication in magnetic fields via magneto-synthesis. Our preliminary results indicate that magnetic fields can not only “edit” crystal structures via Lorentz forces but also produce new phases by taking advantage of the dependence of the Gibbs free energy on the applied magnetic field. Our study finds that magneto-synthesis works particularly well for quantum materials with strong spin-orbit interactions and near-degeneracies, which offers control of structural and physical properties unattainable by other means. The results along with experimental details will be presented and discussed.