



Colorado Science and Engineering Fair

2024 Individual Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: Toward Realization of Novel Quantum Materials via Magneto-Synthesis

Finalist's Name: Tristan Cao

School and City: Stargate Charter School, Thornton

Sponsor's Name: Qi Zhou

Category: Physics & Astronomy (PHYS)

Division: Senior (9th - 12th grades)

Abstract (250 words or less):

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 materials challenges will hinder the development of revolutionizing 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 clearly 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 exquisite control of structural and physical properties unattainable by other means. The results along with experimental details will be presented and discussed.

I hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I also attest that the above properly reflects my own work.

Finalist's Signature:

Date:

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with you Finalist Verification/Permission Form. A signed copy of this form must be included in your notebook.