**Directorate/Division:** Emerging Frontiers Office (BIO/EF)  **Opportunity:** NSF 25-XXX

**Title:** Sustainable Topological Chitin from Genetically Modified Shrimp Grown in Copernicus Crater

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**Summary:** In recent years, we observe rapid growth of interest in topological properties of matter. Fundamental research is required before harvesting of such properties becomes possible. Novel functional topological materials that can be grown quickly and at low cost are needed. Here, we offer a way to synthesize large quantities of topological chitin, which when grown in reduced gravity becomes an intrinsic nontrivial bulk insulator, with metallic spin-momentum locked topologically protected surface states. Optimum conditions for synthesis will be established to maximize the spin-orbit interaction and reproductive cycle of shrimp. Results will help solve Earth’s quantum computing problems by providing a new platform for Majorana’s shrimp cocktail zero-bias modes for topological quantum computing.

**Intellectual Merit:** We are facing a shortage of rare-earth based materials for topological systems, required by the continuously growing needs of quantum computing. Fundamental research of novel materials is needed to unravel the mysteries of topological states and enable predictive power and control of desired properties. Currently, two directions of research are pursued. One is devoted to chitin, a long-chain polymer of N-acetylglucosamine, harvested from cephalophod beaks. When under stress of obligatory watching the news, cephalophods produce chitin with strong spin – orbit coupling, leading to band inversion and appearance of a wide bulk gap. Topological surface states then appear inside the gap. This stress-engineering approach is widely criticized by animal right activists. Another option includes harvesting scales of large specimens of Oyster Toadfish. Unfortunately, the Oyster Toadfish union recently implemented a world-wide scales export embargo. Here we propose a new approach, based on collecting of the endings of Penaeus Monodon shrimp tails, grown under conditions of Moon gravity, which assures appearance of topological states on the surface of chitin. Harvesting is done without harming the animals, which are suspended in underground tanks and equipped with individually fitted breathing apparatus.

**Broader Impacts:** Results of this research will impact the field of topological quantum computing by providing cheap and sustainable source of novel topological materials. Society will benefit from proliferation of affordable quantum computing technologies. Educational activities will include curriculum development and mentoring for shrimp, and inclusion of Wookie trainees from nearby High Schools and Asteroids in laboratory work. Research opportunities for Jedi candidates with low midichlorian count will be created. Outreach to local communities will include presentations of physics experiments at a local Museum, coaching and mentoring of college candidates and setting up a web-based platform for dissemination of short movies about topological materials research and shrimp life.

**Project Description:** In the first year of proposed study we will test the surface density of states, spin texture, and energy-momentum dependence of the Dirac bands as a function of pressure, doping of water with nutrients, and photon flux. We expect that the interactions of multiple degrees of freedom present in the chitin structure can be tuned to result in optimum location of the Dirac point of the topological bands. In the second year we will utilize this state to prepare a new platform for Majorana’s shrimp cocktail zero-bias modes, and demonstrate braiding of the modes. Third year will be devoted to integrating the platform with classical readout and programming electronics and demonstration of topological shrimp quantum computing. Theoretical models of shrimp tail dynamics will be developed and used to inform the experimentation. Cost of the project is kept to minimum by including one month salary for the PI, costs of one graduate student, occasional travel to Tatooine, and modest amounts of fuel for the Millennium Falcon. Results will be freely distributed throughout the Galactic Empire by subspace communications.