A Practical Twist on Condensed Matter

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We are generally more familiar with the beauty of images that showcase the natural world and the heavens than with the beauty inside materials. Advances in theoretical insights, experimental techniques, and reconstruction algorithms, however, now allow us to explore this beauty in condensed matter.

Polymers and ferroelectric ceramics host elegant twist patterns due to competition between electrostatic and elastic energies and their gradients. Chiral liquid crystals display patterns of molecular orientation due to intermolecular elastic and Coulombic interactions, and sometimes also due to bounding surfaces. Magnetic materials can play host to interatomic interactions that stabilize axisymmetric whirls of spin.

Efforts to control the size, density, and dynamics of these patterns inspire applications [1-3]. The collective motions of chiral patterns in liquid crystals could model biological systems. A chiral magnet may offer high-density data storage and reconfigurable analogue logic arrays capable of mimicking neural networks. Other applications include nanoscopic microwave oscillators and topologically resilient quantum entangled states of light.

I will discuss this elegance and its technological practicality via the materials and device architectures we developed recently. Including quantifiable insights toward the stability and dynamics of spin textures and their viability to influence a superconductor for adaptable recipes for fluxonics and chiral superconductivity [4,5]. Time permitting, I will also talk about patterns that develop quantized helicity excitations, offering a new class of building blocks for realizing quantum logic elements [6].

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Brief biography: Christos Panagopoulos received his PhD from the University of Cambridge (Trinity College) in 1997. He is currently Professor of Physics and Applied Physics, the inaugural University Research Professor at the Nanyang Technological University, and the inaugural Investigator of the National Research Foundation, Prime Minister's Office, Singapore. He develops materials possessing complex quantum structure, measurement techniques that provide multiple length-scale and time-scale windows, and theoretical insights into how the wavefunction geometry and topology affect materials performance. Leveraging these capabilities, he connects the quantum architecture of materials with new device responses.