**Topological photonic crystals realized using connected and nested structures**

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We explore the physics of photonic crystals/meta-crystals, whose structure is determined by connectivity. We illustrate this concept with some examples. The first example focuses on a new type of photonic crystal comprising a 3D nested structure composed of co-axial waveguides that connect high-symmetry sites within a space group. These meta-crystals exhibit photonic dispersions similar to scalar waves while possessing vector-wave eigenvectors. This is intriguing because it is commonly believed that the electromagnetic modes in 3D photonic crystals must be explicitly solved as vector waves, rendering the scalar wave approximation inapplicable. However, the nested meta-crystal presents an exception, allowing 3D electromagnetic crystals to exhibit scalar wave dispersions. Consequently, designing topological photonic crystals becomes as simple as performing a tight-binding calculation. These 3D crystals also feature skyrmion-textured surface states with high quality factors within the light cone. We also explore how co-axial cable connected structures can be used to realize photonic non-Abelian topological charges. In these network systems, the bulk topological invariants manifest as non-integer quantities and exhibit non-Abelian properties in 3D or higher dimensions.

**Short Bio:**

C.T. Chan received his PhD degree from the University of California at Berkeley in 1985. He is currently serving as the Associate Vice-President for Research & Development at HKUST. He is also concurrently the Daniel C K Yu Professor of Science, Chair Professor of Physics, and the Director of Research Office of HKUST.