Emerging properties in quantum matter is a major theme of modern physics, with the promise that insights gained would have implications far beyond these materials. This talk will address two interesting examples: topological insulators and high-temperature superconductors.

A class of new quantum matter, so-called topological insulators, has unique properties. It has a symmetry-protected surface state in the absence of time-reversal symmetry breaking, leading to dissipationless edge currents. The strong spin-orbit coupling provides an interesting way to manipulate spin through orbital current. This new class of materials provides a platform for the study of novel physics as well as an opportunity for potential new technologies. After a brief tutorial, angle-resolved photoemission spectroscopy (ARPES) data will be discussed, focusing on the following: i) realization of a large gap topological insulator with a single Dirac cone, ii) creation of a massive Dirac fermion on the surface of a topological insulator with broken time-reversal symmetry, and iii) observation of a single Dirac cone topological surface state in a candidate topological superconductor.

The second part of the talk will report recent advances in the study of cuprate superconductors. It is now exactly 100 years since superconductivity was discovered and it took 45 years before a complete theory was formulated. High-$T_c$ superconductivity was discovered 25 years ago and it remains a major unsolved physics problem today. Recent ARPES results that suggest phase competition is a central piece of the cuprate physics will also be discussed.