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Odd-parity nematic and chiral superconductivity in spin-orbit coupled materials

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Recent experimental advances indicate that superconductivity in doped topological insulator materials such as $Cu_xBi_2Se_3$ is characterized by a full odd-parity pairing gap with spontaneous rotational symmetry breaking. This suggests that the pairing symmetry is unconventional and has two symmetry-related components, akin to unconventional p-wave superconductors with degenerate (p_x,p_y) components. Motivated by these recent experiments, this talk will present a theory of spin-orbit coupled odd-parity superconductors with two-component pairing symmetry. These spin-orbit coupled superconductors can come in two varieties: nematic and chiral. Nematic superconductors spontaneously break the rotational symmetry of the crystal, and are either fully gapped topological superconductors or have Dirac point nodes protected by crystal symmetry. Chiral superconductors spontaneously break time-reversal symmetry, are generally characterized by non-unitary pairing states, and have point nodes. The nodal quasiparticles of chiral superconductors satisfy the Majorana condition and realize Majorana fermions in three dimensions. A comprehensive classification of such Majorana fermions in terms of dispersion and topology will be presented, and experimental signatures as well as candidate materials will be discussed.