On the hunt for topological superconductors

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Topological superconductor (TSC) hosting Majorana bound states (MBS) has been established as a milestone that might shift our scientific trajectory from fundamental research to practical applications in topological quantum computing. Various roadmaps have been proposed in order to realize TSC. One of the intensively studied pathways is the emergence of MBS via proximity effect in systems built from s-wave superconductors and strongly spin-orbit coupled semiconductor nanowires [1], ferromagnetic atomic chains [2], or 3D topological insulators [3]. A promising route towards TSC is through appropriate doping of archetypal topological insulators, such as Bi_2Se_3 [4], or crystalline topological insulators, like SnTe [5]. Another possibility is to induce TSC by external pressure, as achieved, e.g., for Weyl semimetal $MoTe_2$ [6]. Parallel to all these efforts, an intensive search is being conducted for stoichiometric materials, in which TSC will be an intrinsic property emerging at ambient pressure. Most recently, some evidence for such a behavior has been found, e.g., in nematic superconductors $PbTaSe_2$ [7] and $CaSn_3$ [8]. Another strong hope for MBS realization is related to unconventional superconductors with high total angular momentum pairing, predicted teoretically to occur in half-Heusler topological semimetal YPtBi [9].

In my talk, I will present some examples of our own research aimed at identifying novel TSC candidate materials. In particular, I will briefly review our comprehensive experimental studies on superconducting Pd-Bi binaries [10] and rare-earth-based half-Heusler bismuthides [11].

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