Topological Matter, Flat Bands and Room Temperature Superconductivity

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Topological media are fermionic systems whose properties are protected by topology and thus are robust to different perturbations of the system including the interaction. In topological insulators, and in the nodeless topological superconductors and superfluids such as superfluid ^{3}He-B, the bulk-surface and bulk-vortex correspondence gives rise to the gapless Dirac or Majorana fermions on the surface of the system or inside the vortex core. In gapless topological media, the bulk-surface and bulk-vortex correspondence is even more interesting: it produces topologically protected gapless fermions without dispersion – the flat band.[1] Fermion zero modes forming the flat band are localized on the surface of topological media with protected nodal lines, such as cuprate superconductors and graphite-like layered systems, and in the vortex core in systems with topologically protected 3-dimensional Dirac points, such as superfluid ^{3}He-A. Flat band has an extremely singular density of states. This property may give rise in particular to surface superconductivity with an unusually high transition temperature thus opening a possible route for room temperature superconductivity.[2]

[1]T.T. Heikkilä, N.B. Kopnin and G.E. Volovik, Flat bands in topological media, arXiv:1012.0905.
[2]N.B. Kopnin, T.T. Heikkilä and G.E. Volovik, High-temperature surface superconductivity in topological flat-band systems, arXiv:1103.2033.