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Abrikosov Vortex Lattice in 3D Topological Insulator – Superconductor Heterostructures[1] HSIANG-HSUAN HUNG, Department of Electrical and Computer Engineering, the University of Illinois at Urbana-Champaign, TAYLOR HUGHES, Department of Physics, the University of Illinois at Urbana-Champaign, MATTHEW GILBERT, Department of Electrical and Computer Engineering, the University of Illinois at Urbana-Champaign — Majorana fermions have been predicted to exist on the surface of the three-dimensional (3D) topological insulator/s-wave superconductor heterostructures by proximity effects [Phys. Rev. Lett. **100**, 096407 (2008)]. In the diffuse vortex limit, the physics of these non-abelian anyons is theoretically well-understood c.f. Phys. Rev. B **84**, 144507 (2011). However, the dilute vortex limit is unlikely to be available in experimental systems. In this work, we study the dense vortex limit in 3D topological insulator/s-wave superconductor heterostructures using the self-consistent Bogoliubov-de Gennes (BdG) equations under the application of a uniform magnetic flux. We find that as we approach the dense limit of vortices on the surface, that the hybridization between the vortices leads to the formation of a "Majorana bandstructure" which exists within the superconducting gap.We describe the physics of the system as we move from the dilute limit to the the dense limit as we vary the surface chemical potentials and the magnetic field magnitudes.

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