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Entanglement in ground and excited states of gapped fermion systems and their relationship with fermi surface and thermodynamic equilibrium properties MICHELLE STORMS, Ohio Wesleyan University, RAJIV SINGH, University of California, Davis — We study bipartite entanglement entropies in the ground and excited states of model fermion systems, where a staggered potential, μ_s, induces a gap in the spectrum. Ground state entanglement entropies satisfy the "area law," and the "area-law" coefficient is found to diverge as a logarithm of the staggered potential, when the system has an extended Fermi surface at $\mu_s = 0$. On the square-lattice, we show that the coefficient of the logarithmic divergence depends on the fermi surface geometry and its orientation with respect to the real-space interface between subsystems and is related to the Widom conjecture as enunciated by Gioev and Klich (Phys. Rev. Lett. 96, 100503 (2006)). For point Fermi surfaces in two-dimension, the "area-law" coefficient stays finite as $\mu_s \to 0$. The von Neumann entanglement entropy associated with the excited states follows a "volume law" and allows us to calculate an entropy density function $s_V(e)$, which is substantially different from the thermodynamic entropy density function $s_T(e)$ when the lattice is bipartitioned into two equal subsystems, but approaches the thermodynamic entropy density as the fraction of sites in the larger subsystem, that is integrated out, approaches unity.

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