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Maximally Entangled Mode, Metal-Insulator Transition and Violation of Entanglement Area Law in Non-interacting Fermion Ground States MOHAMMAD POURANVARI, KUN YANG, National High Magnetic Field Laboratory and Department of Physics, Florida State University — We study in this work the ground state entanglement properties of two models of non-interacting fermions moving in one-dimension (1D), namely random dimer model and power-law random banded model that exhibit metal-insulator transitions. We find that entanglement entropy grows either logarithmically or in a power-law fashion with subsystem size in the metallic phase or at metal-insulating critical point, thus violating the (1D version of) entanglement area law. No such violation is found in the insulating phase. We further find that characteristics of *single fermion* states at the Fermi energy (which can *not* be obtained from the many-fermion Slater determinant) is captured by the lowest energy single fermion mode of the *entanglement* Hamiltonian; this is particularly true at the metal-insulator transition point. In addition, the inverse-participation ratio of the lowest energy single fermion mode of the *entanglement* Hamiltonian is proportional to that of the single fermion state at Fermi energy in all cases. Our results suggest entanglement is a powerful way to detect metal-insulator transitions, *without* knowledge of the Hamiltonian of the system. Results on metal-insulator transition of 3D Anderson model will also be presented.

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