

Abstract Submitted  
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**Entanglement entropy scaling laws and eigenstate thermalization in free fermion systems**<sup>1</sup> HSIN-HUA LAI, Natl High Magnetic Field Lab, KUN YANG, Natl High Magnetic Field Lab and Florida State University — We demonstrate that the entanglement entropy area law for free fermion ground states and the corresponding volume law for highly excited states are related by a position-momentum duality, thus of the same origin. For a typical excited state in the thermodynamic limit, we further show that the reduced density matrix of a subsystem approaches thermal density matrix, provided the subsystem's linear size is small compared to that of the whole system in all directions. This provides an explicit example of eigenstate thermalization, and reveals how statistical physics emerges from a single eigenstate by tracing out a large number of degrees of freedom.

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