Holographically smeared Fermi surface: Quantum oscillations and Luttinger count in electron stars

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We apply a small magnetic field to strongly interacting matter with a gravity dual description as an electron star. These systems are both metallic and quantum critical at low energies. The resulting quantum oscillations are shown to be of the Kosevich-Lifshitz form characteristic of Fermi liquid theory. It is seen that only fermions at a single radius in the electron star contribute to the oscillations. We proceed to show that the Fermi surface area extracted from the quantum oscillations does not obey the simplest statement of the Luttinger theorem, that is, it is not universally proportional to the total charge density. It follows that our system is a non-Fermi liquid that nonetheless exhibits Kosevich-Lifshitz quantum oscillations. We explain how the Luttinger count is recovered via a field theoretic description involving a continuum of `smeared' fermionic excitations.

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