Flat bands, scanning tunneling microscopy, and the violation of time-reversal symmetry

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The topological fermion condensation of quantum phase transition (FCQPT) paves a new avenue in modern physics. Such a transition belongs to the unique type of quantum phase transitions the originators of the theory of instabilities omitted, and leads to the topological reconstruction of the Fermi surface. We discuss the modification of the systems under the action of FCQPT, representing the "missed" instability, which allows the development of an entirely new approach to or a "second edition" of condensed matter theory, presenting this physics as a completely new method for studying many-body objects [1,2]. Tunneling differential conductivity is a sensitive tool to experimentally test the non-Fermi liquid behavior of strongly correlated Fermi systems. When a strongly correlated Fermi system turns out to be near FCQPT, its Landau Fermi liquid properties disappear so that both the particle-hole and time reversal symmetries break making the differential tunneling conductivity to be asymmetric function of V. Under the application of magnetic field the metal transits to the Landau Fermi liquid state and the differential tunneling conductivity becomes a symmetric function of V. These findings are in good agreement with recent experimental observations [1,2].

1. V. R. Shaginyan, M. Ya. Amusia, A. Z. Msezane, and K. G. Popov, *Scaling behavior of heavy-fermion metals* Phys. Rep. **492**, 31 (2010).
2. V. R. Shaginyan, A. Z. Msezane, V. A. Stephanovich, G. S. Japaridze, and E. Kirichenko, *Flat bands and strongly correlated Fermi systems*, Physica Scripta **94**, 065801 (2019).