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Quantum criticality in non-Hermitian Dirac matter

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Content

In this talk, I will present a quantum field theoretical framework for describing non-Hermitian (NH) Dirac materials, where effects of the coupling to an environment are encoded via an anti-Hermitian deformation of Lorentz-invariant Dirac operators obtained by invoking purely Hermitian mass terms [1]. Such Lorentz-invariant Dirac operators describe symmetry-protected NH Dirac semimetals with real or imaginary linear dispersion and a vanishing density of states at zero energy.
Within this framework, I will first discuss quantum critical behavior of such NH Dirac semimetals driven by strong local electron-electron interactions. Remarkably, the system can either retain its non-Hermitian character or dynamically restore Hermiticity at criticality, depending on the commutation relations between the NH Dirac operator and the mass order parameter. In particular, when the two operators anticommute, the system decouples from the environment and effectively becomes Hermitian and Lorentz invariant, while in the commuting case, non-Hermiticity remains robust, featuring an emergent Yukawa-Lorentz symmetry, characterized by a shared terminal velocity for both fermionic and bosonic excitations. Furthermore, I will also analyze the role of tilt in NH Dirac materials, with a focus on its interplay with interaction effects [2]. Finally, I will discuss how the tilt may serve as a probe of non-Hermiticity in these systems [3].
References:
[1] V. Juričić and B. Roy, Comm. Phys. 7, 169 (2024). [2] S. Pino-Alarcón and V. Juričić, Phys. Rev. B 111, 195126 (2025). [3] S. Pino-Alarcón, J.P. Esparza, and V. Juričić, in preparation.

Primary author(s) : VLADIMIR, JURICIC (UTSFM)

Presenter(s) : VLADIMIR, JURICIC (UTSFM)