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New universality classes of the non-Hermitian Dirac operator in QCD-like theories

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In non-Hermitian random matrix theory there are three universality classes for local spectral correlations: the Ginibre class and the nonstandard classes $AI^\dagger$ and $AII^\dagger$. We show that the continuum Dirac operator in two-color QCD coupled to a chiral U(1) gauge field or an imaginary chiral chemical potential falls in class $AI^\dagger$ ($AII^\dagger$) for fermions in pseudoreal (real) representations of SU(2). We introduce the corresponding chiral random matrix theories and verify our predictions in lattice simulations with staggered fermions, for which the correspondence between representation and universality class is reversed. Specifically, we compute the complex eigenvalue spacing ratios introduced recently. We also derive novel spectral sum rules.

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