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## Wilson Fermions, Random Matrix Theory and the Aoki Phase

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The QCD partition function for the Wilson Dirac operator,  $D_W$ , at finite lattice spacing a can be expressed in terms of a chiral Lagrangian as a systematic expansion in the mass, the momentum and  $a^2$ . Starting from this chiral Lagrangian we obtain an analytical expression for the spectral density of  $\gamma_5 D_W$  in the microscopic domain (also known as the ]*epsilon*-domain). It is shown that the  $\gamma_5$ -Hermiticity of the Dirac operator necessarily leads to the sign of the coefficient of the  $a^2$  term that allows an Aoki phase. The transition to the Aoki phase is explained in detail, and the interplay of topological charge and finite a is discussed. Finally, we formulate a random matrix theory for the Wilson Dirac operator in the sector of topological charge  $\nu$ . It is shown by an explicit calculation that this random matrix theory reproduces the  $a^2$ -dependence of the chiral Lagrangian in the microscopic domain and that the sign the  $a^2$ -term is directly related to the  $\gamma_5$ -hermiticity of  $D_W$ .

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talk

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