

LEILAT04

Density Profiles of the Lowest Eigenvalues of the Dirac Operator for Two-Color QCD at Finite Density Compared to Matrix Models

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THEORY

QCD Dirac operator:

(imaginary eigenvalues)

$$M_{xx'}^{aa'} = \frac{1}{2a} \sum_{\nu} \Gamma_{x\nu} [\delta_{x+\hat{\nu},x'} U_{x\nu}^{aa'} - \delta_{x,x'+\hat{\nu}} U_{x'\nu}^{\dagger aa'}]$$

Adding a chemical potential:

(complex eigenvalues)

$$M_{xx'}^{aa'}(U, \mu) = \frac{1}{2a} \sum_{\nu=\hat{x},\hat{y},\hat{z}} [\Gamma_{x\nu} \delta_{x+\nu,x'} U_{x\nu}^{aa'} - \text{h.c.}] \\ + \frac{1}{2a} [\Gamma_{xi} e^{\mu} \delta_{x+\hat{i},x'} U_{xi}^{aa'} - \Gamma_{xi} e^{-\mu} \delta_{x,x'+\hat{i}} U_{x'i}^{\dagger aa'}]$$

Adjoint fermions:

$$U_{\nu\mu}^{adj} = \frac{1}{2} \text{Tr} (U_{x\mu}^{\dagger} \tau_{\nu} U_{x\mu} \tau_{\nu})$$

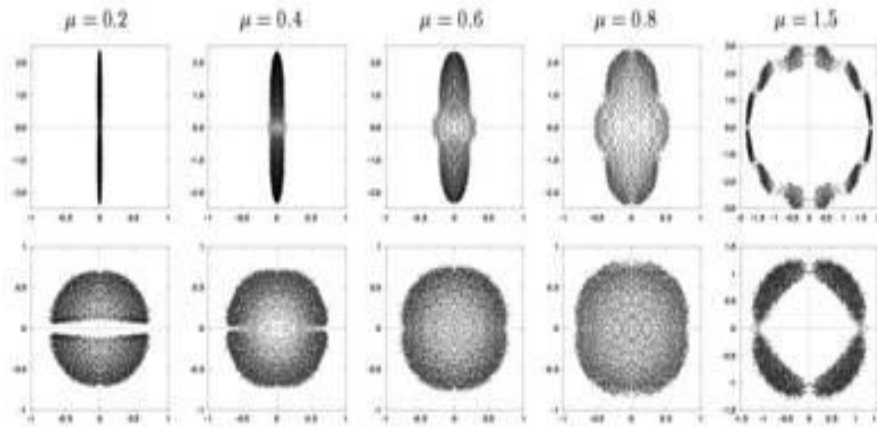


Figure 1. Upper plots: Complex eigenvalues of the Dirac operator at various values of μ for a typical equilibrium configuration of two-color QCD (horizontal axes = real parts, vertical axes = imaginary parts, in units of $1/a$). Lower plots: Same for the "Gor'kov operator".

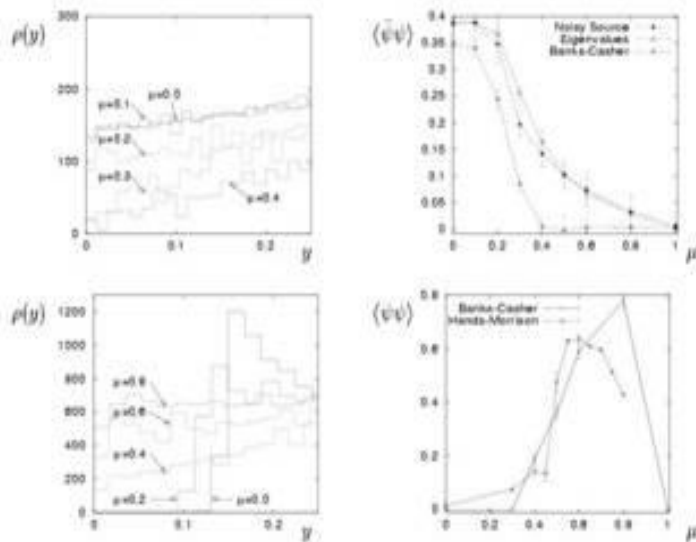
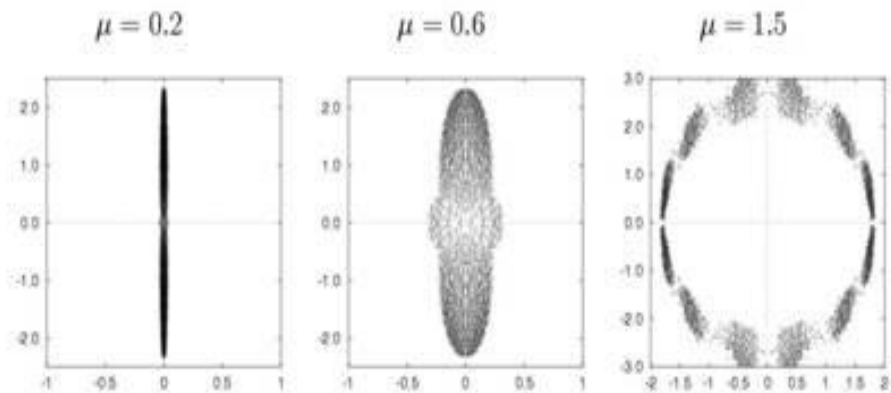


Figure 2. Upper plots: Density $\rho(y)$ of small eigenvalues of the Dirac operator for two-color QCD on a 6^3 lattice from $\mu = 0$ to 0.4 (left). The loss of quasi-zero modes is accompanied by a vanishing of the chiral condensate. Chiral condensate extracted by different methods (right). Lower plots: Similar for the "Gor'kov operator". (see text).

RESULTS

Dirac Spectra

Fundamental



Adjoint

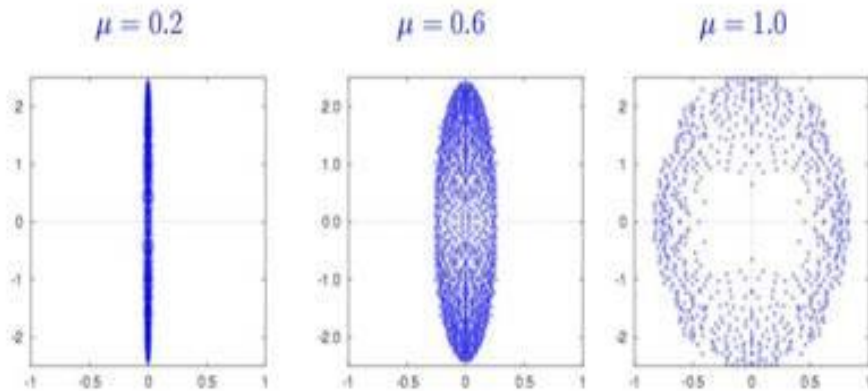
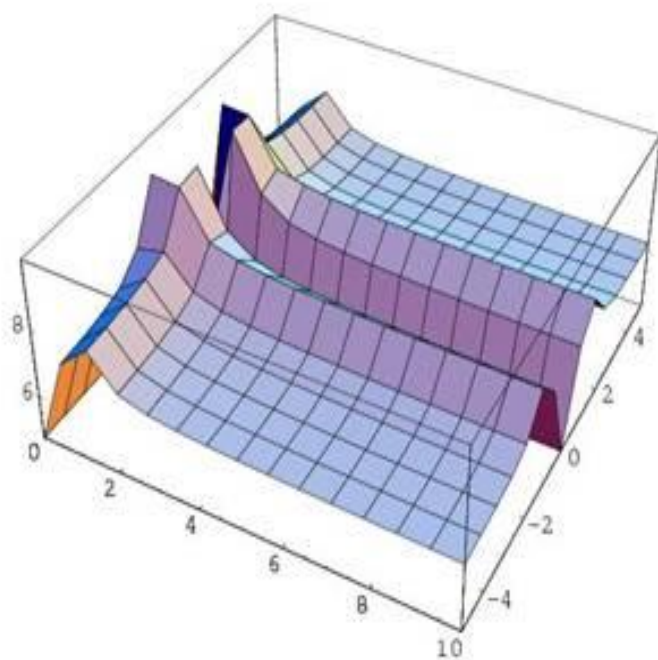
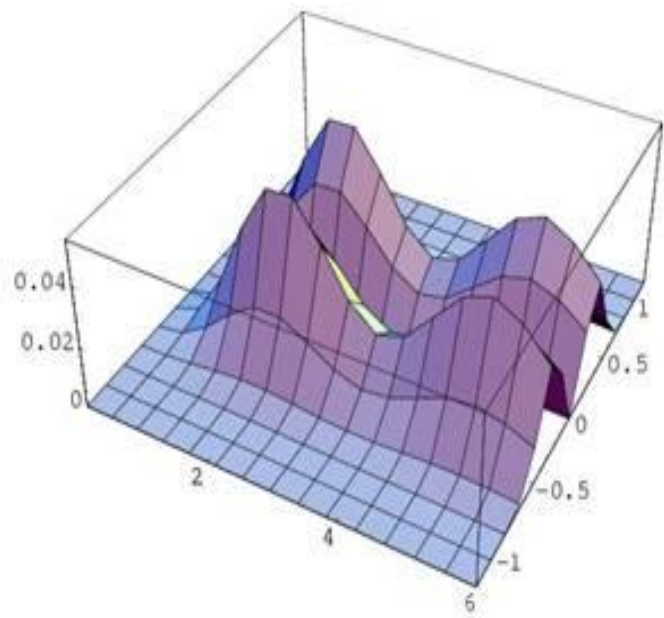
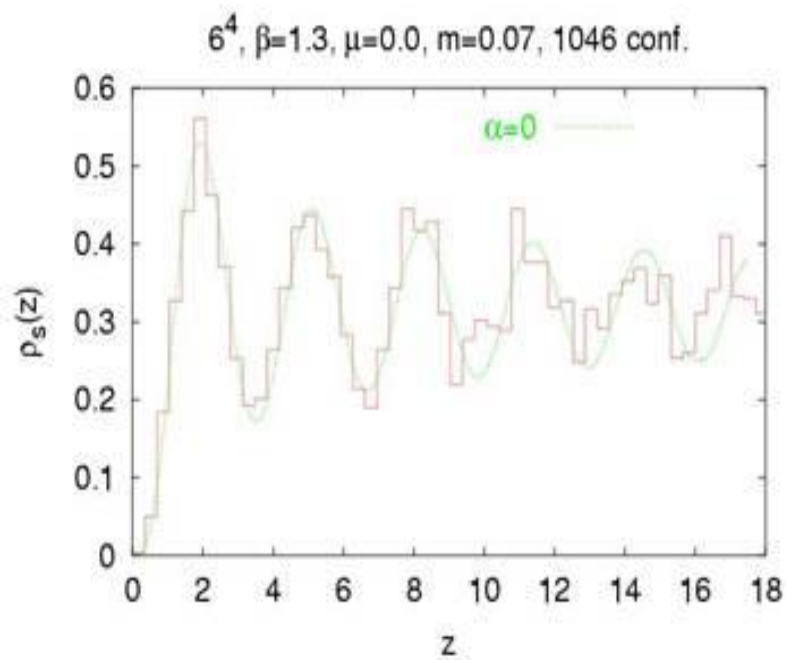
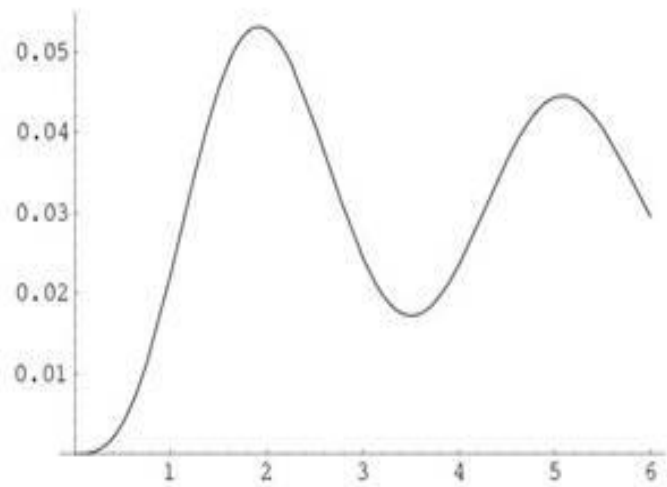
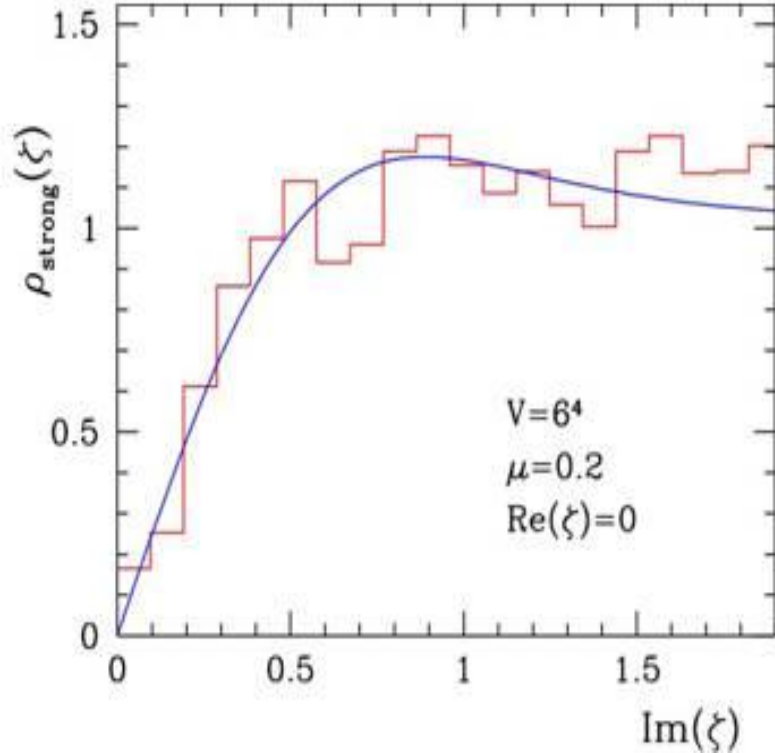
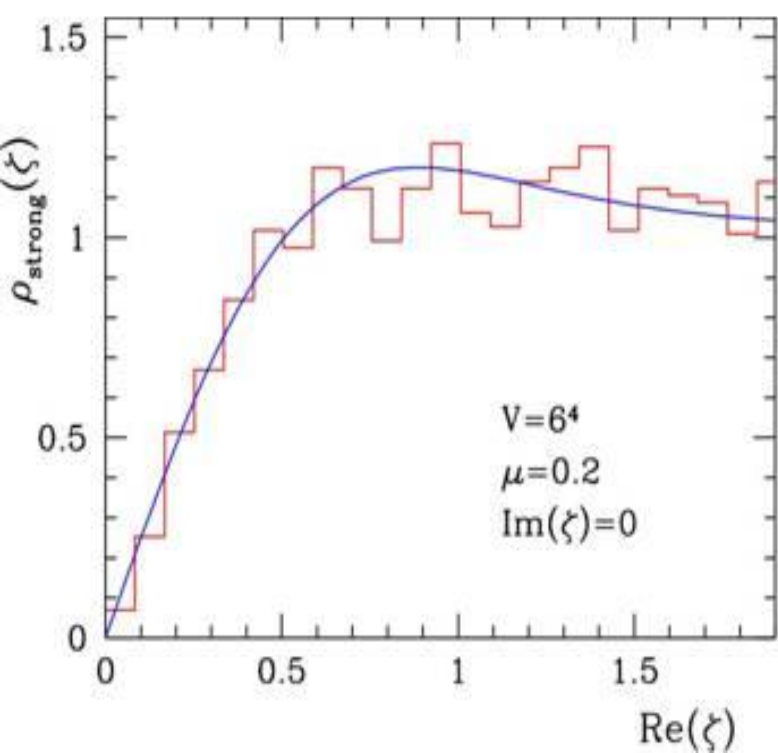
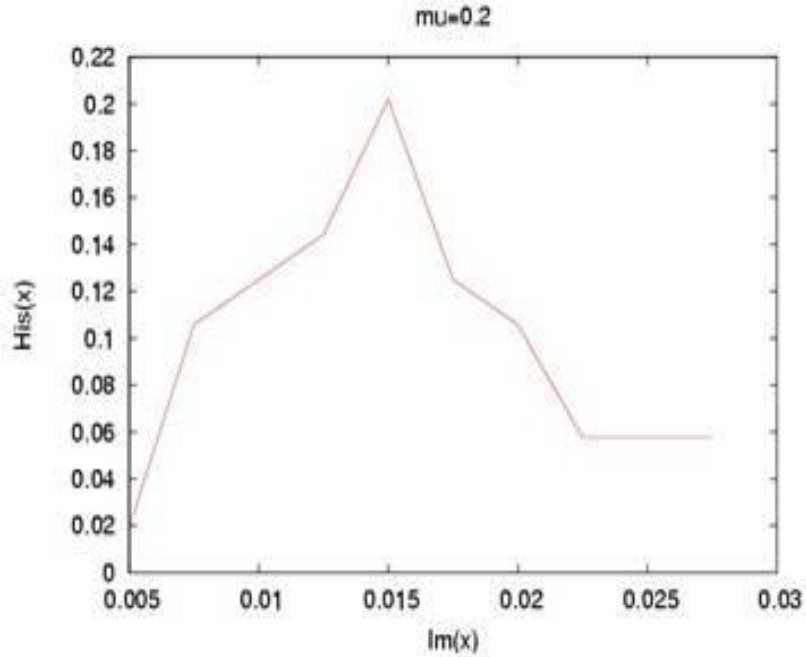
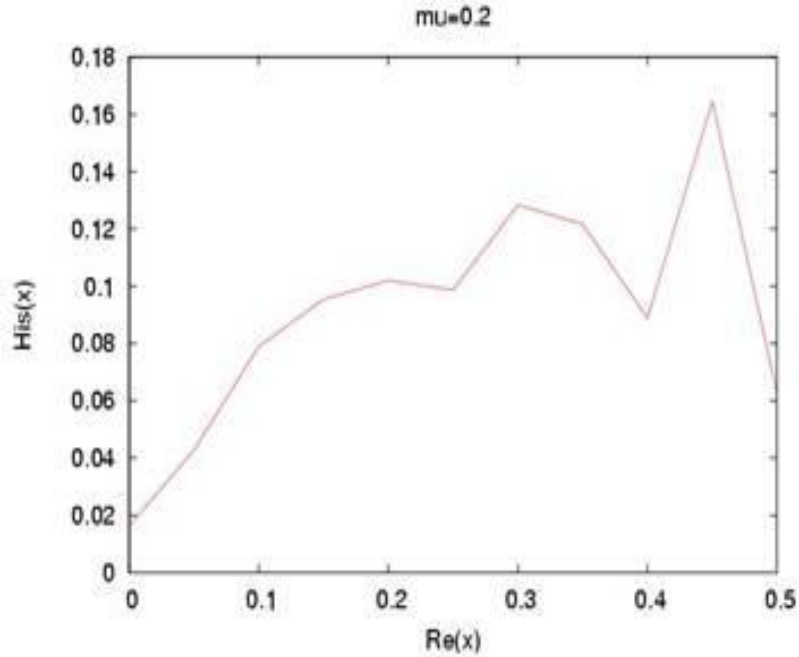
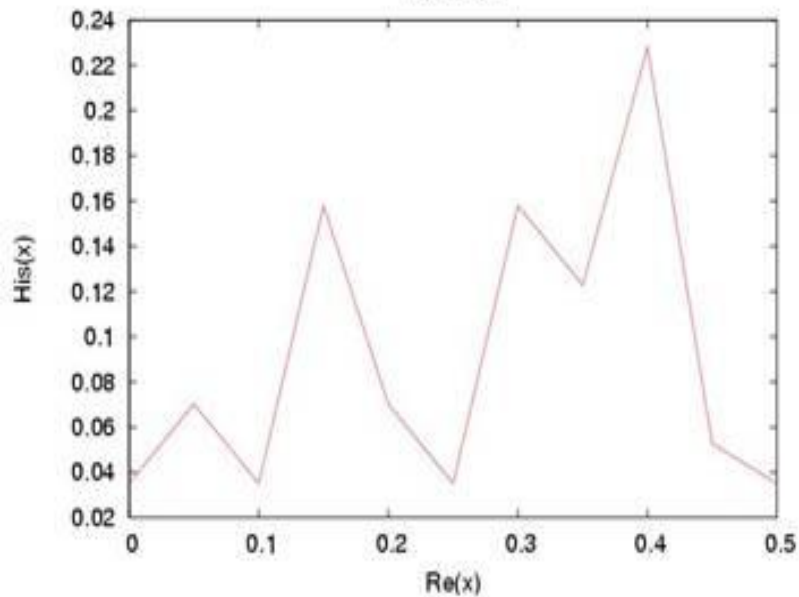
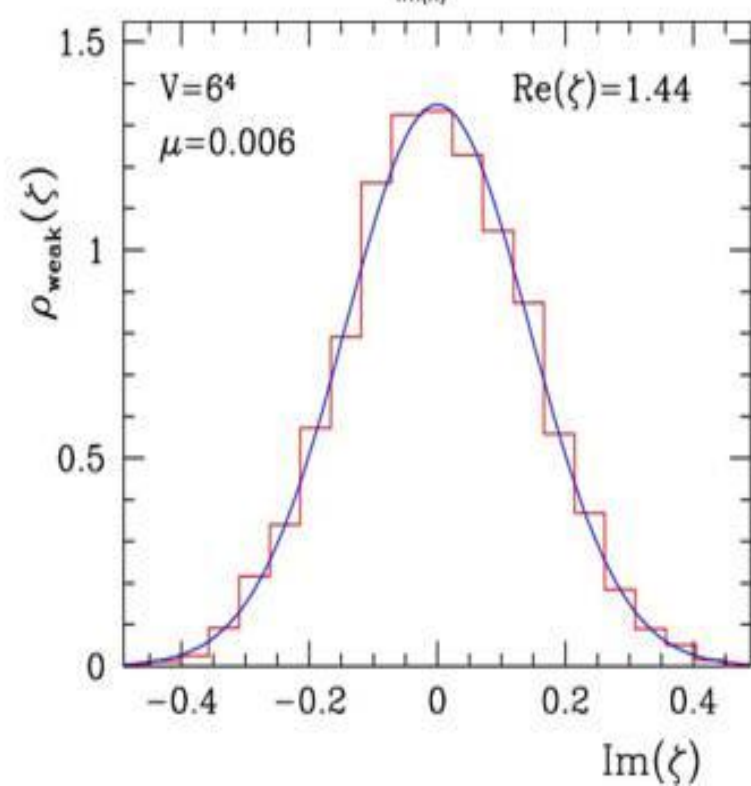
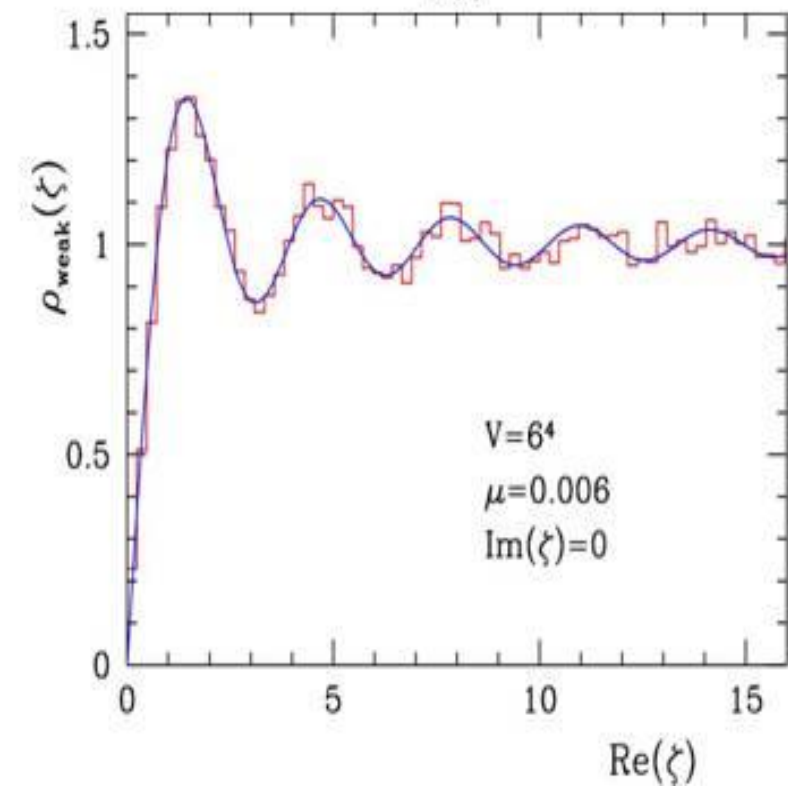
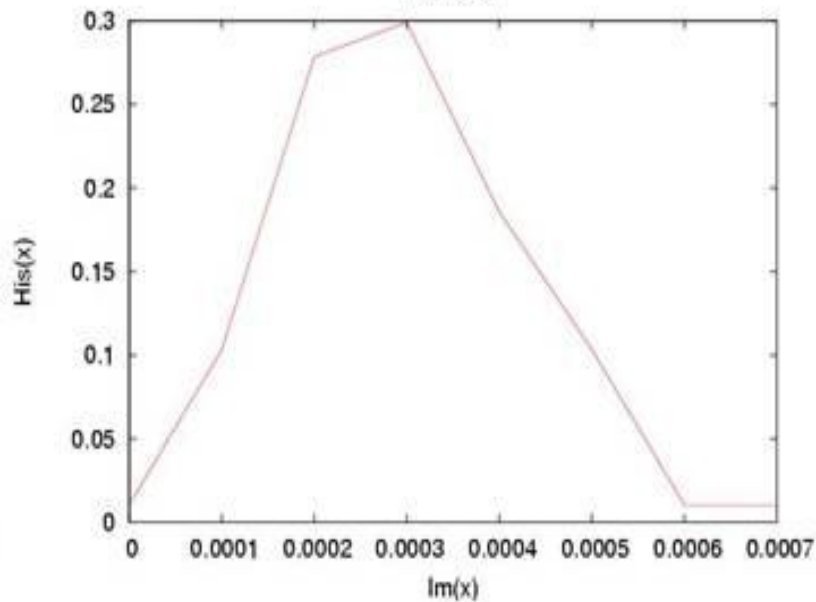
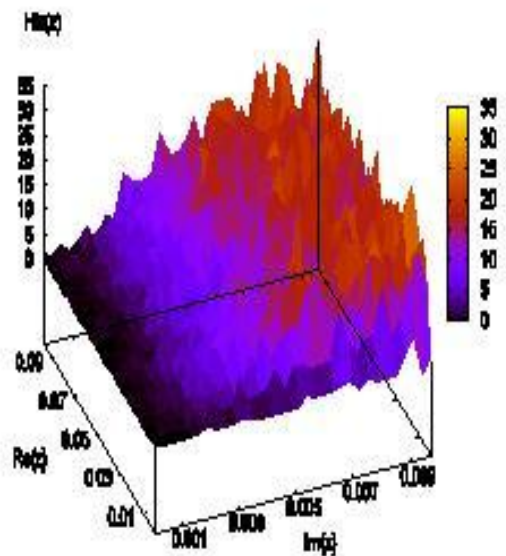
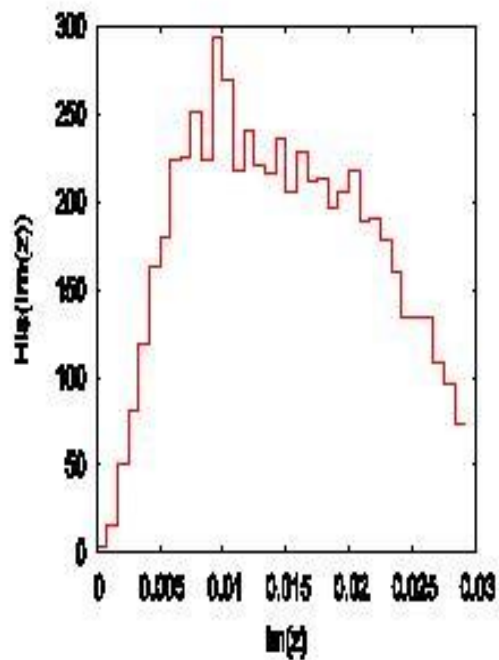
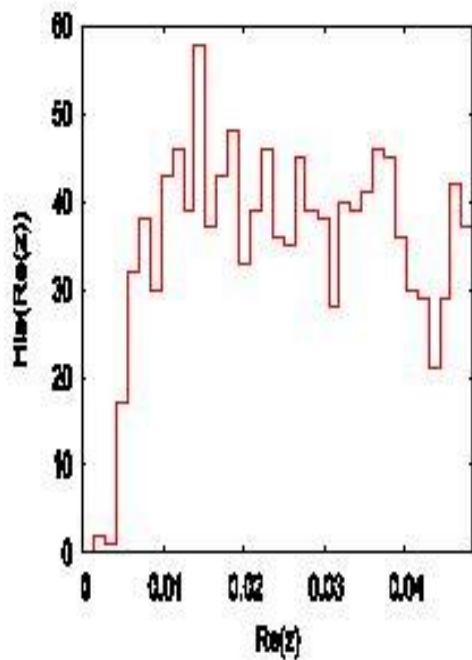
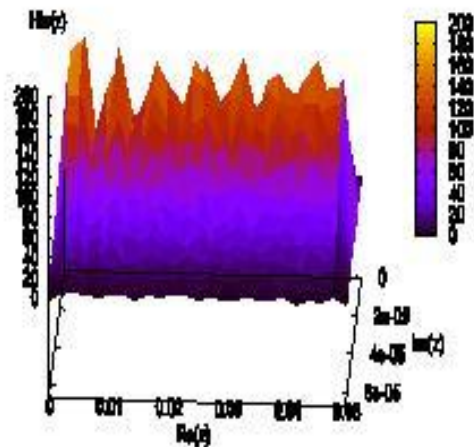
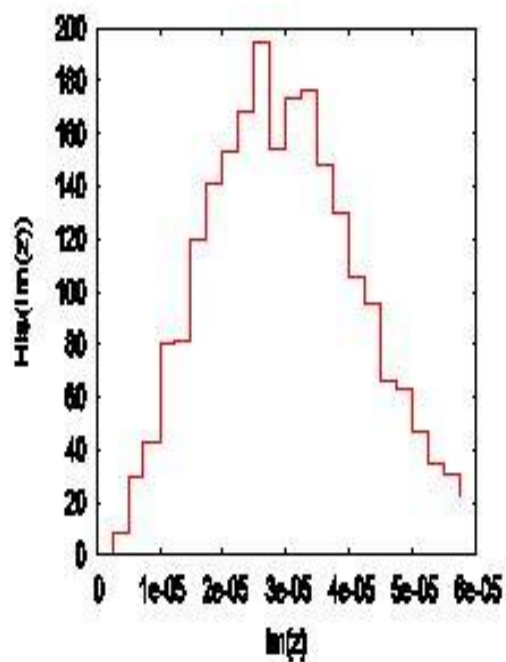
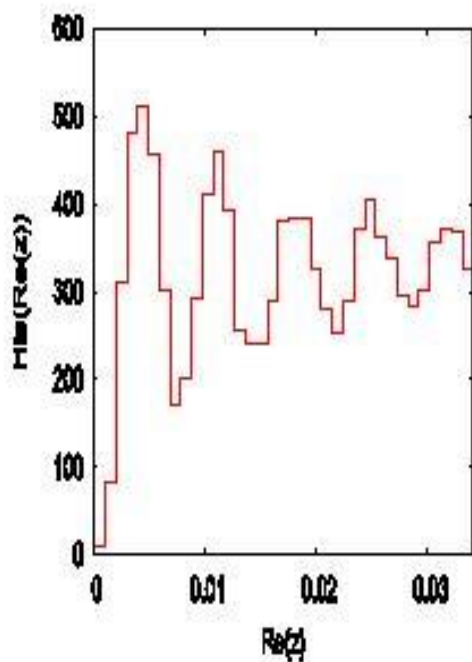


Figure 1: Upper plots: Complex eigenvalues of the Dirac operator for fundamental fermions coupled to a typical equilibrium configuration of two-color QCD at various values of μ (horizontal axes = real parts, vertical axes = imaginary parts, in units of $1/a$). Lower plots: Adjoint fermions.





$\mu=0.01$  $\mu=0.01$ 



Conclusion for Lowest Eigenvalues of Dirac Operator for 2-Color QCD at Finite Density Compared to Matrix Model

Unquenched calculation both for fermions and for chemical potential :)

First test of matrix model predictions for symplectic ensembles – Looks reasonable but more statistics has to be accumulated :(

Play the game for supersymmetric 2-color QCD :O