

Aoki phases in the lattice Gross-Neveu model with staggered Wilson fermion

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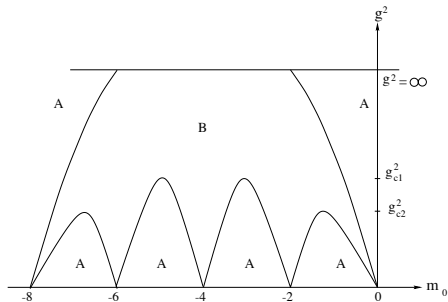
Feb 17, 2012

Workshop on *New-type of Fermions on the Lattice*

Collaboration with M. Creutz (BNL) and T. Misumi (YITP)
Phys. Rev. **D83** (2011) 094506 [[arXiv:1101.4239](https://arxiv.org/abs/1101.4239)]

Wilson fermion

- # of doublers reduced $16 \rightarrow 1$
- Chiral symmetry broken due to “mass term”
- Phase structure



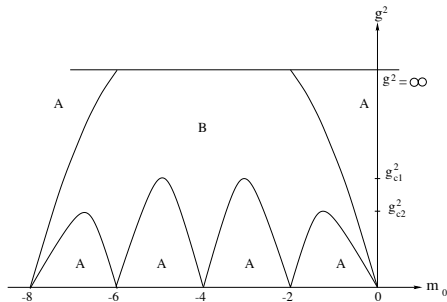
$$\langle \bar{\psi} \gamma_5 \psi \rangle \begin{cases} = 0 & \text{(A phase)} \\ \neq 0 & \text{(B phase)} \end{cases}$$

Parity broken phase

Aoki phase

Wilson fermion

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Parity broken phase

Aoki phase

Chiral limit at 2nd order phase boundary

- Phase structure with **staggered Wilson**

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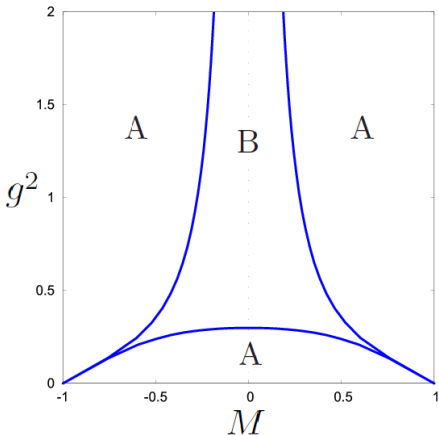
Gross-Neveu model

- Asymptotic free
- Spontaneous chiral symmetry breaking
- Exactly solvable in $2d$ at large N_f

Gross-Neveu model with staggered Wilson fermion

$$\begin{aligned}
 S_{\text{stWGN}} = & \frac{1}{2} \sum_{n,\mu} \eta_\mu \bar{\chi}_n (\chi_{n+\hat{\mu}} - \chi_{n-\hat{\mu}}) + \sum_n \bar{\chi}_n M \chi_n + S_{\text{stW}} \\
 & - \frac{g^2}{2N_f} \sum_N \left[\left(\sum_A \bar{\chi}_{2N+A} \chi_{2N+A} \right)^2 \right. \\
 & \left. + \left(\sum_A i\epsilon_A \bar{\chi}_{2N+A} \chi_{2N+A} \right)^2 \right]
 \end{aligned}$$

- Phase diagram (2 tastes split into 2 branches, $d = 2$)



$$\pi \begin{cases} = 0 & \text{(A phase)} \\ \neq 0 & \text{(B phase)} \end{cases}$$

Parity broken phase
(Aoki phase)

NG mode at critical point \longrightarrow **possibility of chiral limit**