Locality of Overlap Fermions with fixed topology

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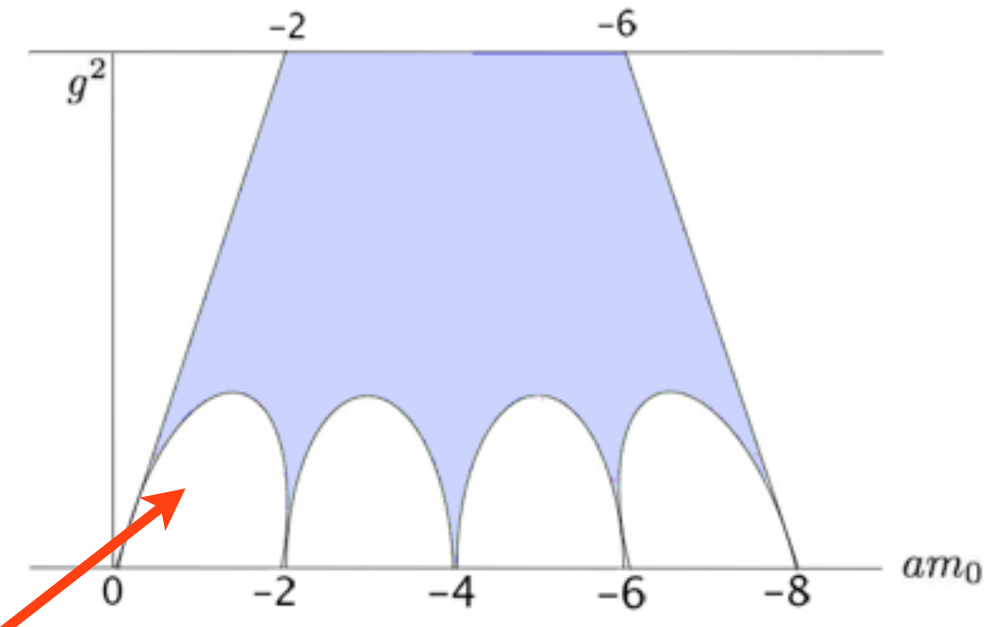
Locality of Overlap Fermions



- Outside of the Aoki phase, the eigenmodes of H_w are localized. (conjecture)

(M.Golterman,Y.Shamir. Phys.Rev., D68:074501, 2003.)

$$H_w\ ;\ hermitian\ Wilson\ Dirac\ operator$$

- Then Overlap Fermions are local.

$$D = 1 + \gamma_5 \frac{H_w}{\sqrt{H_w^2}}$$

Extra-Wilson Fermion/pseudo-Fermions with twisted mass

(H.Fukaya et al. Phys.Rev., D74:094505, 2006.)

- add extra-Wilson Fermions/pseudo-Fermions with twisted mass to the Overlap Fermion action.

$$S = \sum \bar{\psi} D_{ov} \psi + \sum \bar{\chi} D_w \left(-m_0\right) \chi + \sum \bar{\phi} \left[D_w \left(-m_0\right) + i\mu\gamma_5\tau_3\right] \phi$$

large negative mass

D_w ; $Wilson\ Dirac\ Operator$

- Effect of the additional term for partition function.

$$det \left[\frac{H_w^2}{H_w^2 + \mu^2} \right]$$

- addition of extra-Wilson Fermions corresponds to fixing the topology.

Change of the Aoki phase structure by fixing the topology

$$\langle \pi_3 \rangle = 2\pi\rho(0)$$ Banks-Casher relation

$$\rho(0) = \lim_{\lambda\to 0}\frac{1}{V}\int \mathcal{D}\mathcal{U}e^{-S_G}\prod_n\left[\frac{\lambda_n^2}{\lambda_n^2+\mu^2}\right]\sum_n\delta(\lambda-\lambda_n)$$

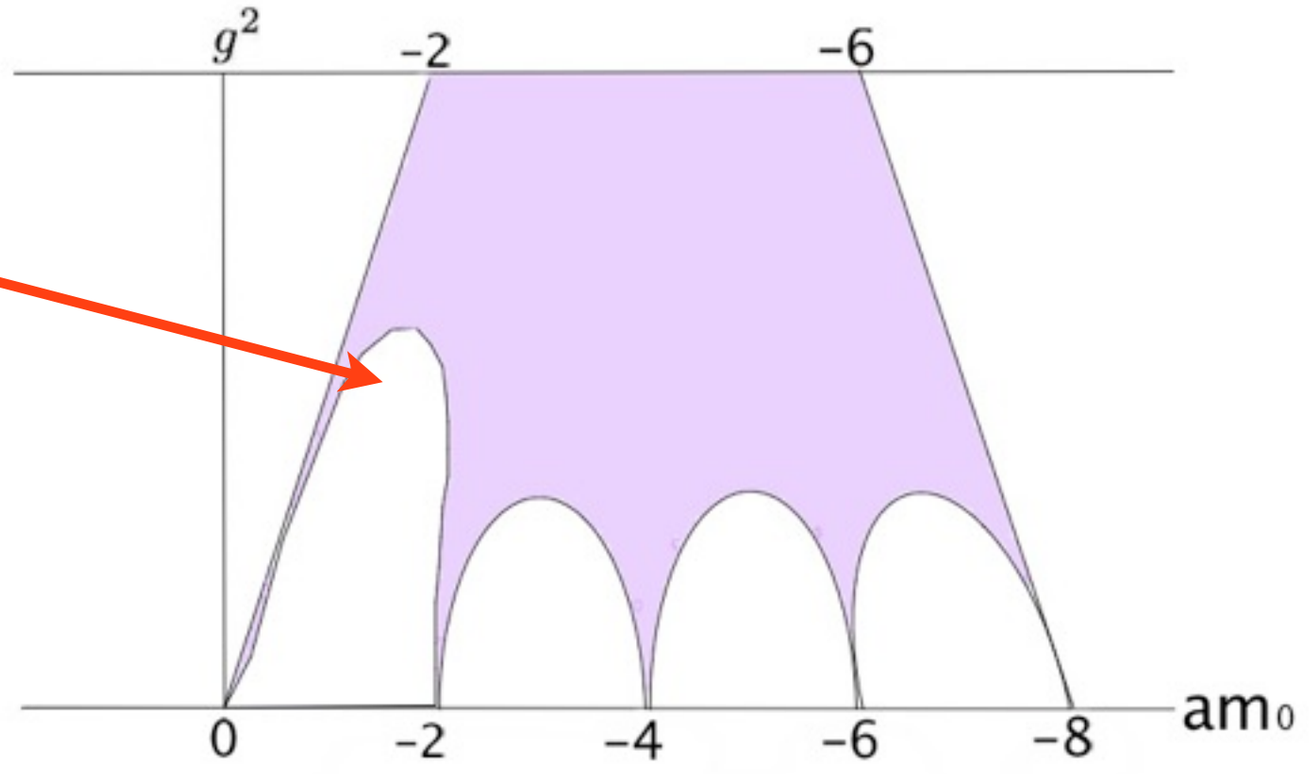
$$\underset{?}{\to} 0$$

effect of extra-Wilson Fermion

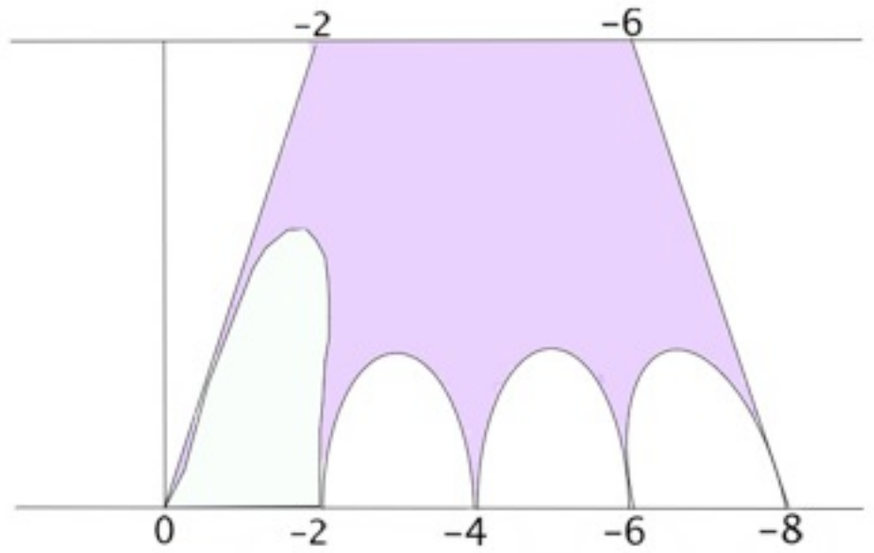
eigenmodes of Hw⇐

↑

localized



Conclusion



- The Aoki phase structure is changed by fixing the topology.
- If we add extra-Wilson Fermions/pseudo-Fermions to the action, the Overlap Fermion is local in strong-coupling region such as β=5.28.(a~0.4fm)