

# Spectrum of SU(2) gauge theory with two Dirac fermions in the adjoint representation

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# Other studies on same theory

Spectrum of  
SU(2)

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- Luigi Del Debbio, Agostino Patella, and Claudio Pica, arXiv:0805.2058 [hep-lat]
- Simon Catterall, Joe Giedt, Francesco Sannino, and Joe Schneible, arXiv:0807.0792 [hep-lat]

# Motivation to study gauge theories in different representations

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- Search for a gauge theory with “walking”  $\beta$  function required by technicolor theories
- Search for a conformal theory required by unparticle physics
- Increase the knowledge of QCD like theories

# SU(2) gauge-theory + adjoint fermions

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- The action

$$S_{\text{lat}} = S_G + S_F, \quad (1)$$

- $S_G$  is the standard Wilson gauge action
- $S_F$  is the Wilson action for two Dirac fermions in the adjoint representation.

# Particle content

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Particle	QCD equivalent
Pseudo scalar meson	$\pi$
Vector meson	$\rho$
Axial vector meson	$b_1$
"Higgs"	$f_0$ or $\sigma$
$UUD$	proton
$UUU$	delta
$UG$	NA

# Signals for conformal behaviour in particle spectrum

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- $M_{\text{hadron}} \rightarrow 0$  as  $m_Q \rightarrow 0$  with same exponent
- Mass of vector meson is larger than axial vector meson
- Hard to distinguish between conformal and walking behaviour

# Simulation details

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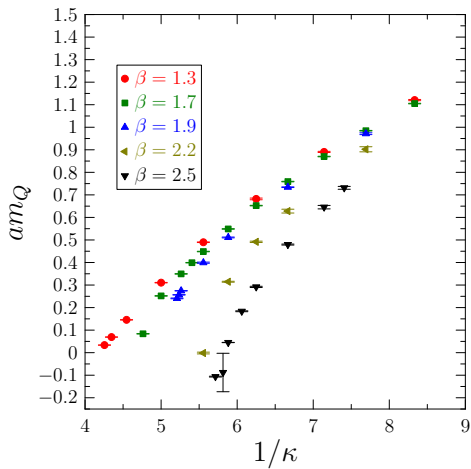
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- Simulations were performed with dynamical Wilson fermions using HMC algorithm.
- Also some simulations in fundamental representation
- Lattices:  $20^4$  and  $(32^4)$
- Values of  $\beta$ : 1.3, 1.7, 1.9, 2.2, 2.5, and (3.0)
- Number of trajectories  $\sim 100 \dots 700$

# PCAC quark-masses

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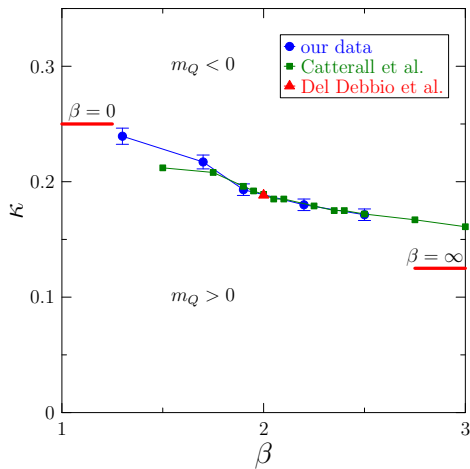


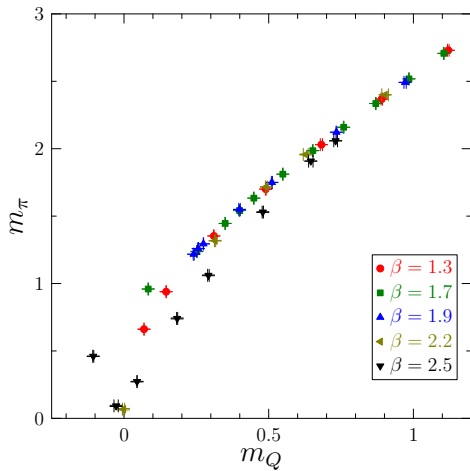


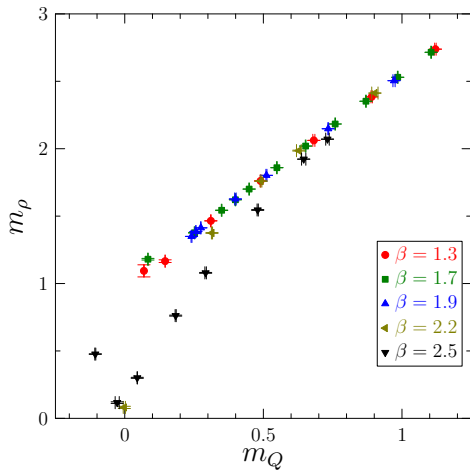
# Phase diagram

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Figure: Mass of  $\pi$ , (pseudo scalar)

Figure: Mass of  $\rho$ , (vector meson)

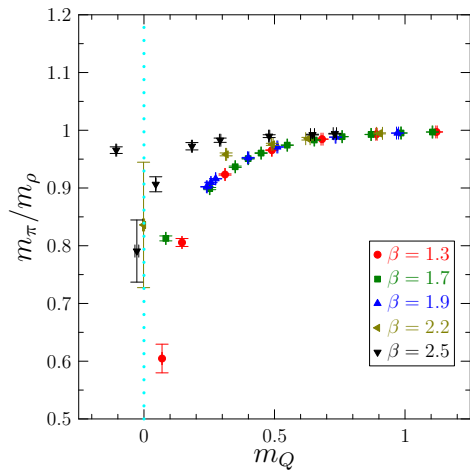


Figure: Ratio between masses of  $\pi$  and  $\rho$  in adjoint representation

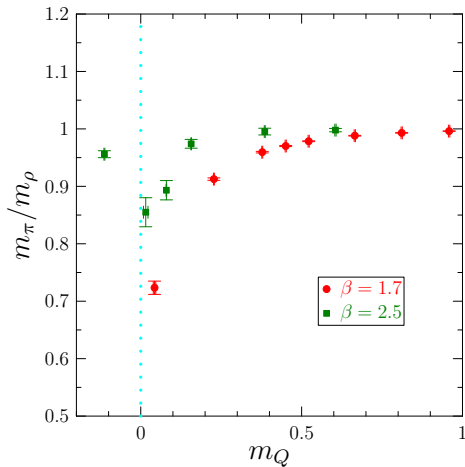
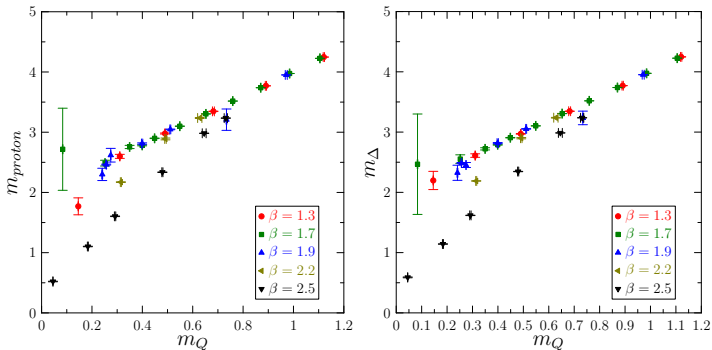


Figure: Ratio between masses of  $\pi$  and  $\rho$  in fundamental representation

Figure: Mass of proton and  $\Delta$

# Comments and outlook

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- Results are preliminary, no definite conclusions
- No proof of conformal behaviour
- Need more trajectories and finite volume studies
- Need measurement of the axial vector
- To distinguish between possible conformal and walking behaviour other methods are required