

# Effect of stout smearing on the phase diagram

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## Goals

- Compare the two rooting methods
- Determine the strength of the crossover region
- Locate the critical point if it is possible

# Introduction

## Action and the smearing

- Wilson gauge action and staggered fermion action
- Smearing parameter in the staggered action

$$U_{x;\mu} \rightarrow U_{x;\mu} + \rho \sum_{\mu \neq \hat{\mu}} U_{x;\nu} U_{x+a\hat{\nu};\mu} U_{x+a\hat{\mu};\nu}^\dagger \quad (1)$$

## Analysis and lattice setup

- $N_t = 4$ ,  $N_s = 8, 10, 12$
- Determine the  $\beta_F$  roots of  $Z(\beta, \mu)$  (Fisher zeros)
- $\text{Im}\beta_F^\infty(\mu) \rightarrow$  strength of the phase transition

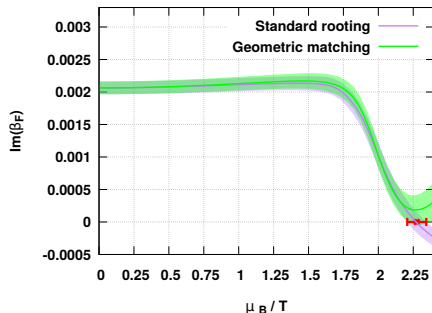
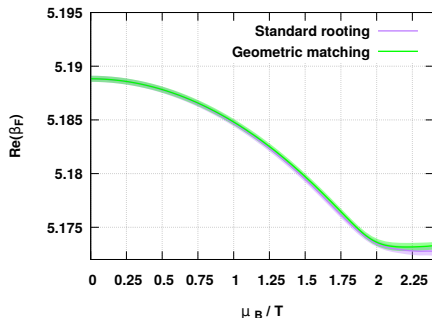
## Weights

$$w_i = \left( \frac{\det M(\mu, \rho)}{\det M(0, \rho)} \right)_i e^{P_i(\beta - \beta_0)} \quad Z/Z_0 = \sum_i w_i \quad (2)$$

# Former results with larger statistics

## Comparison of the two rooting methods

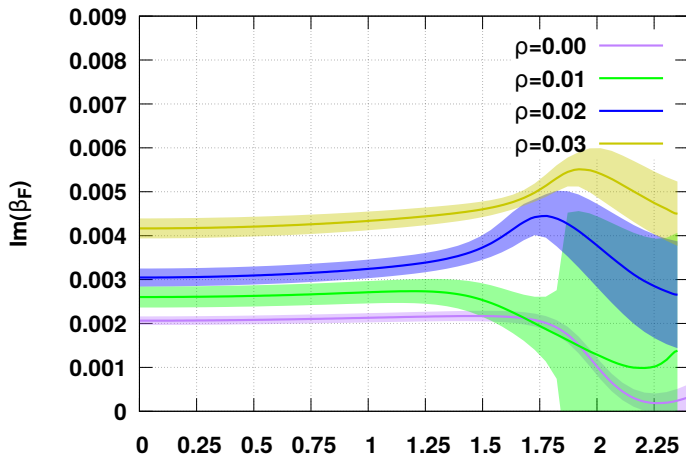
- Real and imaginary part of the Fisher zero as a function of  $\mu_B/T$  without smearing. Both methods give the same result and the critical point can be located.



# Effect of the stout smearing on the phase transition

Strength of the phase transition at different values of  $\rho$

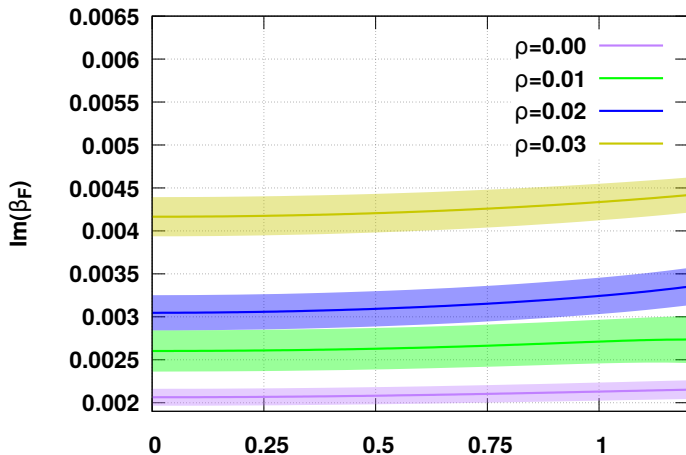
- Infinite volume extrapolations of  $\text{Im}\beta_F$  at different values of the  $\rho$ . There is a nontrivial  $\mu$  dependence.



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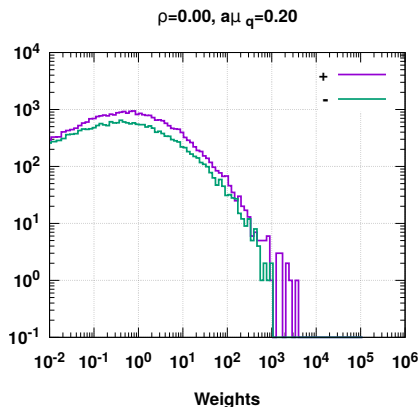
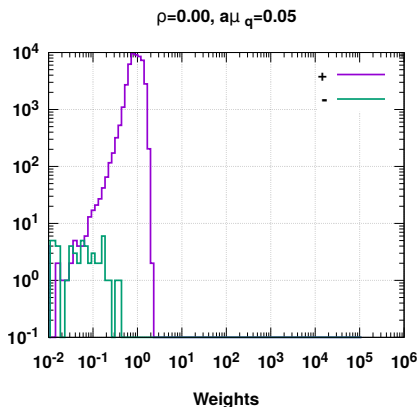
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# Severity of the overlap problem

Overlap problem at different values of  $\mu$

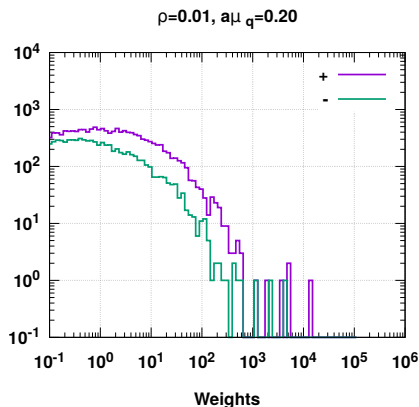
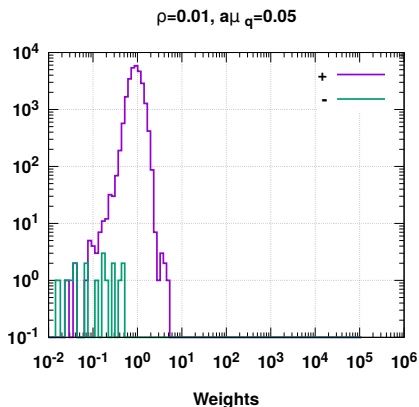
- Distribution of the weights (purple is for the positive, green is for negative weights). No outliers are detected.



# Severity of the overlap problem

Overlap problem at different values of  $\mu$

- Distribution of the weights (purple is for the positive, green is for negative weights). The existence of the outliers is clear.



# Summary

- We see no significant difference between the two rooting methods
- There is a nontrivial  $\mu$  dependence of the strength of the phase transition
- Due to the overlap problem the critical point is out of reach with stout smearing