

# New Mexico State University & Vienna University of Technology



Smearing Center Vortices

Roman Höllwieser

Introduction

Vortices

Vortex Smearing

Lattice Refinemen

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



### Roman Höllwieser

### **Smearing Center Vortices**

work in progress, in coop. with Michael Engelhardt

25. Juni 2014



### Introduction



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Vortices

Vortex Smearing

Lattice Refinement

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook

### non-trivial QCD vacuum

- project out important degrees of freedom
- start with minimal set of d.o.f. / model
- start with vortex-only (Z(2)) configs
  - try to approach full theory and keep the vortex structure
  - smooth vortex configs for gluonic & fermionic operators
  - comes down to minimizing non-trivial (vortex) plaquettes
- 1000 Luescher-Weisz SU(2) configs,  $8^4$ ,  $\beta = 3.3$

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### **Center Vortices**



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Introduction

Vortices

Vortex Smearing

Lattice Refinement

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook A plaquette is pierced by a P-vortex, if the product of its center projected links gives -1.

center vortex in one dimension



center-projected (P-vortex plaquettes)



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### **Standard Smearing Routines**



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Introduction

Vortices

Vortex Smearing

Lattice Refinemen

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results





### Vortex Flux Distribution Smearing



#### Smearing Center Vortices

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Introduction

Vortices

#### Vortex Smearing

Lattice Refinement

Refined Smearing с

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook















### Lattice Refinement



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Introductior

Vortices

Vortex Smearing

Lattice Refinement

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



 $\bullet\,$  2-fold refinement  $\to 2^4$  x more lattice points, links & plaqs

• but only 8 x more neg. links and 4 x more vortex plaqs





### **Refined Link Rotation Smearing**



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Introduction

Vortices

Vortex Smearing

Lattice Refinement

#### Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



• smoother rotations on refined lattices

• problem of even/odd lattice slices



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### **Refined Vortex Flux Smearing**



#### Smearing Center Vortices

- Roman Höllwieser
- Introduction
- Vortices
- Vortex Smearing
- Lattice Refinement

#### Refined Smearing

- Smeared Blocking
- Method Summary
- Preliminary Results
- Conclusions & Outlook



- leave original links untouched and spread vortex flux within the original plaquette
- 2D gauge transformations/rotations i.o. to minimize affected plaquettes

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### **Smeared Blocking**



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- Smearing Center Vortices
- Roman Höllwieser
- Introduction
- Vortices
- Vortex Smearing
- Lattice Refinement
- Refined Smearing
- Smeared Blocking
- Method Summary
- Preliminary Results
- Conclusions & Outlook



- $\bullet$  vortex-only Z(2)  $\rightarrow$  refined smeared  $\rightarrow$  SU(2) (smeared)
- vortex structure is not preserved...



### **Smearing Method Summary**



Smearing Center Vortices

Roman Höllwieser

Introduction

Vortices

Vortex Smearing

Lattice Refinement

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook

- (smoothing thin vortex surface →)
- refine Z(2) lattice configuration
- identify vortex plaquettes, Tr  $U_{\mu
  u}=-1$
- refined link rotation smearing or
- refined flux distribution smearing
- (vortex smeared blocking)





### **Overlap Spectra**





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Vortices

Vortex Smearing

Lattice Refinemen

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



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### **Topological Susceptibility**







### **Topological Susceptibility**







### **Topological Charge**





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Vortices

Vortex Smearing

Lattice Refinemen

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



• fermionic, cooling, smearing vs. vortex topological charge

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• instanton vs. center vortex degrees of freedom



### Vortex - eigenmode - correlation



number of attached vortex plaquettes

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Introduction

Vortices

Vortex Smearing

Lattice Refineme

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results



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### **Vortex limited Wilson loops**





Introduction

Vortices

Vortex Smearing

Lattice Refinemer

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



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Smearing Center

### $\textbf{Creutz Ratios} \rightarrow \textbf{String Tension}$





Lattice

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook



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### **Classical Vortex Configuration**



#### Smearing Center Vortices

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Introduction

Vortices

Vortex Smearing

Lattice Refinemen

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook





### **Conclusions & Outlook**



- Smearing Center Vortices
- Roman Höllwieser
- Introduction
- Vortices
- Vortex Smearing
- Lattice Refinement
- Refined Smearing
- Smeared Blocking
- Method Summary
- Preliminary Results
- Conclusions & Outlook

- smeared center vortices keeping their structure
- removed the eigenvalue gap for overlap fermions
- reproduced gluonic and fermionic observables
- topological (charge) discrepancies
- ideas for further improvements?
- apply the methods to effective center vortex model

→ Engelhardt,Reinhardt 1999

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Smearing Center Vortices

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Introduction

Vortices

Vortex Smearing

Lattice Refinement

Refined Smearing

Smeared Blocking

Method Summary

Preliminary Results

Conclusions & Outlook

## Thank You &

Manfried Faber, Urs M. Heller, Štefan Olejník



Questions?