Roman Höllwieser

Smearing Center Vortices

work in progress, in coop. with **Michael Engelhardt**

25. Juni 2014

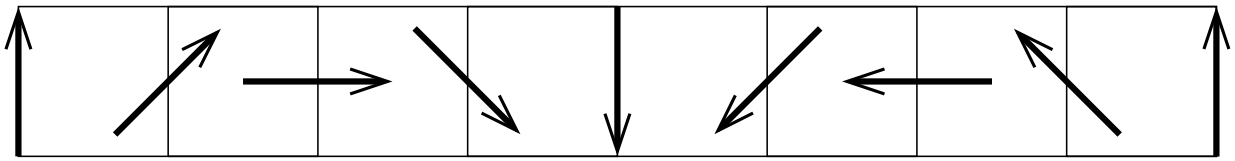
Introduction

- 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, $8^4, \beta = 3.3$

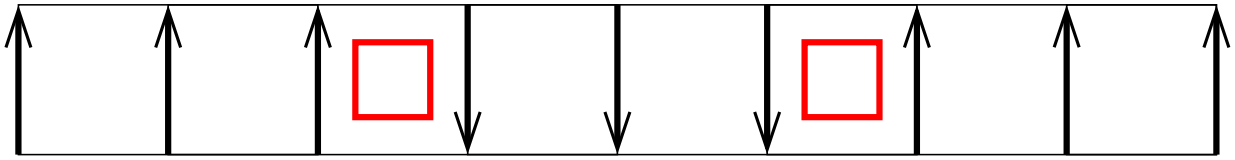
Center Vortices

A plaquette is pierced by a P-vortex, if the product of its center projected links gives $-\mathbb{1}$.

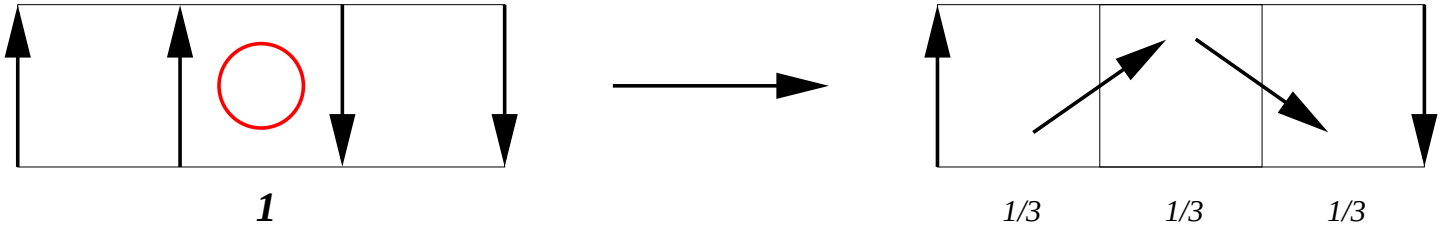
center vortex in one dimension



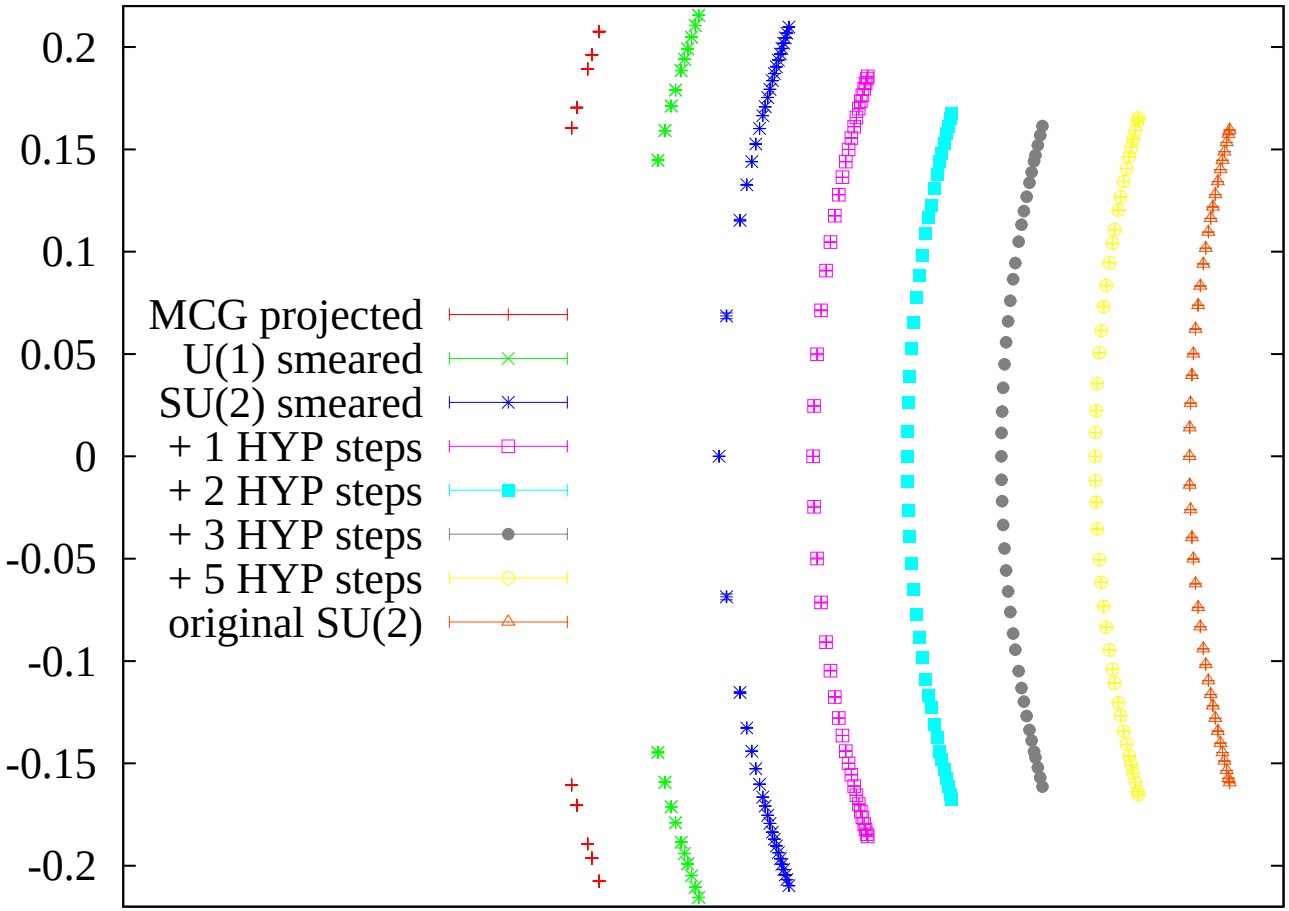
center-projected (P-vortex plaquettes)



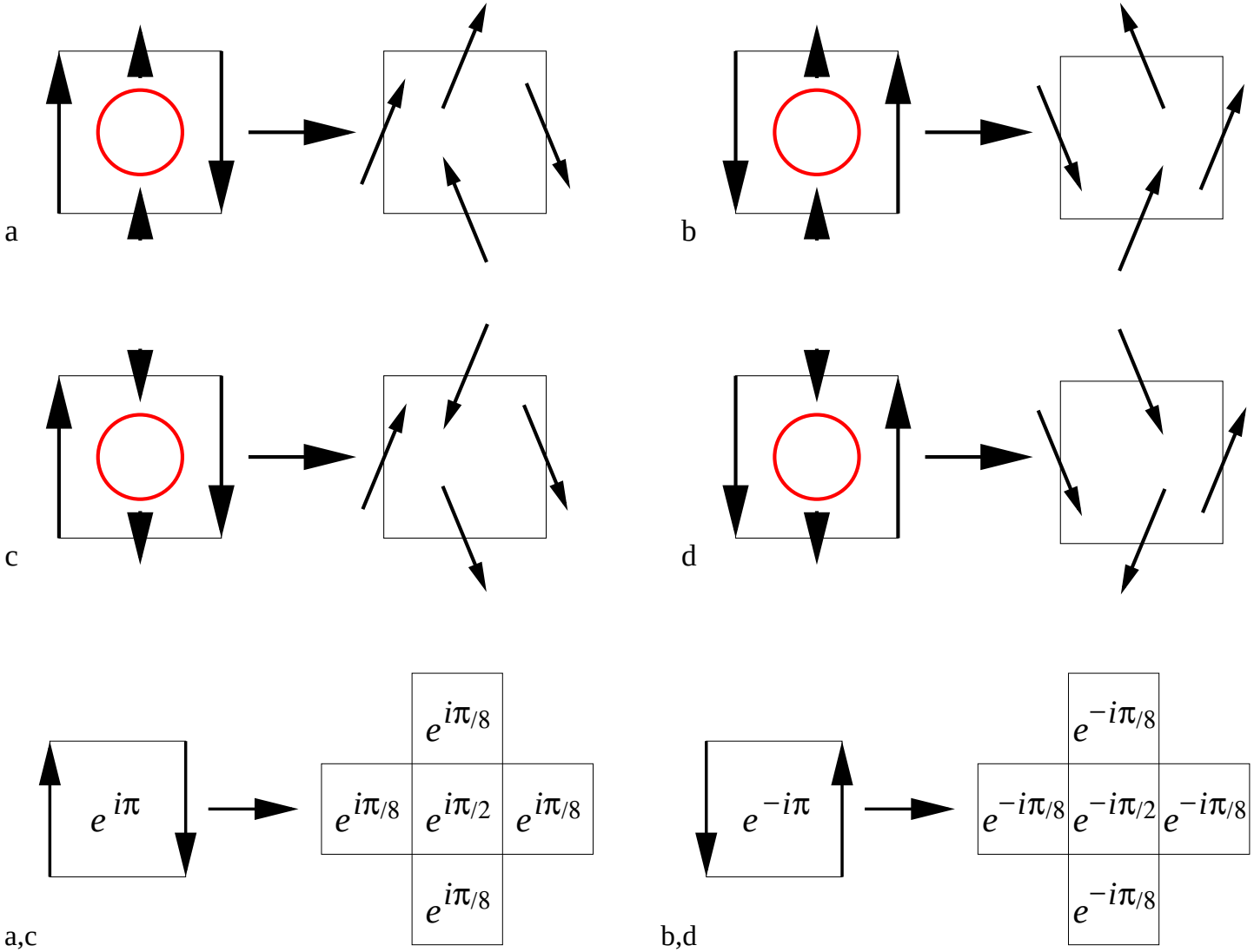
smearing $\rightarrow$ going back, locality, gauge invariance



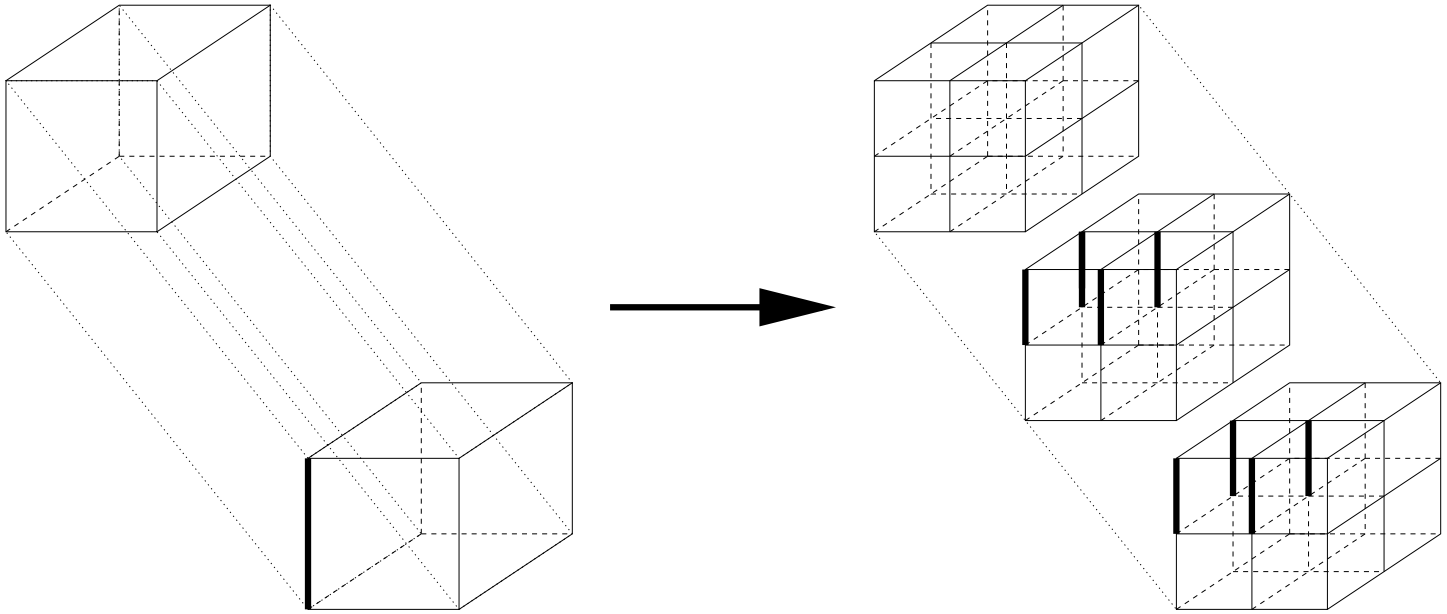
Standard Smearing Routines



Vortex Flux Distribution Smearing

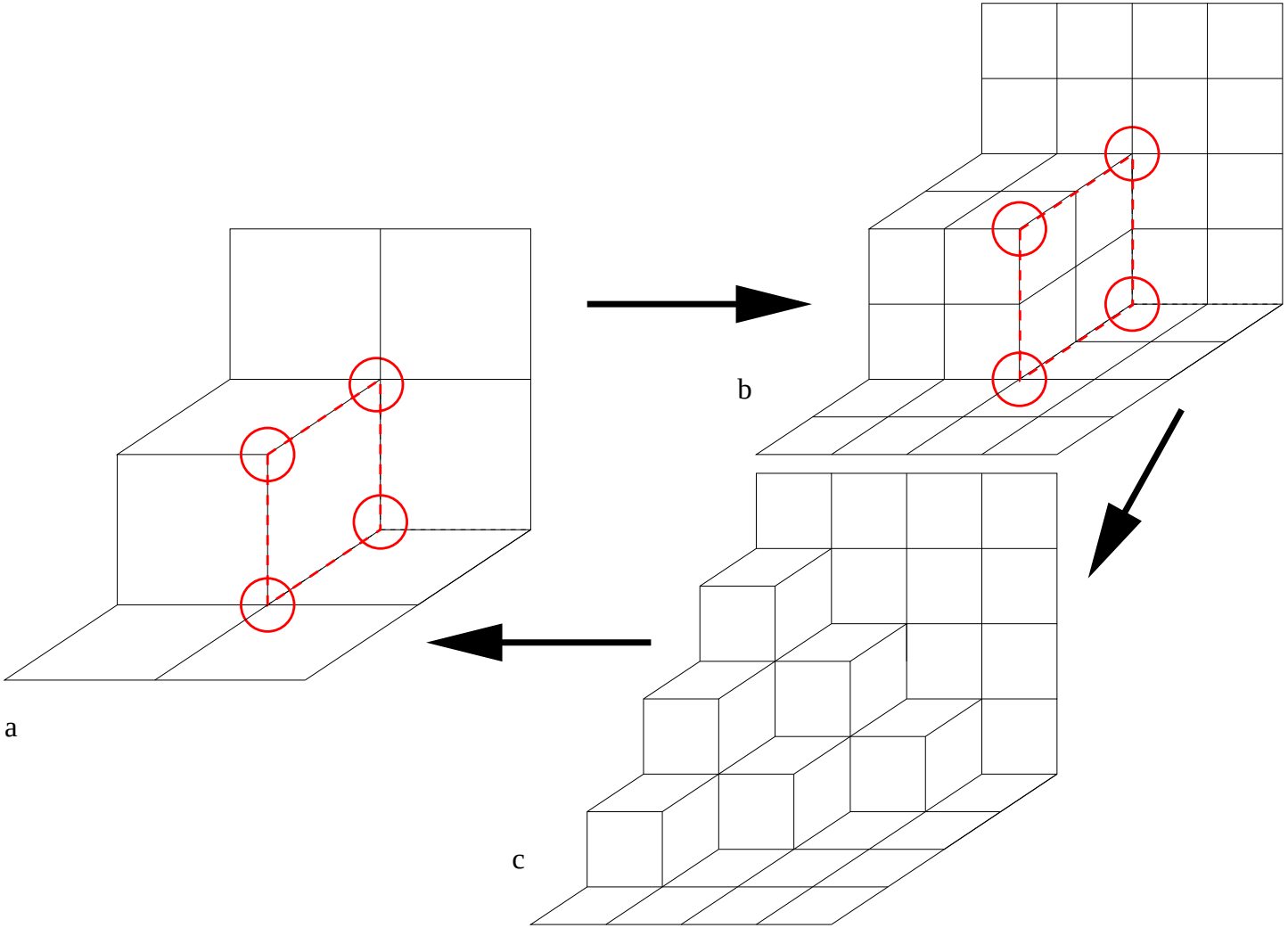


Lattice Refinement

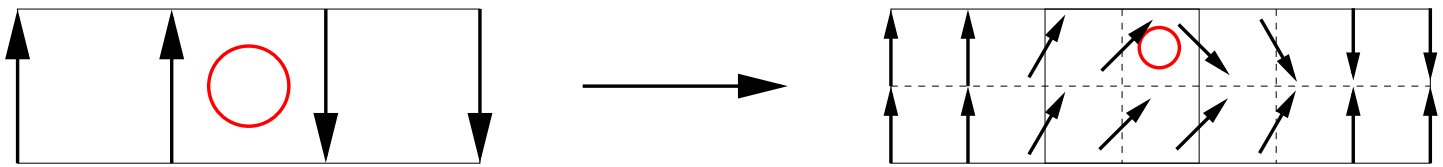


- 2-fold refinement $\rightarrow 2^4$ x more lattice points, links & plaqs
- but only 8 x more neg. links and 4 x more vortex plaqs

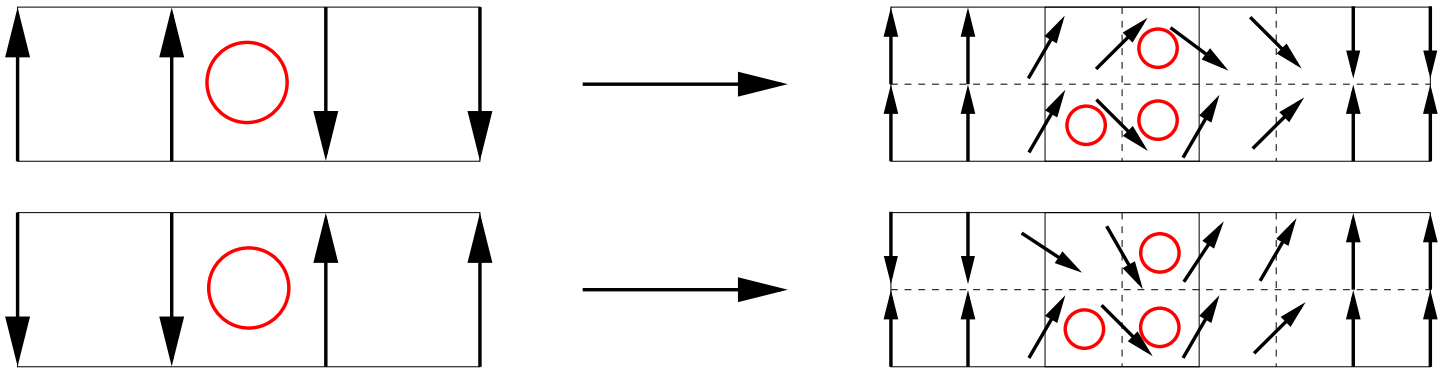
Refinement - Smearing - Blocking



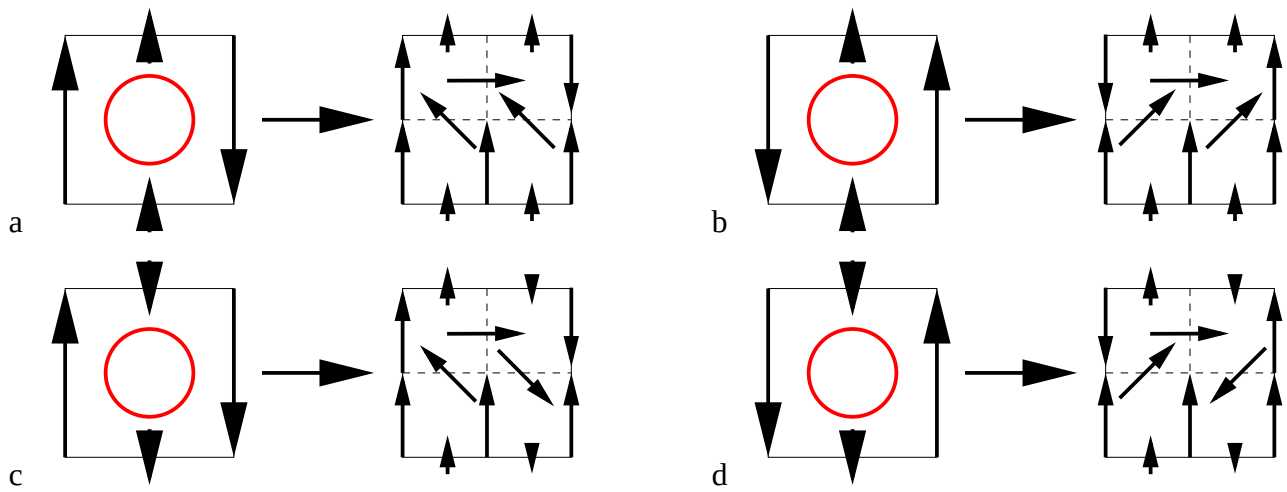
Refined Link Rotation Smearing



- smoother rotations on refined lattices
- problem of even/odd lattice slices

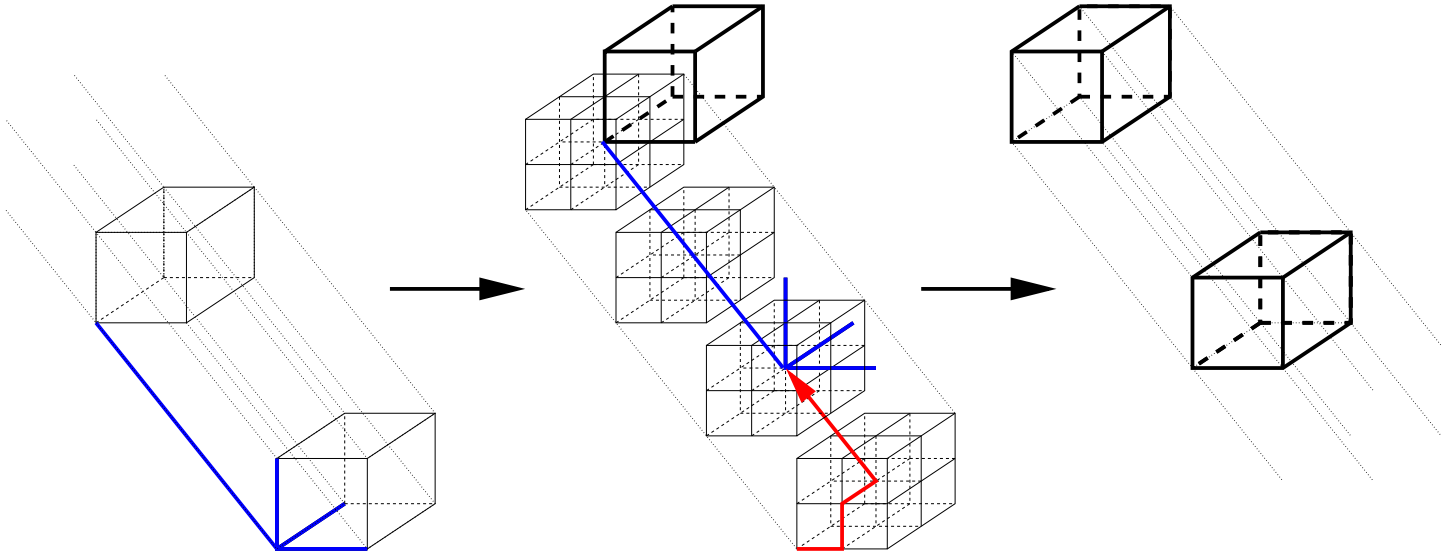


Refined Vortex Flux Smearing



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

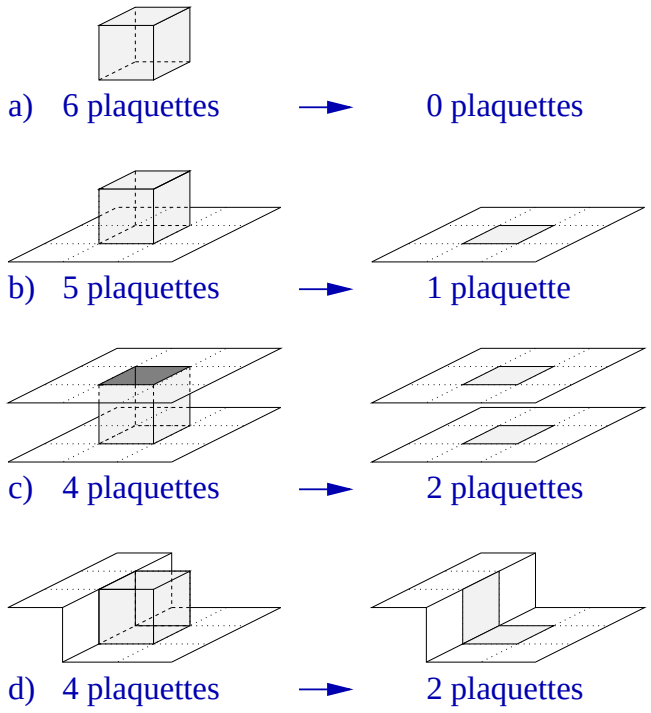
Smeared Blocking



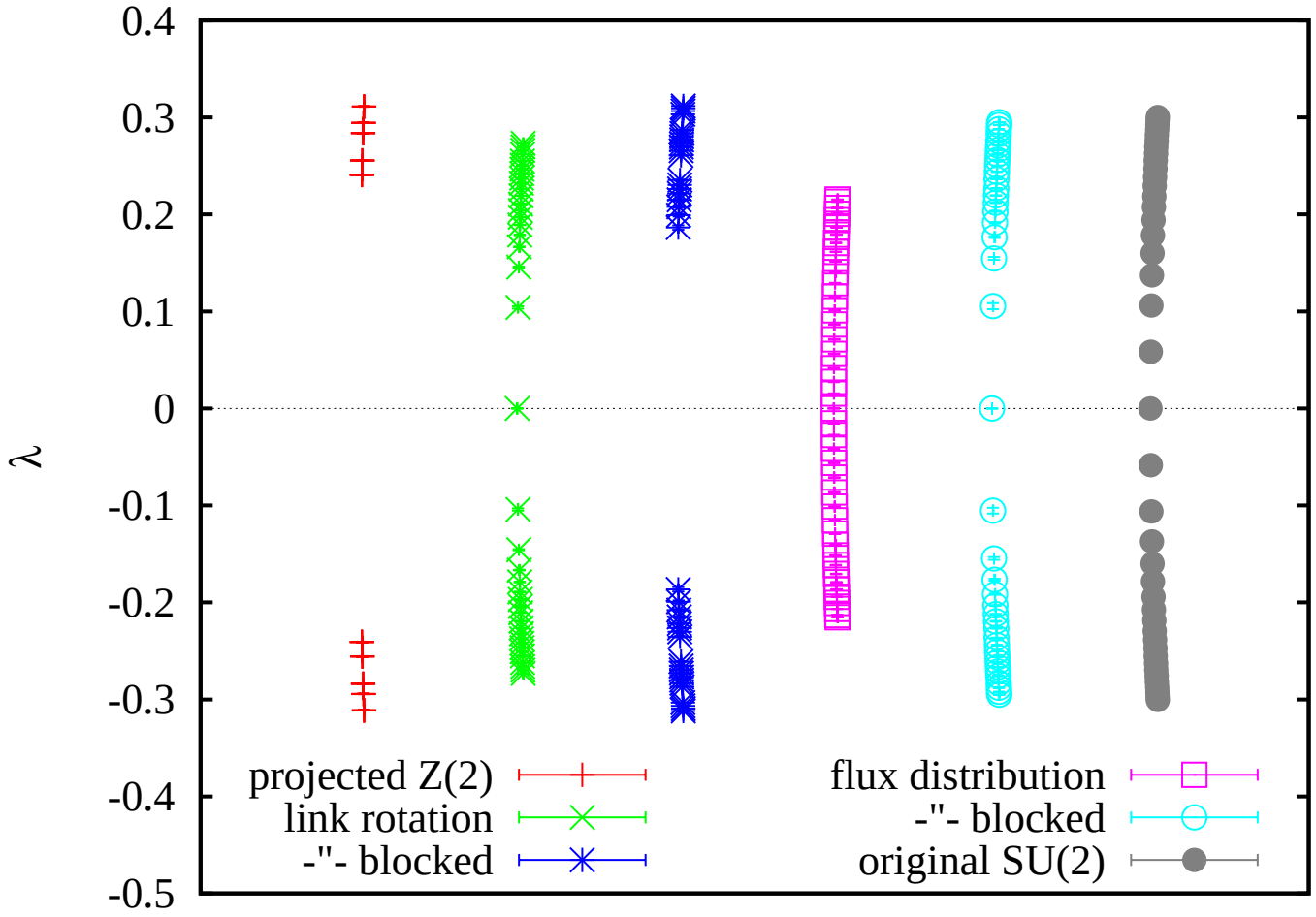
- vortex-only Z(2) $\rightarrow$ refined smeared $\rightarrow$ SU(2) (smeared)
- vortex structure is not preserved...

Smearing Method Summary

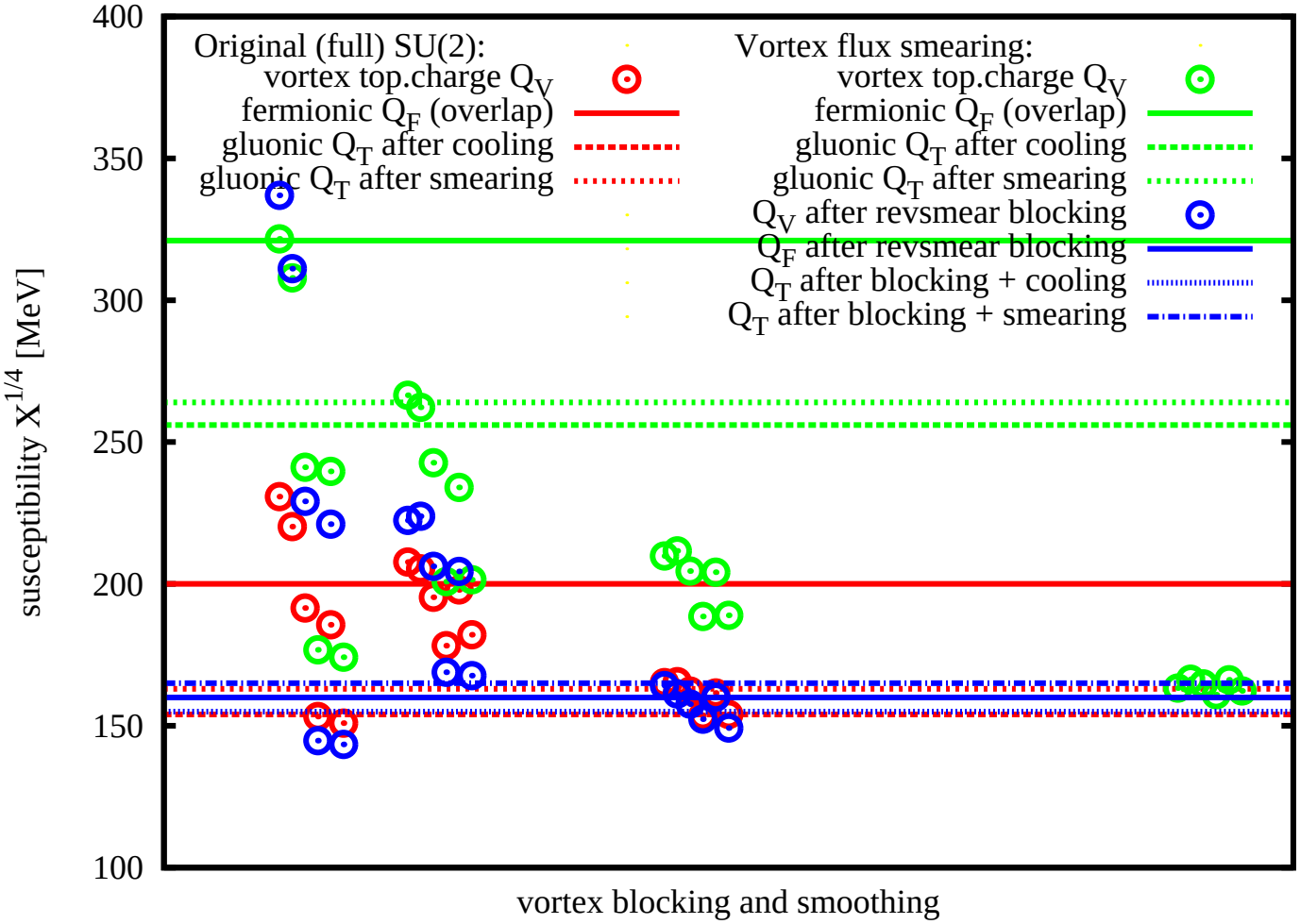
- (smoothing thin vortex surface $\rightarrow$)
- refine Z(2) lattice configuration
- identify vortex plaquettes, Tr $U_{\mu\nu} = -1$
- refined link rotation smearing or
- refined flux distribution smearing
- (vortex smeared blocking)



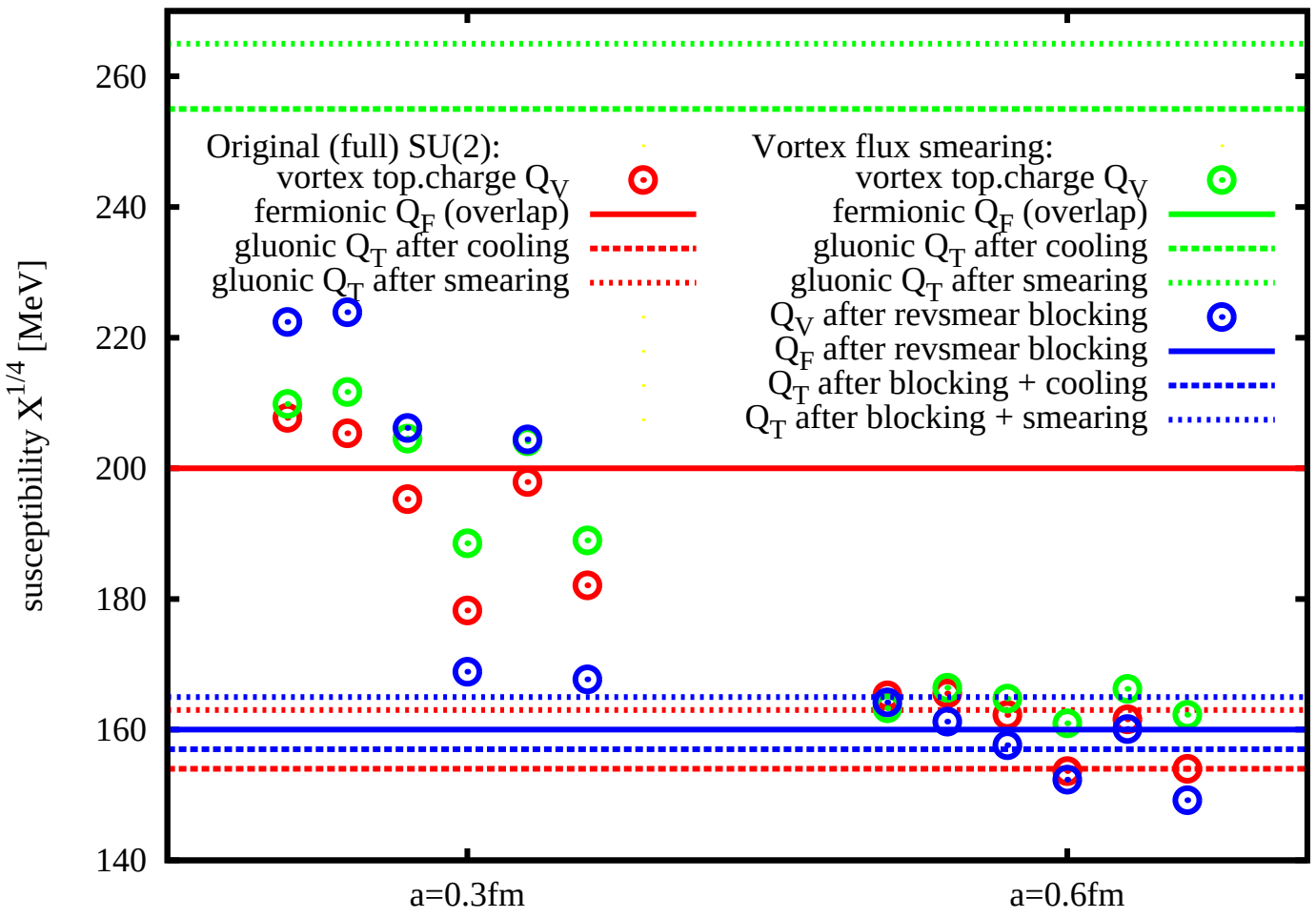
Overlap Spectra



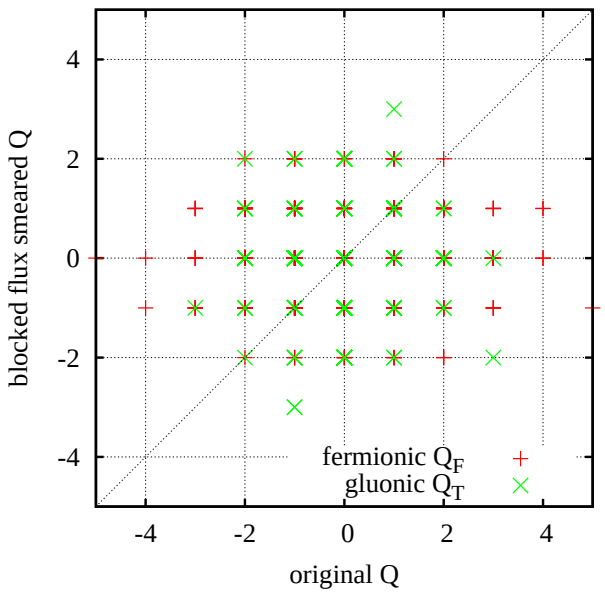
Topological Susceptibility

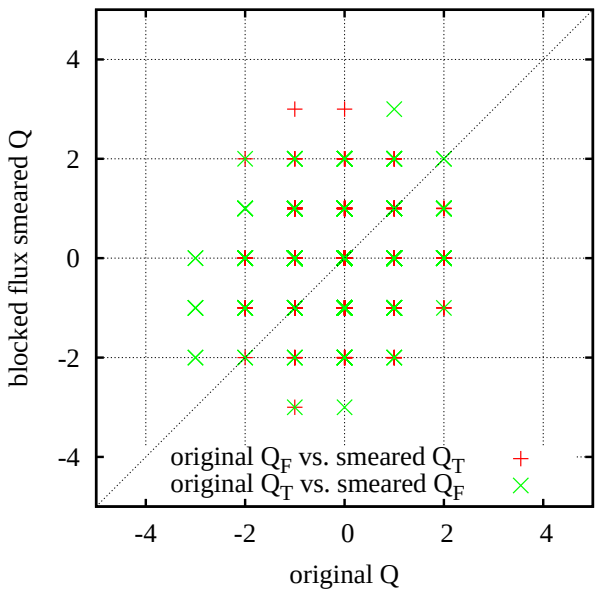


Topological Susceptibility



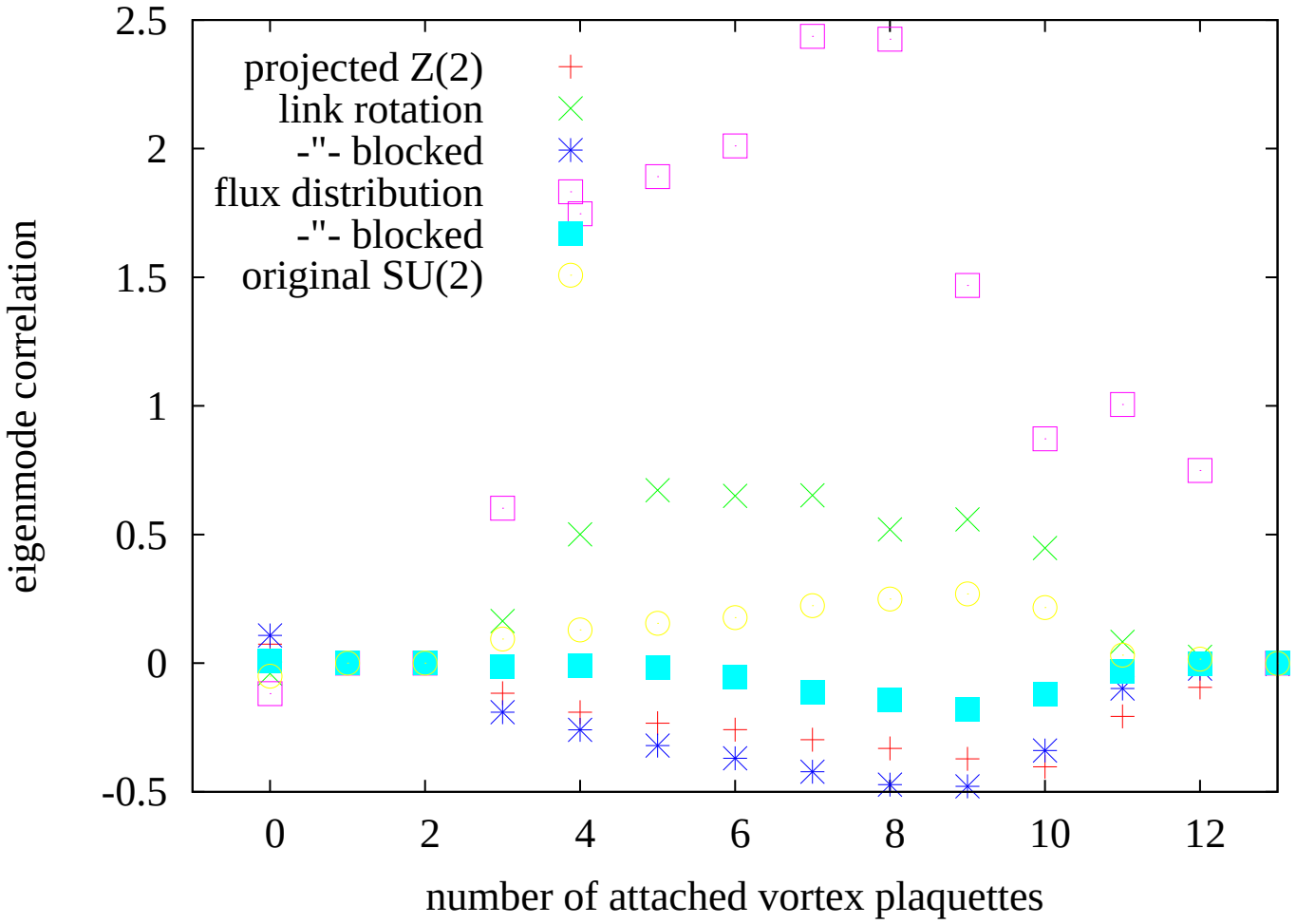
Topological Charge



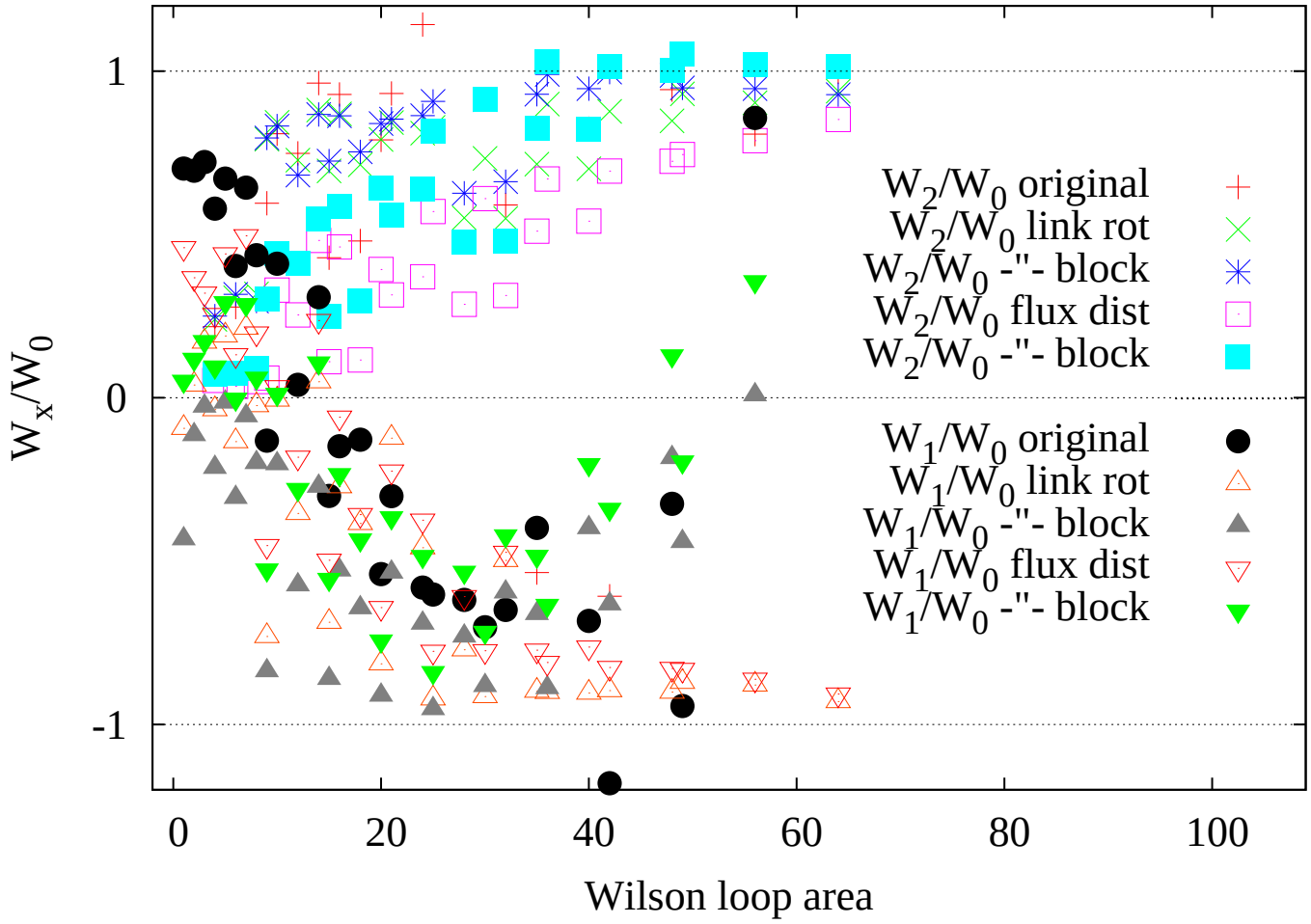


- fermionic, cooling, smearing vs. vortex topological charge
- instanton vs. center vortex degrees of freedom

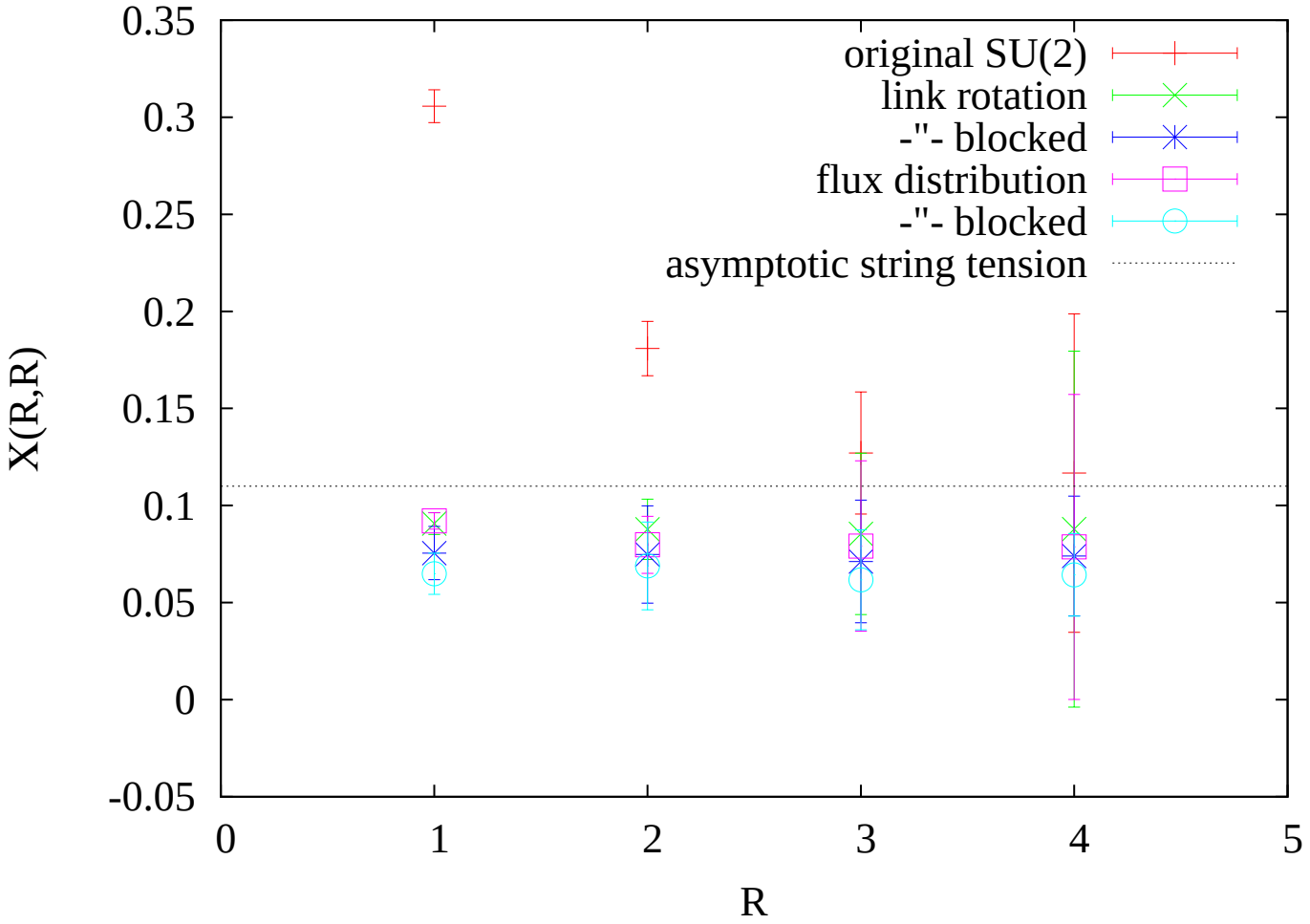
Vortex - eigenmode - correlation



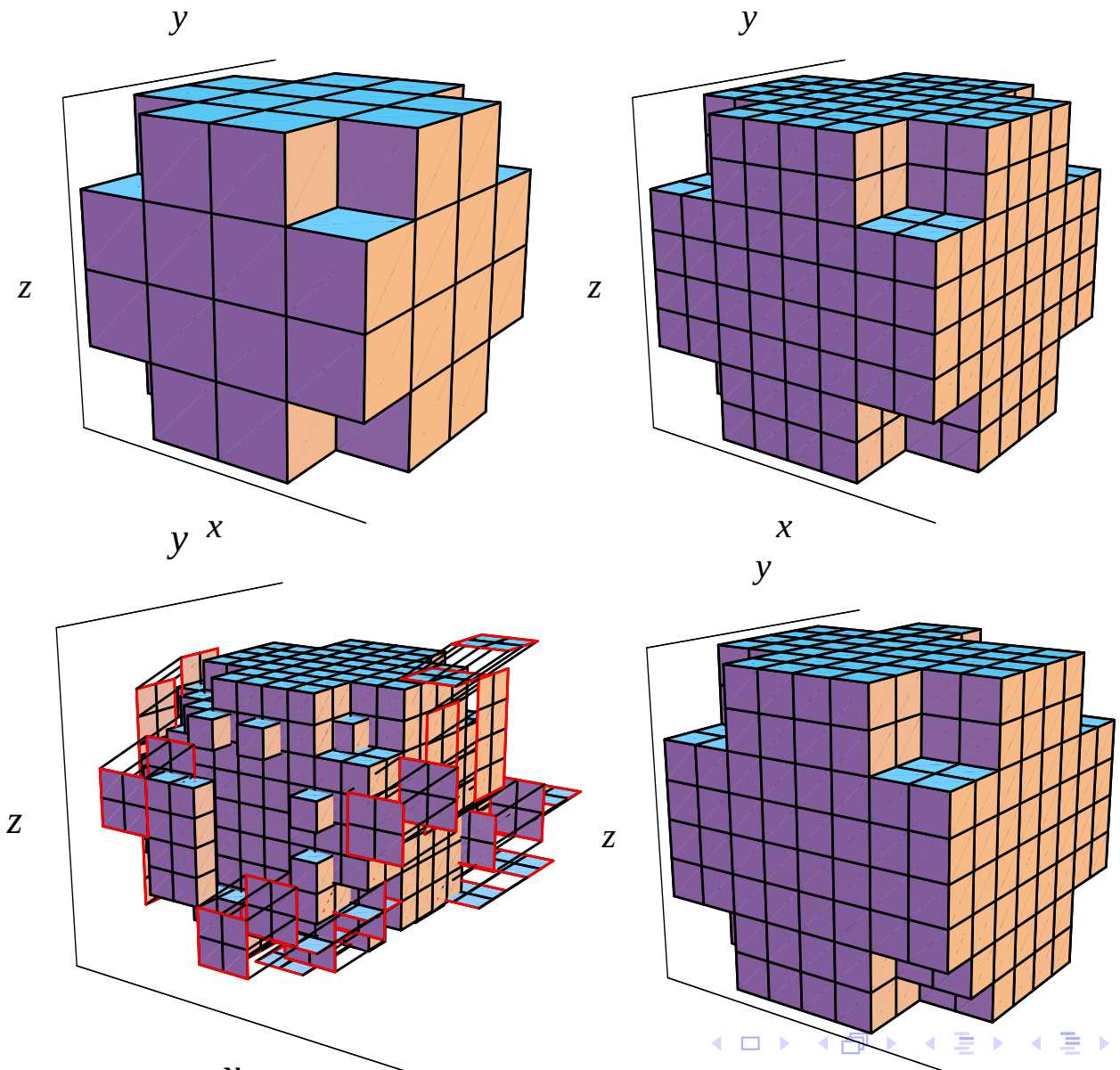
Vortex limited Wilson loops



Creutz Ratios → String Tension



Classical Vortex Configuration



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*

Thank You &

Manfried Faber, Urs M. Heller, Štefan Olejník

Questions?