Topological susceptibility in the SU(3) random vortex world-surface model

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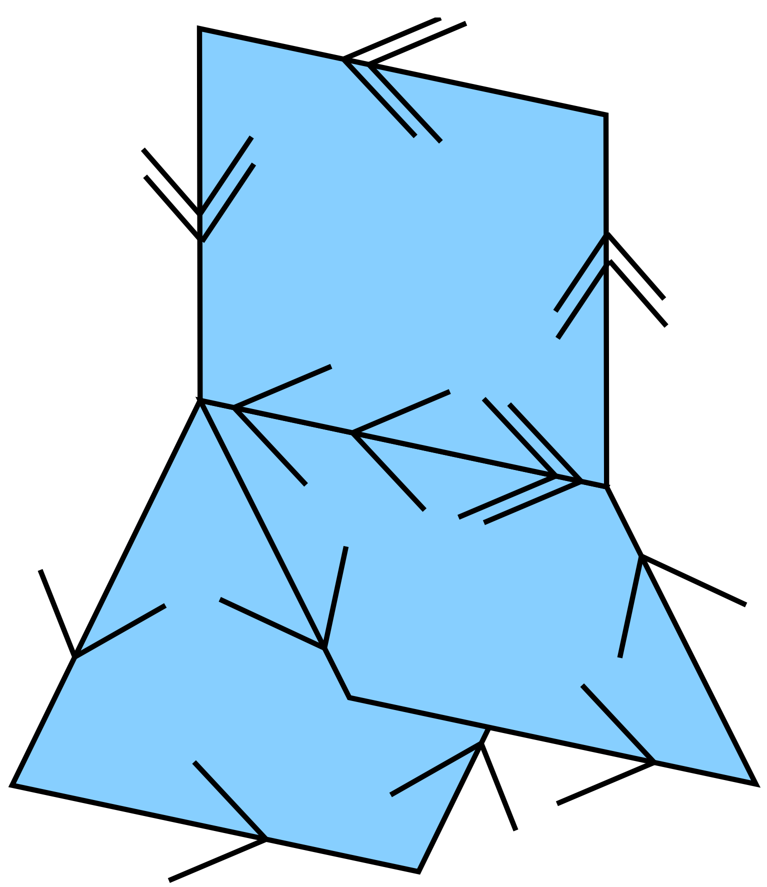
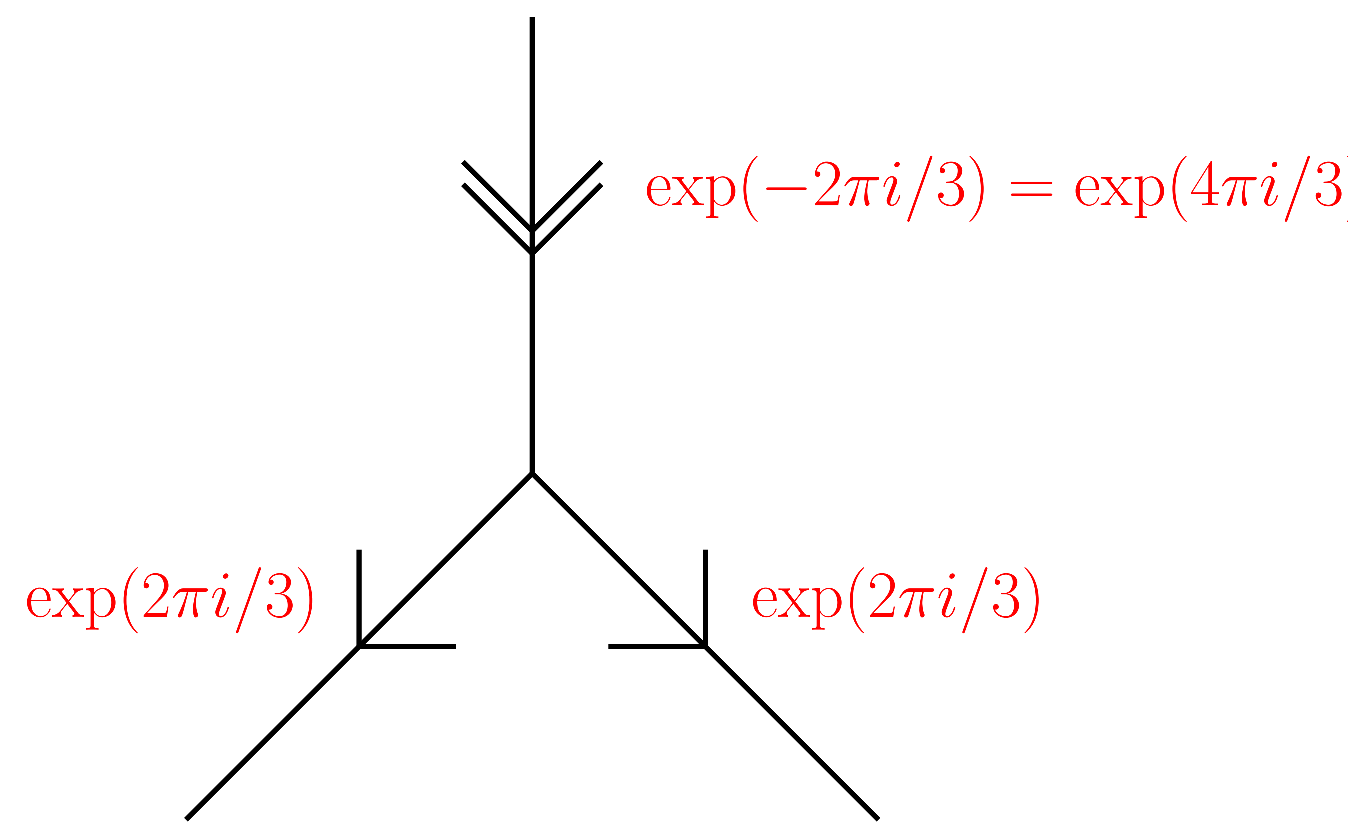
Random vortex world-surface model:

- SU(2)
  - Confined, deconfined phases, second order deconfinement transition
  - Topological susceptibility
  - Quenched chiral condensate
- SU(3)
  - Confined, deconfined phases, weakly first order deconfinement transition
  - Baryonic Y law
  - Topological susceptibility
- SU(4), Sp(2)
  - Confined, deconfined phases, first order deconfinement transition
  - Increasing complexity of effective dynamics

SU(3) center vortices

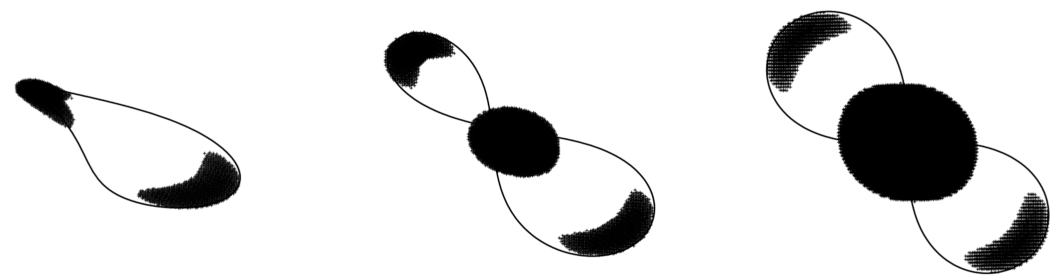
- Two-dimensional closed world-surfaces of chromomagnetic flux
- Flux quantized such as to contribute a center phase $\exp(\pm 2\pi i/3)$ to any Wilson loop to which they are linked (orientation of flux determines sign)
- Branching possible (as opposed to SU(2)):





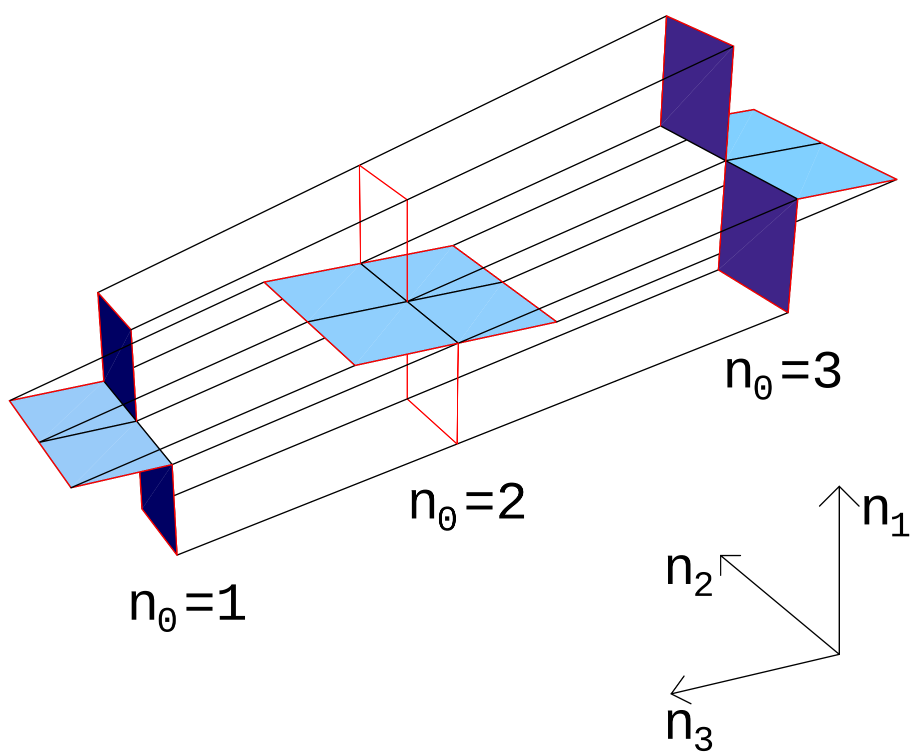
Vortex topological charge

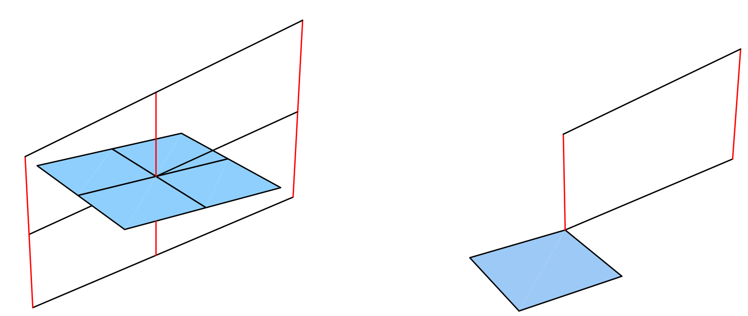
- Topological charge carried by vortex surface writhe and intersection points



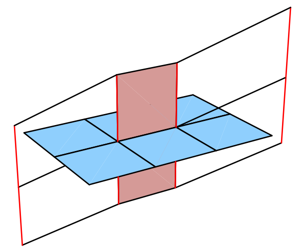
$$Q = \frac{1}{32\pi^2} \int d^4x \, \epsilon_{\mu\nu\lambda\tau} \, \mathrm{Tr} \, F_{\mu\nu} F_{\lambda\tau}$$

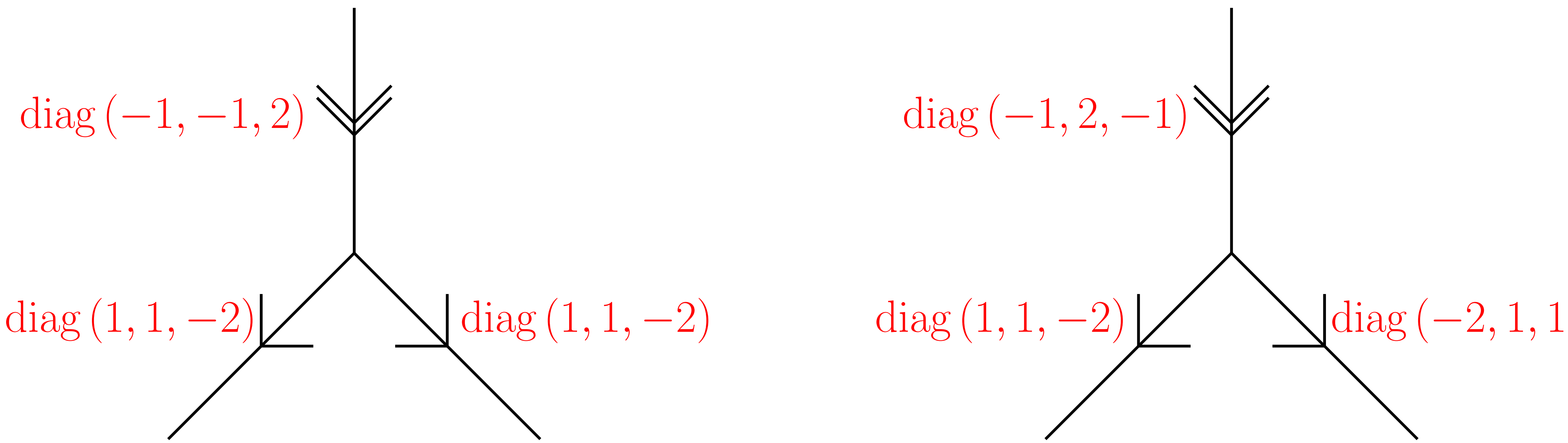
- Orientation of surfaces enters via sign of F and generic surfaces are non-orientable – in Abelian gauge, surface patches of varying orientation separated by monopoles
- On lattice, topological charge concentrated at sites:





Resolving ambiguities in lattice surfaces

- Resolve intersection lines  via slight deformations of surfaces on finer lattices (1/3, 1/9)
- Edges of patches coinciding with sites carrying topological charge – use suitable color structure at branchings!



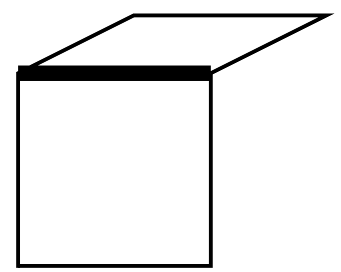
Minimal description:
$T = \pm\mathrm{diag}\,(1, 1, -2)$

Non-minimal description:
$T = \pm\mathrm{diag}\,(1, 1, -2),$
$\pm\mathrm{diag}\,(1, -2, 1),$
$\pm\mathrm{diag}\,(-2, 1, 1)$

$$W = (1/3)\,\mathrm{Tr}\,\exp(2\pi i\, T/3)$$

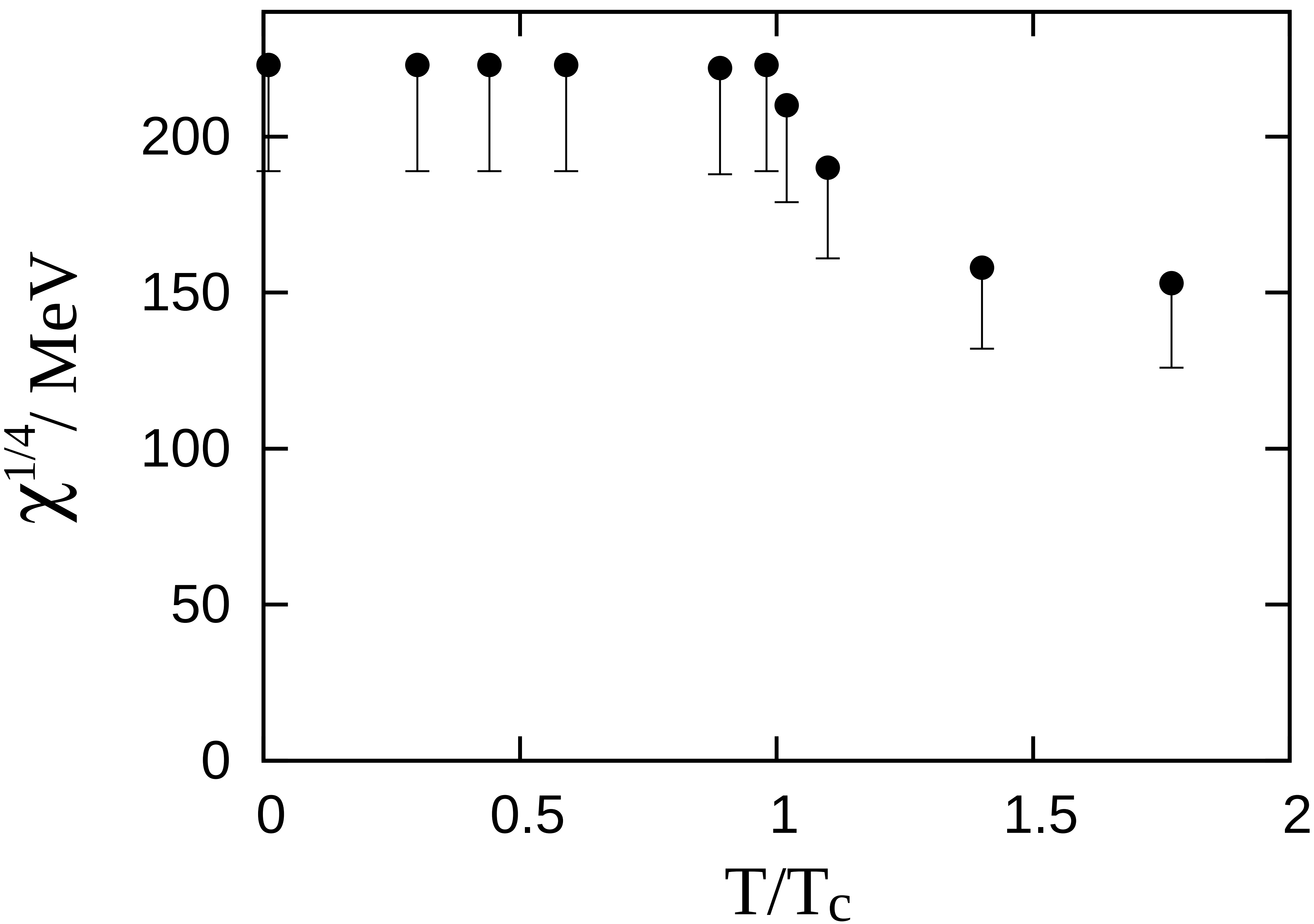
SU(3) random vortex world-surface model

- Vortex world-surfaces composed of elementary squares on a hypercubic lattice
- Fixed lattice spacing $\longleftrightarrow$ vortex thickness
- Vortex world-surface curvature action

$S = c \times$ 

- Dimensionless coupling constant c tuned to reproduce ratio $T_c/\sqrt{\sigma} = 0.63$ from SU(3) Yang-Mills theory $\longrightarrow$ $c = 0.21$
- Scale determined by setting $\sigma = (440\,\mathrm{MeV})^2$ $\longrightarrow$ lattice spacing $a = 0.39\,\mathrm{fm}$

Topological susceptibility



Conclusions

- Substantial systematic uncertainty of topological charge measurement engendered by the necessity to remove ambiguities introduced through the hypercubic description
- Taking into account this uncertainty, topological susceptibility predicted by the SU(3) random vortex world-surface model is compatible with SU(3) Yang-Mills theory
- Alternative representation of the vortex surfaces (e.g., random triangulations) would remove this uncertainty