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

\[ Q = \frac{1}{32\pi^2} \int d^4x \epsilon_{\mu\nu\lambda\tau} \text{Tr} F_{\mu\nu} F_{\lambda\tau} \]

- 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!

\[ T = \pm \text{diag} (1, 1, -2), \pm \text{diag} (1, -2, 1), \pm \text{diag} (-2, 1, 1) \]

\[ W = (1/3) \text{Tr} \exp(2\pi i T/3) \]
SU(3) random vortex world-surface model

- Vortex world-surfaces composed of elementary squares on a hypercubic lattice
- Fixed lattice spacing $\leftrightarrow$ 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 $\rightarrow c = 0.21$
- Scale determined by setting $\sigma = (440 \text{ MeV})^2$ $\rightarrow$ lattice spacing $a = 0.39 \text{ fm}$
Topological susceptibility

\[ \chi^{1/4} \text{/ MeV} \]

\[ T/T_c \]

![Graph showing the relationship between \( \chi^{1/4} \text{/ MeV} \) and \( T/T_c \).]
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.