CALORONS AND CONSTITUENT MONOPOLES

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INTRODUCTION

ORDER PARAMETER IN FINITE T QCD:

$$P(x) = P e^{\int_0^\beta A_0 dt}$$

$$\langle \tfrac{1}{N} \mathrm{Tr}\, P(x) \rangle \sim 0 \qquad T < T_c$$

$$\langle \tfrac{1}{N} \mathrm{Tr}\, P(x) \rangle \not\sim 0 \qquad T > T_c$$

LOOK FOR TOPOLOGICAL EXCITATIONS IN SUCH NONTRIVIAL POLYAKOV LOOP BACKGROUND

→ SELF-DUAL SOLUTIONS WITH

$$\text{HOLONOMY} = P = \lim_{|x| \to \infty} P e^{\int_0^\beta A_0 dt} \neq \text{CENTER}$$

→ MASSIVE MONOPOLES RELEVANT FOR $T < T_c$

MOTIVATION AND RELATED WORKS

'78 HARRINGTON-SHEPARD
TRIVIAL HOLONOMY

'98 KRAAN-VAN BAAL-LEE-LU
NON-TRIVIAL HOLONOMY
CHARGE 1

- $SU(2) \to 2$ LUMPS OF ACTION, OPPOSITE
- MAGNETIC CHARGE,
- B.C. DETERMINES WHERE CHIRAL ZERO MODE LOCALIZES
- EACH BPS IF WELL-SEPARATED

'02 GATTRINGER
HOPPING OF LOCALIZED ZERO MODES OBSERVED IN DYNAMICAL CONFIGURATIONS $T < T_c$

'00 - '01 ILGENFRITZ, MÜLLER-PREUSSKER ET AL.

CONSTITUENT PICTURE OBSERVED IN COOLED DYNAMICAL CONFIGURATIONS $T < T_c$

'04 DIAKONOV ET AL.

PERTURBATIVE EFFECTIVE POTENTIAL'S MINIMUM SHIFTED FROM TRIVIAL TO NON-TRIVIAL HOLONOMY BY NON-PERTURBATIVE CONTRIBUTION OF CONSTITUENT MONOPOLES AT HIGH T

SUPERPOSITION OF MONOPOLES

HOW TO HAVE MANY?

PARAMETER SPACE OF CHARGE k SU(2) INSTANTONS : $4k + 3k + k$ DIM.

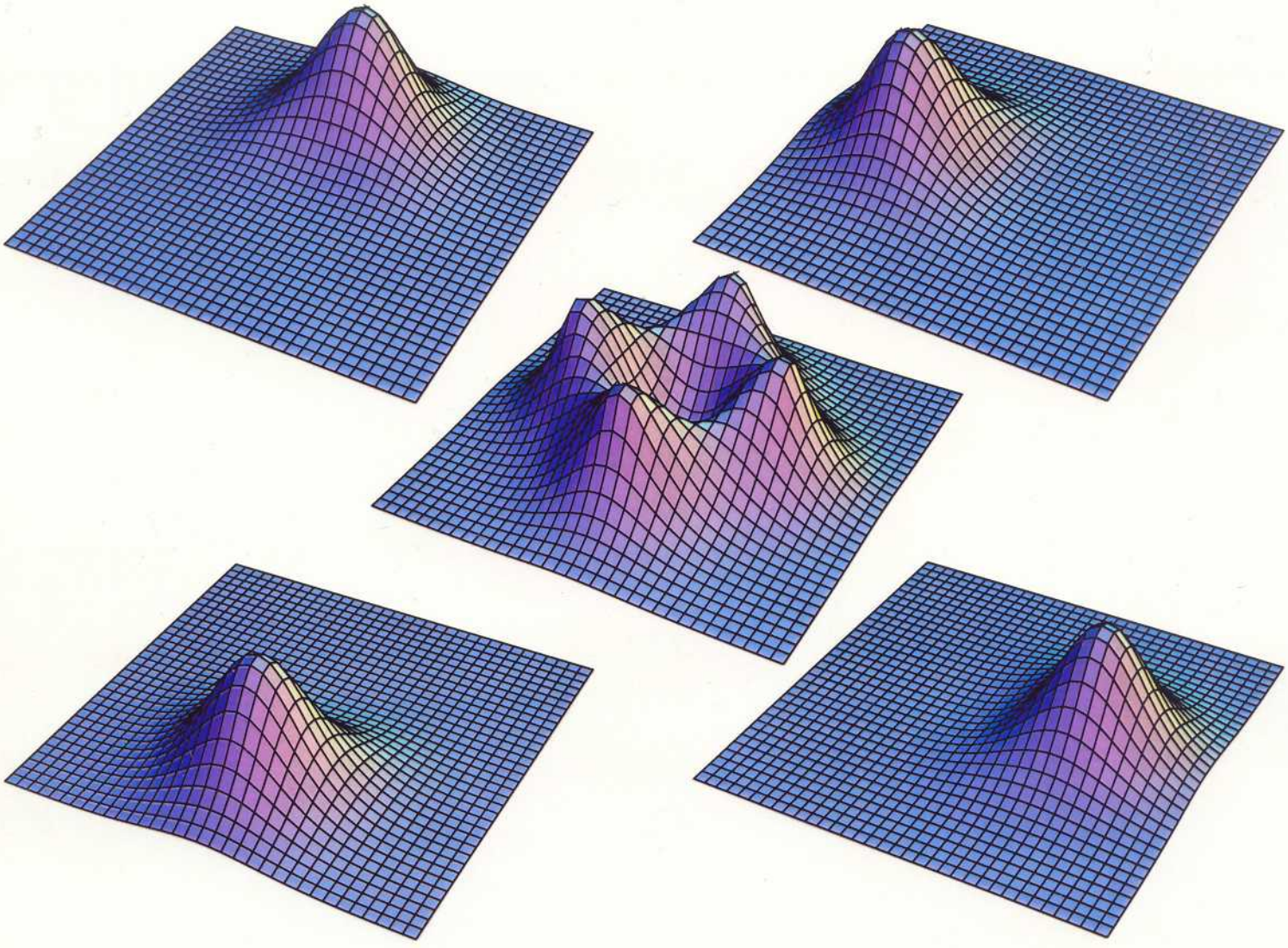
OF $2k$ MONOPOLES :
$2(3k + k)$ DIM.

CHARGE k SELF-DUAL SOLUTION WITH NON-TRIVIAL HOLONOMY WILL HAVE $2k$ CONSTITUENTS.
(Nk FOR SU(N))

NEED HIGHER CHARGE SOLUTIONS

→ ADHM-NAHM METHOD

SU(2) CHARGE 2



CHIRAL FERMION ZERO MODE PERIODIC

ACTION DENSITY

CHIRAL FERMION ZERO MODE ANTIPERIODIC

PROPERTIES OF SOLUTIONS

MASS $\sim T$

$\rightarrow$ EXP. LOCALIZATION

EXCEPT FOR SPECIAL B.C.: DELOCALIZATION

FAR FIELD (ABELIAN) LIMIT:

- ONLY KEEP LONG-RANGE COMPONENTS
- STATIC
- WELL-SEPARATED: DIRAC MONOPOLES
- OTHERWISE: CHARGE DISTRIBUTION ρ

SU(2): $\Delta\phi = -\rho$

CONCLUSION

- ANALYTIC CONTROL OF EXACT SOLUTIONS, CONSTITUENT MONOPOLE PICTURE VERY CLEAR

- LATTICE EVIDENCE IN DYNAMICAL CONFIGURATIONS : - COOLING
  - ZERO MODES

- EFFECTIVE POTENTIAL FAVOURS NON-TRIVIAL HOLONOMY

- AT $T < T_c$ THESE CONSTITUENT MONOPOLES SEEM TO BE THE RELEVANT DEGREES OF FREEDOM