The Origins of Lattice Gauge Theory

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The Origins of Lattice Gauge Theory

I. 1974 - 2004 Homage

II. 1973 - 1974 Origins

III. 1958 - 1971 Thesis and After

IV. 2004 - Research Questions

I. 1974 - 2004 Homage

A. Current knowledge vs. 1974

B. The next thirty years

C. Thirty years: a long time?

D. How about 2700 years?

II. 1973 - 1974 Origins (1)

A. 1973: Asymptotic Freedom

B. I have a problem

C. Solution: try a lattice

D. Confinement?

II. 1973 - 1974 Origins (2)

A. Summer: Formalism clear

B. Orsay talk

C. Strong coupling

II. 1973 - 1974 Origins (3)

A. Another problem

B. Months of struggle

C. Confinement!

II. 1973 - 1974 Origins (4)

A. Prior experience with lattices, critical phenomena

B. The Ising Model:

- A field theorist's laboratory

II. 1973 - 1974 Origins (5)

Retrospective:

A Discovery Waiting to Happen

III. 1958 - 1971 Thesis and After (1)

A. 1958 Topic (Gell-Mann)

B. 1-d Integral equation

C. I become irrelevant to Physics (1958-1969)

III. 1958 - 1971 Thesis and After (2)

A. Learning computing

B. Unexpected discovery

C. Gell-Mann and Low

D. Feynman anecdotes

III. 1958 - 1971 Thesis and After (3)

A. In my own world

- Theorist's laboratories for Strongly Coupled Field Theories

B. Computers (someday)?

III. 1958 - 1971 Thesis and After (4)

A. A laboratory experiment:

- Butchering a Field Theory

B. Momentum Slices

- $1 < k < 2$, $1000 < k < 2000$ …

III. 1958 - 1971 Thesis and After (5)

New Renormalization Group:
Solving Field Theory Slice by Slice

Number of couplings per step:
Infinite

III. 1958 - 1971 Thesis and After (6)

Two Payoffs!

- Critical Phenomena - A New Expansion
- The Kondo Problem - RG, Slices, solved by Computer

  Adjacent Slices

III. 1958 - 1971 Thesis and After (7)

A. A blunder

B. A bizarre episode

IV. 2004 - Research Questions

A. Colored partners for the gluon

B. An RG Infrared Limit Cycle in altered QCD?

C. New expansions???

The Origins of Lattice Gauge Theory Some Historical References

- K. G. Wilson, “Renormalization Group and Critical Phenomena,” *RMP*, **55,** 583 (1983), Nobel address
- Andrew Pickering: *Constructing Quarks*

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- Lillian Hoddeson, et.al., *The Rise of the Standard Model*
- The Dibner Institute for the History of Science and Technology Web Site: in preparation

References for the Two Payoffs

- "The Renormalization Group and Critical Phenomena II: Phase Cell Analysis of Critical Behavior," K.G. Wilson, *Phys. Rev.* **B4**, 3184 (1971)
- "Critical Exponents in 3.99 Dimensions," M.E.Fisher and K.G. Wilson, *Phys. Rev. Lett.* **28**, 240 (1972)

References for the Two Payoffs

- "Feynman Graph Expansion for Critical Exponents," K. G. Wilson, *Phys. Rev. Lett.* **28**, 548 (1971)

- "The Renormalization Group: Critical Phenomena and the Kondo Problem," K.G. Wilson, *Rev. Mod. Phys.* **47**, 773-840 (1975)