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Submitted to Rapid Communications to Physical Review D

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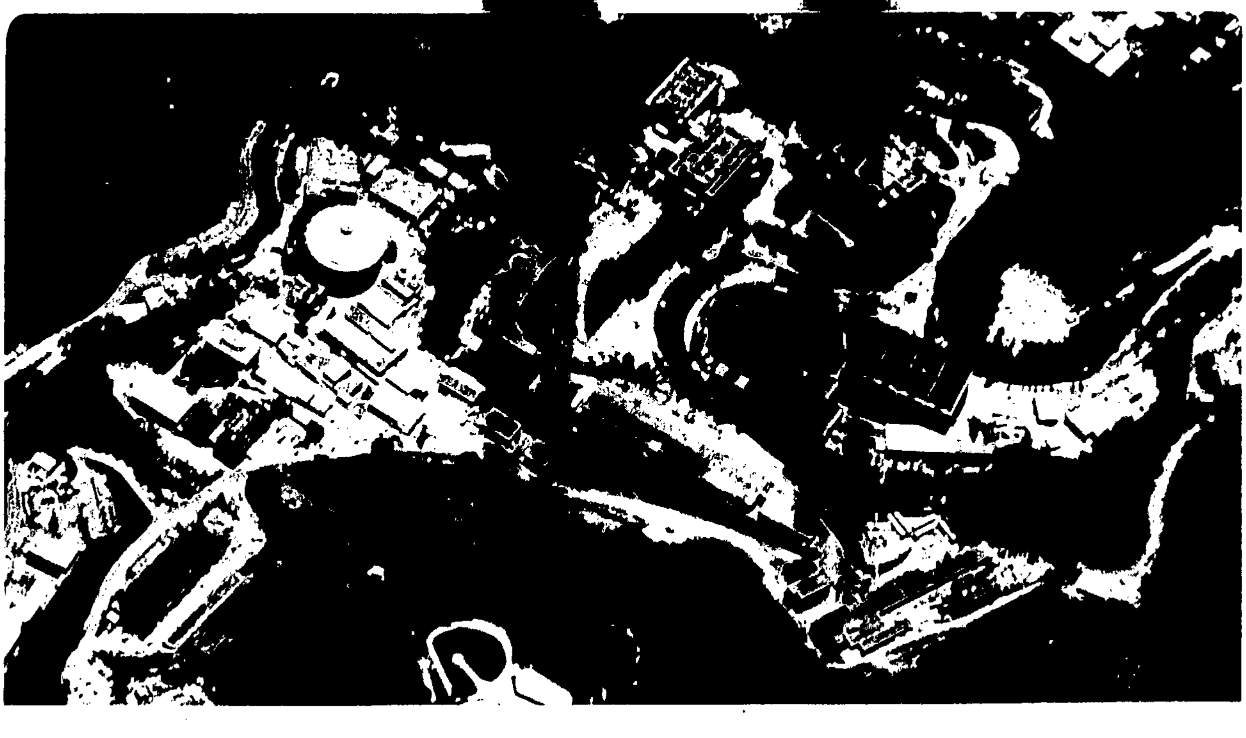
June 1982



Prepared for the U.S. Department of Energy under Contract DE-AC03-76SF00098

June 1982 LBL-14510

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ABSTRACT

Topological particle theory distinguishes strong from weak vertices of Feynman graphs, as well as distinguishing between strong (hadron) and weak (nonhadron) lines. "Explicit" weak vertices touch weak lines, while "implicit" weak vertices touch strong "naked" tadpoles. Strong vertices touch only "clothed" strong lines--carrying "color and chirality quark switches"--or single ends of "naked" strong lines.

*This work was supported in part by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics Division of High Energy Physics of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

In the course of developing Feynman rules for amplitudes within the topological expansion[1,2] a distinction between three general types of Feynman-graph vertex has been discovered. Attention to this distinction--which we show is appropriately described by the terms, "strong", "explicit weak" and "implicit weak" vertices--promises to stimulate further development of the theory.

A Feynman line is defined to be "weak" if it does not correspond to an elementary hadron, and any vertex touched by a weak line is defined to be "explicitly weak". A strong line corresponds to an elementary hadron but not all vertices touched exclusively by strong lines should be called "strong"; distinction needs to be made between "naked" and "clothed" strong lines. (Weak lines may always be regarded as naked.) A naked strong line we define as one that lacks "switches" along the accompanying "quark" lines; these switches involve "color"[3] and "chirality"[4] and are described in detail in Ref. (5). Internal naked strong lines can be removed by contractions (duality) that do not change topological complexity (entropy). It turns out that by the contraction rules of Ref. (1) an internal naked strong line may always be removed (identifying the end points) unless one end is at an explicitly-weak vertex or both ends lie at the same vertex--a "tadpole". A naked strong tadpole may in fact be erased if removal does not alter the genus and boundary structure of the "classical surface" that embeds the "thickened" Feynman graph. Figure 1 shows examples of removable and irremovable naked strong tadpoles. We propose to classify as "implicitly weak" any vertex to which a (noncontractible) naked strong tadpole is attached.

Our terminology is justified by two considerations.

(1) If one estimates by a Feynman loop integral the effect of adding a tadpole to a graph, one encounters a factor

$$N \frac{g_0^2}{16\pi^2}$$

where g_0 is the zero-entropy coupling constant and N is the multiplicity of the tadpole line--determined by the number of closed quark loops that accompany the Feynman loop. It has been shown that g_0 is of order of magnitude e,[6] so only if quark lines close and thereby lead to a large value of N (quark multiplicity is 32)[7] can the magnitude of a tadpole contribution avoid being small. But the considerations of Ref. (1) show that naked uncontractible strong lines, such as in Fig. 1 (b,c), have no closed quark loops. It is furthermore shown in Ref. (5) how "color switching" can lead to closed quark loops in topologies such as Fig. 1(c). Thus a "clothed" tadpole is capable of a large contribution.

(2) Clothed strong lines carry switches in "color" and (or) chirality[3,4] and are never erasable. Reference (5) explains that, so long as a vertex touches only clothed strong lines or single ends of naked strong lines (external lines are always naked), a Feynman rule assigns to the vertex function the value of a zero-entropy (strong) amplitude. Such a vertex we designate as "strong". All singularities of a strong vertex correspond to elementary hadrons. In contrast a vertex touched by a weak line or by a

naked (noncontractible) strong tadpole cannot be evaluated as a zero-entropy amplitude. The former vertex function has no singularities while the latter has singularities in addition to elementary hadrons. The topology of Fig. 1(b), in particular, is the naked cylinder discussed in Ref. (8), where it is argued that such a vertex contains among its poles a Higgs scalar (forcing introduction into the theory of the Weinberg-Salam electroweak-boson family).[9] The discontinuities of any Feynman vertex with naked strong tadpoles would similarly contain Higgs scalars.

It is not true that any topology built entirely from strong vertices--vertices neither explicitly nor implicitly "weak"--gives a large contribution. But the Feynman rule for any such "strong" topology, as shown in Ref. (5), is completely expressible through zero-entropy connected parts--i.e. through elementary hadrons. Strong-vertex discontinuities are exclusively hadronic. Any weak vertex as defined in this paper involves electroweak bosons, either explicitly through incident weak lines or implicitly through Higgs poles of the vertex function. The theory nevertheless does not allow "opening up" of implicit weak vertices to make explicit their electroweak content; herein resides the opportunity for an electroweak bootstrap.[8] Herein also resides the need to define carefully the meaning of "weak vertex".

ACKNOWLEDGMENT

Discussions with J. Finkelstein, M. Levinson and H. P. Stapp have contributed importantly to the ideas described here. This work was supported in part by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics Division of High Energy Physics of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

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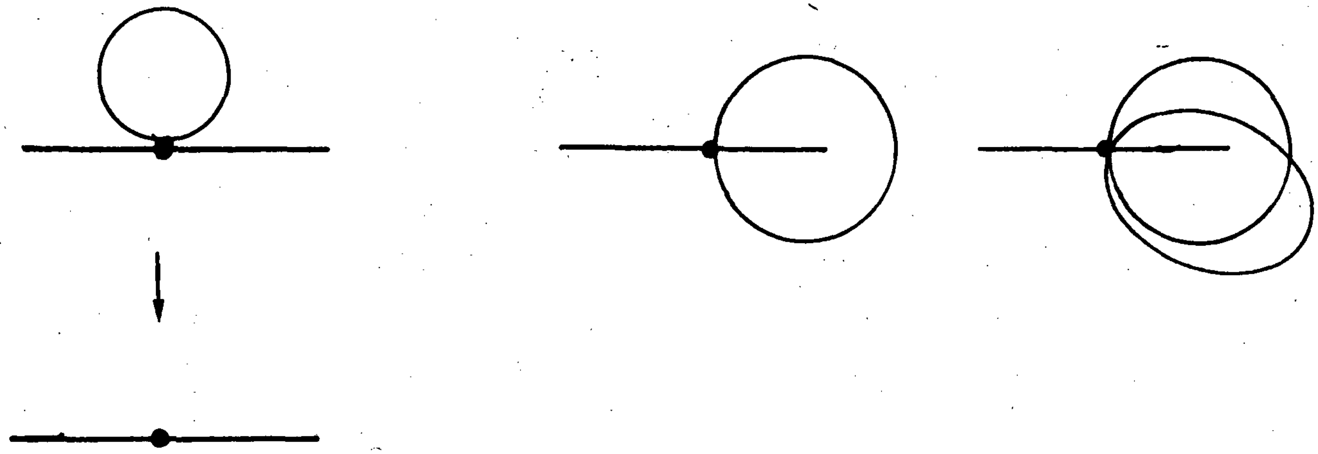
FIGURE CAPTION

1. (a) A contractible strong naked tadpole.
   (b) A noncontractible tadpole. The thickened Feynman graph is embedded in a cylinder.
   (c) A noncontractible tadpole pair. The thickened Feynman graph is embedded in a torus.



(A) (B) (C)

FIGURE 1