# Comment on "Stigma of a Dirac Particle in an Even Environment"

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It is pointed out that Good's result is subject to two different interpretations.

The result that Good establishes in his note[1] is both interesting and correct, but the precise significance of his result is a bit subtle. There are two distinct ways in which one may view his result:

(a) *If* $\rho_1$ has a *fixed significance* (which appears possible via weak interactions), *then* it is not possible to identify stigma with the parity operator of Dirac's equation. [Proof: Stigma as defined in Ref. 2 commutes with $\rho_1$ (chirality) whereas Dirac parity does not.]

(b) If $\rho_1$ does *not* have a fixed significance, *then* one can establish the following result: There exists[3] an invertible mapping of $A_1$ (Dirac) onto $A_2$ which maps: Dirac parity $\leftrightarrow$ stigma.

The fact that this possibility of distinguishing (a) and (b) exists is, we feel, of considerable interest, and merits further study.[3]

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[1]R. H. Good, Jr., preceding paper, Phys. Rev. D 5, 1538 (1972).

[2]L. C. Biedenharn, M. Y. Han, and H. van Dam, Phys. Rev. Letters 27, 1167 (1971).

[3]L. C. Biedenharn, M. Y. Han, and H. van Dam, Phys. Rev. D (to be published).

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# Gauge Invariance and the Reactions $2\gamma \to (2n+1)\pi$

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We give the conditions on the possible Lagrangians which are compatible with a chiral SU(2)⊗SU(2) symmetry broken by the electromagnetic field. Among some examples of such Lagrangians, we present the most general one which dominates the $2\gamma \to (2n+1)\pi$ reactions at the soft-pion limit. Some consequences are compared with particular results obtained earlier by Aviv, Hari Dass, and Sawyer, and by Yao.

Recently a few articles[1] have been published treating the $2\gamma \to (2n+1)\pi$ reactions together with the requirements of chiral symmetry. This problem is closely connected to the so-called anomalous terms discovered by Adler.[2]

In this paper, arguing from first principles, we should like to review the Lagrangian formulation of the underlying invariance properties. We believe that our derivation has not only the merit of clarifying the subject but also that of correcting and extending some claims made by the authors of Ref. 1.

The four fields $(\sigma_0, \vec{\pi})$ are supposed to transform as a $(\frac{1}{2}, \frac{1}{2})$ representation of SU(2)⊗SU(2). By imposing the relation

$$\vec{\pi}^2 + \sigma_0^2 = f^2 \quad (f \text{ constant}), \tag{1}$$

we make $\sigma_0$ a dependent field and are led to a nonlinear representation of SU(2)⊗SU(2). The electromagnetic interactions reduce the symmetry to