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Higher Spin BRS Cohomology of Supersymmetric Chiral Matter in $D = 4$

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Abstract: We examine the BRS cohomology of chiral matter in $N = 1$, $D = 4$ supersymmetry to determine a general form of composite superfield operators which can suffer from supersymmetry anomalies. Composite superfield operators $\Psi_{(a,b)}$ are products of the elementary chiral superfields S and $\bar{S}$ and the derivative operators $D_\alpha, \bar{D}_{\dot{\beta}}$ and $\partial_{\alpha\dot{\beta}}$. Such superfields $\Psi_{(a,b)}$ can be chosen to have "a" symmetrized undotted indices α_i and "b" symmetrized dotted indices $\dot{\beta}_j$. The result derived here is that each composite superfield $\Psi_{(a,b)}$ is subject to potential supersymmetry anomalies if $a - b$ is an odd number, which means that $\Psi_{(a,b)}$ is a fermionic superfield.

1. Introduction

The only known candidate for a unified theory of all matter and forces is superstring theory, but there are two major obstacles to making a comparison between this theory and experiment. The first problem is to discover how and why supersymmetry gets broken, preferably without generating a ridiculously huge cosmological constant. The second problem is to explain why our own universe is picked out from other possibilities. In a recent book written for the general public [15], Weinberg has expressed some doubt whether either of these questions has a mathematical answer – and suggested that the explanation may simply be that if our universe were not as it is, we wouldn't be here to ask the question.

But of course this "explanation" is a last resort. Our purpose here is to continue the search for supersymmetry anomalies. If these exist, their elimination would naturally be expected to impose restrictions on the possible superstring theories. In addition, it has been conjectured [5] that such anomalies might also provide a natural mechanism whereby "supersymmetry breaks itself," while at the same time retaining the cosmological constant at the zero value it naturally has in many unbroken supersymmetric theories.