THE ICTP SERIES IN THEORETICAL PHYSICS – VOLUME 1

APPLIED $N = 1$ SUPERGRAVITY

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FOREWORD

Each summer from June through July, there are held at the Trieste Centre extended workshops on particle physics and condensed matter physics on areas of topical interest. The format is by and large informal with lectures in the mornings, the afternoons being free for discussion sessions.

It was felt that, to make the material covered available to a wider audience, it would be worthwhile to publish the proceedings of these workshops as 'The ICTP Series in Theoretical Physics'. The current volume is the first such, and is based on the 1983 particle physics workshop on $N=1$ Supergravity.

March 1984

Abdus Salam

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ABSTRACT

A review of recent developments in the applications of $N=1$ Supergravity to the construction of unified models of elementary particle interactions is given. Couplings of $N=1$ Supergravity with matter consisting of an arbitrary set of left handed multiplets and a gauge multiplet are discussed. General formulation of spontaneous symmetry breaking and the criteria for breaking of internal symmetry and of local supersymmetry are described. Construction of specific Supergravity GUT models, the gauge hierarchy in GUT models and a deduction of the low energy effective potential are discussed. The phenomena of $SU(2) \times U(1)$ electro-weak gauge invariance breakdown by Supergravity in tree models and by radiative corrections using renormalization group methods are described. Model independent formulations of low energy physics which encompass tree and the renormalization group methods of breaking $SU(2) \times U(1)$, but also allow more general scenarios are discussed. The particle content of Supergravity unified theories at low energy is given which includes predictions, for a class of supergravity models, of light gauge fermions, i.e. of a charged Dirac fermion, the Wino, with a mass below the W boson mass and a neutral fermion, the Zino, below the mass of the Z boson mass. "Direct" gaugino masses arising from loops for the photino and the gluino, (which are massless at the tree level) are exhibited. Decays of the W and Z into photino, Wino, and Zino modes and their branching ratios into various channels are given. Experimental signals for the supersymmetric decays are discussed and some prominent signatures such as decays into one and two jets with unbalanced energy and momentum are pointed out. The current status of the p -

parameter, including supergravity GUT effects is given. Other experimental consequences of supergravity unified theories are also discussed.

Notation: Secs. VII and VIII use the Lorentz metric $\text{diag } \eta_{\mu\mu} = (-1, +1, +1, +1)$ and standard left handed Weyl spinors (projected by $P_- = (1 - \gamma_5)/2$, $\gamma_5^\dagger \gamma_5$). The discussion of the supergravity - matter couplings, Sec. II and App. A, are in the notation of [C4] and [C7].

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