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The Kadomtsev-Petviashvili Equations and Fundamental String Theory*

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Abstract. In this paper the infinite sequence of non-linear partial differential equations known as the Kadomtsev-Petviashvili equations is described in simple terms and possible applications to a fundamental description of interacting strings are addressed. Lines of research likely to prove useful in formulating a description of non-perturbative string configurations are indicated.

Introduction

The state of current understanding of string physics is incomplete and far from satisfactory. The theory of the dynamical evolution of entire strings as such, consistent with and following from the principles of quantum mechanics, has yet to be elucidated. Conventional wisdom would hold that, viewed as a system in quantum mechanics, an assemblage of strings ought to be describable by a Hamiltonian. For now, however, the true Hamiltonian of heterotic strings subject to mutual interaction remains undiscovered. Also undiscovered is the manifestly invariant path-integral formulation of such a system. Alternatively one might flaunt conventional wisdom and hope that the quantum physics of interacting heterotic strings could be deduced without ever "writing down a Lagrangian and quantizing." After all there exist in (perhaps not coincidentally) two dimensions a number of conformal quantum field theories characterized by an infinite number of conserved quantities for which no Lagrangian is known. Of course in these cases one knows what to do; for example the quantum field theory may be formulated entirely in terms of Ward identities [1]. For string theory in the absence of a Hamiltonian, in contrast, it is at present entirely unclear as to how to proceed in describing the quantum theory to allow for the computation of, for instance, non-perturbative effects. Indeed it is not at all obvious how some computations usually

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