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Existence of quantum soliton for ϕ^6-like field theories in $1+1$ dimensions

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Abstract. We reexamine the recent claim that the soliton of the $1+1$ dimensional field theories does not survive quantum corrections if the adjacent minima of the potential do not have same curvature and show that it is in fact possible to choose counter terms such that the quantum correction to the soliton mass is finite.

Keywords. Solitons; 2-D scalar field model; triple-well potential.

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1. Introduction

In a recent article, Kaul and Rajaraman (1985) (KR) have considered the ϕ^6 field theory model in $1+1$ dimensions which has three degenerate minima and have claimed that the quantum soliton does not exist in this model. These authors have claimed that the quantum soliton will not exist in all those $1+1$ dimensional field theory models in which the curvatures at the adjacent degenerate absolute minima are unequal. In particular they showed that in all these cases the quantum correction to the soliton mass has a L-dependent piece which diverges as the length L of the box in which the system is quantized goes to infinity.

We find this claim rather surprising since all such neutral scalar field theories are in fact renormalizable in $1+1$ dimensions. We have therefore taken a fresh look at this problem and find that in *all* these cases, contrary to the claim of KR it is in fact possible to choose the counterterms in such a way that the quantum correction to the soliton mass is finite.

The paper is organized as follows. In §2 we sketch the essential steps of KR so as to make the paper self-contained. In §3 we demonstrate as to how counterterms can be appropriately chosen to make the quantum correction to the soliton mass finite. Finally, in §4 we compute one-loop effective potential for the case of ϕ^6-field theory with the same counterterms and show the phenomenon of spontaneous symmetry breaking.