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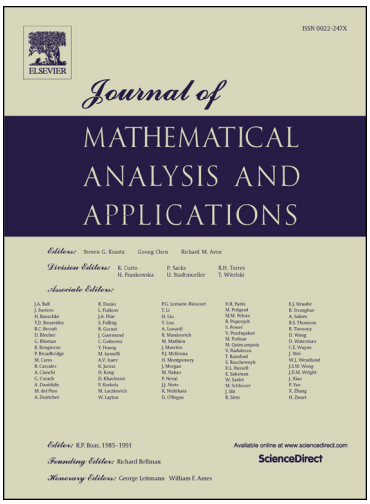

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The maximum principle and sign changing solutions of the hyperbolic equation with the Higgs potential

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Abstract

In this article we discuss the maximum principle for the linear equation and the sign changing solutions of the semilinear equation with the Higgs potential. Numerical simulations indicate that the bubbles for the semilinear Klein-Gordon equation in the de Sitter space-time are created and apparently exist for all times.

Keywords: maximum principle; sign-changing solutions; semilinear Klein-Gordon equation; de Sitter space-time; global solutions; Higgs potential

1. Introduction

In this article we discuss the maximum principle for the linear equation and the sign changing solutions of the semilinear equation with the Higgs potential. The Klein-Gordon equation with the Higgs potential (the Higgs boson equation) in the de Sitter space-time is the equation

$$\psi_{tt} - e^{-2t}\Delta\psi + n\psi_t = \mu^2\psi - \lambda\psi^3, \tag{1}$$

where Δ is the Laplace operator in $x \in \mathbb{R}^n$, $n = 3$, $t > 0$, $\lambda > 0$, and $\mu > 0$. We assume that $\psi = \psi(x, t)$ is a real-valued function.

We focus on the zeros of the solutions to the linear and semilinear hyperbolic equation in the Minkowski and de Sitter space-times. One motivation for the study of the maximum principle, sign changing solutions and zeros of the solutions to the linear and semilinear hyperbolic equation comes from the cosmological contents and quantum field theory. It is of considerable