Pramāṇa, Vol. 15, No. 5, November 1980, pp. 501–505. © Printed in India.

Classical ϕ^6-field theory in (1+1) dimensions 2. Proof of the existence of domain walls above the transition point

S N BEHERA and AVINASH KHARE*†
Institute of Physics, Bhubaneswar 751 007, India
*Department of Theoretical Physics, The University, Manchester M13 9PL, U.K.
†Permanent address: Institute of Physics, A/105 Saheed Nagar, Bhubaneswar 751 007, India

MS received 27 August 1980

Abstract. The existence of a domain wall-like contribution to the free energy above the first order phase transition point is demonstrated for a system described by the ϕ^6-field theory in (1+1) dimensions.

Keywords. ϕ^6-field theory; domain walls; structural phase transition.

1. Introduction

In an earlier paper (Behera and Khare 1980a; hereafter referred to as I) the dynamics and thermodynamics of the ϕ^6-field theory in (1+1) dimensions were extensively studied. The use of the ϕ^6-field theory as a model for first order structural phase transitions (see I and the references therein) was also discussed. Of particular importance to the problem of structural phase transitions is the existence of domain wall-(kink) like solutions, which are responsible for the occurrence of the central peak phenomena. It was shown that these domain wall solutions exist below the transition point ($a < 9/8$, notations are same as in I), the latter being determined by the parameters of the ϕ^6-potential. However, the exact evaluation of the free energy of the system in this regime revealed that the tunnelling-like contribution expected for the domain wall free energy is absent *i.e.* identifying the domain wall free energy as the exact free energy minus the phonon part, it was found to be large and proportional to T^2 instead of exp $(-\text{const}/T)$. In the concluding section of I, it was conjectured that the presence of local minima in the ϕ^6-potential, above the transition point, *i.e.* $9/8 < a < 3/2$, will lead to the existence of a tunnelling-like contribution to the free energy which can explain the experimentally observed central peak in ferroelectrics at temperatures above T_c. The purpose of the present paper is to prove this conjecture.

The plan of the rest of the paper is as follows. In § 2 an upper bound to the ground state energy eigenvalue of the corresponding Schrödinger equation (see I) for the ϕ^6-potential will be calculated for $a > 9/8$. This will then be used to calculate the free energy using equation (62) of I, and the existence of a domain wall-like contribution will be demonstrated. The concluding § 3 is devoted to the discussions of the results.