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The Mass Spectrum and the S Matrix of the Massive Thirring Model in the Repulsive Case

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Abstract. The repulsive case of the quantum version of the massive Thirring model is considered. It is shown that there is a rich particle spectrum in the theory. The S matrix of fermions proves to be a discontinuous function of the coupling constant. These effects are the result of the qualitative change of the physical vacuum in the limit of the strong repulsion $g \to -\pi$.

1. Introduction

The massive Thirring model abounds in interesting results. In [1] the classical equation was shown to be integrable. In quantum version there is no multiple production, N particle S matrix is the product of two particle S matrices due to the infinite number of the integrals of motion [2]. It was shown in [3] that in the quantum case the massive Thirring model is equivalent to the sine-Gordon model, the same problem was considered in [4]. Classical integrability of the sine-Gordon model was established in [5]. The quasiclassical mass spectrum and the S matrix of the sine-Gordon model were calculated in [6, 7]. Quantum version of the massive Thirring model is investigated quite well in the attractive case $g>0$. The mass spectrum and the scattering matrix were calculated in [8–10], respectively. A direct way to exact quantum results for the sine-Gordon model is provided by the quantum inverse scattering method [11, 12]. In particular in [11] the value of the generating function for the integrals of motion on the physical particle state was calculated.

In present paper it is shown that in the repulsive case of the massive Thirring model $g<0$ the mass spectrum and the S matrix are of essentially new form. We study only the zero charge sector of the theory. The main idea is to use the Bethe ansatz, i.e. all eigenfunctions of the quantum Hamiltonian of the massive Thirring model [13] and the method of constructing of physical states developed in [14]. The technical aspect of this paper is a direct matrix generalization of [15, 16].

The plan of the paper is the following: In Sect. 2 the main results are described. In Sect. 3 we describe all the eigenfunctions of the quantum Hamiltonian. In Sect.

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