Instituto de Física
Universidade de São Paulo

Elementary Excitations of a Relativistic Scalar Plasma System

Natti, ERT; Lin, C-Y; Toledo Piza, AFR
Instituto de Física, Universidade de São Paulo, CP 66318
CEP 05315-970. São Paulo. SP.Brasil

Publicação IF - 1434/2000

High Energy Physics - Phenomenology, abstract hep-ph/9902216

1434

From: Lin Chi Yong <lcyong@fma.if.usp.br>
Date: Mon, 1 Feb 1999 20:47:43 GMT (12kb)

Elementary Excitations of a Relativistic Scalar Plasma System

Authors: E. R. Takano Natti, Chi-Yong Lin, A. F. R. de Toledo Piza, P. L. Natti
Comments: 17 pages, LaTex file, two figures

We investigate the physics of elementary excitations for the so called relativistic scalar plasma system. Following the standard many-body procedure we have obtained the RPA equations for this model by linearizing the TDHFB equations of motion around equilibrium and shown that these oscillation modes give one-meson and two-fermion state of the theory. The resulting equations have a closed solution, from which one can examinate the spectrum of excitation modes. In partticular, our results indicate existence of bound state for certain region of phase diagram.

Paper: Source (12kb), PostScript, or Other formats

(N.B.: delivery types and potential problems)

refers to , cited by

Links to: xxx, hep-ph, /find, /abs (-/+), /9902, ? form interface

Elementary Excitations of a Relativistic Scalar Plasma System

E.R. Takano Natti[†], Chi-Yong Lin[†] and A.F.R. de Toledo Piza

Instituto de Física, Universidade de São Paulo
Caixa Postal 66318, 05315-970, São Paulo
São Paulo SP Brazil

P.L. Natti

Departamento de Matemática, Universidade Estadual de Londrina,
Caixa Postal 6001, Cep 86051-970, Londrina Paraná Brazil

ABSTRACT

We investigate the physics of elementary excitations for the so called relativistic scalar plasma system. Following the standard many-body procedure we have obtained the RPA equations for this model by linearizing the TDHFB equations of motion around equilibrium and shown that these oscillation modes give one-meson and two-fermion state of the theory. The resulting equations have a closed solution, from which one can examinate the spectrum of excitation modes. In partticular, our results indicate existence of bound state for certain region of phase diagram.

PACS Numbers : 03.65.Ge, 03.65.Nk, 11.30Rd, 11.10Kk

[†] Supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

I. INTRODUCTION

In a previous work [1] (hereafter referred to as I) we have presented a framework to investigate the initial-value problem in the context of interacting fermion-scalar field theories. The method allows one to obtain a set of self-consistent equations for the expectation values of linear and bilinear forms of field operators. These dynamical equations acquire the structure of kinetic type, where the lowest order of the approximation corresponds to the usual gaussian mean-field approximation (collisionless). As application, we have implemented a zero-order calculation within the simplest context of relativistic scalar plasma system. We have shown that the usual prescription of renormalization can also apply to these nonoperturbative calculation. In particular, we have obtained a finite expression for the energy density and the numerical results suggested that the system presents always a single stable minimum .

In continuation of I we will report in this paper a particular application of the renormalized nonlinear obtained the previous publication. We follow here a recent work by Kerman and Lin [2, 3] in order to investigate the near equilibrium dynamics around the stationary solution. We shall show that one-meson and two-(quasi)fermion physics can be studied from the linear approximation of the mean-field equations. In particular, one can solve these equations in a closed form and find scattering amplitude as well as the conditions for the two-fermion bound state.

For completeness and notational purpose, we repeate here a few key equations of I. A summary of derivation for these equations is shown in Appendix A. For the scalar plasma model, the dynamics are governed by the hamiltonian

$$\begin{aligned} H &= \int_{\mathbf{x}} \mathcal{H} , \\ \mathcal{H} &= -\bar{\psi}(i\vec{\gamma}.\vec{\partial} - m)\psi - g\bar{\psi}\phi\psi + \frac{1}{8\pi}\left[\frac{(4\pi)^2}{1+Z}\Pi^2 + (1+Z)|\partial\phi|^2 + \mu^2\phi^2\right] + \mathcal{H}_c \ , \end{aligned} \tag{1.1}$$

[We use the notation: $\int_{\mathbf{x}} = \int d^3x$] where ψ is a spin-$\frac{1}{2}$ field while ϕ is a scalar field. The