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BOSE-FERMI MIXTURES IN TWO OPTICAL LATTICES

NIKOLAY A. KOSTOV, VLADIMIR S. GERDJIKOV
AND TIHOMIR I. VALCHEV

Institute for Nuclear Research and Nuclear Energy
Bulgarian Academy of Sciences, 1784 Sofia, Bulgaria

Abstract. We present stationary and travelling wave solutions for equations describing Bose-Fermi mixtures in an external potentials which are elliptic functions of modulus k. There are indications that such waves and localized objects may be observed in experiments with cold quantum degenerate gases.

1. Introduction

Recently, there has been a strong interest on quantum degenerate mixtures of bosons and fermions [3, 14, 16]. In this paper, we study a system of coupled nonlinear Schrödinger equations modelling a quantum degenerate mixture of bosons and fermions in optical lattice. Here we extend the results of our recent paper [10] and obtain new exact solutions in elliptic functions for the case when the boson and fermion ingredients are trapped by potentials with different strengths $V_{0,\mathrm{F}} \neq V_{0,\mathrm{B}}$.

2. Bose-Einstein Mixtures in Optical Lattice: Basic Equations in Mean Field Approximations

In this section we consider a mixture of BEC consisting of one boson and N_f fermion ingredients. In the one-dimensional approximation it is described by the following $N_f + 1$ coupled equations (see [16] and the references therein)

$$\mathrm{i}\hbar\frac{\partial\Psi^b}{\partial t} + \frac{1}{2m_{\mathrm{B}}}\frac{\partial^2\Psi^b}{\partial x^2} - V_{\mathrm{B}}\Psi^b - g_{\mathrm{BB}}|\Psi^b|^2\Psi^b - g_{\mathrm{BF}}\rho_f\Psi^b = 0 \tag{1}$$

$$\mathrm{i}\hbar\frac{\partial\Psi^f_j}{\partial t} + \frac{1}{2m_{\mathrm{F}}}\frac{\partial^2\Psi^f_j}{\partial x^2} - V_{\mathrm{F}}\Psi^f_j - g_{\mathrm{BF}}|\Psi^b|^2\Psi^f_j = 0 \tag{2}$$