

Abstract

Non-Abelian Atom Optics

Artificial electromagnetism may be created for neutral atoms, e.g. by rotating the gas. Other forms of inducing artificial electromagnetism are possible, including ways of generating non-Abelian vector potentials.

In this talk, we will discuss simple laser setups that allow the creation of non-Abelian gauge potentials for atoms with a tripod level scheme. This scheme can for instance be implemented using the transition $2^3S_1 \leftrightarrow 2^3P_0$ in 4He^* or the transition $5S_{1/2} (F=1) \leftrightarrow 5P_{3/2} (F=0)$ in 87Rb . We consider a non-Abelian vector potential proportional to a spin-1/2 operator and a possible additional scalar potential.

First, we discuss the perspectives for the observation of a non-Abelian Aharonov-Bohm effect in non-commutative interferometric arrangements [1].

In a second part, the Landau levels of cold atomic gases in non-Abelian gauge fields are analyzed. In particular we identify effects on the energy spectrum and density distribution which are purely due to the non-Abelian character of the fields. We investigate in detail non-Abelian generalizations of both the Landau and the symmetric gauge [2].

In a third part, we consider the effects of the dispersion relation on the wave packet dynamics. In particular the possibility of creating a bright soliton in the region of positive and/or negative mass is considered [3]. As another consequence of the dispersion relation, atom reflection shows unusual features, since an incident wave may split into two reflected ones at a barrier, an ordinary specular reflection, and an additional non-specular one [4]. Furthermore the dispersion can lead to a quasi-relativistic motion of ultracold atoms and to Veselago-type lensing.

[1] Cold atom dynamics in non-Abelian gauge fields, Appl. Phys. B 89 (2007) 439

[2] Landau levels of cold atoms in non-Abelian gauge fields, New J. Phys. 10 (2008) 045022

[3] Chiral confinement in quasirelativistic Bose-Einstein condensates, arXiv:0908.3631

[4] Double and negative reflection of cold atoms in non-Abelian gauge potentials, Phys. Rev. Lett. 100 (2008) 200405