Title of Thesis
Quantum Interference Effects In Atom-Atom and Ion-Atom Cold Collisions In The Presence Of External Fields

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Abstract

Purpose of this thesis is to describe some aspects of quantum interference in atom-atom and atom-ion cold collisions and atom-molecule conversion at low energy. Quantum interferences and coherences have been studied mostly in atomic and molecular systems. In case of ultracold atom-molecule coupled systems, quantum interference has not been adequately addressed. We make use of well known Fano’s theory to treat atom-molecule coupled systems and study quantum interference effects in such systems. Our aim is to show that the quantum interferences in such systems are useful for the modification of decoherence and dissipation in cold atoms and molecules.

In Chapter 1, we give a general introduction and a short outline of the thesis.

In Chapter 2, we briefly review quantum interference emphasizing on Fano interference, vacuum-induced coherence and quantum beats.

In chapter 3, we describe in short different single- and multi-channel resonances with special emphasis on Fano-Feshbach resonance in the presence of magnetic and optical fields in cold atom-molecule coupled system.

In chapter 4, we discuss photoassociation (PA) in the presence of the presence of magnetic Feshbach resonance (MFR) in the framework of Fano’s theory. We show that it is possible to obtain large light shift along with extremely narrow line width using the tunability of
the magnetic field. This may be useful for efficient manipulation of scattering properties of cold atoms by magneto-optical method.

In chapter 5, we study vacuum- and light-induced coherences in case of ultracold PA and propose novel PA schemes for realization of vacuum-induced coherences in atom-molecule coupled system. We show that it is possible to generate and manipulate coherences between the two excited rovibrational states of a molecule using the technique of PA spectroscopy.

Chapter 6 describes ion-atom collisions at low energy and presents a new formalism for producing cold molecular ion by ion-atom photoassociation.

In chapter 7, we conclude and discuss the outlook of the thesis.