I. INTRODUCTION

Tunnelling in a double well lattice is a coherent phenomenon. This occurs due to quantum interference between the states of the atoms in the lattice. Grossman *et al.* [1] has shown that by driving a double-well potential by strong coherent field, one can slow down the tunnelling of the wave packet in one of the wells (left or right) and essentially can have coherent suppression of tunnelling. This has been implied as dynamical localization of wave packet. Once the field is switched off, the tunnelling is resumed, reflecting the preservation of coherence in the wave packet. Such coherent control can also be done in molecular systems by using frequent sequence of short pulses [2].

It is a natural question how any incoherent event would affect a double-well system. Caldeira and Leggett in their seminal paper [3] had modelled the decoherence as a phenomenological "frictional force" and showed that the tunnelling of the wave function is slowed down by the decoherence process. Dynamical localization of two-level atoms in presence of spontaneous emission has been studied in [4], which is an effect of loss of coherence in the atoms.

In this paper, we focus on how to preserve the atomic coherence in the optical lattice in presence of decoherence. We present a technique that relies on a quantum interference approach as originally proposed by Shapiro and Brumer [5]. A suitable choice of initial superposition of the atomic states in the lattice creates different pathways of evolution of the states. The quantum interference of these pathways leads to control in the evolution of the initial state. Note that such a method has been successful in controlling various molecular processes, including photodissociation, scattering cross section etc. [5].

We demonstrate this technique in context of a double-well optical lattice, prepared by a set of four counter-propagating laser fields [6]. Specific choices of field intensity and the polarizations of the participating fields create this lattice. Within the pair, the barrier height and the relative depths of the two potential minima sites are externally controllable. Such lattice has been studied to implement two-qubit phase gate [7] and to demonstrate controlled exchange interaction between atoms [8]. Note that in [9], the spontaneous emission from a two-level atom in double-well lattice has been studied. In the present paper, we propose a coherent control technique to combat the spontaneous emission of atoms, the states of which are allowed to be expanded over all bound energy eigenstates.