Asymmetric second-order coherence function in arrays of two-level atoms

# Outline:

## Introduction

Importance of manipulating the statistical properties of light using the collective behaviour of atomic arrays scattering the incident EM wave.

## System

1. Consider two two-level atoms in free space, interacting through the dipole-dipole interaction with each other and through the dipole interaction with the EM wave.
2. Consider two atomic arrays with 4 atoms in square lattice.

## Results

1. Find the eigenenergies and eigenstates of the system.
   * For the arrays compute the bands and decay rates depending on k.
2. Introduce collective operators  and .
3. Compute waiting-time distributions (WTD) for both of these operators.
4. Compute angular distributions of the  function.
5. Find analytical form for the  function.
6. Numerically (or analytically) find the maximum contrast for forward (or backward)  function.
7. Consider the two-array case
   * Find the contrast
   * Understand if it is better to have arrays

### Eigenenergies and eigenvalues

#### Two atoms

Hamiltonian of two atoms in a free space takes the form:



Non-Hermitian effective Hamiltonian has the form:



Let us consider the eigenstates and eigenenergies of the system without the driving field. In this case, we simply put  and obtain the following effective non-Hermitian Hamiltonian:



We assume that matrices  and  are symmetric, so we find following eigenenergies of the Hamiltonian using Schrödinger equation:



Where



The corresponding eigenstates are:



Where



At , these states become pure dark and bright states: .

## Open questions

1. Why WTD for  does not coincide with the  distribution?
   1. Is it even correct to compare  and WTD for ?
2. Is forward and backward  a measure for an asymmetric behaviour?
   1. How can I take into account bunching/antibunching property?