



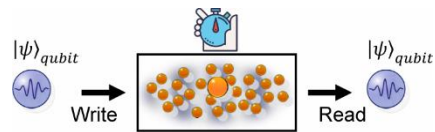
Quantum optics with atomic arrays

Darrick Chang
ICFO

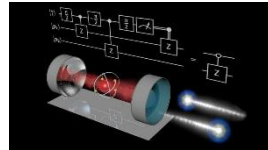
Non-Equilibrium Emergence in Quantum Design
June 23, 2022

Motivation

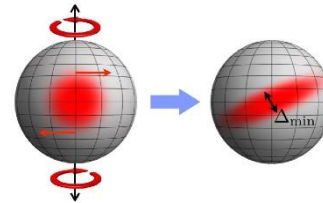
- Goal: realize efficient quantum atom interfaces



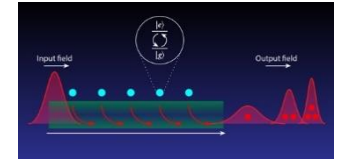
Quantum memories



Photon-photon gates

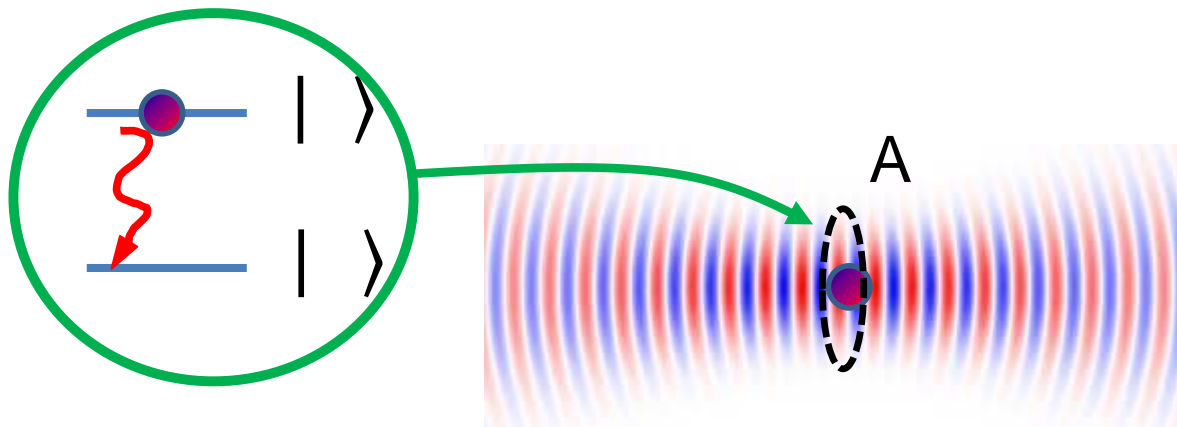


Metrology/sensing



Many-body physics with photons

- Fundamental challenge: low collection efficiency



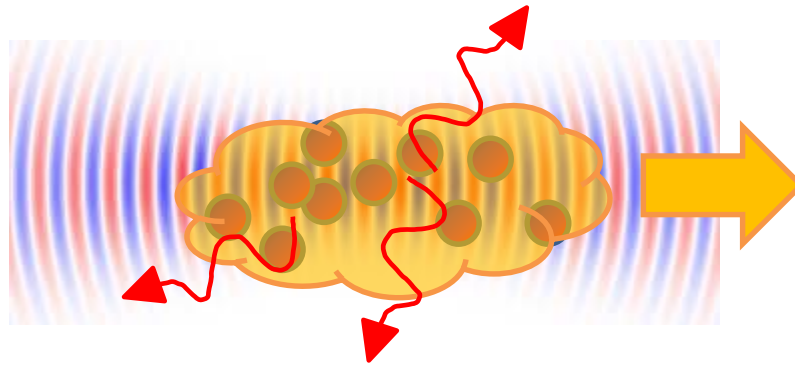
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diffraction limit

- Record with single atoms in free space Kurtsch (Singapore)

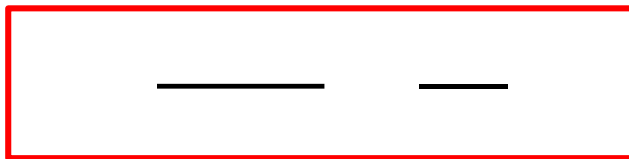
A possible fix: collective enhancement

- “ Atomic ensemble: collective enhancement of emission in preferred mode



Single collective excitation $| \quad \rangle$

- “ Branching



A.A. Svidzinsky et al, PRA
81, 053821 (2010)

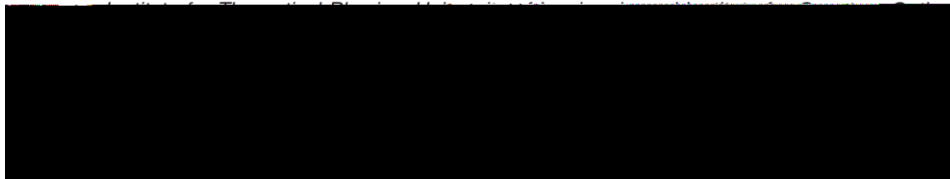
- “ Optical depth sets fundamental limits to errors of applic

A fundamental limit

- “ Optical depth sets a fundamental limit to efficiency of applications involving atom-light interfaces

Quantum interface between light and atomic ensembles

Klemens Hammerer



Universal Approach to Optimal Photon Storage

Alexey V. Gorshkov,¹ Axel André,¹ Michael Fleischhauer,² and Mikhail D. Lukin¹

off-resonant Raman fields to photon-echo-based storage. Furthermore, we derive an optimal control strategy for storage and retrieval of a photon with a given shape. All these approaches, when optimized, yield identical maximum efficiency that depends on the optical depth of the medium.

| ® ® « ~~®~~

- “ Experimental proof-of-theory for photon qubits

Error

Laurat (Paris), 2017

- “ Fundamental error shrinks too slowly with D
- “ Increasing D too much creates other problems

