Opening of the GPU day

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Focus fields (beginning of 2020)

1. **Quantum optics and photonics based quantum technologies**

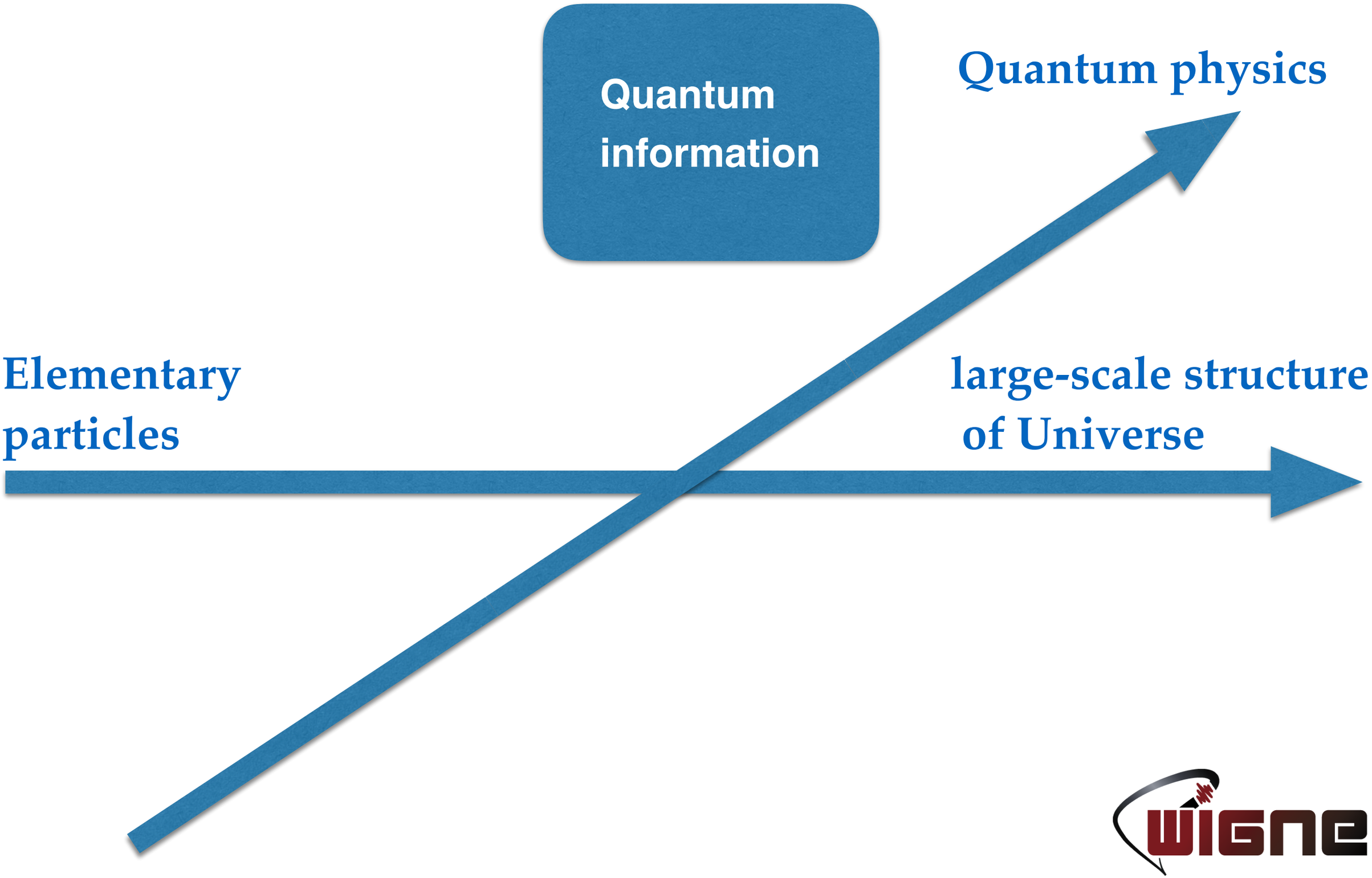
2. **Fundamental interactions, new experimental technologies** → **GPU Day**

3. **Structural study of new materials at the atomic scale**

4. **Artificial intelligence, deep learning and big data** → **GPU Day**

5. **Environmental studies and technologies**

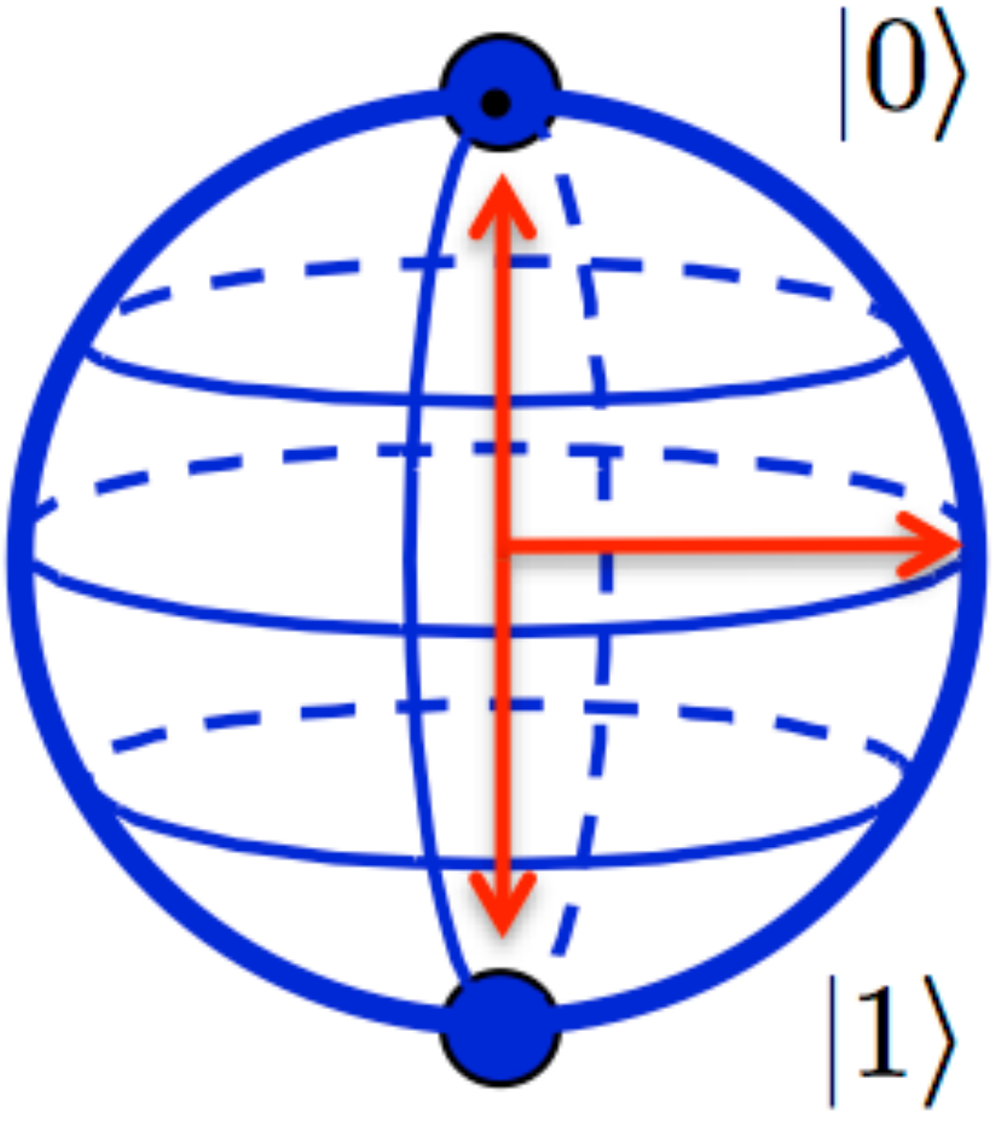
Wigner RCP: All colours of physics



Quantum information

bit ⟶ **kvantumbit (Qubit)**

- *COMMUNICATION*
- *COMPUTING*



$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

Examples

- **photon + polarization**
- **atom ground- and excited state**
- **atom hypefine states**

CQED : INTERACTING QUANTUM BITS

Quantum physics @ WIGNER

few researchers

3-4 theory groups

3 experimental + 3-4 theory groups

1990 2000 2010 2017 2020

HUNQUTECH

NATIONAL LABORATORY FOR QUANTUM INFORMATION

National Research, development and Innovation Office
Hungary

PROJECT FINANCED FROM THE NRDI FUND
MOMENTUM OF INNOVATION

National Laboratory for Quantum Information

Strategic goals

1. **Creation of a quantum information network**

   → **forming the ability to join the European Quantum Internet**

2. **Development of atom and artificial atom based hardware components to quantum information processing**

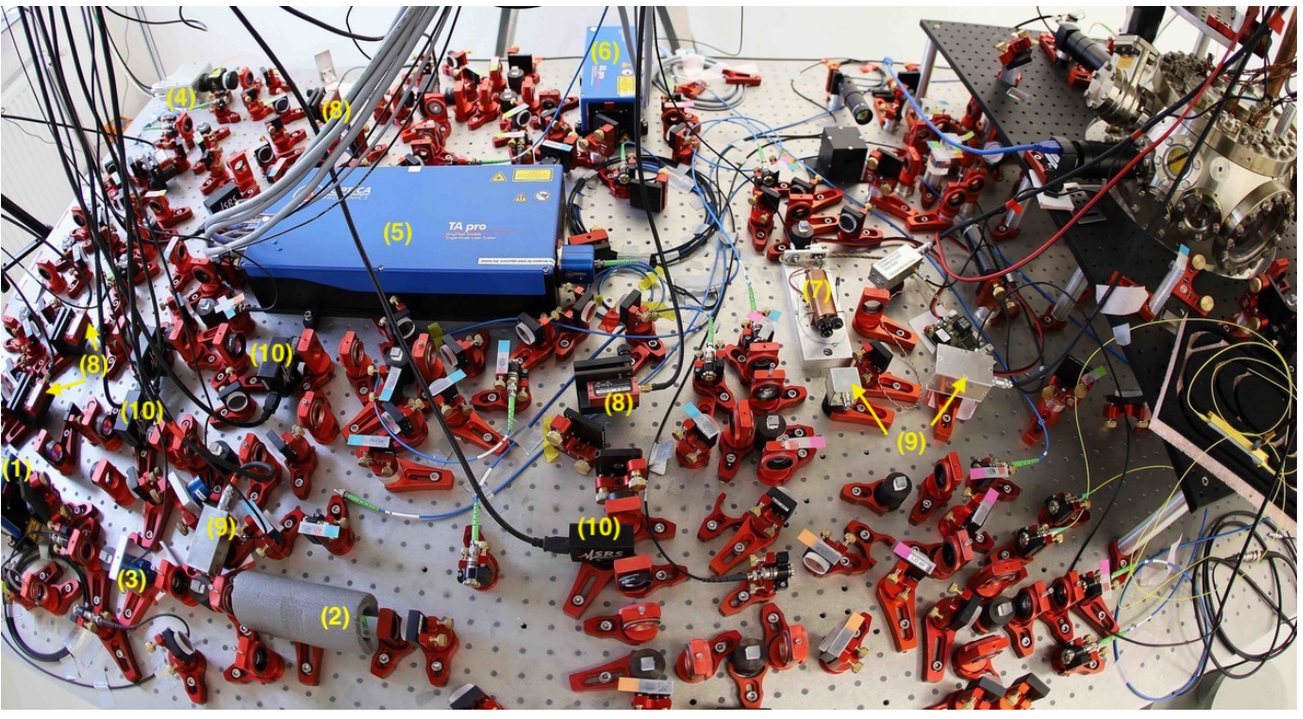
   → **forming and maintaining the necessary laboratory background at a high international level**

3. **Quantum computation theory**

   → **forming the expertise to use large infrastructures**

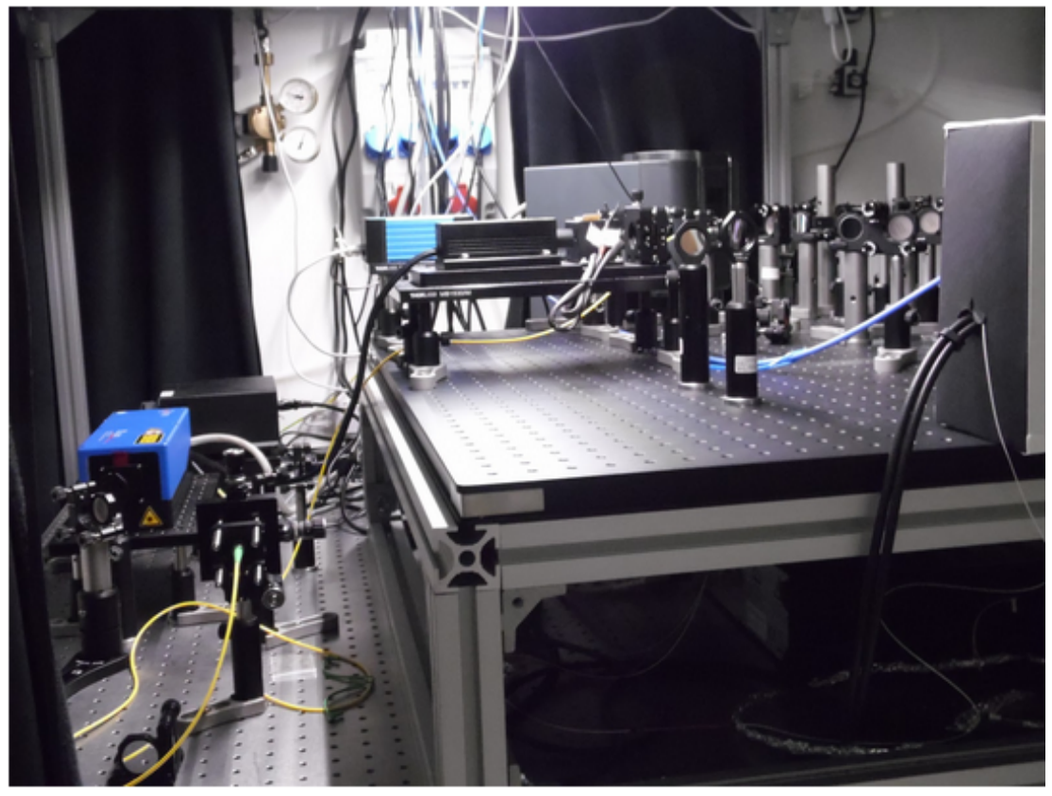
Quantum experiments @ WIGNER

Atom-photon interface



cavity QED system, Rb87 atoms

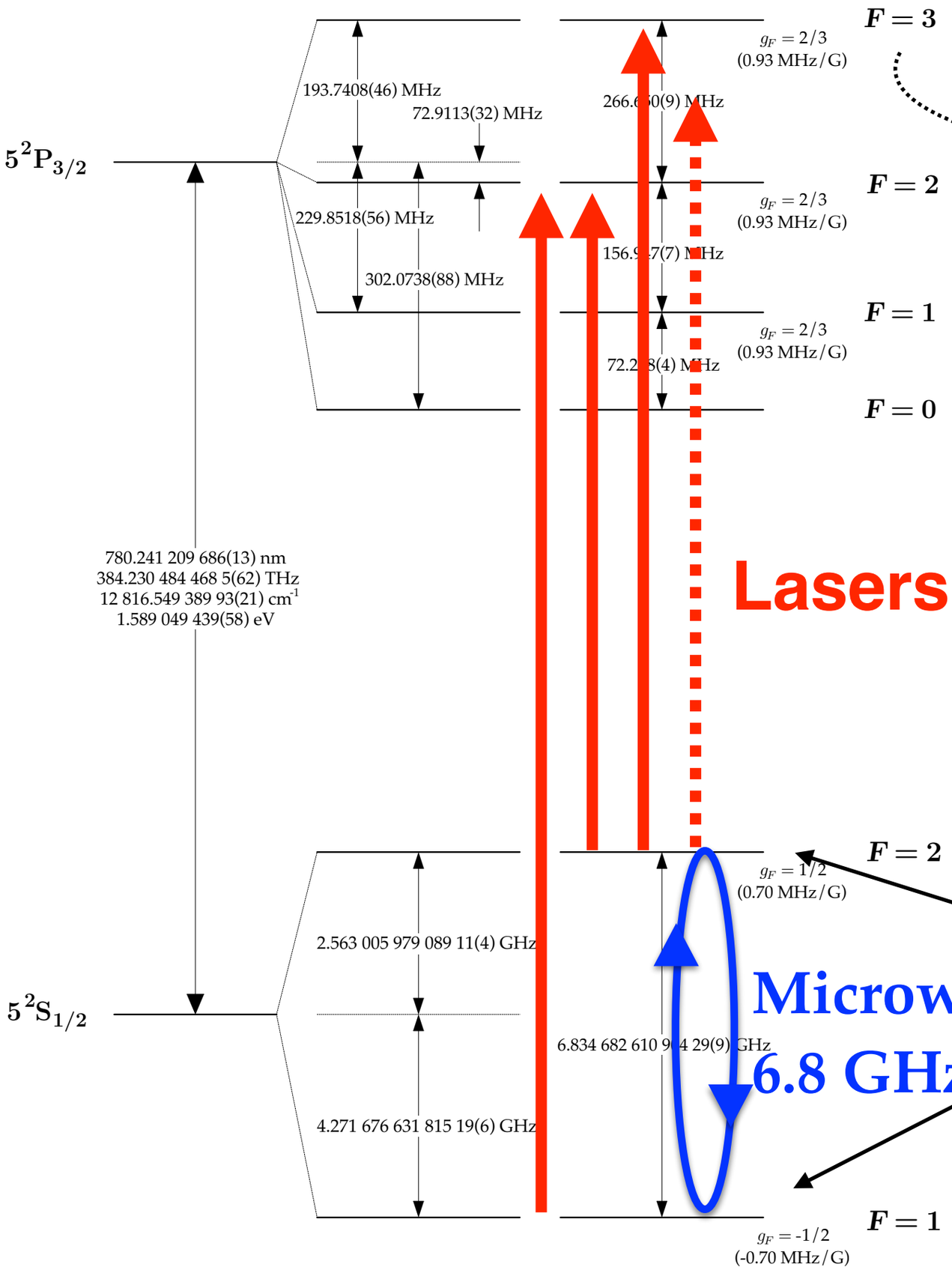
Optically Detected Magnetic Resonance

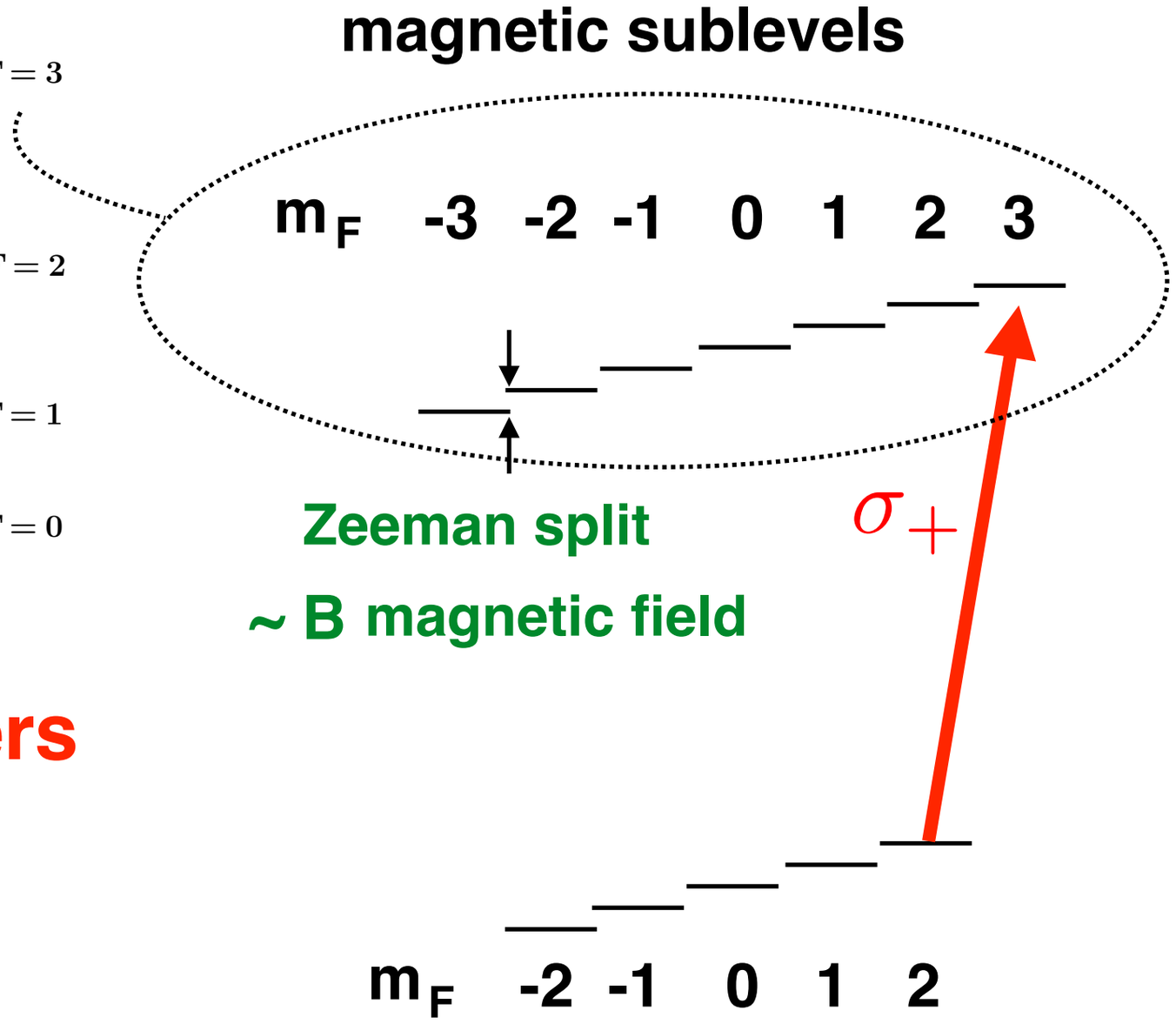


NV centers in diamond

SiC nanocrystals

The atom is a 'lab'

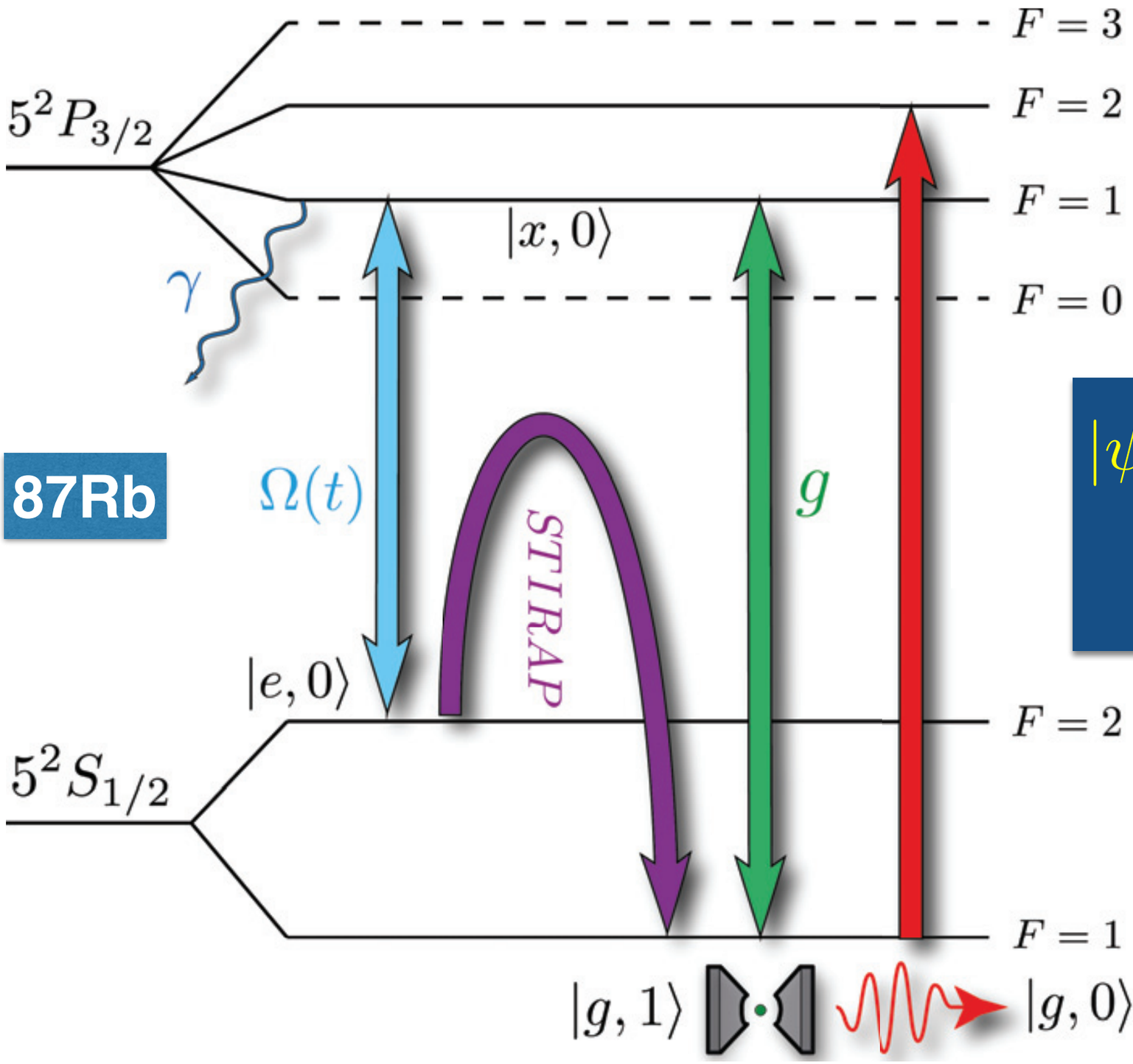




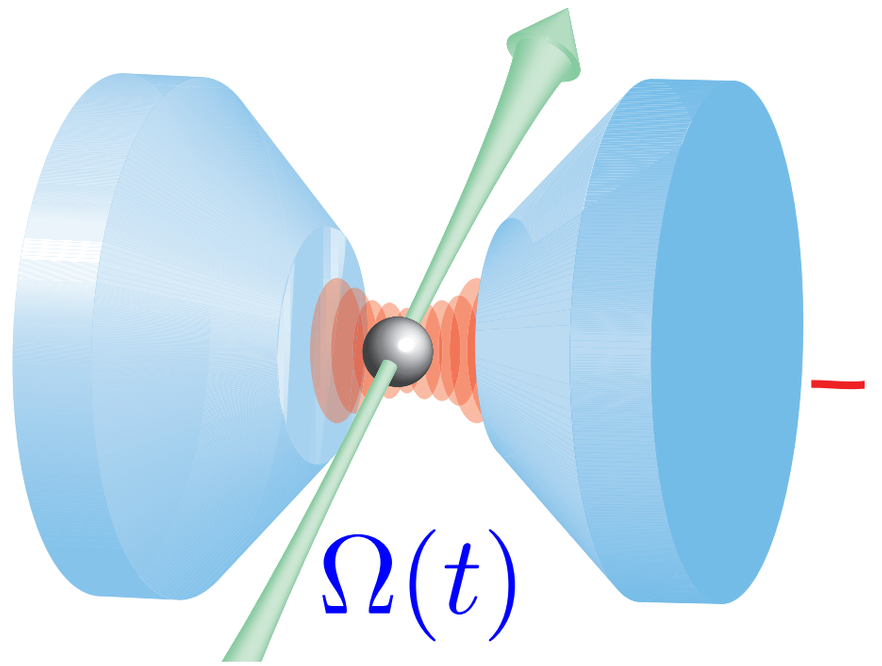
long-lived states for quantum memory

Quantum nonlinear optics

Vacuum StiRAP



87Rb

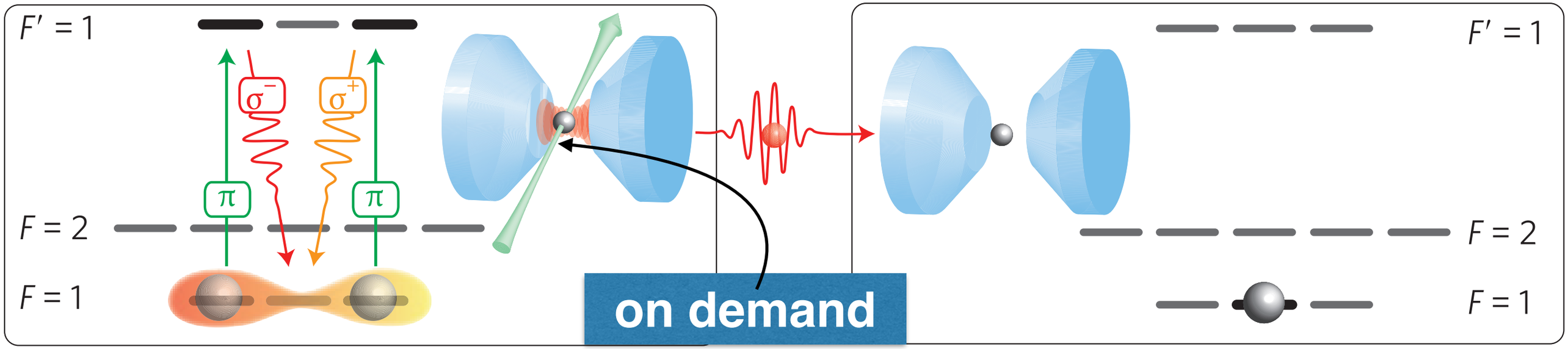


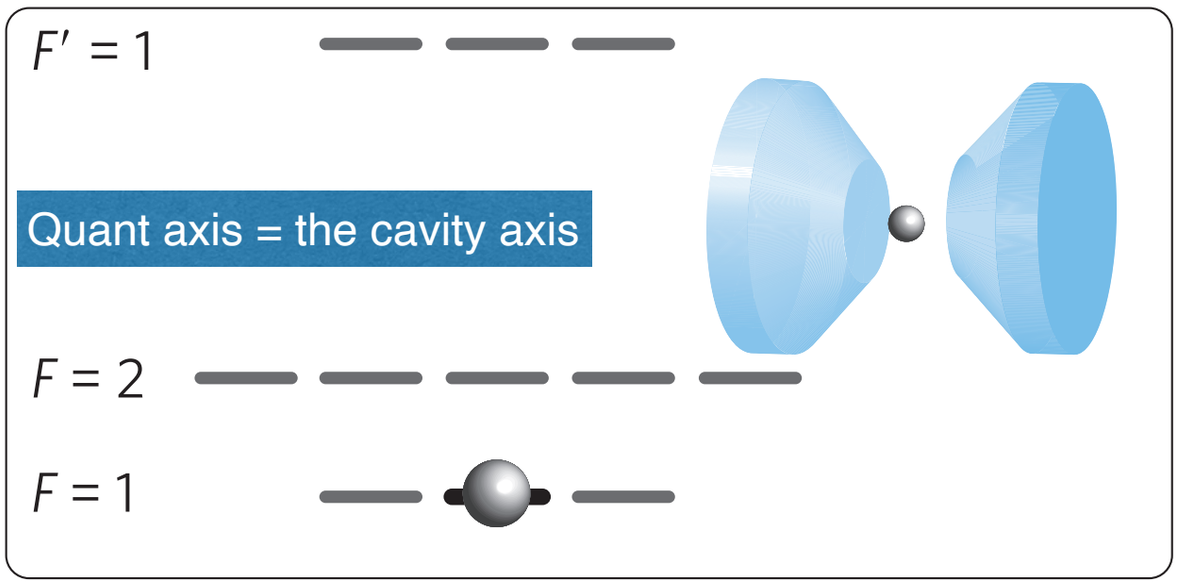
$$|\psi\rangle = \cos\theta|e,0\rangle - \sin\theta|g,1\rangle$$

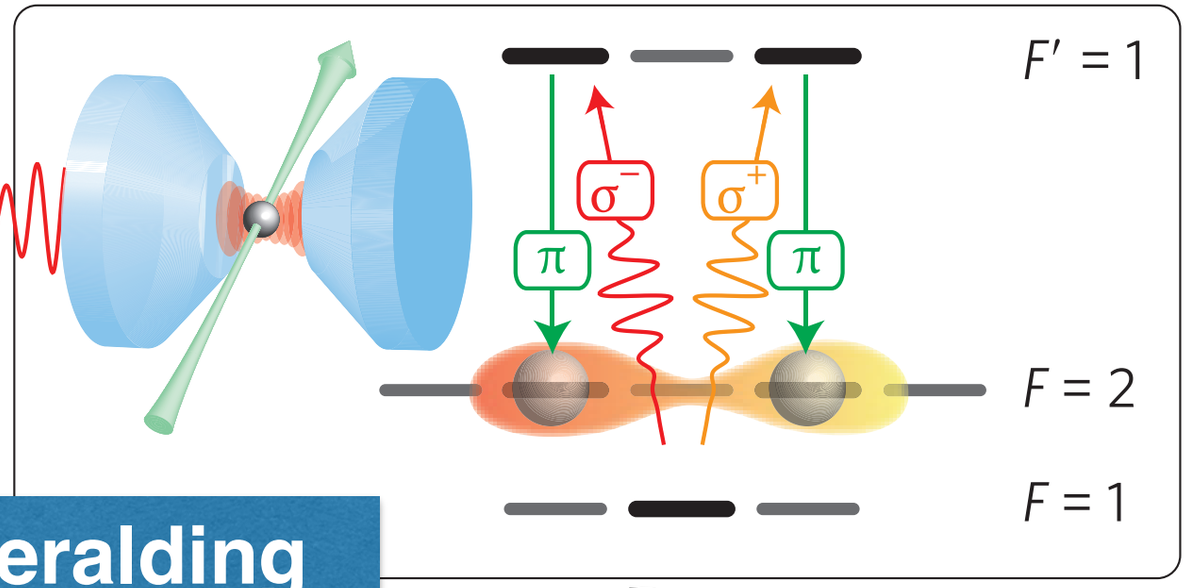
$$\tan\theta(t) = \Omega(t)/2g$$

coherent process

Bidirectional qubit state transfer







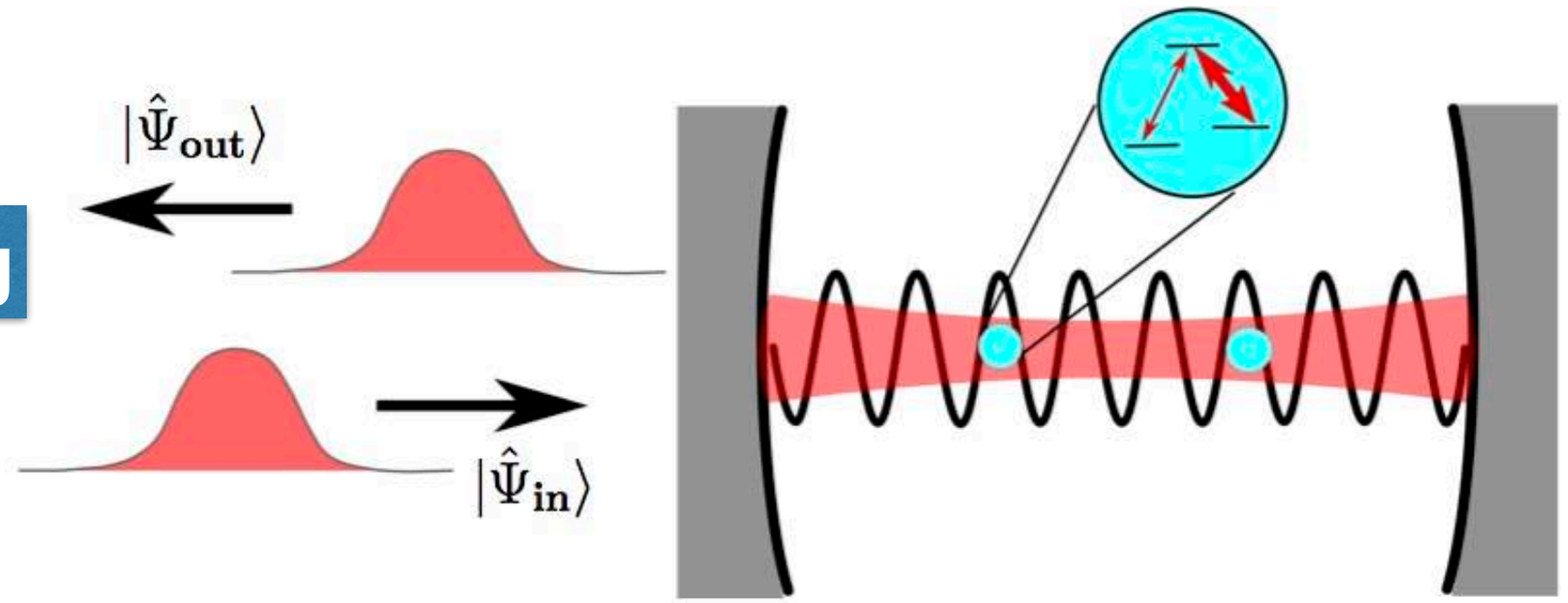
	Efficiency	Fidelity
Atom-photon state transfer	**56%**	**0.98**
Quantum memory	**17%**	**0.98**

Ritter @ MPQ, Nature 2012

Quantum memory

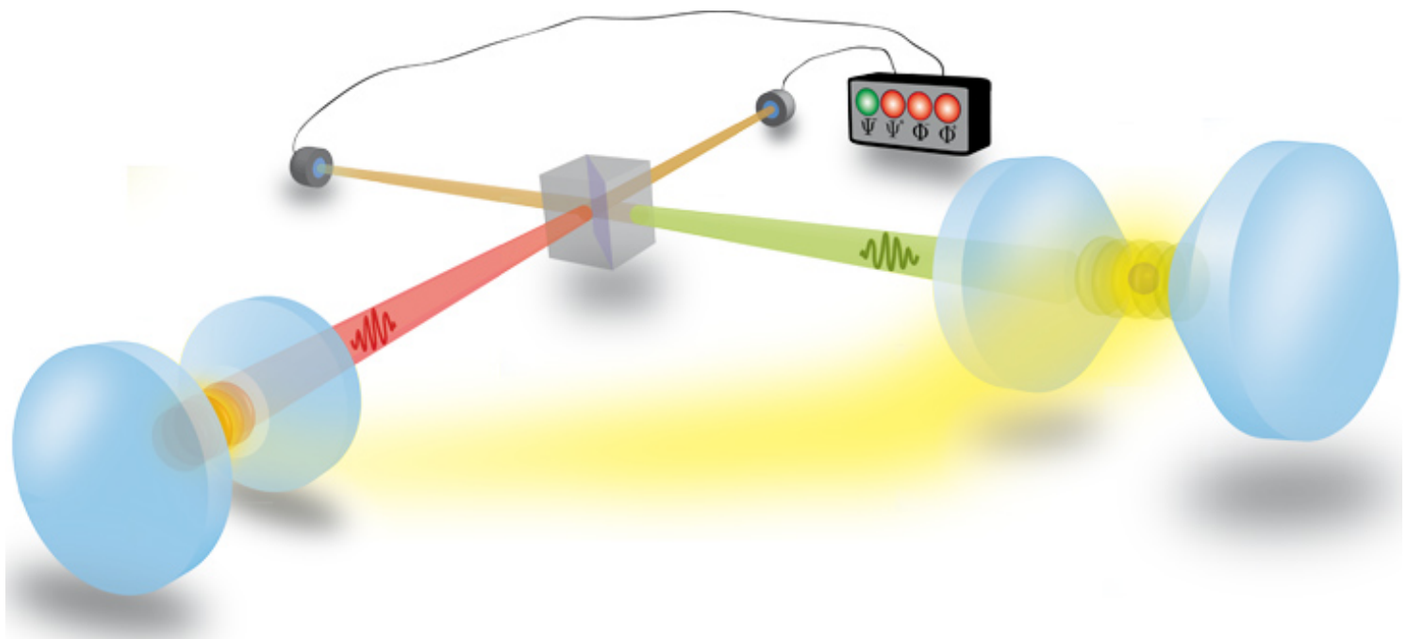
photon = flying qubit <—> atom = memory qubit

weakly interacting



strong interaction, long coherence time

Quantum network



Microwave — visible (NIR) conversion

Linking quantum computation to communication

foton <—> atom

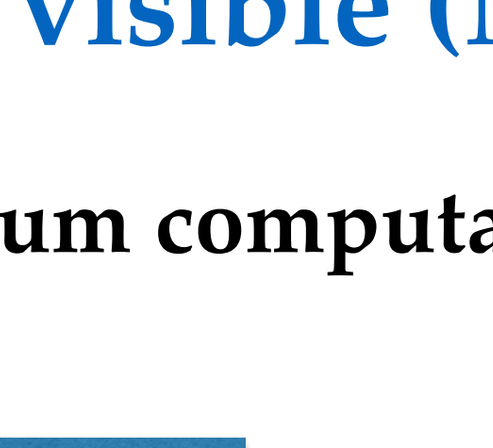
atom <—> chip

$|\Psi\rangle$

$3 \times 10^{14}\mathrm{Hz}$

$|\Psi\rangle$

$5 \times 10^{9}\mathrm{Hz}$



$|\Psi\rangle$

$|\Psi\rangle$