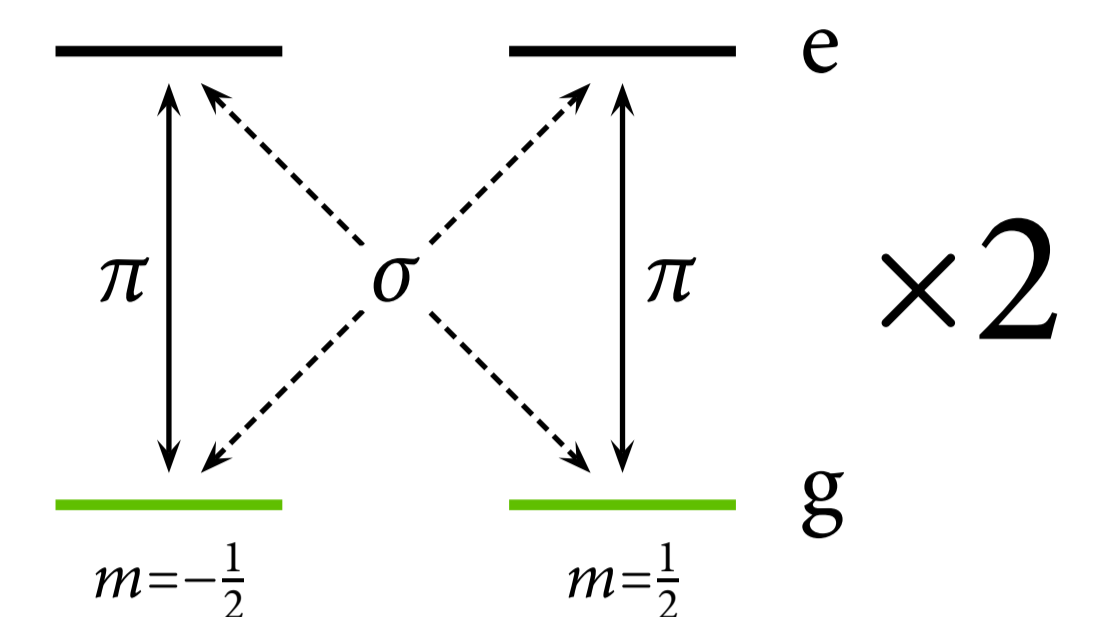
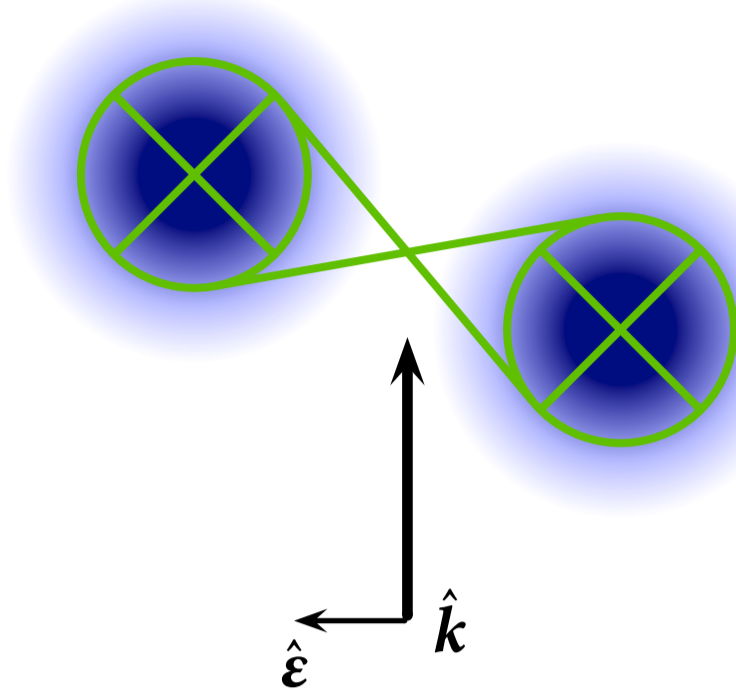


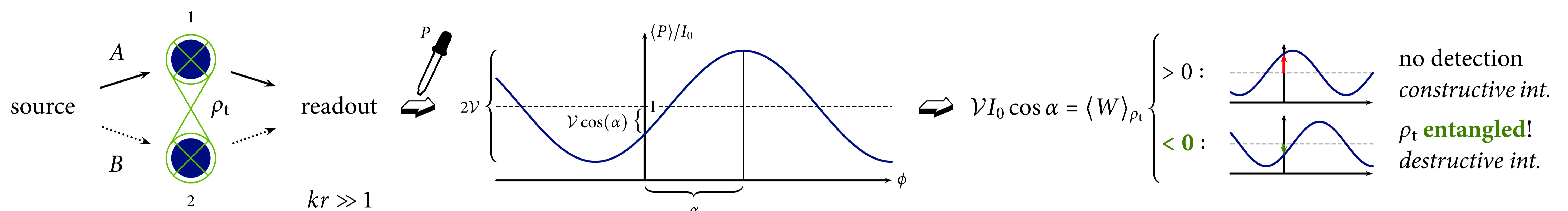
Creating and Ascertaining Entanglement of Atoms by Photon Scattering

1. Motivation

- **task:** light scattering dynamics of 2 *tightly* trapped atoms
- **aim:** manipulate *populations* and *coherences* by selective tuning of photon field parameters, i.e.
 - polarization $\hat{\epsilon}$
 - orientation
 - atomic distance kr
 - laser intensity & detuning
- **interests:** preparation of *entanglement* and its subsequent *witnessing*



2. Witnessing Entanglement



3. Entanglement Preparation

interaction with classical external field
 one-particle propagation

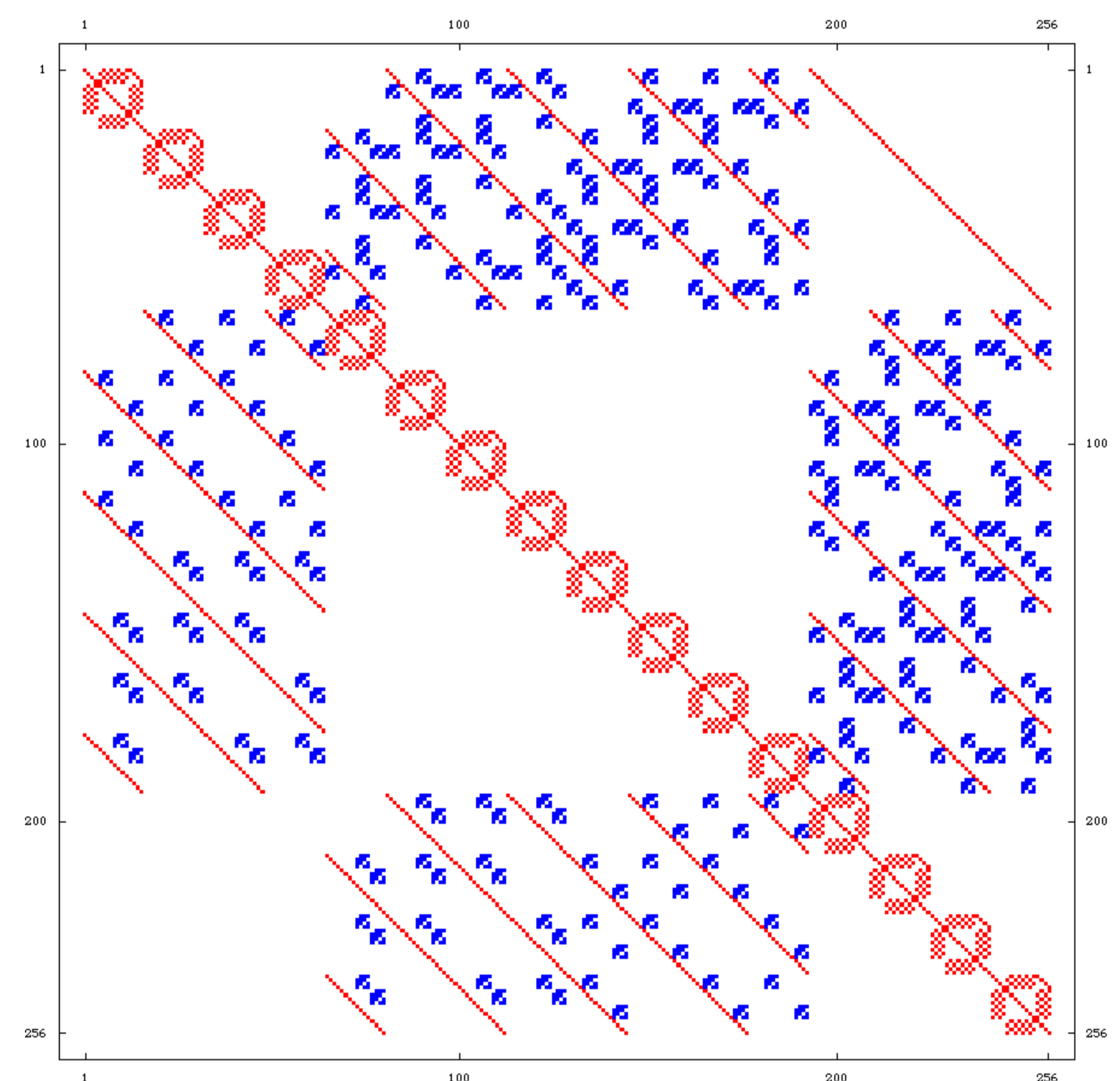
master equation

$$\mathcal{L}^{(1)} \rho = -i[\mathcal{H}^{(1)}, \rho] + \mathcal{L}_{\text{damp}}^{(1)} \rho$$

$$\dot{\rho} = \mathcal{L} \rho = \mathcal{L}^{(1)} \rho + \mathcal{L}^{(2)} \rho$$

$$\mathcal{L}^{(2)} \rho = -i[\mathcal{H}^{(2)}, \rho] + \mathcal{L}_{\text{damp}}^{(2)} \rho$$

resonant dipole-dipole interaction
 exchange of photons along $\mathbf{r} = \mathbf{r}_2 - \mathbf{r}_1$



4. Steady State

resolvent

• $\mathcal{R}(\zeta) \equiv \frac{1}{\zeta - \mathcal{L}}$

$\Rightarrow \bar{\rho} \equiv \lim_{t \rightarrow \infty} \rho(t) = \lim_{t \rightarrow \infty} e^{\mathcal{L}t} \rho(0) = \lim_{\zeta \rightarrow 0} \zeta \mathcal{R}(\zeta) \rho(0) = \text{Res}_0 \mathcal{R} \rho(0)$

null space

• $\text{col } \dot{\rho} = -i(\mathbb{1} \otimes \mathcal{H} + \mathcal{H}^T \otimes \mathbb{1}) \text{col } \rho + \text{col}(\mathcal{L}_{\text{damp}} \rho) \equiv L \text{col } \rho \stackrel{!}{=} 0$

$\Rightarrow \bar{\rho} \in \ker(L) = \{\rho : L \text{col } \rho = 0\}$

5. Questions

- **technical problems:** analytic solution feasible?
 For $\mathcal{R}(\zeta)$ one has to invert a matrix with 65536 entries...
- preparation of entanglement possible

{	for $kr < 1$?
	for $kr \geq 1$ or even $\gg 1$	

References

- [1] G. Brennen et al., Phys. Rev. A **61**, 062309 (2000).
- [2] B. Gao, Phys. Rev. A **48**, 2443 (1993).
- [3] A. Omont, Prog. Quantum Electron. **5**, 69 (1977).
- [4] arxiv:0710.0825