

# Rydberg polaritons

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## Few-body physics with photons

- ▶ tunable single photon sources
- ▶ easy manipulation with (non)linear optics
- ▶ **problem:** lack of interactions
- ▶ induce strong nonlinearity with the medium
- ▶ Rydberg EIT as a possible way

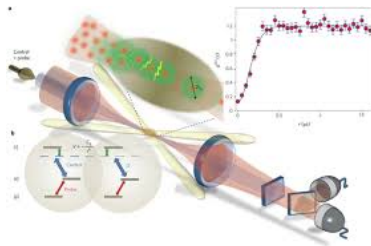


Figure: Harvard experiment, Nature Photonics 8, 685 (2014)

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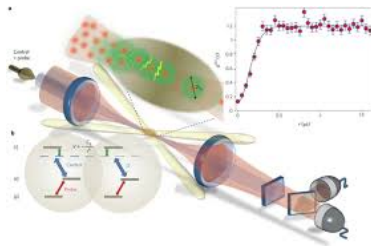


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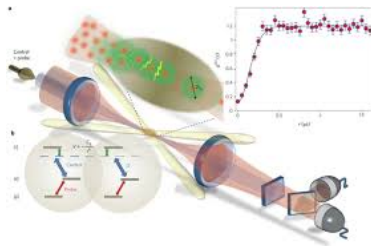


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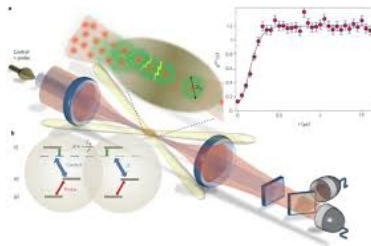


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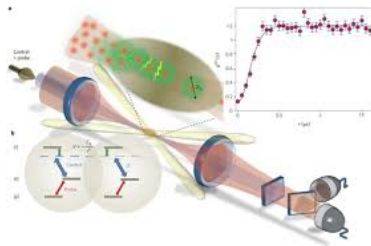


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- ▶ interaction of light with three-level atoms
- ▶ dark state is immune to radiative losses
- ▶ high admixture of atomic state - slow propagation with effective mass
- ▶ slowing and storing light

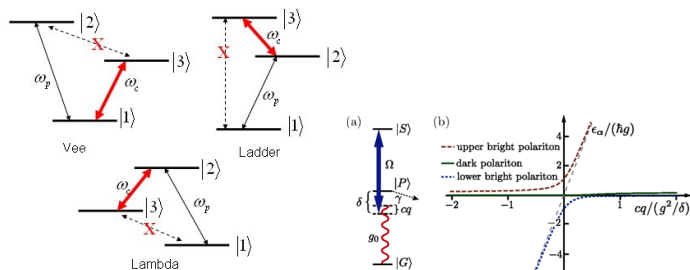


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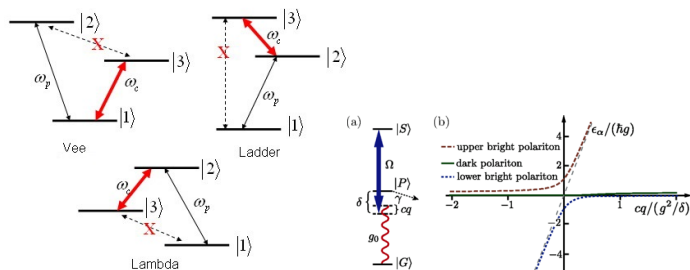


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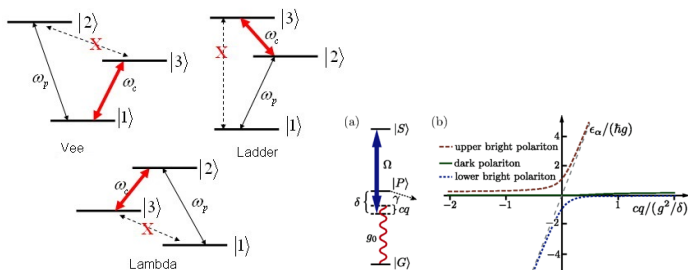


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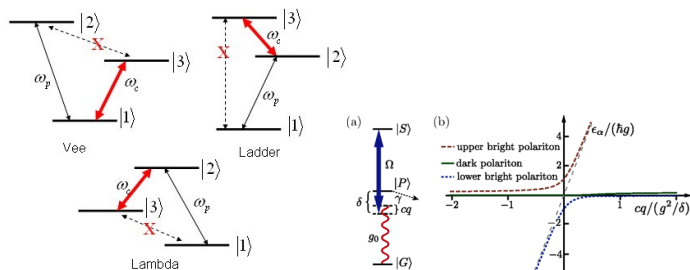


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- ▶ nonlinear optics at single photon level
- ▶ input-output problem with nonlinear and “nonlocal” phase shift

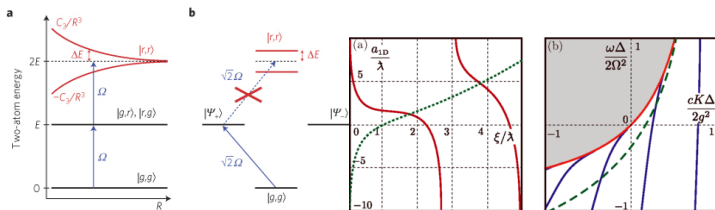
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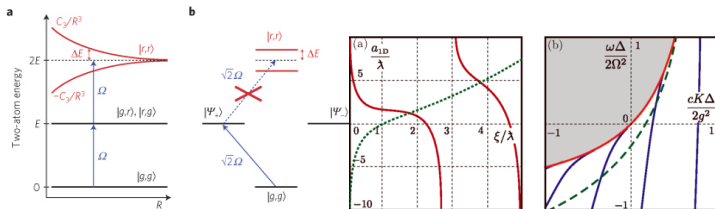
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**Figure:** Gaetan et al, Nat. Phys. 5, 115 (2009); Bienias et al, PRA 90, 053804 (2014)

- ▶ Rydberg blockade leads to saturation of interactions at short range
- ▶ diagrammatic derivation of the interaction: Bienias et al, PRA 90, 053804 (2014)
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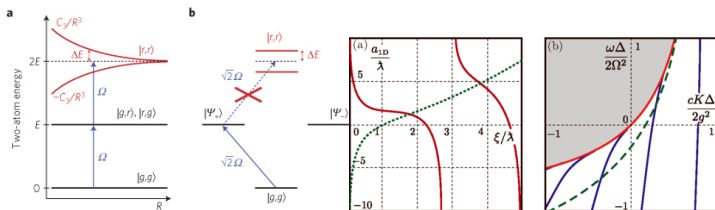
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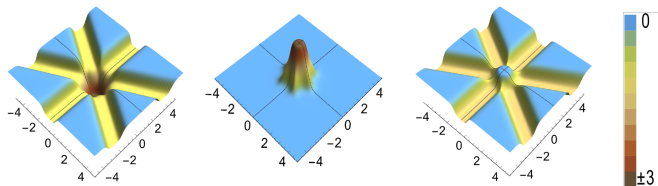
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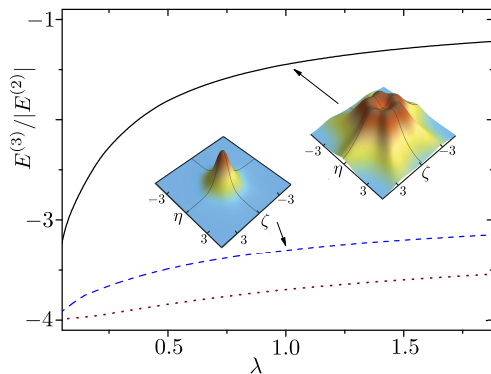
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- ▶ tuning the properties by altering the mode structure (Sommer et al, arXiv:1506.00341)
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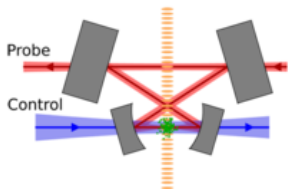


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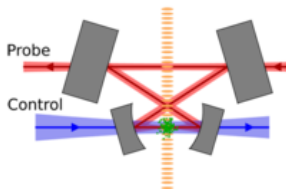


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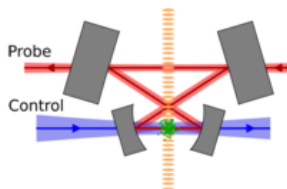


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## Conclusions & outlook

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