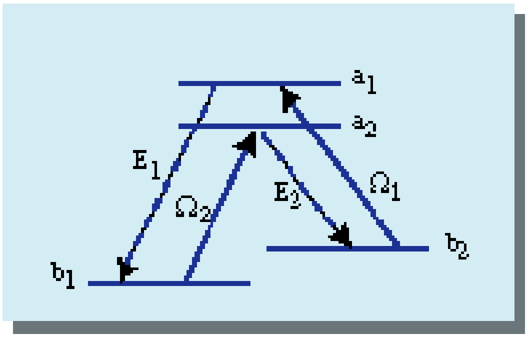
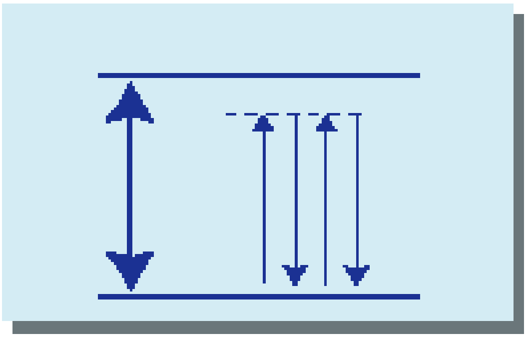
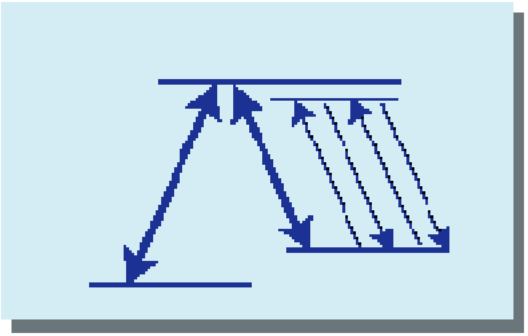
Generation of Squeezed Light by use of EIT

Robert W. Boyd and C. R. Stroud, Jr., University of Rochester

Three Approaches



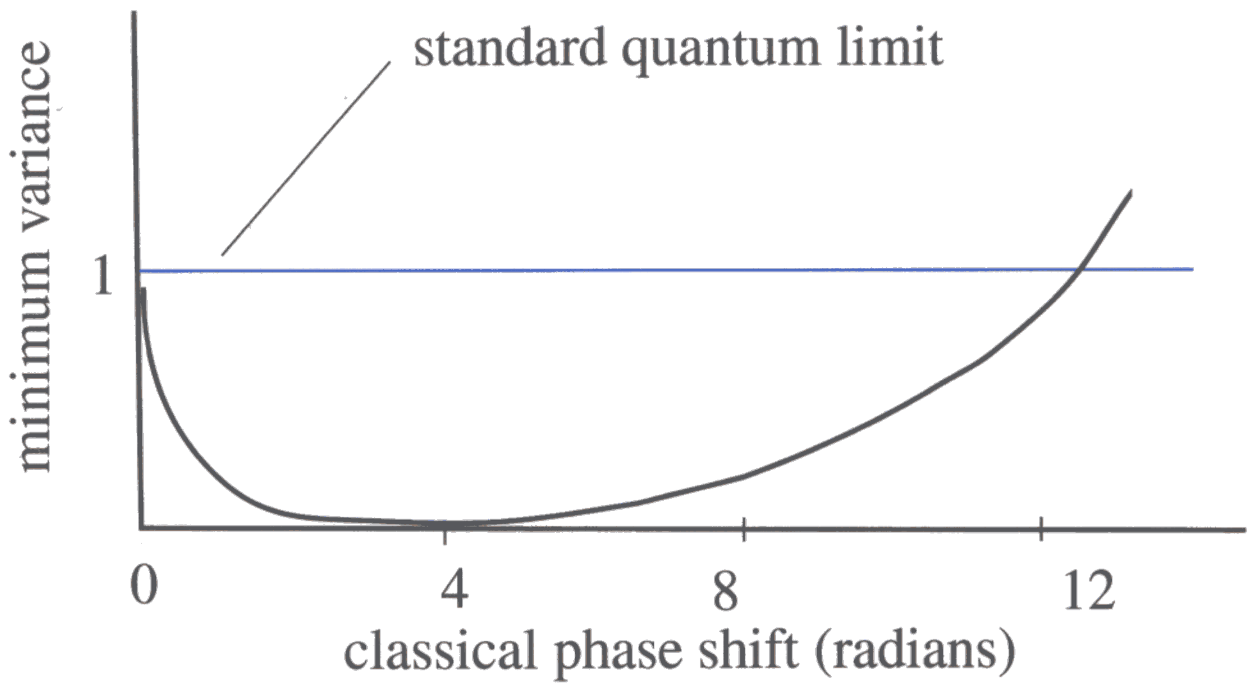




Fundamental idea: EIT eliminates linear absorption so that there is no spontaneous emission background noise.

Application of Two-Level EIT to Squeezed-Light Generation

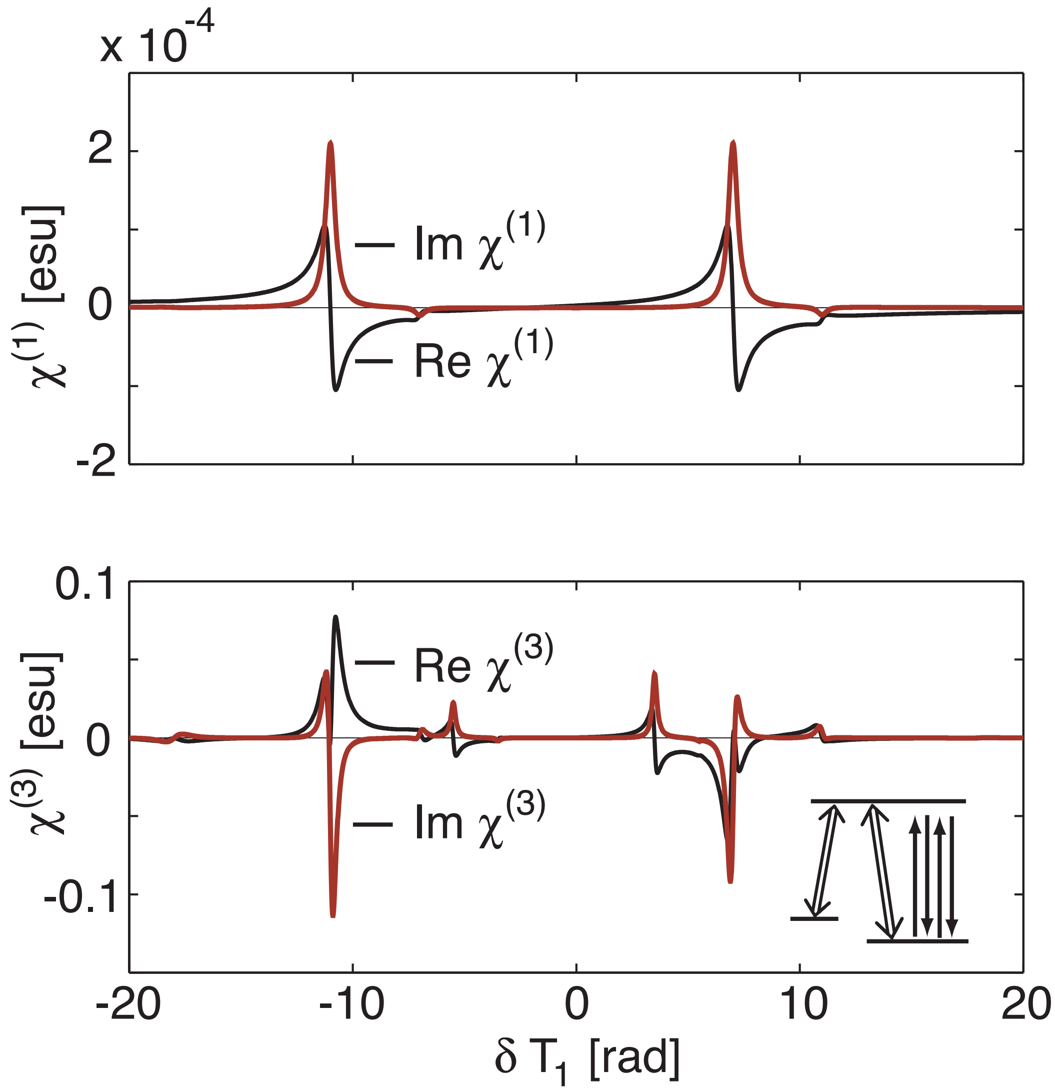
- Squeezing by self-phase modulation

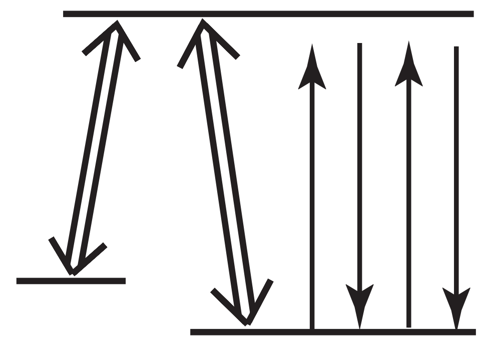


Blow, Loudon, and Phoenix, J. Mod. Opt., 40, 2515, 1993

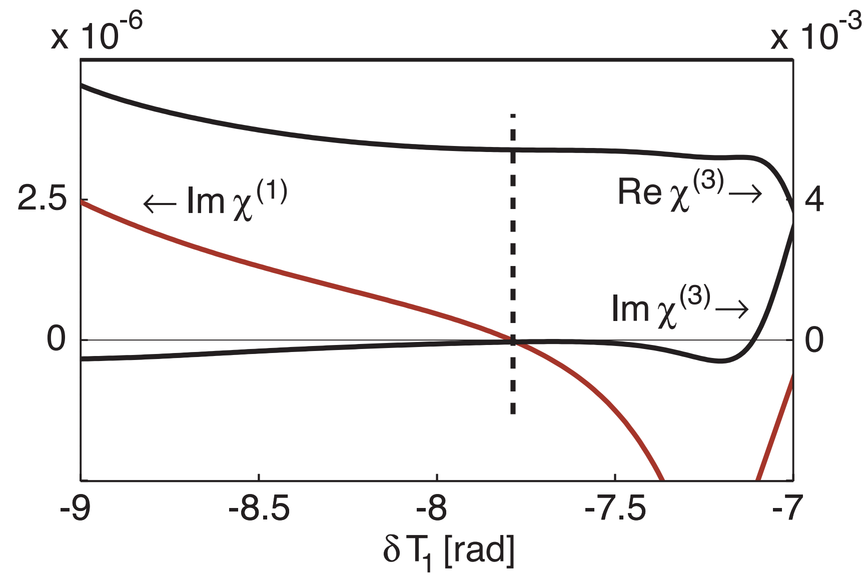
EIT allows phase shifts large enough to produce significant squeezing, and prevents signal-beam absorption which can degrade the squeezing.

Strong Absorption-Free Nonlinearity by Dark-State EIT



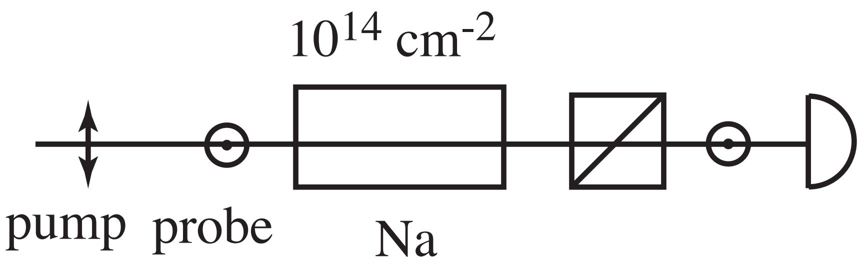


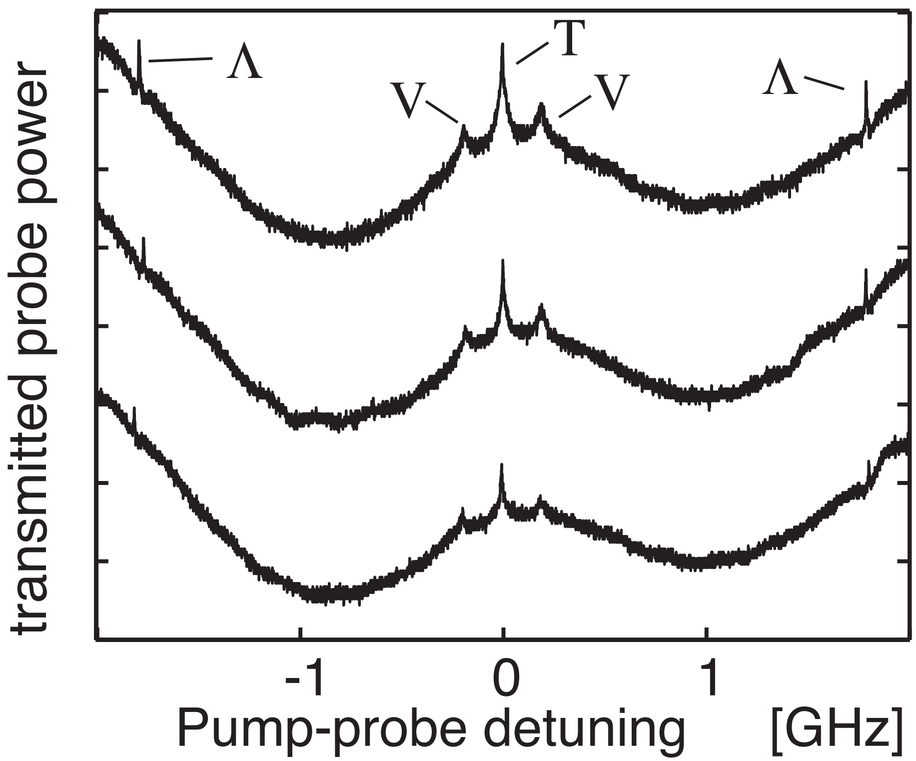
DETAIL:

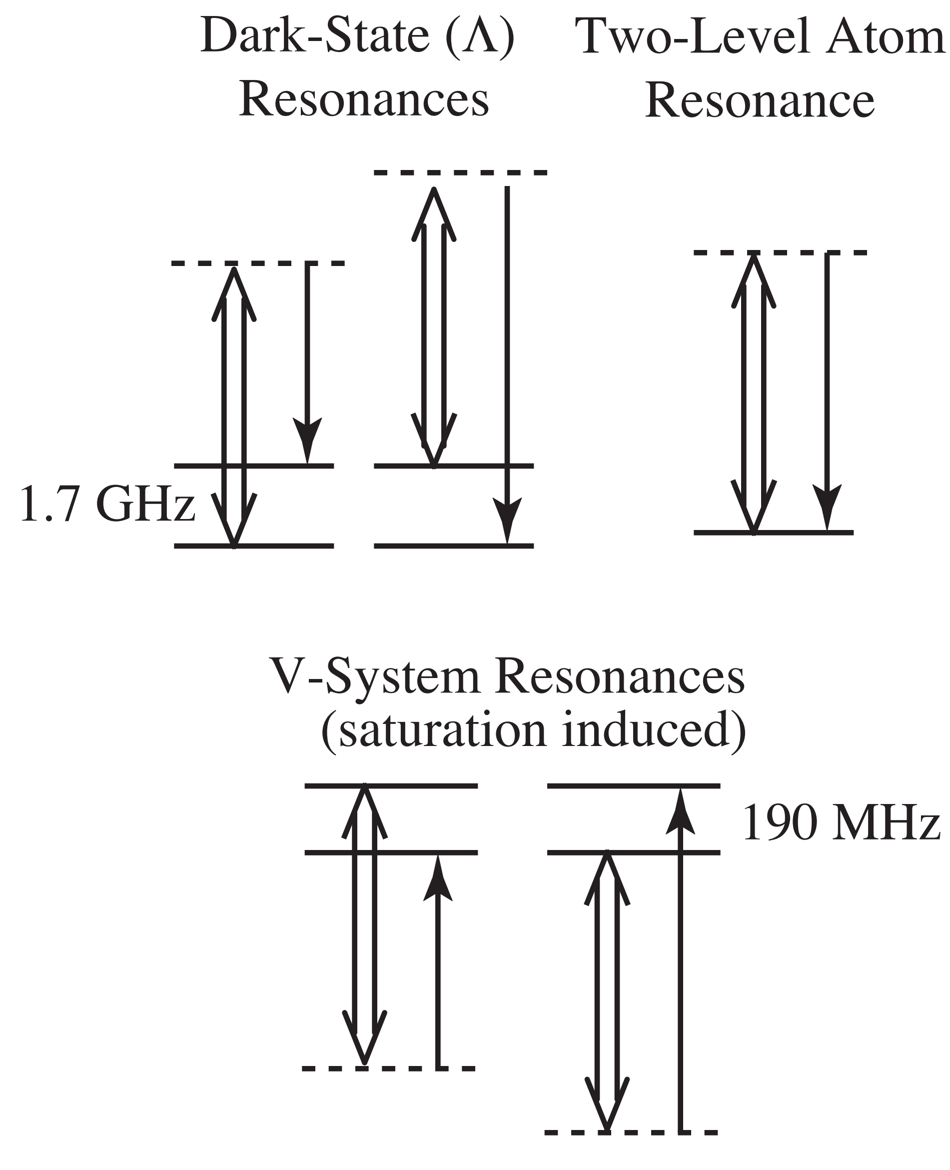


Wong, Boyd, Stroud et al, Phys. Rev. A, 65, 013810-1 (2001)

Saturation-Induced Extra Resonances







Honey Comb Pattern Formation

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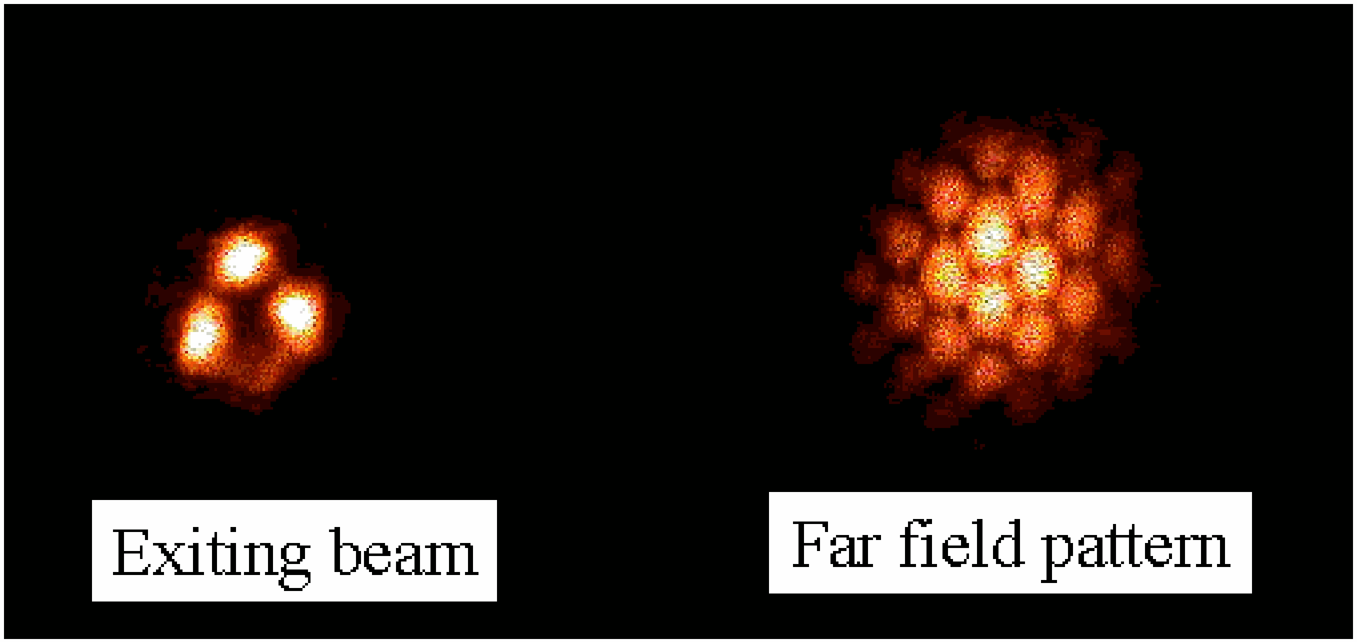
Output from cell with single gaussian beam input

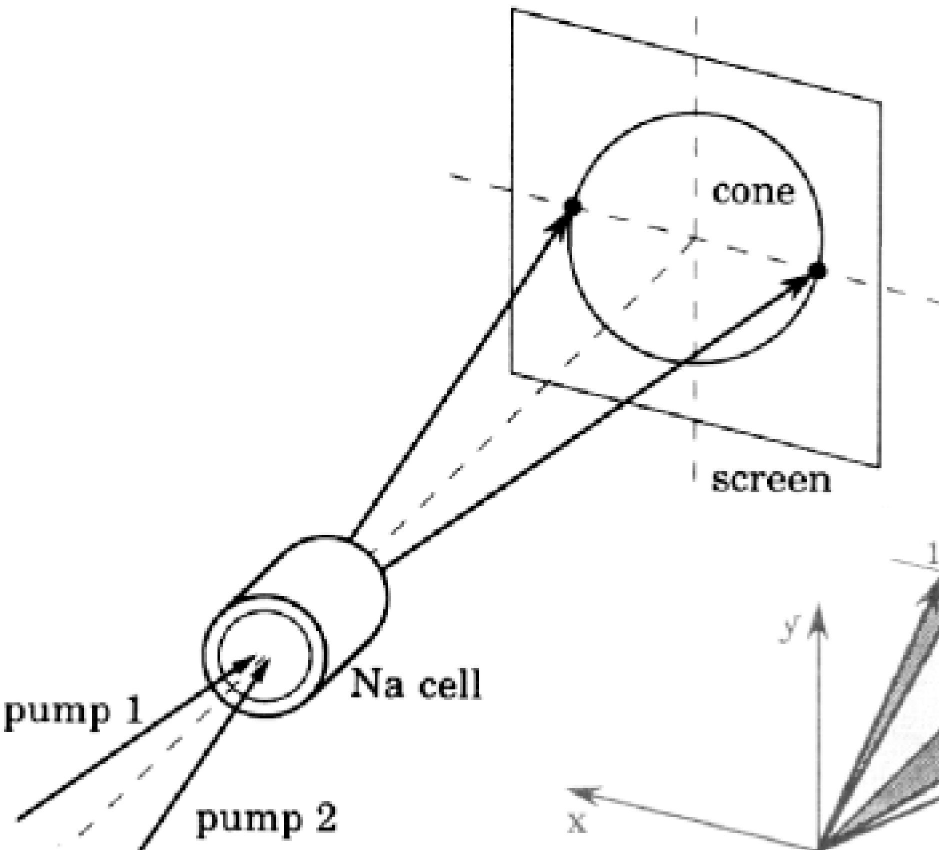


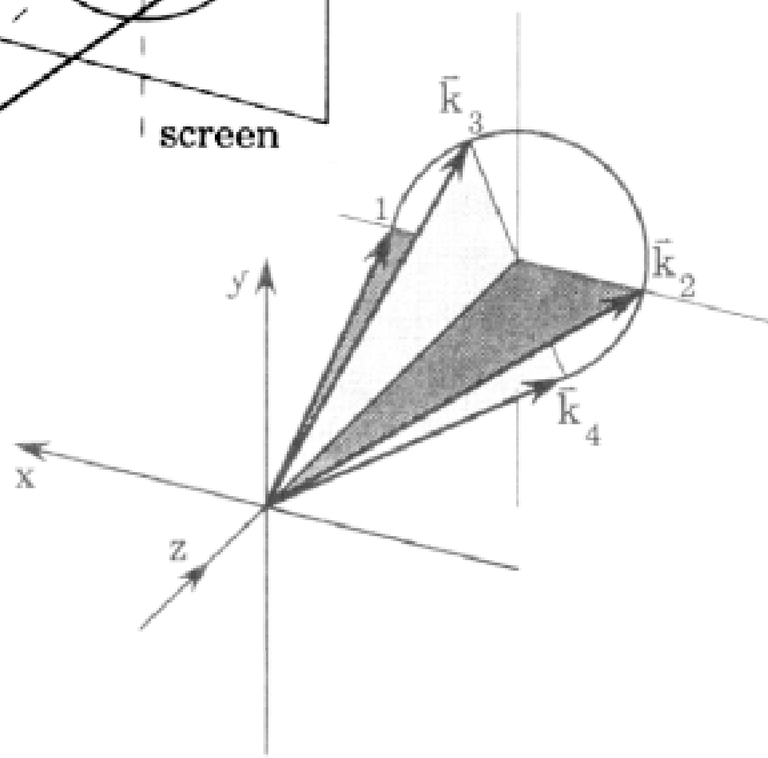
Quantum image?

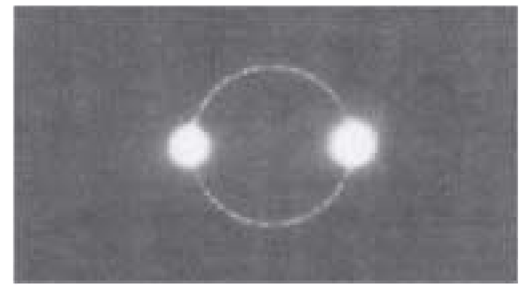
Input power 150 mW
Input beam diameter 0.22 mm
$\lambda = 588.995$ nm

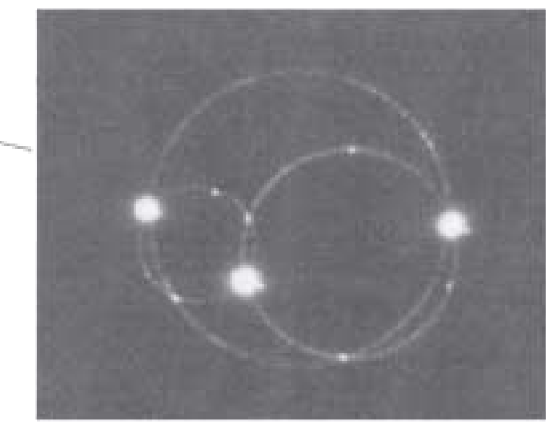
Sodium vapor cell
T = 220° C

Generation of Quantum States of Light by Two-Beam Excited Conical Emission



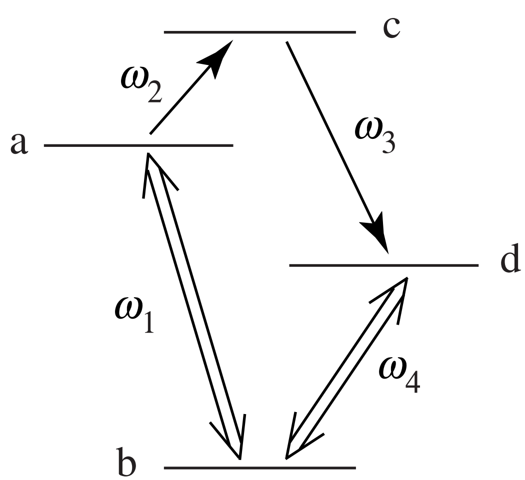


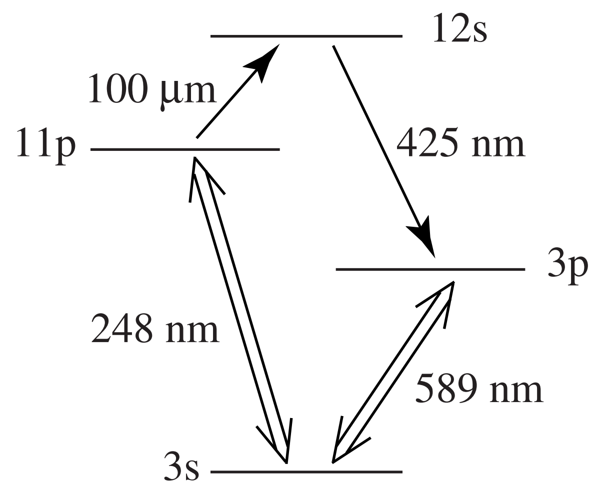




Kauranen et al, Opt. Lett. 16, 943, 1991; Kauranen and Boyd, Phys. Rev. A, 47, 4297, 1993.

Efficient Far IR and THz Imaging by use of EIT





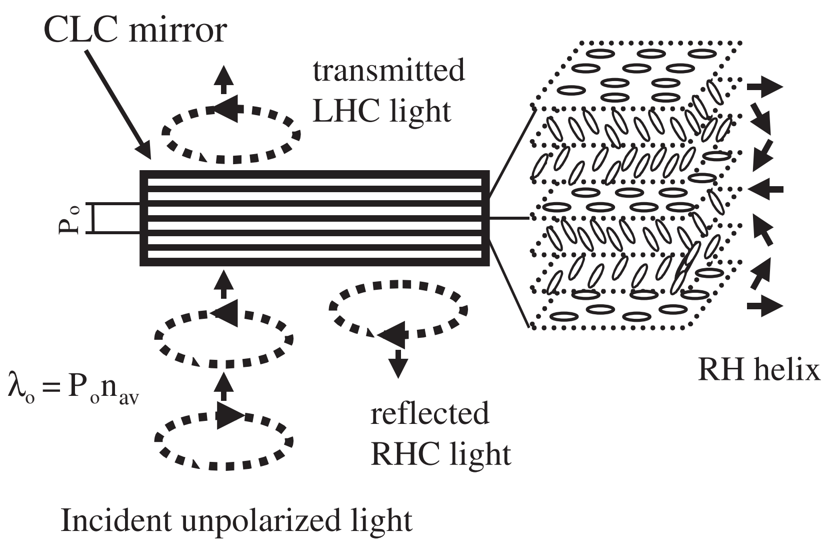
Basic concept of our approach. Because of strong saturation of the lower transitions, upconversion occurs with essentially unit efficiency.

Sodium energy levels for the conversion of 100 micron radiation to the visible.

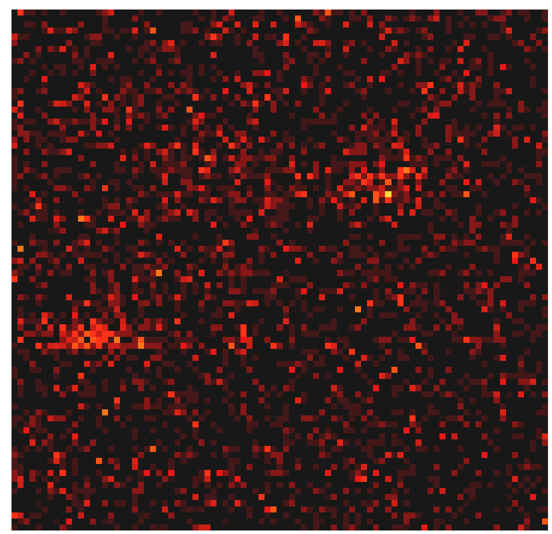
R. W. Boyd and M. O. Scully, Appl. Phys. Lett. 77, 3559, 2000.

Source of Polarized, Single-Photons on Demand

- Useful for secure communication by quantum cryptgraphy
- Embed isolated dye molecules in chiral nematic liquid crystal
- Host acts as self-assembled photonic bandgap material
- Host composition helps prevent dye from bleaching
- Fluorescence shows strong antibunching



Experimental procedure



Single-molecule fluorescence

Implementation with S. Lukishova

Semiconductor MQW structures for Solid-State EIT

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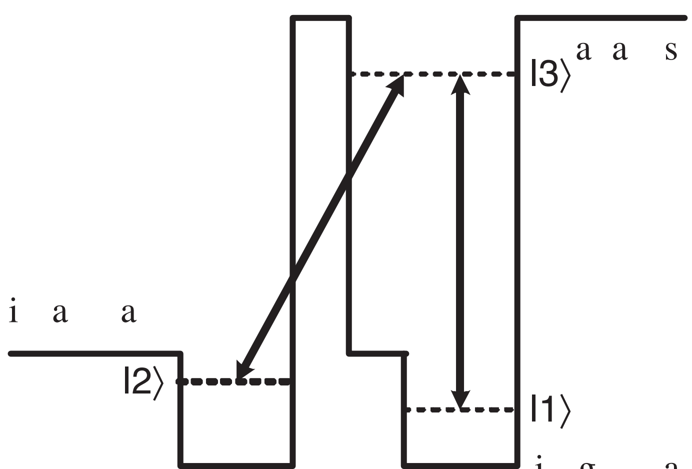

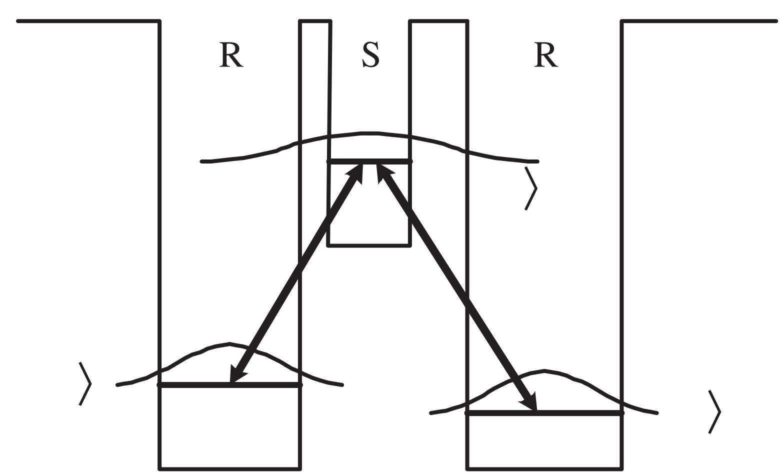

a a s TT

R i Sg T a i pI

S i Ra T a

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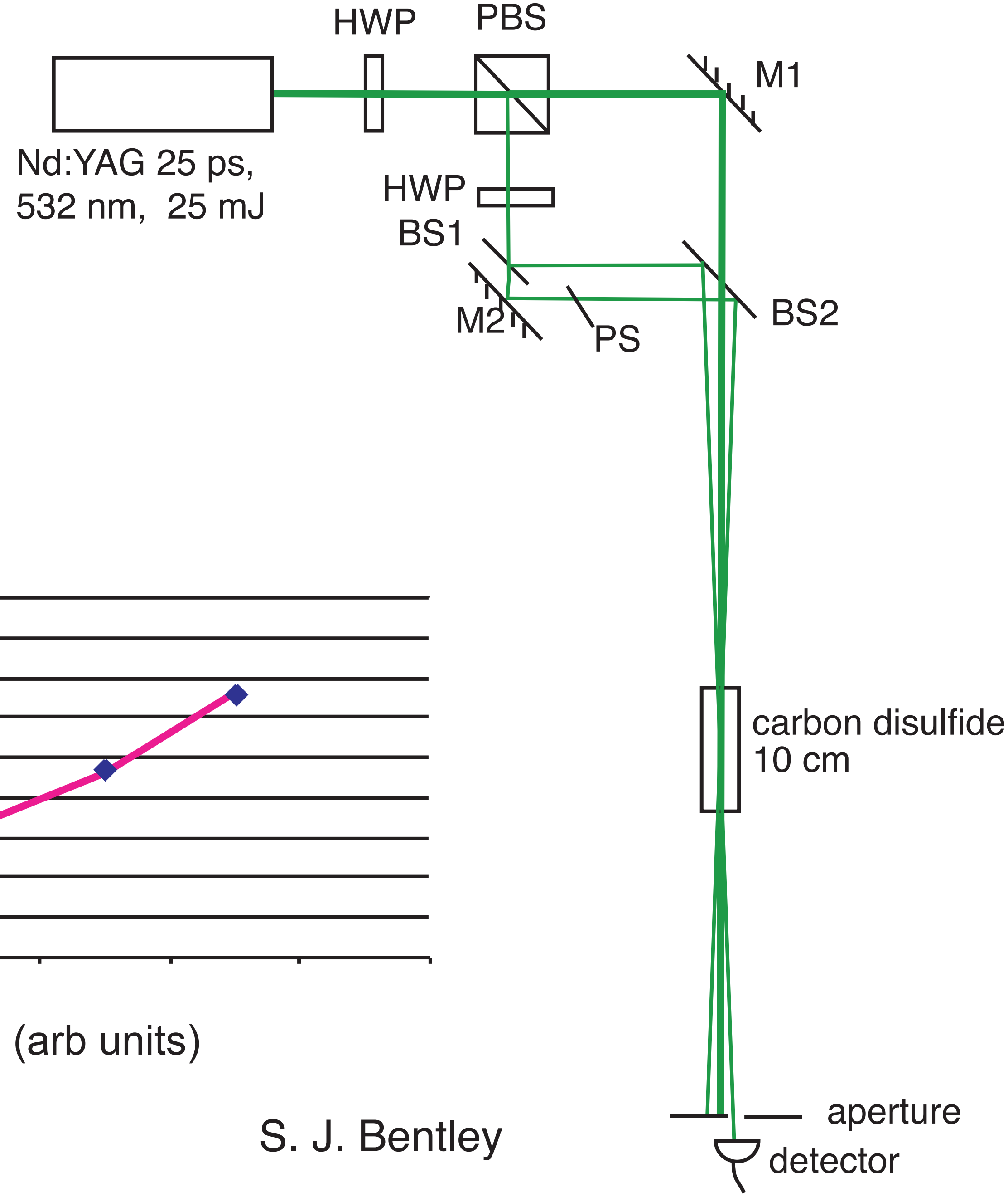
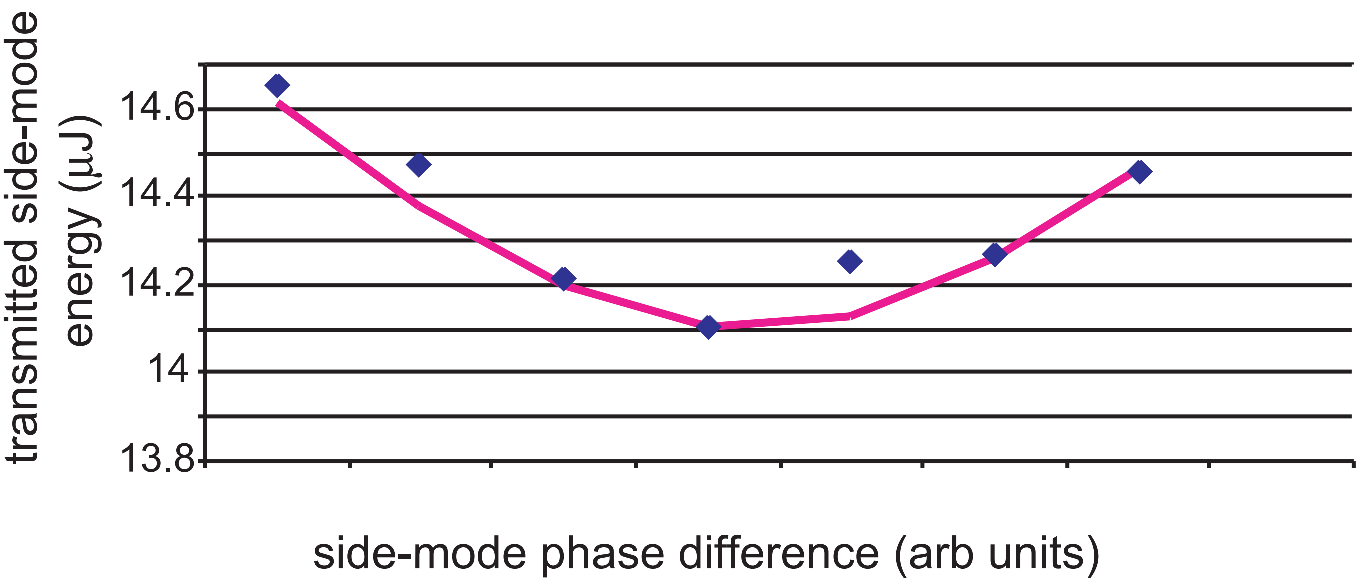
Preventing Laser-Beam Filamentation

- Use phase to control forward FWM gain
- Control of (laser-beam) decoherence

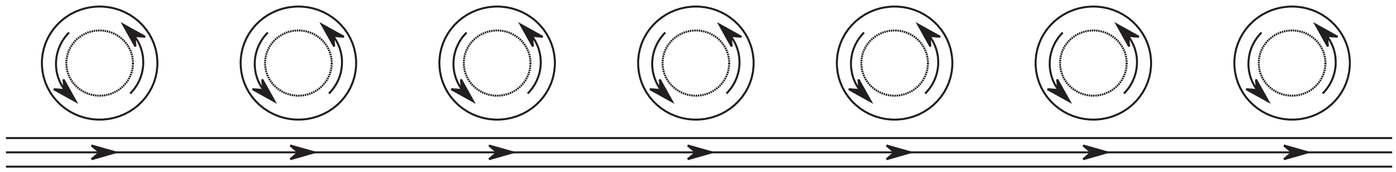




S. J. Bentley

NLO of SCISSOR Devices

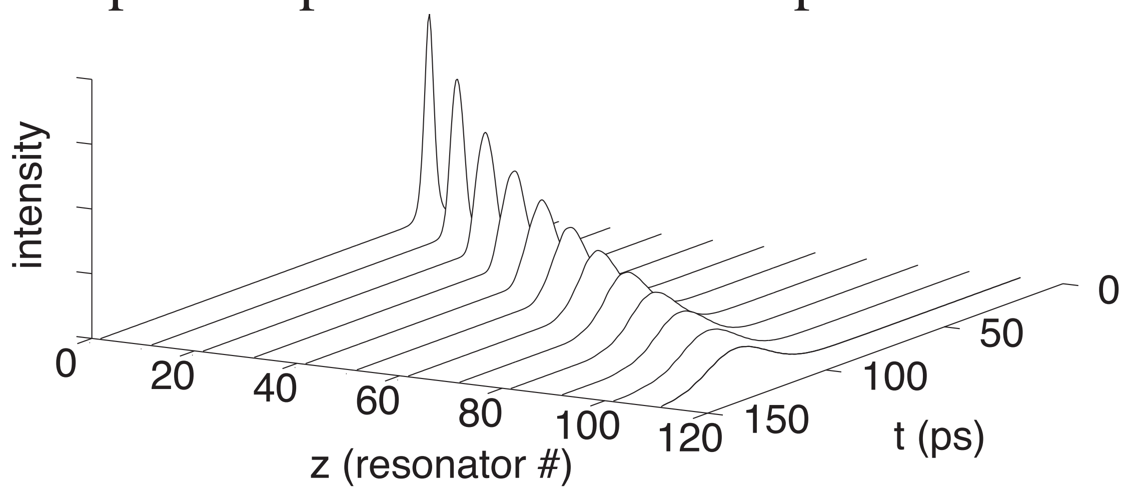
(Side-Coupled Integrated Spaced Sequence of Resonators)



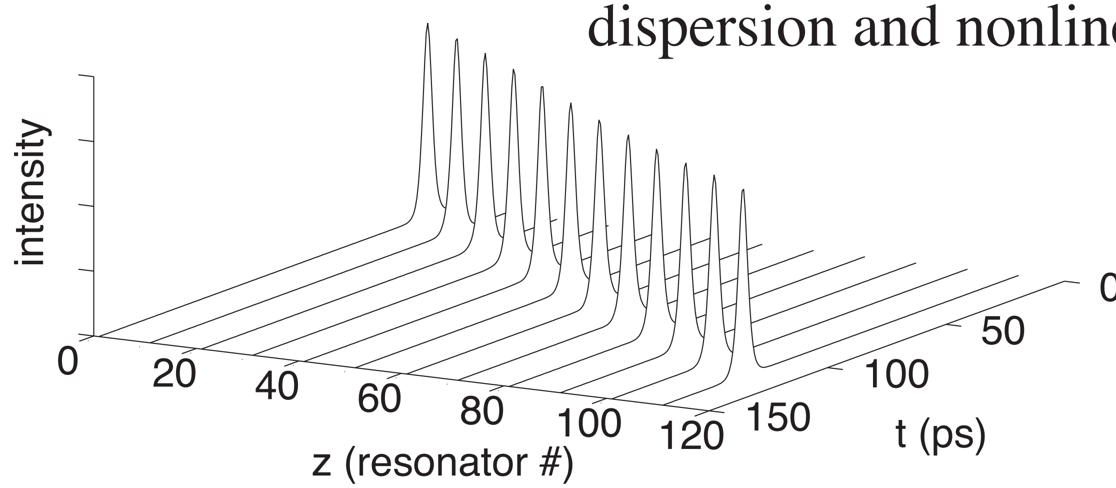
Shows slow-light, tailored dispersion, and enhanced nonlinearity

Optical solitons described by nonlinear Schrodinger equation

- Weak pulses spread because of dispersion



- But intense pulses form solitons through balance of dispersion and nonlinearity.



Photonic Devices for Biosensing

Objective:

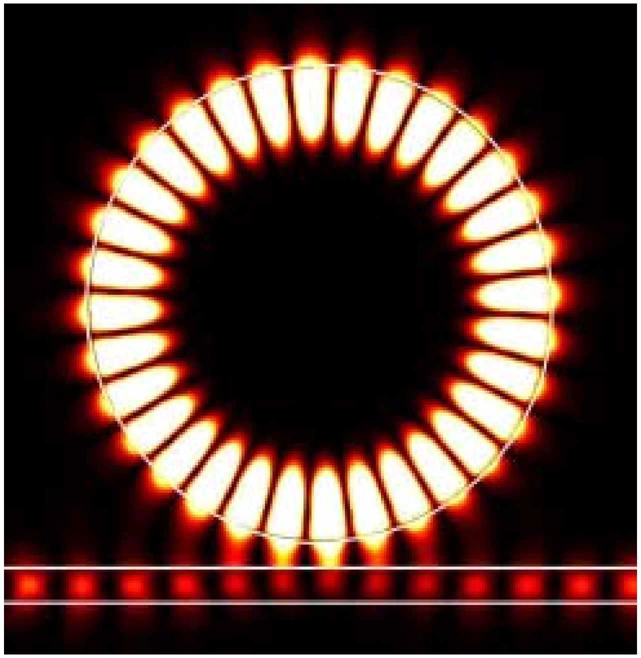
Obtain high sensitivity, high specificity detection of pathogens through optical resonance

Approach:

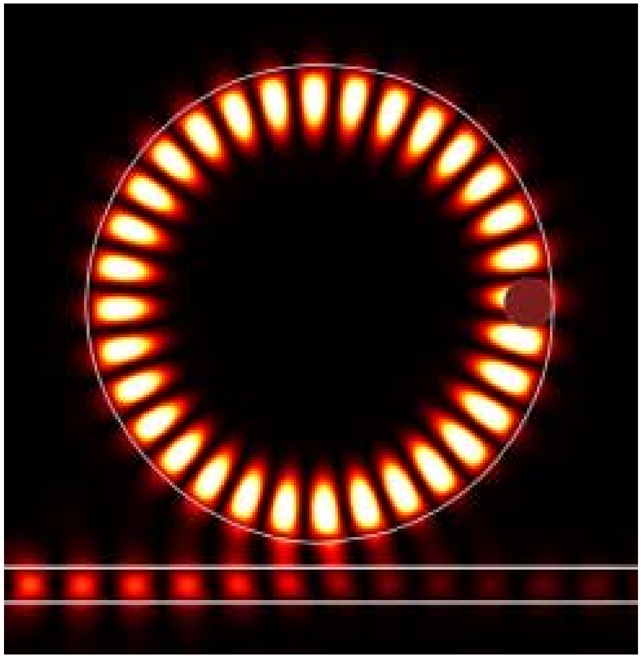
Utilize high-finesse whispering-gallery-mode disk resonator.

Presence of pathogen on surface leads to dramatic decrease in finesse.

Simulation of device operation:



Intensity distribution in absense of absorber.



Intensity distribution in presence of absorber.

FDTD

Photonic Devices in GaAs/AlGaAs