Generation of Squeezed Light by use of EIT

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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


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

Saturation-Induced Extra Resonances

10^{14} \text{ cm}^{-2}

pump probe Na

Dark-State (Λ) Resonances

Two-Level Atom Resonance

V-System Resonances (saturation induced)

1.7 GHz

190 MHz

transmitted probe power

Pump-probe detuning [GHz]

Λ

V

T

Λ
Honey Comb Pattern Formation

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Output from cell with single gaussian beam input

Exiting beam  
Far field pattern

Quantum image?

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

Sodium vapor cell

$T = 220^\circ \text{ C}$
Generation of Quantum States of Light by Two-Beam Excited Conical Emission

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.

Source of Polarized, Single-Photons on Demand

- Useful for secure communication by quantum cryptography
- 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
Implementation with S. Lukishova

Single-molecule fluorescence
Semiconductor MQW structures for Solid-State EIT

Offers benefits of EIT in a solid-state environment!


1 - AlAs$_{.56}$Sb$_{.44}$
2 - In$_{.53}$Ga$_{.47}$As (lattice matched to InP)
3 - In$_{.52}$Al$_{.48}$As

Our design.
Preventing Laser-Beam Filamentation

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

![Diagram showing optical components and wavefront propagation]

- **Nd:YAG 25 ps, 532 nm, 25 mJ**
- **HWP**
- **PBS**
- **carbon disulfide 10 cm**
- **aperture**
- **detector**

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.
**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.

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**Simulation of device operation:**

Intensity distribution in absence of absorber.

Intensity distribution in presence of absorber.

FDTD
Photonic Devices in GaAs/AlGaAs