have still not been experimentally demonstrated yet.

In this paper we report an experimental study of effects of the linewidths of the coupling field and the probe field on the EIT in a three-level Λ-type atomic system of rubidium. This Λ-type three-level system consists of Rb^{87} atoms in a Doppler-broadened vapor cell. The two hyperfine levels $F_g = 1$ and $F_g = 2$, spaced by 6.8 GHz, of the ground state $5S_{1/2}$, serve as the two lower states of the lambda system. The excited state $5P_{1/2}$, $F_e = 2$ serves as the common upper state.[3] The other hyperfine level of the excited state ($5P_{1/2}$, $F_e = 1$) is 814 MHz away (outside the Doppler-broadening linewidth) and its effect can be neglected. The coupling field is provided by a diode laser (output power of about 30 mW) with a free running linewidth of about 5 MHz in few ms time scale when operating under current stabilization and temperature stabilization. The probe field is also provided by a diode laser (few μW power) with a linewidth of about 5 MHz in free-running under current stabilization and temperature stabilization. The coupling laser beam and the probe laser beam copropagate through the vapor cell to achieve the two-photon Doppler-free condition.[3] By using a random noise generator, we were able to increase the linewidth of either the coupling field or the probe field from 5 MHz to above 100 MHz continuously.[5]

In the first experiment, the linewidth of the probe field was kept at the same (about 5 MHz) while the linewidth of the coupling field was increased from 5 MHz to be more than 100 MHz. As the linewidth of the coupling field increases, the absorption reduction at the line center reduces rapidly depending on the strength of the coupling Rabi frequency. We measured the dependence of the EIT on the coupling Rabi frequency and on the linewidth of the coupling laser. Detail experimental studies were made and the experimental results were compared with theoretical predictions. In the second experiment, we kept the linewidth of the coupling field unchanged (about 5 MHz) and varied the linewidth of the probe laser. As the linewidth increases, only the central part of the frequency components of the probe field passes through the medium as a result of EIT and the frequency components that are out of the EIT window are absorbed. This effect is related to the frequency matching between the coupling field and the probe field and has implication in the noise correlation between the coupling field and the probe field through the atomic coherence effect in multilevel atomic system. Detailed study of this experiment and comparison with theoretical calculation will be given and possible applications of this frequency filtering effect will be discussed.

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QTuC 9:00 am–10:00 am Room 341

High Field Interactions

Louis B. DaSilva, *Lawrence Livermore National Laboratory, Presider*

QTuC1 (Invited) 9:00 am

Observation of electron positron pair production and nonlinear Compton scattering in laser-electron interactions

C. Bula, K. T. McDonald, E. J. Prebys, *Princeton Univ.*; C. Bamber, S. Boege, T. Kotseroglou, A. C. Melissinos, D. D. Meyerhofer, W. Ragg, *Univ. Rochester*; D. L. Burke, R. C. Field, G. Horton-Smtih, A. C. Odian, J. E. Spencer, D. Walz, *Stanford Univ.*; S. C. Berrige, W. M. Bugg, K. Shmakov, A. W. Weidemann, *Univ. Tennessee.*

We report the observation of the production of electron positron pairs and evidence for nonlinear Compton scattering in the interaction of a high intensity (10^{18} W/cm^2) laser pulse with an ultra-relativistic (50 GeV) electron beam.

QTuC2 9:30 am

Relativistic laser–plasma interaction above 10^{19} W/cm^2 by 2D and 3D PIC simulations: Single channel, hole piercing, MeV electrons, 100 MG magnetic fields

Alexander Pukhov, Jürgen Meyer-ter-Vehn, *Max-Planck-Institute for Quantum Optics, Garching, Germany*

We present, we believe, the first fully explicit three-dimensional (3D) particle-in-cell (PIC) simulations of ultrashort, high-intensity, laser-pulse interaction with slightly underdense plasmas. We show that relativistic filamentation and self-focusing is accompanied by acceleration of background electrons to multi-MeV energies in the forward direction. The relativistic electrons are pinched by self-generated 100 MGauss magnetic fields and channel light into a single filament 1–2 wavelengths wide. This super-channel contains most of the incident laser power. Recent experiments at the Rutherford Appleton Laboratory (M. Borghesi *et al.*) confirm the PIC simulations. We also simulate a ponderomotive piercing of overdense plasma layers by ultraintense laser pulses in 2D slab geometry. We show that the relativistic electrons propagate deeply in the overdense plasma in the form of magneticly collimated jets. These are key issues for the Fast Ignitor concept in Inertial Confinement Fusion (ICF). The direct fully electromagnetic 3D PIC simulations of actual short pulse laser–plasma experiments are based on the code VLPL (Virtual Laser Plasma Laboratory) developed at MPQ Garching. Being designed for massively parallel processing (MPP) computers like CRAY-T3E, the code VLPL exists in 2D and 3D versions, is highly portable, and can be run on high-performance work stations as well.

QTuC3 9:45 am

A three-dimensional ponderomotive trap for high-energy electrons

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Electrons injected into a high-intensity laser focus by tunneling ionization quickly escape as a result of the strong ponderomotive force. This limits the probability of observing harmonic radiation from free electrons oscillating in the field[1] and other nonlinear effects. Two-dimension (radial) optical confining schemes have been proposed to increase the lifetime of the electron in the intense field.[2,3] These do not confine the electrons in the direction of the laser propagation, which limits their effectiveness. In intense fields the electrons have significant momentum in this direction.[4] To our knowledge, neither of these schemes has been demonstrated.

We have developed a three-dimensional ponderomotive optical trap suitable for high-intensity lasers by using a phase mask to change the phase of half of the beam's near-field pattern by π. In this case, the laser intensity has a minimum at the best focus allowing electrons to be ponderomotively trapped. The phase mask has been created by cutting a disk out of a zeroth-order half-wave plate, rotating it by 90°, and reinstalling it. The inner disk covers approximately 50% of the beam's near field. We have used equivalent-target-plane images to demonstrate the trapping potential and show that the peak intensity at the trap boundaries is approximately 20% of the peak intensity of the beam without the phase mask. By changing the relative angle of the two wave-plate sections, the trap depth can be varied.

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