Abstract Submitted
for the TSF09 Meeting of
The American Physical Society

Heterodyne effect in Hybrid CARS XI WANG, AIHUA ZHANG, MIAOCHAN ZHI, ALEXEI SOKOLOV, GEORGE WELCH, MARLAN SCULLY, Department of Physics and Institute for Quantum Studies, Texas A&M University, College Station, TX 77843, USA, INSTITUTE FOR QUANTUM STUDIES TEAM
— We study the interaction between the resonant Raman signal and non-Raman field, either the concomitant nonresonant four-wave-mixing (FWM) background or an applied external field, in our recently developed scheme of coherent Anti-Stokes Raman scattering, a hybrid CARS. Our technique combines instantaneous coherent excitation of several characteristic molecular vibrations with subsequent probing of these vibrations by an optimally shaped, time-delayed, narrowband laser pulse. This pulse configuration mitigates the non-resonant FWM background while maximizing the Raman-resonant signal, and allows rapid and highly specific detection even in the presence of multiple scattering. We apply this method to non-invasive monitoring of blood glucose levels. Under certain conditions we find that the measured signal is linearly proportional to the glucose concentration due to optical interference with the residual background light, which allows reliable detection of spectral signatures down to medically-relevant glucose levels. We also study the interference between the CARS field and an external field (the local oscillator) by controlling their relative phase and amplitude. This control allows direct observation of the real and imaginary components of the third-order nonlinear susceptibility ($\chi^{(3)}$) of the sample. We demonstrate that the heterodyne method can be used to amplify the signal and thus increase detection sensitivity.

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Date submitted: 28 Sep 2009 Electronic form version 1.4