DEGENERATE Z-SCAN MEASUREMENTS WITH WHITE-LIGHT CONTINUUM.

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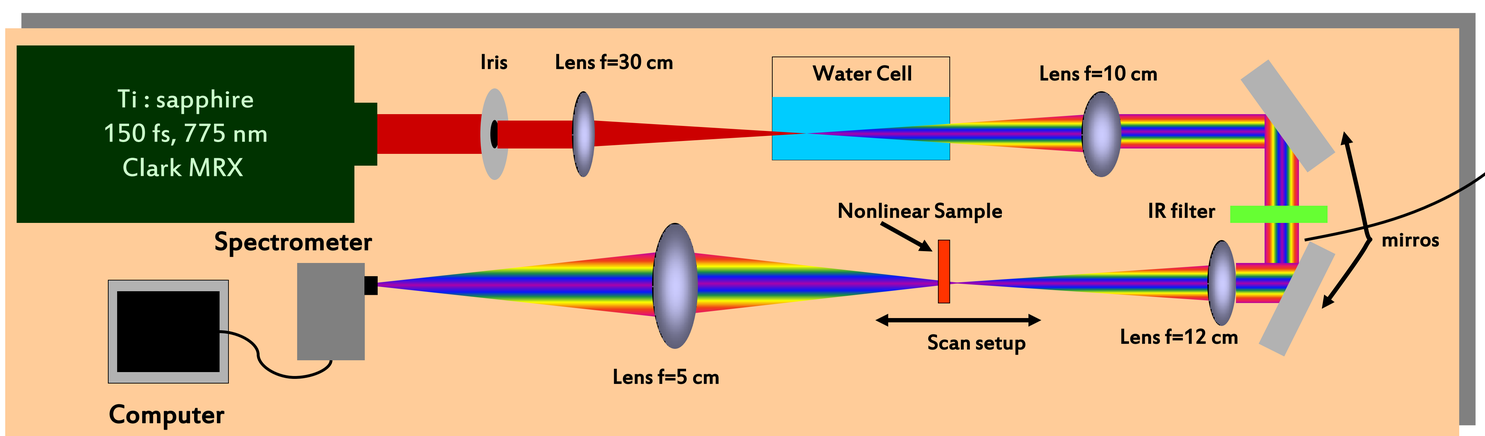
Abstract

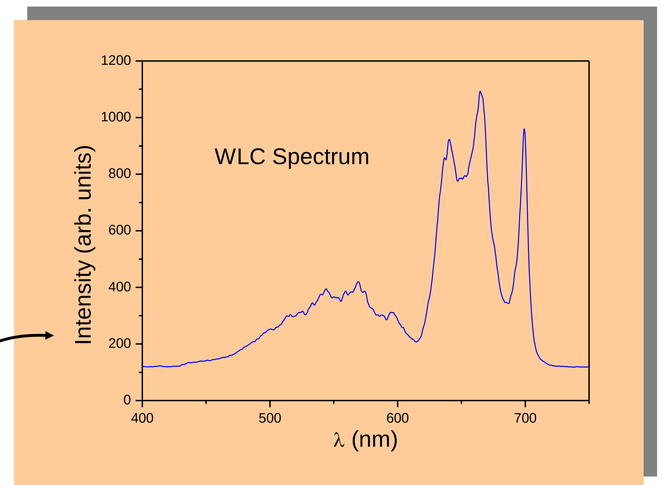
Here we present a new Z-scan technique for direct measurements of nonlinear absorption spectra. This technique is based in the use of an intense single white-light continuum (WLC) beam as the coherent broadband light source. The WLC beam is focussed and the nonlinear sample is scanned along the beam propagation direction, as the Z-scan technique requires. Since each color is focussed in different z-position, the degeneracy of the nonlinearity is preserved. Here we have measured the nonlinear absorption spectrum of a two azobenzene solution from 400 to 750nm. These solutions present a strong saturable absorption (SA) process around the linear absorption band.

✓With-Light Continuum Z-Scan experimental setup

In our experiments distilled water was used as the nonlinear medium to provide the WLC generation. As pump source for this continuum generation was used a focused ultrashort pulse laser beam provides by a femtosecond amplified laser system. The femtosecond laser was a commercial chirped pulse amplified CPA 2001 system from Clark MRX Inc. The system cans delivery pulses up to 0.8 mJ with 150fs at 775nm at 1KHz repetition rate. The 150 fs at 775nm laser beam was focused by f=30 cm lens into the center of a 4cm long water cell. The output continuum light beam was re-collimated via an f=10 cm lens. In sequence, the WLC beam has been used in the Z-scan measurements. The focused WLC beam passes through the sample and then it is focused into the small spectrometer. By scanning the sample along z-direction each spectral component generate a typical Z-scan signature in accord with it nonlinear property.



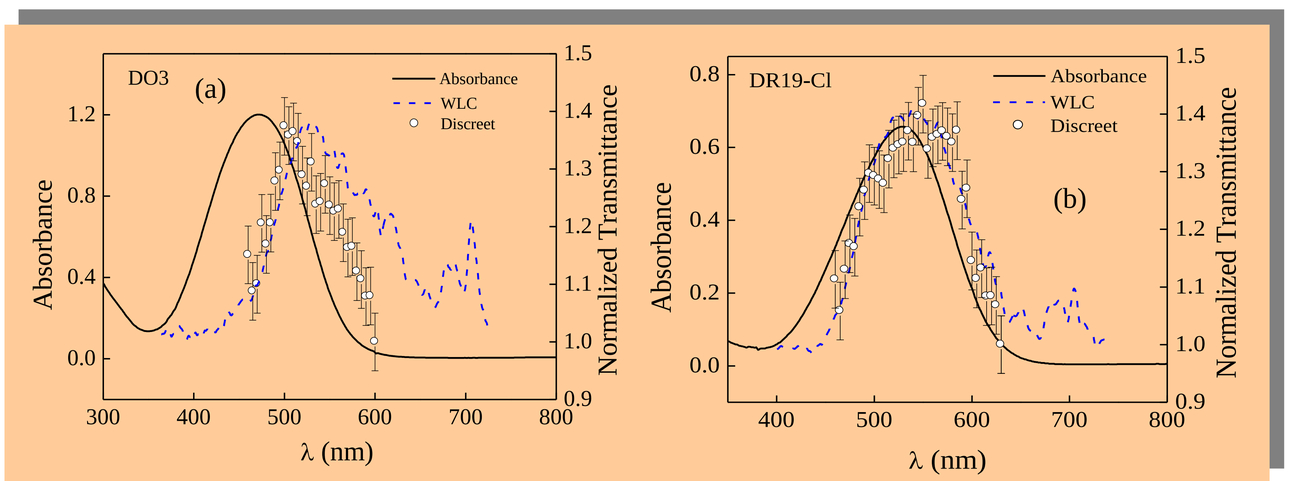
✓Typical spectrum of the WLC



Using about 0.1 mJ of 150 fs Ti:sapphire laser pulse we were able to generate about 3 μJ of WLC in the visible range using the 4 cm length water cell. An IR filter was used to remove the strong 775 nm pump pulse. This spectrum is a function of the intensity and the wavelength that is applied in the water cell.

✓Experimental results

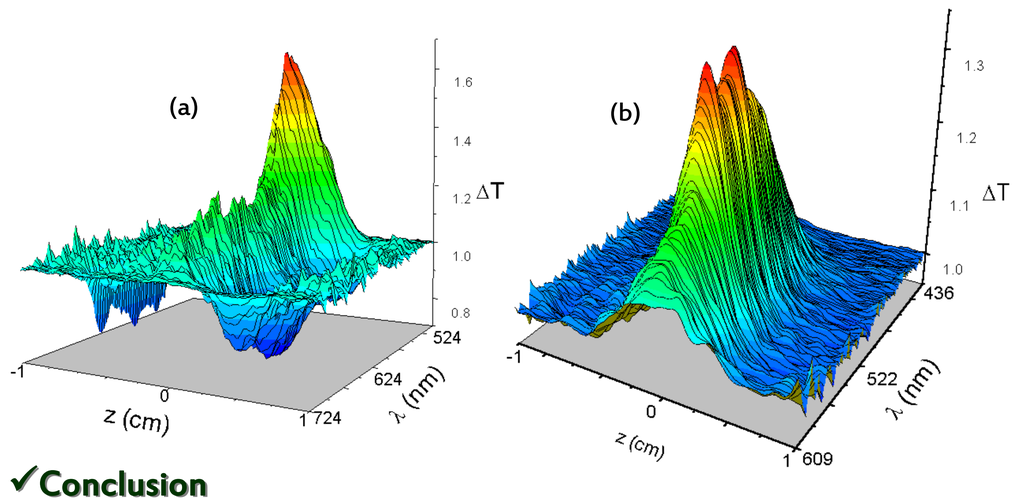
The samples measured in this work were DO3 and DR19-Cl azobenzene dye with same concentration of 0.04 mg/ml. These azobenzene molecules present a photoinduced cis-trans isomerization and a strong saturable absorption process at resonance wavelengths. The figure shows the Z-scan signatures for the WLC spectrum for both samples. These signatures were obtained simultaneously as the samples are scanned. In sequence we also performed the traditional discreet Z-scan measurements using the tunable OPA. We have measured from 460 to 650 nm in 5 nm step. The power used was kept fix at 0.05 μJ for all color. As we can see from the figure a good agreements exist between the two methods.



Linear (solid line) and nonlinear absorption spectra of DO3 (a) and DR19 (b) dye solutions. The dashed line and the circle were obtained from WLC Z-scan and discreet Z-scan technique, respectively.

✓WLC Z-scan analyses

The WLC Z-scan is performed as similar as the traditional Z-scan method. Since we have a lot of Z-scan and each color has different intensity, a computer code was developed to analyze the data. 3D Z-scan signature is obtained for each measurement. We can use an aperture or no aperture to measure the refractive (a) or absorptive (b) nonlinearities.



✓Conclusion

In summary, we have demonstrated a new experimental method for measuring the nonlinear absorption spectra in a single measurement using white-light continuum beam. A good agreement between the results obtained by the method using a WLC and the traditional discreet measurements. These results allow concluding that the Z-scan using WLC is a very fast and simple method to determine the nonlinear absorption spectra of any nonlinear samples.