Liquid Characterization Using Visible Light Lasers

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Introduction:

•The motivation for this study was to provide information on a nonlinear liquid to be used in future experiments.

• In this study, a green, 532 nm, visible light laser was used to measure the nonlinear properties of a thermal liquid.

•The liquid characterized was a solution of iodine and ethanol, where the iodine worked to absorb the green light and the ethanol allowed the liquid to heat quickly.

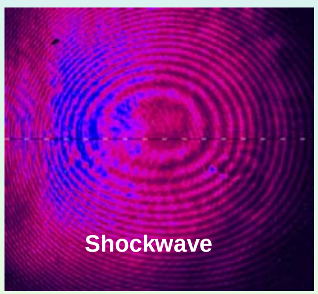
•The liquid was characterized at different concentrations of iodine (5 drops, 10 drops, 20 drops, etc.) in 3 mL of ethyl alcohol.

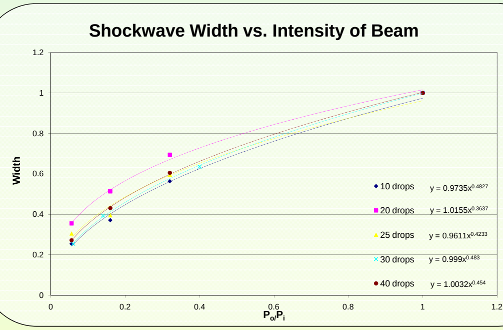
Nonlinear Diffraction:

•Nonlinear diffraction occurs where the plane wave and the Gaussian beam interfere.

•The plane wave acts as a background for the Gaussian beam to "shock".

•The CCD camera recorded the shockwaves. The widths of the shockwaves were measured and plotted against the intensity of the beam itself to create a function showing the growth rate of the shockwave. The measurements were taken at various concentrations of iodine.





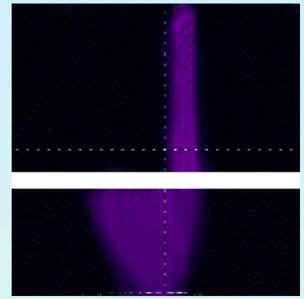
Response Time:

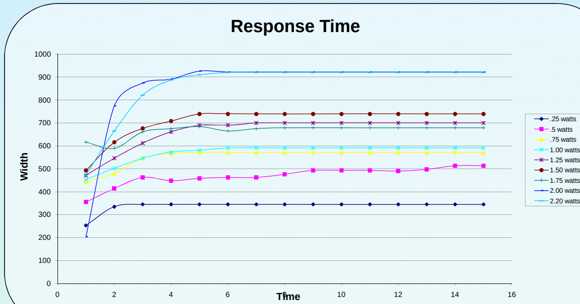
•As the Gaussian beam travels through space the light diverges. Over time, the beam diverges more and more and spreads a noticeable amount.

•The beam in this experiment was filtered through a narrow slit to make it thinner. The camera recorded the expansion of the beam over time.

•The first and last frames captured by the camera were measured and plotted against the time to find the response time, or how long it took for the beam to diverge completely.

•The figure to the right shows the beam as it first appears (top) and after it has completely diverged (bottom).





Absorption and Index of Refraction:

•Absorption and index of refraction were both found at each of the concentrations of the liquid. The equation used to find absorption is:

$$\alpha = -\frac{1}{L}\ln\frac{I_{out}}{I_{in}}$$

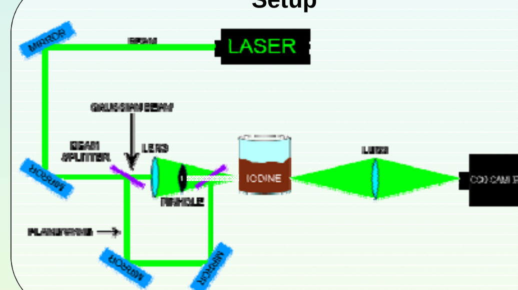
•Where I is the intensity at the output and the input, alpha is the absorption and L is the distance between the input and the output.

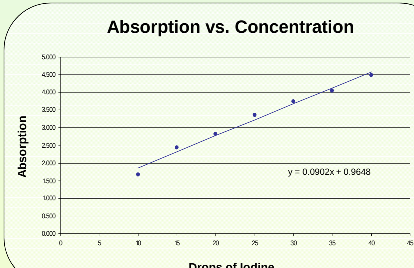
•We found the index of refraction by using the equation:

$$\frac{L}{D} = n_{iodine}$$

•Where L is the distance between the input and the output, D is the distance the lens was moved to focus the input and the output, and n is the refractive index.

Setup





Conclusions:

•The absorption of the liquid is directly proportional to the concentration of iodine.

•The index of refraction stayed nearly constant at all concentrations and is about 1.56.

•The curves of the shockwave widths vs. intensity grew at faster rates for higher concentrations of iodine.

•The response time of the liquid was faster for higher intensities of light.

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