Conclusions and visions

This thesis contains studies of the optical behavior of condensed and nanostructured media in the strong and intense laser-matter interaction regimes. Various instrumentation works carried out in the course of these experiments also are presented.

Nonlinear transmission measurements in core-shell silver nanocomposites show that they possess excellent optical limiting properties. The sample used is in thin film form, making it useful for device applications. Measurements show that the sample performs well at different wavelengths and laser pulsewidths, so that its action is truly broadband. The femtosecond response times indicate its suitability for photonic switching applications. The laser damage threshold value of this material is one of the best reported so far.

Similar studies in tellurium and silver telluride nanowires have revealed their potential as broadband optical limiters. The fact that silver telluride is a semiconducting material makes it more interesting from a hybrid device point of view.

A simple and elegant method to visually determine the sign of refractive nonlinearities in thin nonlinear samples, based on spatial self-phase modulation
patterns, is devised and experimentally verified. Theoretical simulations and experimental results are found to agree well with each other.

A white-light continuum generated using femtosecond laser pulses is used for performing a nondegenerate z-scan experiment, where the spectral dispersion of the optical nonlinearity in a 200 nm wavelength range is measured in a single experiment. The white-light z-scan is a fast and cheap alternative to the use of a tunable optical parametric amplifier (OPA) in a conventional z-scan configuration.

The necessary experimental platform for intense laser-solid interaction studies in a vacuum environment is completed, which will have long term use in the laboratory. The required electronic circuits are designed and fabricated, and softwares developed. X-ray and γ-ray detectors are calibrated and detection schemes perfected. An experimental scheme for x-ray emission studies from irradiated liquid jets in ambient pressures is also realized.

The plasma emission measured from ultrafast laser irradiated planar liquid jets shows them to be good sources of soft x-rays. A scheme is devised to enhance the x-ray emission yield by adding metallic nanostructures to clear liquids. X-ray emission from an irradiated Nickel target under an ambient pressure of $10^{-6}$ Torr is measured, and the hot electron temperature is calculated from the bremsstrahlung emission spectrum.

The above studies which comprise this thesis are by no means exhaustive. A more detailed study of the optical nonlinearity in metal nanostructures, involving time resolved measurements, will give better insights into the electron dynamics of the media. Similarly, devising ways to improve the S/N ratio of white-light z-scan measurements will be rewarding, in view of the advantages this non-degenerate z-scan technique offers over conventional single wavelength configurations. For instance, by using crystals like barium fluoride or calcium fluoride instead of water the white-light emission yield can be enhanced, and the S/N ratio can be improved.

The results obtained from the plasma studies are very promising. Laser produced plasmas are rich sources of electromagnetic radiation, energetic ions and free electrons. More research on improving the x-ray and ion emission yields in a
laser produced plasma will be of immense interest, from the viewpoints of a tabletop x-ray source and tabletop accelerator. There may be enhancements in the ion and electron yields as well, in addition to the x-ray yield, by the incorporation of metallic nanostructures into a plasma target. Metal nanostructures with sharper features which enhance the local fields even more, and with surface plasmon resonance peaks closer to the excitation wavelengths, shall be interesting materials for plasma studies. Finally, extension of plasma investigations to ion and electron spectroscopy in future will be a fitting complement to the x-ray emission studies presented in this thesis.