"Acoustic and Ultrasonic Resonances Induced by Laser Irradiation"

Kevin E. Claytor, Los Alamos High School, Los Alamos, NM – 2004-05 National Individual Finalist

Abstract: This project takes a novel approach to materials analysis by using a Nd:YAG Q-switched laser to remotely generate acoustic waves in a material. In this project, two methods that create acoustic waves remotely were examined. The material was ablated, where part of the material was vaporized. This generated the acoustic waves from the reaction force of the removed material. A non-destructive method – the thermoelastic method – was used to generate acoustic waves by heating the material, but below the point of vaporization. This caused a deformation in the surface that generated acoustic waves. Contrary to expectations, the thermoacoustic method produced amplitudes only a factor of two less than the ablative method, reinforcing the use of the thermoacoustic method in materials analysis. In addition to examining the types of generating acoustic waves in a material with a high power pulsed laser, this project also examined the practicality of using the acoustic signals of the plasma plume, generated by ablating the material, as a method of materials analysis.

"Superconductivity in High-Pressure Phases of Lithium"

Wei Gan, Wootton High School, Rockville, MD – 2002-03 National Individual Finalist

Abstract: Superconductivity in compressed lithium is observed by both magnetic susceptibility and electrical resistivity measurements. Experiments carried out using new diamond-anvil cell techniques reveal a superconducting critical temperature T_c in the material ranging from 9 K to 16 K at 23 GPa to 80 GPa. An unusual pressure dependence of T_c suggests multiple phase transitions consistent with theoretical predictions and reported X-ray diffraction results.

The observed values for Tc are much lower than those theoretically predicted indicating that more sophisticated theoretical treatments similar to those proposed for metallic hydrogen may be required to understand superconductivity in dense phases of lithium.

Mentors: Wilson Bascom, Dr. Viktor Struzhkin.