Direct-Drive Inertial Confinement Fusion Research: Theory and Experiments

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Inertial confinement fusion (ICF) ignition research is being carried out with both direct and indirect drive. Each approach has advantages. The direct-drive approach to ICF offers the possibility of higher gain than indirect-drive ICF and simpler engineering of an inertial fusion energy power plant. Many different physical processes occur during the implosion, including the physics of laser interaction with the target, the growth of nonuniformities due to the Rayleigh–Taylor instability during the acceleration and deceleration phases of the implosion, assembly of the compressed core, and nuclear burn. These processes can be studied in an integrated sense by performing spherical target implosions, and in a piece-wise sense, where individual processes are studied with little effect of others. This talk will describe experimental and theoretical research in direct-drive ICF, concentrating on the strong interplay between these efforts. It will concentrate on research carried out at the University of Rochester, where the primary experimental tool—the 60-beam, 30-kJ OMEGA laser system—is used for both integrated and individual physics process experiments. A brief comparison of direct and indirect drive and examples from other laboratories will be included. The intermediate-term goal of the ICF program is target ignition on the 1.5-MJ National Ignition Facility, currently under construction at LLNL. Direct-drive ignition designs will be reviewed, and the relationship of the current research to these designs will be described. These include the performance of cryogenic target experiments on the OMEGA laser system.

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