Inertial Confinement Fusion

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ABSTRACT

In these series of lectures, the fundamentals of implosion hydrodynamics are described leading to a full model of thermonuclear ignition for spherical implosions of deuterium-tritium shells. The lectures review the basic physics of laser-driven implosions followed by a one-dimensional model of an imploding thin shell. This model provides the basis to determine the compressed core conditions. After the one-dimensional model, the multi-dimensional effects of hydrodynamic instabilities are considered and the linear and nonlinear phases of the instabilities are described. The stagnation properties of the central hot-spot plasma are derived and the conditions for triggering the thermonuclear instability (ignition) are described in detail.

OUTLINE

Fundamentals of Implosion Hydrodynamics

(a) Thermal conduction in plasmas
(b) Laser absorption
(c) Mass ablation
(d) Ablation pressure
(e) Shock waves
(f) Adiabat
(g) Rocket model
(h) Laser pulse shaping

One Dimensional Spherical Implosions

(a) One dimensional model of an imploding thin shell driven by the ablation pressure
(b) The In-flight aspect ratio
(c) The areal density of the compressed core
(d) The pressure of the compressed core
(e) The density of the compressed core

Hydrodynamic instabilities of imploding shells

(a) The linear classical Rayleigh-Taylor instability
(b) The ablative stabilization
(c) Feedthrough of the outer surface perturbations
(d) Multimode bubble front penetration
(e) The role of the in-flight aspect ratio

Hot spot dynamics

(a) Thermal transport and the hot spot temperature
(b) Energy balance
(c) Alpha heating
(d) Thermonuclear ignition