Status and prospects for burning plasmas via laser fusion

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The recent results from the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory raise the hopes for producing a thermonuclear burning plasma in the laboratory for the first time. A plasma is defined as "burning" when the self-heating from the fusion reactions is the main energy input to the plasma. A burning plasma represents the stage before thermonuclear ignition. The latter occurs when the plasma burns out of control through a thermal runaway process (ignition). Assessing the degree to which fusion alpha particles contribute to the fusion yield is essential to assess when the plasma is burning. The recent results from the NIF show that the alpha heating is comparable to the input energy to the central hot spot of a compressed core. The level of alpha heating of NIF indirect-drive implosions is inferred from the measurements of areal density and neutron yield, and compared to the results achieved by other approaches to nuclear fusion. Progress in both indirect and direct drive will be reviewed including the latest experimental results from the OMEGA laser on conventional direct drive and shock ignition. Recent advances in the theory of ignition indicate that the performance from direct-drive scaled-down implosion experiments on the OMEGA laser can be extrapolated to the ignition-relevant energies of the NIF. The data extrapolation analysis from 26kJ to about 1.5MJ of laser energy provides a useful tool to determine if the OMEGA cryogenic implosions will ignite when scaled-up to NIF energies (hydro-equivalent ignition).