Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Ultrafast cavitation induced by an X-ray laser in water drops

CLAUDIU STAN, PHILIP WILLMOTT, SLAC National Accelerator Laboratory, HOWARD STONE, Princeton University, Department of Mechanical and Aerospace Engineering, JASON KOGLIN, MENGNING LIANG, ANDREW AQUILA, JOSEPH ROBINSON, KARL GUMERLOCK, GABRIEL BLAJ, RAYMOND SIERRA, SEBASTIEN BOUTET, SERGE GUILLET, ROBIN CURTIS, SHARON VETTER, HENRIK LOOS, JAMES TURNER, FRANZ-JOSEF DECKER, SLAC National Accelerator Laboratory — Cavitation in pure water is determined by an intrinsic heterogeneous cavitation mechanism, which prevents in general the experimental generation of large tensions (negative pressures) in bulk liquid water. We developed an ultrafast decompression technique, based on the reflection of shock waves generated by an X-ray laser inside liquid drops, to stretch liquids to large negative pressures in a few nanoseconds. Using this method, we observed cavitation in liquid water at pressures below -100 MPa. These large tensions exceed significantly those achieved previously, mainly due to the ultrafast decompression. The decompression induced by shock waves generated by an X-ray laser is rapid enough to continue to stretch the liquid phase after the heterogeneous cavitation occurs in water, despite the rapid growth of cavitation nanobubbles. We developed a nucleation-and-growth hydrodynamic cavitation model that explains our results and estimates the concentration of heterogeneous cavitation nuclei in water.

Claudiu Stan
SLAC National Accelerator Laboratory

Date submitted: 13 Jun 2016 Electronic form version 1.4