

EXPLORING THE LIMITS OF CAVITATION

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In acoustic cavitation, a sound field forces small gas bubbles in a fluid to oscillate in a non-linear fashion to produce high temperature, high pressure and even the emission of light – sonoluminescence (SL). These temperatures and pressures have fueled speculation that cavitation concentrates enough energy to initiate an acoustic inertial confinement fusion (AICF) reaction. This dissertation is dedicated to probing different systems in an attempt to observe evidence of a deuterium - deuterium (D-D) fusion reaction; consideration was always taken to choose systems that could simultaneously be probed for interesting concepts related to the basic understanding of cavitation.

The primary system sought to increase the strength of the cavitation collapse by applying a larger force to the bubble radial motion; this research developed a resonator capable of increasing the acoustic pressure amplitude by a factor of 25 above typical SL resonators. A new nucleation method was discovered that allowed for a more authentic probe of the acoustical effect on the bubble with a reduced dependence on the nucleation.

Restricting the vapor content through chemical means provides a second method of increasing the energy of the cavitation collapse. Previous experiments have shown increased SL emission intensities with lower vapor pressure fluids but these increases had not previously been correlated to the motion of the bubble. Radial motion measurements of a single bubble in aqueous sulfuric acid have shown a continuously changing radial profile for each acoustic cycle; this changing bubble radial motion prevents the bubble from remaining spatially located at the center of the sound field.

Finally, both of these systems were studied in an attempt to observe evidence of an AICF reaction. When two deuterons are forced to fuse together, the detectable products are tritium and free neutrons; due to increased detection sensitivity, experiments were primarily centered on neutron detection. From all systems studied, no evidence of an AICF reaction was found. While no system tested provided evidence of AICF, many experimental conditions remain to be explored. This work has developed methodology that can easily be expanded to a wider range of cavitation conditions.