Energy Focusing in Bubbly Flows

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Sonoluminescence, cavitation damage at surfaces, and cavitation in accelerating flows are realizations of spectacular levels of energy focusing in nature. In a resonant sound field a single trapped bubble of gas can focus the ambient sound energy by 12 orders of magnitude to generate a clocklike string of picosecond flashes of ultraviolet light\(^1\). In more complicated geometries a high level of sound leads to the formation of hemispherical bubbles attached to an exposed surface. These bubbles also emit light and in addition damage the surface. Measurements show that the pulsation of these bubbles maintains the hemispherical symmetry\(^2\), thus raising the question as to whether cavitation damage is due to (micro)jets or imploding (hemispherical) shock waves. Finally, flow through a Venturi tube generates a stream of bubbles which also emit subnanosecond flashes of light\(^3\). Luminescence from an isolated trapped bubble in water seems to work well with any noble gas, whereas luminescence from cavitating flows and surface bubbles is quite dependent on xenon [argon bubbles appear to give no light at all].

The width of the SL flash\(^4,5\) has been found to be independent of wavelength suggesting that light is emitted from a new high energy phase of matter—probably a cold dense nano-plasma.

The key unknowns of SL are the size and temperature of the hot spot from which the light is emitted. Experiments aimed at measuring these quantities will be discussed. [Research supported by the NSF.]

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1) B.P. Barber et al; Defining the Unknowns of Sonoluminescence, Physics Reports, 281, 65 (1997).