DESIGN OF A MULTIBUBBLE SONOLUMINESCENCE EXPERIMENT FOR A MICROGRAVITY PLATFORM

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Sonoluminescence (SL), consisting in the emission of light by an oscillating bubble which collapses under a high frequency sound wave was accidentally discovered in 1934. In order to produce SL, acoustic cavitation starting at nuclei inside the liquid (gas bubbles, solid particles containing small amounts of gas, or trapped gas at the walls of the recipient) is needed. When a standing sound wave is applied, a sinusoidal variation on the ambient pressure is imposed. When the pressure amplitude decreases to negative values, tiny bubbles are excited and start to grow. SL starts when a bubble is trapped by a standing wave, imposing the stable oscillation of the bubble, which usually increases its initial radius (see Figure 1).
Among fluid phenomena this transduction of sound into light is unique in that the energy enters the fluid at low energy and long wavelengths and it results to visible photons. A very high sound energy is concentrated, but only a small fraction of this energy ends up as visual photons. We present the experimental setup and procedure to carry out a set of experiments focused on the study of the effects of instabilities into a multibubble sonoluminescence (MBSL) system under controlled conditions. By means of an acoustic wave generation system connected to a flask containing water, a multibubble sonoluminesceing field will be initially generated, which presumably produces a different light intensity level in microgravity than in normal gravity. Later on, instabilities in the MBSL phenomenon will be induced through water and bubble jets injected into the system. We expect that liquid circulation and size and number of bubbles in the jets may influence the MBSL process inside the flask. The experimental setup is designed in order to be able to change the main parameters of the acoustic wave generation system (frequency and amplitude of the acoustic wave) and the injection system (liquid and gas flow rates). The flow rates used in the injection system fully determine the number and size of injected bubbles. The experiment is also designed to output information on the MBSL intensity. The data obtained will be compared to the results of a single bubble SL in microgravity experiment [1], MBSL experiment on ground [2], effects of injection of fluid flow on MBSL in normal gravity [3] and our ground testing. The experimental setup is composed by three main systems, which are the acoustic wave generation (creation of cavitation bubbles and bubble trapping), the flow injection system (which is controlled by liquid and gas flow rates) and finally the data acquisition system.

The acoustic wave generation system is composed by two PZT, fed by the function generator, to produce the sonoluminescence phenomenon. The flow injection system consists of two circuits, one of liquid and another of gas, joined by a T-junction. Finally, the data acquisition system consists of a hydrophone detecting the cavitation, a Photomultiplier Tube (PMT) capturing the SL intensity, the flask itself and a laptop monitoring the whole experimental setup (see Fig. 2) We expect that the influence of the input flow will either enhance SL intensity, making cavitation bubbles not to coalesce and start clustering because the flow breaks them up, or weaken it by making the instabilities of the bubbles increase. The benefits of flow circulation could be to prevent the shield effect and make bubbles stay at the pressure antinodes.

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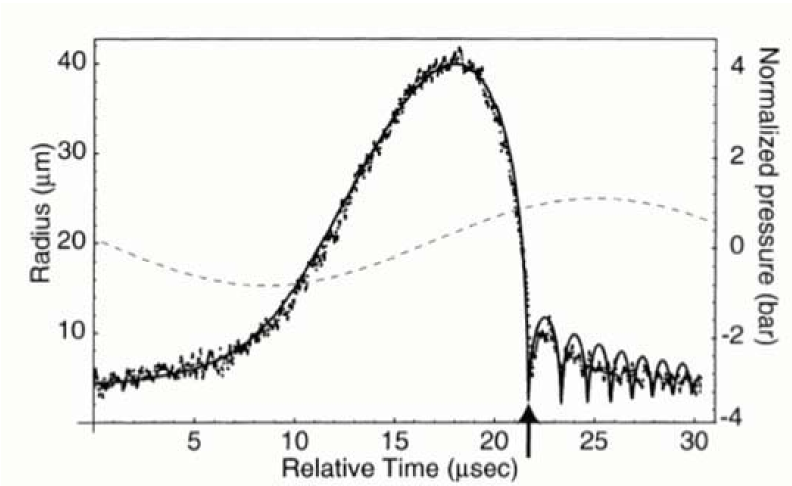

Figure 1: The nonlinear, radial response of a bubble in normal gravity subject to an oscillating acoustic pressure field of 0.14 MPa. The heavy line is the calculated bubble radius, the dashed line is the normalized acoustic drive pressure. The arrow indicates where, in the hydrodynamic motion of the bubble, the light flash occurs. Extracted from [1].