Sonoluminescence – the plot thickens

Sonoluminescence (the conversion of sound into light by the extraordinary nonlinear pulsations of tiny bubbles of gas trapped in water) is a phenomenon that has attracted strong interest. The subject of sonoluminescence has also had an unusual history, characterized by promising avenues of research being left unexplored following interesting and unexpected experimental results (see, for example, May 1998 pp38–42). Another example of sonoluminescence being discovered, only for the researcher to abandon this line of study, recently came to my attention.

In a remarkable set of experiments in 1970 for his master's thesis at the University of Vermont in the US, Paul R Temple trapped a single gas bubble at a velocity node of a resonant sound field and then observed the emission of light as the acoustic drive was increased. Temple found that one flash was emitted with each cycle of sound and that (in water) the flash widths were shorter than could be determined by his instruments (20 ns). He also noted that the bubble disappeared when the pressure was higher than 1.4 atmospheres, and that it required 5–10 s to "turn on".

So why were these amazing results, which took us more than two decades to rediscover and trust, abandoned in 1970? I believe that there are two reasons, which are related to gas in the fluid, and bubble-shape stability. Although Temple degassed the fluid to prevent uncontrolled cavitation (yet another advance!), the degassing was not as effective as that carried out two decades later by Felipe Gaitan from the University of Mississippi for his 1989 thesis entitled "An experimental investigation of acoustic cavitation in gaseous liquids". Gaitan's degassing system yielded a much greater level of stability.

The other reason why Temple's work on cavitation luminescence was ignored for so long was that he was immediately interested in maximizing sonoluminescence, and reasoned that any distortion of the bubble's shape should be minimized. He therefore mixed glycerine into the water to increase the viscosity and to damp out the shape distortions and the "dancing" of the bubble. Although this work generated great interest at the 81st meeting of the Acoustical Society of America in 1971, the lack of an obvious way to improve control over the shape of the bubble discouraged further work.

Without realizing that we were following in Temple's footsteps, George Vazquez and I recently added glycerine to water, with the goal of increasing the viscosity and achieving a greater level of sonoluminescence. When the viscosity of the room-temperature fluid mixture was increased to the value that pure water has at 0 °C, the intensity of light emission remained unchanged, namely 10 times less bright than water at 0 °C. Before one concludes that theories of shape instability are wrong (March p20), it is important to realize that sonoluminescence occurs as a singularity is forming. Adding glycerine to water therefore changes more than the viscosity. The fact that the energy focusing remains robust despite all of the competing effects guarantees a rich future for this field that, we trust, will not be abandoned for some time to come.

Seth Putterman
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Portrait detail

While it may seem churlish to protest at Denys Wilkinson's insightful and generally favourable review of my book *Making Physics: A Biography of Brookhaven National Laboratory* (June pp49–50), his negative remarks appear to be based on the unspoken assumption that a portrait of a laboratory community should be chiefly about science. But the life and work of a laboratory community is heavily shaped by political, social, economic and even psychological factors, which means that the canvas must include much more than science.

I did not intend to write a science history, given the existence of many references that already do that job. With all I had to cover, to paint a portrait that had any hope of being effective meant using people, programmes and events symbolically, as "significant details" that would have to stand for much else that could not be included. The absence of any reference to Wilkinson's important and path-breaking work at Brookhaven is indeed regrettable – although much other important research also had to be left out – and must have rankled in the light of my inclusion of seemingly irrelevant information.

Wilkinson asks, for instance, whether "we really need to be told" about the link between an accelerator company and the real-estate developer Donald Trump, or between the head of Brookhaven's graphic arts department and Yoko Ono. Given what I was trying to accomplish, the answer is yes. By including the former detail I hoped to help underscore the feverishly competitive atmosphere of accelerator construction immediately after the Second World War, and by including the latter detail I hinted at the intensely artistic climate within Brookhaven's graphic arts programme.

I had hoped that these details might help to convey what kind of place Brookhaven was to work in – and that, rather than a comprehensive chronology of scientific achievements, was the aim of the book.

Robert Crease
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At your service

I was surprised to read such a complex solution to such a simple problem as slowing down the pace of a tennis match (June p19). Neither changing the balls, nor the rackets, nor the court size, is necessary. Why not simply eliminate the second serve? This would mean that players have to increase the percentage of first serves they put in by slowing them down, as we can see with the second serve in the present game.

It would be an interesting game-theoretic exercise to estimate the correct risk to take with the first serve. For any given player, we know the percentage of first serves he puts in on average. What would be the optimum percentage of maximum speed at which he should serve to maximize his chances of success? Is there any difference at different stages of the game – in other words, are all points equal? I believe we would still see powerful serves, which are an exciting part of the game, but only when the player felt it was worth the greater risk.

While we are fixing up anomalies, we could adjust another glaring fault of the game, which is the need for right-handed players to start each game serving to their opponent's forehand side. Parity experts know that a slight edge serving to the forehand side means that left-handers will do rather better, since the "big" points (30–40 and advantage) in tennis always end up with the ball served to the backhand for the right-handed player, but to the forehand for left-handed players. It would be fairer to allow players to choose from which side to serve first. I would wager that all right-handers would swap.

Another victory for theoretic analysis. There is nothing quite so satisfying as solving a problem without leaving your chair.

Ron Lazarovits
Melbourne, Australia

Last laugh

I must congratulate you on the elegant symmetry of your joke in the June issue of *Physics World*. I refer, of course, to Tom Wheldon's lateral thoughts article entitled "The accountant's delusion", which criticizes the belief that everything in life has a monetary value, and your editorial, which praises the fact that "theoretical physicists can create wealth" in the City. Like all the best jokes, it takes a few minutes to realize it is intended as one.

David Greene
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