Sonoluminescence, or “sound into light,” occurs when a small bubble, surrounded by liquid, is bombarded with sound. This bombardment causes the bubble to rapidly collapse, and due to the high energies then present in the bubble, light is produced. Much of the light emitted by a bubble in water has been discovered to be ultraviolet. Light of higher wavelengths such as x-rays may also be emitted, but remain undetected because energies above 6 eV (corresponding to a wavelength of 0.2 microns and a temperature of 72,000 K within the bubble) cannot pass through water. The temperature at the surface of the sun is only roughly 6,000 K, and much less than 1.8e8 K at the core where the sun’s fusion reactions take place. What the emitted light indicates is that temperatures inside the bubble might be great enough to support the types of fusion reactions that take place within the sun. It does not indicate that fusion *is* taking place within the bubble, but there is certainly the *potential* for fusion to occur.

Fusion, if it can be achieved, will be a clean, abundant energy source. Its only fuel, species of hydrogen, can be extracted at very low cost from the seawater that comprises about two-thirds of the Earth’s surface. However, the main drawback to achieving fusion has been the containment of the high-temperature plasma in which fusion takes place. Plasma temperatures are great enough to melt all metals, so no solid container can be built around it. There have been two approaches to plasma containment, magnetic confinement and inertial confinement, and both of these methods of achieving fusion require massive amounts of energy input, resulting in very high construction and maintenance costs. Magnetic confinement takes advantage of the positive charge of protons, deuterons, and tritons; an extremely powerful magnetic field repels the plasma inward away from the walls of the large toroid container. To produce such a large tesla field, a large amount of electric current is needed. Inertial confinement involves directing the beams of trillion-watt lasers on a small amount of fusionable material. About two months ago, I learned of the production of 178 trillion watts of energy that had been produced by such an inertial confinement fusion system, a burst of energy that had lasted only 0.8 microseconds. Researchers have been able to produce as much energy from a fusion reactor as they input, but not greater, and not without the extremely high construction and operation costs of such a reactor.

Currently, single-bubble sonoluminescence (to distinguish from multiple-bubble sonoluminescence, which produces less light) requires only enough power to run a function generator, audio amplifier, oscilloscope, and two speakers. A single bubble is injected into a cylindrical flask of degassed water and held in place by the sound waves produced from speakers on opposite sides of the flask. When the function generator is set at just the right frequency and intensity (around 110 decibels at 26 kHz, ultrasound), the bubble emits light in very short, seemingly continuous bursts that corresponds to a temperature perhaps high enough to support nuclear fusion. The energy required to run this potential fusion reactor is easily and inexpensively obtainable from a nearby power outlet.

Although temperatures are just right for fusion to occur, researchers have not measured through the water any great energy output or detected any other signs of fusion such as stray neutrons or alpha particles. The only energy production taking place is the emission of light, part of which may be blocked by the water. While attempting to measure x-ray production through the water will indicate the presence of incredible temperatures within the bubble, the production of a large amount of energy or any of the fusion products would certainly indicate fusion within the bubble.

I propose making a few changes in the sonoluminescence system to see whether a larger bubble can be made to emit light. From the diagram of the system, I noticed that the sound waves emitted by the two speakers on either side of the bubble are responsible for providing a couunterbuoyant force to hold the bubble in place. If the bubble was in equilibrium and the sound waves did not have to exert a force on it, would the frequency required to “light” the bubble, if it can still be lighted, change? Also, will the addition of more or less intense sound waves at same or different frequencies at crucial points in the light production cycle (graph, p. 2 of Sonoluminescence Overview and Future Applications) help to prolong the interval in which the bubble collapses beyond its rest radius, producing light?

Since a larger bubble tends to rise to the surface of a liquid faster than a smaller bubble, the sound waves will have to be more intense to provide a greater counterbuoyant force on the bubble. To avoid having to increase the intensity of the sound waves, the cylindrical flask could be set into rotation to keep the bubble at the center of the flask at all times. The intensity and/or frequency of the sound waves could then be changed to see if the larger bubble can be lit. If it can, I would like to try doubling the volume of the bubble, determining both the intensity and frequency required to light the bubble then, and determining the intensity of the light being produced.