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physics : Bubbling hot

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In terms of physics, sound is the consequence of waves of compression and tension passing through a medium. If a really energetic sound is blasted through a liquid, a wave of tension can literally pull the liquid apart, forcing bubbles into existence. These bubbles contain gases that would otherwise be dissolved in the liquid -- the bubbles feel the squeeze when the tension is succeeded by a wave of compression, and their contents heat up dramatically. Theory predicts that temperatures in bubbles generated by this process, known as 'acoustic cavitation' may reach thousands of degrees Kelvin, comparable with the surface of the Sun.

Perhaps understandably, acoustic cavitation presents a few experimental challenges: good measurements inside a hot, cavitating bubble are scarce, and nobody has studied how temperature is influenced by external parameters such as the composition of the solution used in the experiments. Enter Kenneth S. Suslick and colleagues from the University of Illinois and Urbana-Champaign, Illinois, who have come up with an ingenious method to take the temperatures of cavitating bubbles. They present their findings in a report in *Nature*[1].

Given that inserting a thermometer into a cavitating bubble is impossible, Suslick and colleagues get the solution to report its own temperature. Chemical compounds containing the so-called 'transition' metals -- such as iron, and less familiar elements such as molybdenum and chromium -- are inherently colourful by virtue of peculiarities in their electronic structure. Some of these compounds emit light of a given colour the intensity of which is a direct measure of temperature. Suslick and colleagues show that if solutions of these metals are subject to acoustic cavitation, the intense light emitted by compound trapped inside cavitating bubbles will provide a direct reading of temperature inside the bubbles. Using this technique, the researchers establish beyond doubt that cavitating bubbles in a solution of the compound iron hexacarbonyl may reach 5,100 kelvin.

Now that the researchers have a precise probe of temperature, they can get to work on understanding the factors that influence temperature. The chemical composition of the solution is an important determinant: temperatures in solutions of molybdenum hexacarbonyl, for example, do not get as high as in an iron hexacarbonyl solution. But what makes the bubbles so hot to begin with? The researchers think that there is more to it than simple compression. One reason is that the heated bubbles become tiny chemical reactors, the consequences of which will naturally change the environment inside the bubble.

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1. McNamara III, W.B., Didenko, Y.T. & Suslick, K.S. Sonoluminescence temperatures during multi-bubble cavitation. *Nature* **401,** 772 (1999).