Re: Shake some supercooled water and you get ice, why?

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- *From*: andy everett <vze2qxq3@xxxxxxxxxxx>
- *Date*: Tue, 20 Feb 2007 16:57:48 GMT

Edward Green wrote:

> On Feb 19, 4:07 am, andy everett <vze2q...@xxxxxxxxxxx> wrote:
>
>> n...@xxxxxxxx wrote:
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>>> On Feb 18, 4:01 pm, andy everett <vze2q...@xxxxxxxxxxx>
>>> wrote:
>>>
>>>> I set out 5 half litter bottles of spring water
>>>> after lunch. Temps just
>>>> below freezing. Around 6 pm, temps now in
>>>> the low 20's, I put a chunk of
>>>> ice into one of the bottles, being careful
>>>> opening the cap. Ice
>>>> instantly formed around the piece of ice. We
>>>> know now the water in the
>>>> bottles are in a super cooled state. Next grab
>>>> a bottle and shake
>>>> vigorously in such a way to impart circular
>>>> motion. Small crystals seen.
>>>> Allow things to cool further. Open cap
>>>> carefully and drop in a very
>>>> small amount of snow. Starting from the top
>>>> a pretty group of ice
>>>> crystals forms.
>>>>
>>>> On the last bottle I shook vigorously, the
>>>> bottle became cloudy with
>>>> crystals, quickly I poured the mixture of
>>>> water and crystals into a
>>>> measuring cup and filtered the crystals out

> > with a paper towel. The
> > paper towel was squeezed to get more of the
> > water out. Out of 16.9 oz.
> > of water less then .9 oz of the water was ice.

> Excellent!

> > Time to get a good thermometer.

> Yes, absolutely. I'd just love to know the temp of the remaining
> water, and the temp of the supercooled water pre−freezing.

> BTW, can you photograph the ice crystals per the drop−in−the−snow
> trick?

I think I would need a better camera then I have. The human eye is pretty good at seeing detail up close. Will try.

How far down into the water did they extend?

After only a minute the ice that formed, all in the form of very thin sheets with beautiful detail that only nature can "paint", extended to the bottom.

Also, how'd the

> rate of growth of the crystals go, fast, then slow, or what?

On a human scale slow, time scale in seconds, You−tube has many great videos that show the effect. If the bottles are too cold I think you would miss more subtle changes.

I set out another 5 bottles around 7 pm. In the low 20's and down to 11F this morning. I also put one bottle of spring water into a clean glass and covered with plastic. Shoulder hurts, can't sleep, 3:15 am. Of the 5 bottles only 2 showed no signs of ice (one kicked over). I grabbed one of the clear bottles and shook it violently, it iced up instantly. With

> > the last remaining unfrozen bottle I was more subtle. I tapped the side with a flick of a finger, nothing. Then with a gentle back and forth motion, rotation about the bottom of the bottle, in a matter of 3 seconds the water clouded up, starting at the top and working its way down completely clouding the bottle.
> >
> > The water in the glass froze. The glass looked clean.
> >
> > The article that Ed refereed to suggested that above some temperature but below freezing the supercooled water (in glass I think) would not freeze with aggressive shaking. Maybe it is the plastic container that is different.

> The effect seems sensitive to small variations in the system, that's sure. I like the hysteresis thing: the idea that a fixed sample may have a reproducible spontaneous freezing temperature (below 0 C). Maybe the degree of sensitivity to agitation depends on the kind of nucleation centers.
>
> It's also a good idea to compare the temperature, heat capacity, and enthalpy of fusion, as you suggest. If the sample forms a uniform slurry as a result of some catalyzing event (a sharp knock, if the system is in a condition where a sharp knock does the trick), one would expect the reaction to be heat limited: the crystalization will stop when the resulting slurry returns to 0 C.
>
> That's kind of interesting, when you stop to think about it: that a phase change can cause a system to promptly change its temperature in bulk without bulk heat flow, or change in energy density. That's a good illustration that temperature "really" is defined by a derivative of entropy, and only incidently montonically related to the energy density in many circumstances. No energy goes very far, the molecules in the supercooled liquid rearrange themselves, and all of a sudden the system is characterized by a different temperature! If we couldn't achieve this peculiarity with a common container of water in our freezer, but only with liquid He, it would be written up as a exotic and counterintuitive behavior of matter.

Thank you for your thoughts, time for more important questions:

How did that field get quantized, exactly...

from:

spamspamspam3@xxxxxxxxxxx

I'm trying to understand, on a simpletons' level, how the EM field might wind up quantized so that its incremental excitations show the characteristic E = hv .

Quantized fields are not hard to understand: violin strings do it, hydrogenic atoms do it; they say in Boston even beans do it. Ok. But these fields are spatially confined (except for the pythagorean output of the beans, which goes over into the continuum spectrum).

But what "confines" the EM field? Although cavity radiation figures in the history of the thing, as far as I know the energy relation given applies to free radiation in vacuum: and the size of the cavity doesn't enter in to it. And of course the spectrum of excitations doesn't suggest a particle in a box, but an harmonic oscillator −− of a spring constant k = ... hmm...

Ok... spring constant doesn't really seem to work, since it involves "m"! But something analogous to an harmonic osciallator. So are we to think of the EM field as springy thing, which vibrates when plucked? But it doesn't have a natural frequency −− it can vibrate at _any_ frequency: the only concession it seems to demand is that the apparent elastic constant adjusts itself with frequency to make the energy ladder scale appropriately.

Why would this be so? And for that matter, why doesn't size matter? Well... it does in the sense that lower energy vibrations demand greater wavelength.

Hmm... maybe it turns out to act like a wave in a box after all... a certain number of wavelengths of a standing wave of a given frequency fit inside a box much larger than the wavelength. And then it will turn out ... magically or inevitably ... that the effective springness of the field depends only on the wavelength/frequency, and not on the number of nodes included. So we get our HO spectrum, and can ignore the size of the box: at least if we don't ask why it doesn't matter why in general only a non−integral number of wavelengths fit, or in general there really is not box anyway...

What do you think?

No... I don't like it that much, either. But maybe something can be made of it.
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