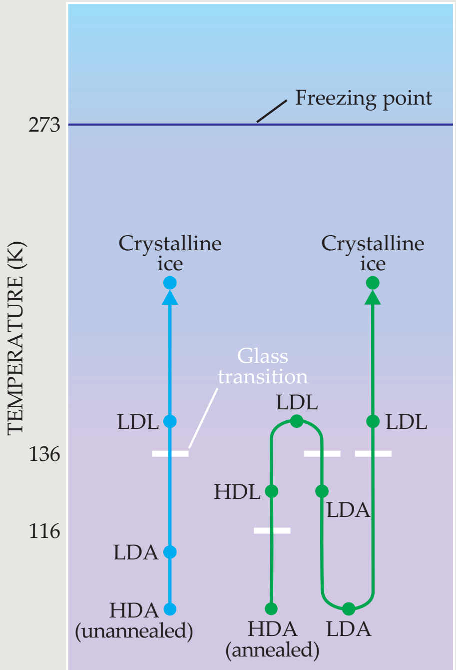

Figure 2. Water's transformations. When heated, unannealed high-density amorphous ice (HDA) undergoes the phase-transition sequence shown at left: HDA converts to low-density amorphous ice (LDA) at roughly 110 K; LDA undergoes a glass transition (white bar) to low-density liquid (LDL) at 136 K; and at higher temperatures LDL forms crystalline ice. By contrast, annealed HDA remains stable up to 116 K, where it undergoes a glass transition to high-density liquid (HDL). Applying the heating and cooling protocol shown at right, it's possible to detect both glass transitions in a single experimental run.

extended time at the brink of its glass transition and thereby allow it to adopt a more energetically favorable, but still disordered, molecular configuration. Five years ago, Loerting's grad student Katrin Amann-Winkel began developing annealing protocols for HDA. She found that annealing yielded HDA samples that remained stable to significantly higher temperatures—possibly high enough to detect an ambient-pressure glass transition.

Loerting, Amann-Winkel, and their collaborators set out to find that transition using a pair of experimental techniques. The Innsbruck group performed a calorimetry experiment, in which one tracks how a sample's heat capacity varies with heating and cooling. Sudden rises in heat capacity indicate endothermic events like relaxation and melting; sharp falls indicate exothermic events such as freezing. The Dortmund group, meanwhile, studied identically prepared samples using dielectric spectroscopy. In that method, liquefaction is detectable as a telltale decrease in a sample's dielectric relaxation times.

As sketched at left in figure 2, an ambient-pressure heating run performed on unannealed HDA reveals just one glass transition: HDA converts to LDA at around 110 K; LDA undergoes a glass transition, to LDL, at 136 K; and LDL eventually freezes to crystalline ice.

By contrast, the experiments with annealed HDA, depicted at right in the figure, reveal a second glass transition, from HDA to HDL, at 116 K. At higher temperatures, HDL expands to the more stable low-density form, LDL. Recooling and reheating the LDL reveals the more familiar glass transition at 136 K as LDL converts to LDA and back.

The existence of two glass transitions is a hint of two liquids but not a proof. More definitive would be to show that the two liquids can coexist and transition reversibly between one another. Such studies may not be far off. Both liquids are robust, says Loerting. "We can maintain them for hours without any signs of transformation, provided we work at the right temperature. That should allow us to do a lot of experiments."

Ashley G. Smart

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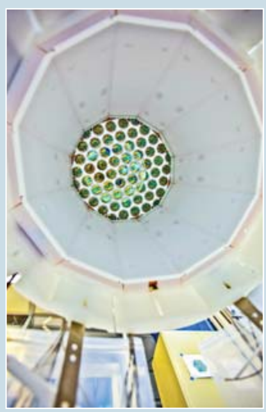
physics update

These items, with supplementary material, first appeared at http://www.physicstoday.org.

Fiat LUX: Dark-matter detector's initial results. The nature of the dark matter that makes up some 85% of the material stuff of the universe remains a mystery. Current consensus favors a weakly interacting massive particle, or WIMP, inspired by extensions of the standard model of particle physics. One approach to understanding those putative particles is to look for their rare interactions with conventional matter. A number of experiments have undertaken such searches. Last week the most sensitive of them, the LUX (Large Underground Xenon) experiment, announced via webcast its first results. The experiment's initial three-month run saw no evidence of WIMPs, which significantly lowered the upper limits for the mass-dependent WIMP interaction strength. Moreover, the new results ruled out the handful of possible light-WIMP sightings that had been reported earlier. Located 1.5 km belowground at the Sanford Underground Research Facility in Lead, South Dakota, the LUX detector monitors 250 kg of liquid xenon. When a WIMP collides with a xenon atom, the recoiling atom plows through the scintillating liquid, generating photons received by photomultiplier tubes (such as those shown in the figure) at the top and bottom of the detector. Details of the photomultiplier signals reveal the energy and position of the WIMP interaction. The experiment is difficult in part because cosmic-ray particles and electrons from radiogenic decay can trigger a WIMP-like signal. The detector's underground location mitigates the cosmic-ray problem; a surrounding tank filled with pure water provides additional shielding. The LUX researchers plan to collect data for another two years. The collaboration's next-generation detector, already being planned, will contain 20 times the xenon of LUX and will be so sensitive that it will see background neutrinos. (D. S. Akerib et al., LUX collaboration, http://arxiv.org/abs/1310.8214.)



—SKB