Water can flow below -130 C

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When water is cooled below zero degrees, it usually crystallizes directly into ice. Ove Andersson, a physicist at Umea University, has now managed to produce sluggishly flowing water at 130 degree below zero under high pressure – 10,000 times higher than normal pressure. It is possible that this sluggishly fluid and cold water exists on other heavenly bodies.

“The finding is also interesting in that it helps us understand the many abnormal properties of water. For example, it has been predicted that water would have two different liquid phases at low temperatures. The finding supports the existence of one of those two phases,” explains Ove Andersson.

Water is extremely difficult to chill in a way that makes it sluggishly

flowing. Ove Andersson has accomplished this feat by exposing crystalline ice, in which the atoms are arranged in an orderly manner, to increased pressure at temperatures below -130o C. The order of the molecules and the ice collapsed into amorphous ice, with random order among the water molecules.
“When I then raised the temperature, the ice transformed into sluggishly flowing water. This water is like regular water but its density is 35 percent higher, and the water molecules move relatively slowly, that is, the viscosity is high.”

Water has a great number of properties that deviate from normal behaviors. For example, in super cooled water, i.e. when the temperature drops below zero, the density decreases when the temperature is lowered and increases when it is raised.
“There are deviations that have been known for many years, and they are very important. Yet there is no general explanation for them, but the answer may lie in how the properties of water are affected when it’s exposed to high pressure,” says Ove Andersson.

Some theories are predicated upon water existing in two different liquid phases, one with low density and another with high density. The theories revolve around the transition between the phases taking place at low temperature and high pressure. When water cools and approaches this zone, there can be a gradual transformation that affects the properties and lends water its abnormal properties. Unfortunately this transformation is difficult to study, since water normally crystallizes. An alternative way to approach the zone is first to create amorphous ice. The new findings show that amorphous ice probably converts into sluggishly flowing water when it is warmed up under high pressure. Ove Andersson has thereby also verified the existence of one of the two fluid phases predicted to exist at low temperatures.

“This is an important piece of the puzzle of understanding the properties of water, and it opens new possibilities for studying sluggishly flowing water."

More information: Glass–liquid transition of water at high pressure, *PNAS*, Published online before print June 20, 2011, doi: 10.1073/pnas.1016520108

Abstract
The knowledge of the existence of liquid water under extreme conditions and its concomitant properties are important in many fields of science. Glassy water has previously been prepared by hyperquenching micron-sized droplets of liquid water and vapor deposition on a cold substrate (ASW), and its transformation to an ultraviscous liquid form has been reported on heating. A densified amorphous solid form of water, high-density amorphous ice (HDA), has also been made by collapsing the structure of ice at pressures above 1 GPa and temperatures below approximately 140 K, but a corresponding liquid phase has not been detected. Here we report results of heat capacity Cp and thermal conductivity, in situ, measurements, which are consistent with a reversible transition from annealed HDA to ultraviscous high-density liquid water at 1 GPa and 140 K. On heating of HDA, the Cp increases abruptly by (3.4 ± 0.2) J mol-1 K-1 before crystallization starts at (153 ± 1) K. This is larger than the Cp rise at the glass to liquid transition of annealed ASW at 1 atm, which suggests the existence of liquid water under these extreme conditions.

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