

Bringing water down to a new critical point

For a liquid so common and intensively studied, water can still spring a surprise or two. Indeed, further evidence of the astonishing quirkiness that distinguishes water from virtually all other liquids has now surfaced in computer simulations of the behavior of water molecules cooled to temperatures well below water's normal freezing point.

These simulations indicate that supercooled water exhibits trends in behavior that suggest the existence of a previously unsuspected critical point. Such a point corresponds to a specific combination of temperature, pressure, and density at which two forms of a substance in equilibrium with each other become identical, forming a single phase.

For water, one critical point occurs at a temperature of 647 kelvins (374°C) and a pressure of 22.1 megapascals (218 atmospheres). At higher temperatures and pressures, water's liquid and vapor phases become indistinguishable.

"What we have found in our computer model of water is a second critical point," says physicist H. Eugene Stanley of Boston University. This one appears to mark the temperature-pressure combination at which two distinct forms of ice blend into a single phase. Stanley, Peter H. Poole, and co-workers describe their findings in the Nov. 26 NATURE.

What makes the results even more startling is that the two types of ice involved are amorphous — ordinary water solidified into disordered, noncrystalline forms. The new findings suggest a

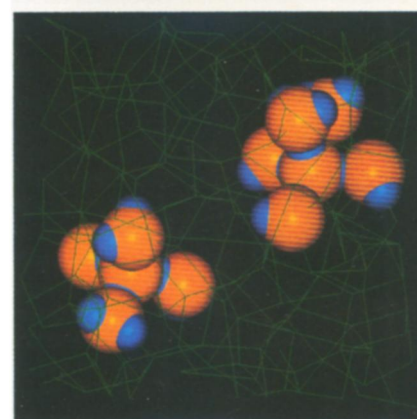
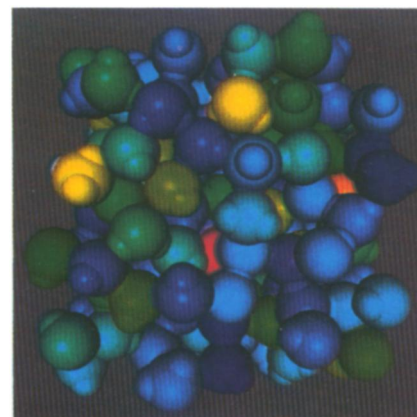
Computer simulations of water molecules at temperatures well below water's normal freezing point reveal a jumbled arrangement (upper right). Each molecule's color indicates the strength of its interaction with all other molecules, dark blue being strongest and red weakest. On the lower right, the underlying hydrogen-bond network (green) includes configurations having one water molecule bonded either to four neighbors, corresponding to a low-density form of water, or to five neighbors, corresponding to a high-density form.

link between these two types — high-density and low-density amorphous ice — and supercooled water.

"I have yet to hear of another material in which two solid phases could have a critical point — another plus for water," remarks Christopher M. Sorensen of Kansas State University in Manhattan.

Poole and his colleagues simulated the behavior of 216 particles representing water molecules enclosed in a cubic box at temperatures below water's usual freezing point. They monitored the strength of hydrogen bonds, created by the attractive force between a hydrogen atom in one water molecule and the oxygen atom of another (SN: 4/14/90, p.231; 11/30/91, p.359).

These simulations allowed the researchers to explore the behavior of supercooled water over a temperature range impossible for experimenters to reach. This also meant there is no direct



Boris Ostrovsky/Boston Univ.

way of experimentally checking their results.

Nonetheless, Sorensen notes, "although never attainable in a real experiment, this distant critical point would send out its influence into the attainable regimes, perturbing the thermodynamic landscape and creating a most remarkable liquid."

— I. Peterson

Depression rates rise over generations

Rates of severe, often incapacitating depression have increased in each succeeding generation born since 1915, according to the first international study of trends in the frequency of depression.

The magnitude of the elevation in severe, or major, depression varied considerably from one site to another, with some areas also exhibiting short-term fluctuations, possibly in response to local events such as warfare, reports a 40-member "cross-national collaborative group" in the Dec. 2 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

Reasons for the jump in depression rates across generations, as well as for variations at different sites, remain unknown, the researchers assert. For now, they maintain, the findings suggest that many countries should mount efforts similar to that of the National Institute of Mental Health in Bethesda, Md., which recently launched a program to improve recognition and treatment of major depression in the United States.

It is estimated that at least 9 percent

of females and 5 percent of males in the United States suffer from severe depression at some time in their lives.

Two New York City psychiatrists, Myrna M. Weissman of Columbia University and the late Gerald L. Klerman of Cornell University Medical College, organized the new study after noting in 1989 that diverse research methods made it hard to compare data on depression rates from different countries.

They contacted the directors of nine independent population surveys of approximately 39,000 people and three family studies of about 4,000 people. Population surveys originated in Edmonton, Canada; Puerto Rico; Munich, Germany; Florence, Italy; Beirut, Lebanon; Christchurch, New Zealand; Taiwan; Savigny, France; and the United States. The U.S. sample consisted of residents of Baltimore, St. Louis, Los Angeles, New Haven, Conn., and a rural North Carolina county.

The family studies recruited parents, siblings, and offspring of individuals

treated for major depression at clinics in Mainz, Germany, and the United States.

Investigators at each site determined depression rates using either of two similar diagnostic guidelines.

Rates of severe depression proved higher in the family studies than in the population surveys, since the disorder occurs more often among biological relatives. Still, both data sources revealed an increasing frequency of depression in succeeding younger groups.

One exception to this pattern emerged among a subsample of 1,305 Hispanics surveyed in Los Angeles. Older and younger Hispanic groups experienced about the same rate of major depression.

Beirut residents displayed dramatic fluctuations in depression, the researchers note. Those who reached their 20s between 1950 and 1960 and between 1970 and 1980 reported surges of depression that coincided with warfare and social chaos in the area, they point out. Individuals who attained young adulthood between 1960 and 1970, a period of relative calm, reported a declining rate of depression.

— B. Bower