

Supercomputer simulation of ice formation gives evidence of paradoxical phenomenon of water

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Scientists have developed the first supercomputer-powered simulations to capture the long existing paradox of water that had eluded scientists for long-- hotter water freezing faster than colder water, a phenomenon technically called Mpemba effect.

This research published in the journal *Communication Physics* can provide new insights into phenomena such as relaxation of materials due to sudden temperature changes technically called out-of-equilibrium phenomena and also can lead to diverse applications, such as giving a new perspective to thermal control in next generation electronic or defining better cooling strategies.

Aristotle, in the *Meteorological*, wrote, “the fact that water has previously been warmed contributes to its freezing quickly”.

The phenomenon forgotten over time was rediscovered in the last century by Erasto Mpemba after whom it is now named. Since then, there has been considerable interest in understanding it and identifying whether the effect is specific only to phase transitions in water. Even though it is recently shown that the effect appears during phase transitions in several other systems, the understanding remains largely elusive. Furthermore, quite interestingly, the case of water has recently become controversial, even at the experimental level. Due to the demanding nature of water simulations, there exists no computational study to resolve the debate.

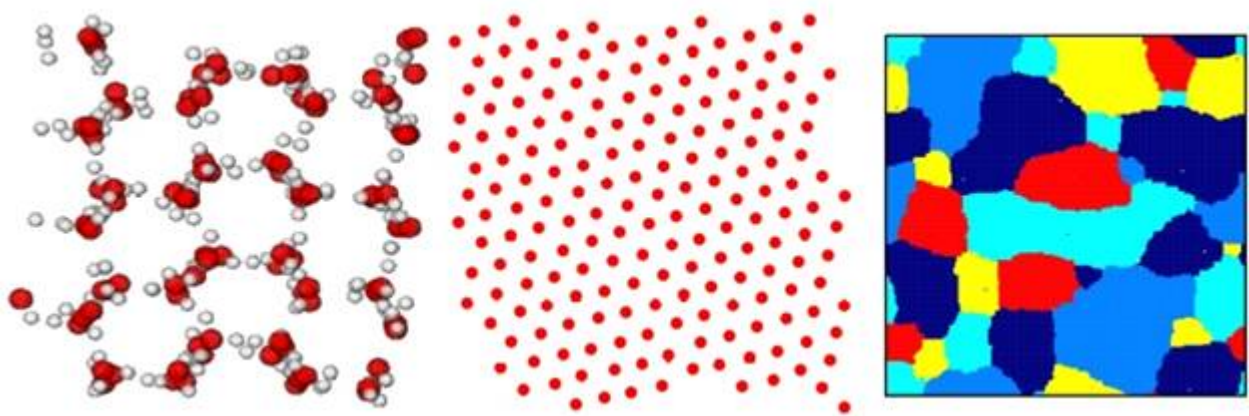


Fig 1: Snapshots from the phase transitions in the TIP4P/Ice model of water, the 2D Lennard Jones model and the Potts model

Researchers from Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), an autonomous institute of the Department of Science and Technology (DST) has used supercomputers to develop the first simulation of ice formation proving the Mpemba effect of water and also demonstrating that it can appear during fluid-to-solid transitions in systems other than water.

They have explained that when water cools, it can get stuck in intermediate states of short-lived molecular arrangements before true ice begins to grow. Different starting temperatures get stuck for varied lengths of time.

Hotter water can sometimes “choose” a quicker path to nucleation, the birth of ice, bypassing the delays that colder water suffers.

The best explanation yet of why “hot can freeze faster than cold” is one major step into the world of nonequilibrium physics.

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