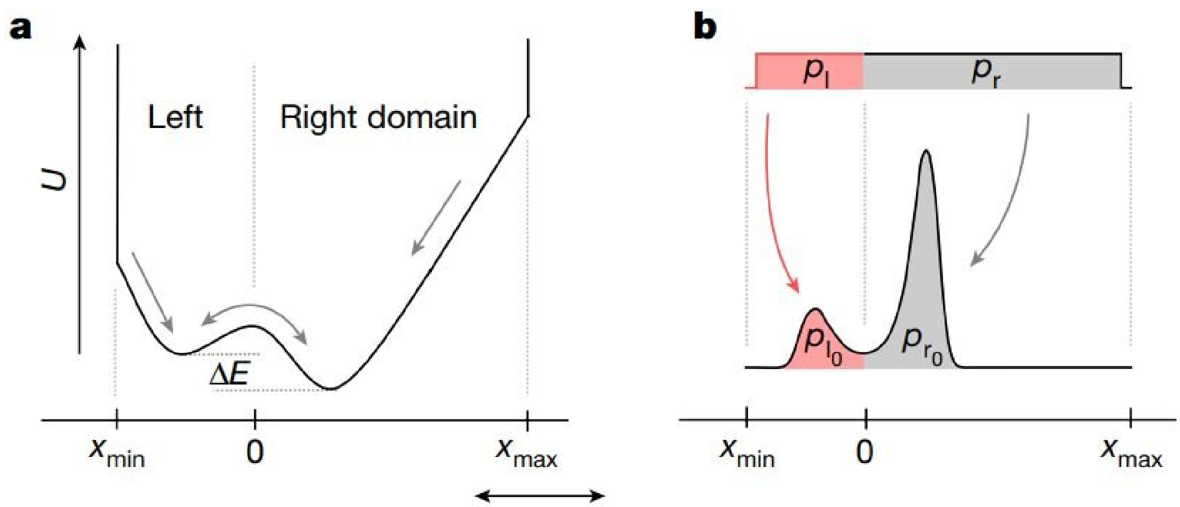
Demonstrating the Mpemba effect in a controlled setting

August 6 2020, by Bob Yirka



Schematic of the energy landscape and Boltzmann distribution for the Mpemba effect. Credit: *Nature* (2020). DOI: 10.1038/s41586-020-2560-x

A pair of physicists at Simon Fraser University has developed a means for demonstrating the Mpemba effect in a controlled setting. In their paper published in the journal *Nature*, Avinash Kumar and John Bechhoefer describe the setup they used, what it showed and other possible uses for it.

Back in 1963, a young schoolboy in Tanzania named Erasto Mpemba found himself busy making ice cream for a group of people. Part of the process involved heating water to disinfect the equipment he was using. At one point, he noticed something that seemed to go against common sense—the hot water sometimes froze faster than the cold water. He later made a report of his findings and was credited as the first to recognize the effect—it is now known as the "Mpemba effect."

Since Mpemba's report, scientists have taken a much closer look at what happens when water freezes and have not been able to decide if the effect is actually real—this is because of the complexity of water, and also because of the variables involved. Researchers have noted that even the end result can be open to interpretation—for example, does the water need to start boiling or come to a full boil? Or does it just need to reach the boiling point? Such variables impact the time involved; thus, the effect has been difficult to reproduce. In this new effort, the researchers have developed a system to replicate the Mpemba effect in a reliable way.

The work involved building a thermal quench (a type of cooling) colloidal system inside of a beaker filled with water, which served as a heat bath. In practice, it involved dropping a small glass bead into the beaker thousands of times from different spots using a probability distribution. And as each bead fell, the researchers used optical tweezers to gain a virtual potential profile. Doing so forced a change in the probability distribution and a change in the system's temperature.

The researchers note that as they changed parameters in specific ways, they were able to observe hot water cooling faster than cold water in some cases.

More information: Avinash Kumar et al. Exponentially faster cooling in a colloidal system, *Nature* (2020). DOI: 10.1038/s41586-020-2560-x

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