Zippy ions could be the key to superfast quantum computers

Quantum computers hold much promise for rapid computation. However, the potential speed of quantum computers is limited by the speed at which quantum bits - known as qubits - can be moved across the processor. With ion qubits, the process of them physically moving around the processor takes much longer than the duration of logic operations on the ions, thus dramatically reducing the potential maximum speed of these quantum computers. However, a team of researchers from the US National Institute of Standards and Technology (NIST) has now come up with a way to accelerate beryllium ions from zero to 100 miles per hour and stop them in just a few microseconds, which could be key in enabling quantum computers to reach their true speed potential.

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Tags

ion NIST quantum computing

The animation shows the rapid transport of a single ion over about 0.37 millimeters in just 8 millionths of a second. The ion is held and moved using electric fields, with its transport controlled by changing electric potentials 50 million steps per second. The blue ribbon in the video illustrates the changing field potential moving along the track. When the potential minimum starts to move, the ion first lags behind, but then accelerates to catch up with the minimum. It then charges ahead and gets decelerated, eventually landing in the same place as the potential minimum. This cycle repeats at the natural oscillation frequency of the ion in the potential well. By ensuring that the potential minimum stops moving exactly at the end of one of these cycles, the team were able to stop the ion in a state of minimal energy. This is, of course, important for quantum computers, where information stored in the ion's energy levels needs to be moved around without compromising the information content.

The researchers explain this technique using an analogy of moving a ping-pong ball inside a curved salad bowl, with the ball at rest before and after the transport. During the transport, the ping-pong ball will oscillate back and forth relative to the center of the bowl. However, if the bowl is suddenly stopped at just the right time, the ping-pong ball can be made to come to rest together with the bowl.

This research is published in the current issue of *Physical Review Letters*.

- Andrew Purcell

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