# In the world's smallest ball game, scientists throw and catch single atoms using light

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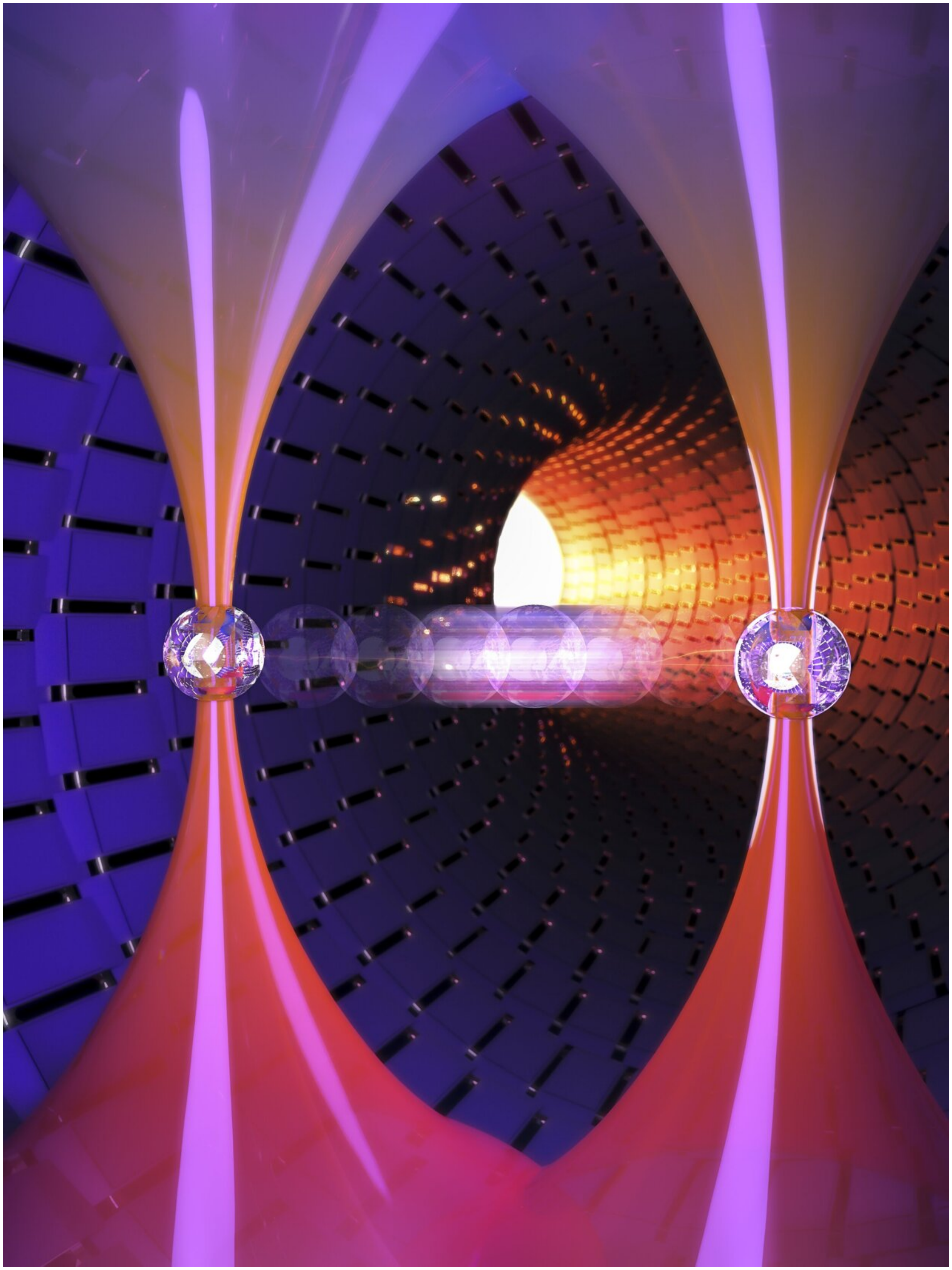


Scientists used two optical traps to throw and catch individual atoms. This is the first time an atom has been released from a trap—or thrown—and then caught by another trap. Credit: Jaewook Ahn, Korea Advanced Institute of Science and Technology

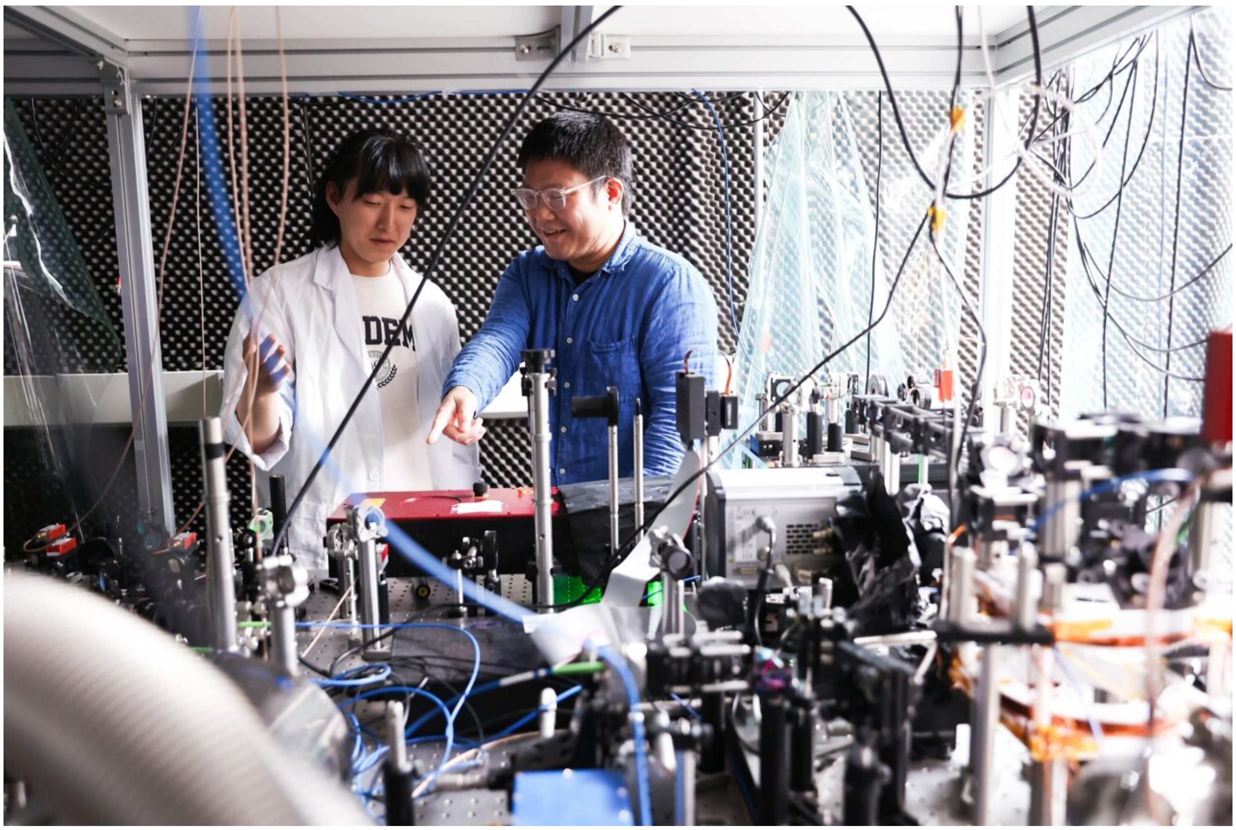
In many baseball-obsessed countries like Korea, Japan and the United States, with spring months comes the start of the season and quite a few balls flying through the air. But it's not just balls that can be thrown. On the tiniest field imaginable, scientists have now shown they can also throw and catch individual atoms using light.

This amazing feat was achieved with optical traps, which use a highly focused laser beam to hold and move tiny objects. Although optical traps have been used to move individual atoms before, this is the first time an atom has been released from a trap—or thrown—and then caught by another trap.

"The freely flying atoms move from one place to the other without being held by or interacting with the optical trap," said research team member Jaewook Ahn from the Korea Advanced Institute of Science and Technology. "In other words, the atom is thrown and caught between the two optical traps much like the ball travels between the pitcher and a catcher in a baseball game."

In the journal *Optica*, the researchers report successfully throwing chilled rubidium atoms over a distance of 4.2 micrometers at a speed up to 65 centimeters per second. The technology could be used to make quantum computers, which use quantum physics to solve problems too complex for classical computers.

"These types of flying atoms could enable a new type of dynamic quantum computing by allowing the relative locations of qubits—the quantum equivalent to binary bits—to be more freely changed," said Ahn. "It could also be used to create collisions between individual atoms, opening a new field of atom-by-atom chemistry."



Research team members Hansub Hwang (left) and Andrew Byun (right) are pictured with the optical setup used to create free-flying atoms. For throwing, a trap holding an atom is accelerated and then turned off, which causes the atom to launch out of the trap. Another trap is then turned on to capture the incoming atom and decelerated until the atom stops completely. Credit: Jaewook Ahn, Korea Advanced Institute of Science and Technology

## How do you catch a flying atom?

The new research is a part of ongoing quantum computing project that involves using optical traps to arrange atoms into a particular array. "We often encountered arrangement errors that rendered an array defective," said Ahn. "We wanted to find an efficient way to fix a defective array without having to move a large number of atoms, because that could result in even more defects."

To create free-flying atoms, the researchers chilled rubidium atoms to close to 0 K (near absolute zero of temperature) and formed optical traps with an 800 nm laser. To throw an atom, they accelerate the optical trap holding it and then turn the trap off. This causes the atom to launch out of the trap. Another trap is then turned on to capture the incoming atom and decelerated until the atom stops completely.

To test their method, the researchers performed a set of proof-of-principle demonstrations. In addition to throwing and catching atoms, they showed that the atoms could be thrown through another stationary optical trap and weren't affected by other atoms encountered along the way. They also used their method to create arrays of atoms.

In the experiments, the researchers successfully created free-flying atoms about 94% of the time. They are now working to fine tune the technique to get closer to 100% success.

**More information:** Jaewook Ahn et al, Optical tweezers throw and catch single atoms, *Optica* (2023). DOI: 10.1364/OPTICA.480535

Provided by Optica

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