Krypton-81 Can Help Map Underground Waterways

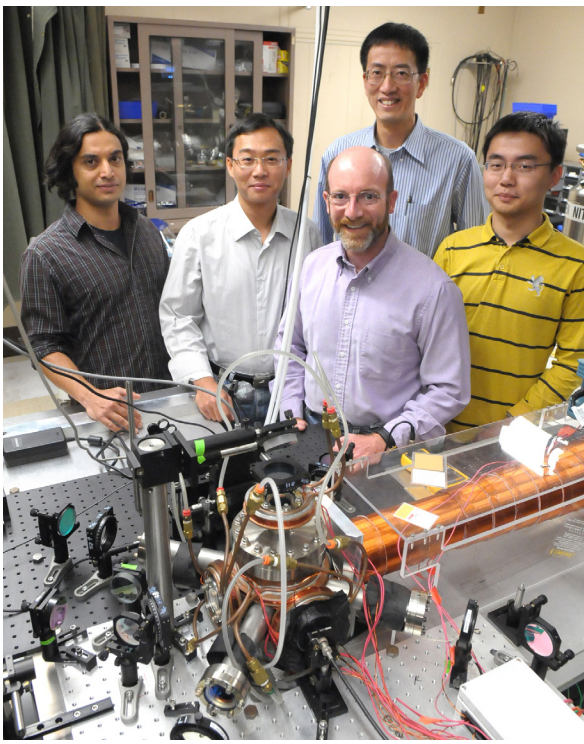
About a fifth of the population on Earth drinks water from underground aquifers, and crops around the world depend on it. Water accumulates in aquifers only after filtering through sand and cracks in rocks, a very slow process. To manage this resource fairly and effectively, consumers need to know how fast the water is replenished. Computer models can help predict water availability.

The Challenge

In order to develop reliable models, hydrologists need to know the "age" of water in aquifers, or how long the water has been underground.

The Solution

Argonne physicist Zheng-Tian Lu, with collaborators from the University of Illinois at Chicago and the International Atomic Energy Agency (IAEA), developed the Atom Trap Trace Analysis (ATTA) method to determine water age by counting rare krypton-81 atoms in aquifer waters. ATTA is based on laser trapping and cooling of atoms, an area of physics pioneered by Steven Chu.



Argonne physicist Zheng-Tian Lu (in back) and his team (from left to right: Arjun Sharma, Wei Jiang, Kevin Bailey, and Guomin Yang) stand with the ATTA device, which measures individual atoms of the isotope krypton-81.

The Results

Water picks up traces of krypton-81 from the air before it migrates underground. Krypton-81 decays very slowly over a million years. By counting the remaining krypton-81 atoms in aquifer waters, scientists can calculate how long it's been since the water was above ground. An earlier ATTA study to determine the age of the Nubian aquifer in the Sahara Desert agreed with independent hydrodynamic models, showing that counting krypton-81 atoms is effective.

Future Work

Argonne is now partnering with the Isotope Hydrology Section of the IAEA to conduct a large-scale study of water samples from around the world.

"It's great fun to count atoms—even better when the results are important to water resource management," **said Zheng-Tian Lu, senior physicist.**

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