Available for Licensing

Isotopic Abundance in Atom Trap Trace Analysis

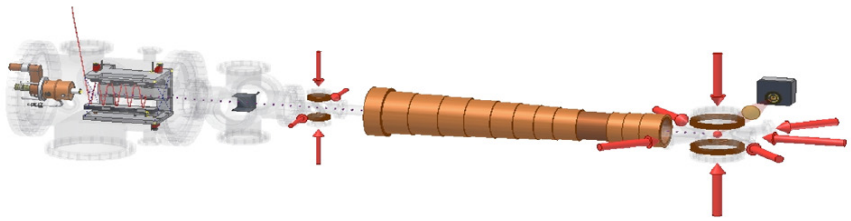
Argonne's unique trap-and-trace analysis method for long-lived isotopes can help map underground waterways and much more.

Background and Need

The noble gas Krypton (Kr) permeates the atmosphere at a concentration of about one part per million. ^{81}Kr, a long-lived isotope, is an ideal tracer isotope for dating water and ice in the age range of 10^5-10^6 years, a range beyond the reach of carbon-14 dating. Due to its long residence time, this isotope is expected to be distributed uniformly through the atmosphere. A second isotope, ^{85}Kr, is a fission product of uranium-235 and plutonium-239 and is released into the atmosphere primarily by nuclear fuel reprocessing activities. ^{85}Kr can be used as a tracer isotope to study air and ocean current, determine residence time of young groundwater in shallow aquifers, and monitor nuclear fuel processing activities. A method is needed to measure isotopes for climate change and nuclear proliferation interests.

The Invention

Argonne scientists have created a novel method and system for detecting the ratios and amounts of noble gas isotopes of Krypton in samples of water and ice, which helps reveal the geological age of the samples and their movements in a changing Earth. The invention, based on the ATTA (Atom Trap Trace Analysis) method, uses a combination of a cooled discharge source, a beam collimator, a beam slower and a magneto-optic trap with a laser to apply resonance frequency energy to the noble gas to be quenched and detected (as noted in the schematic diagram below).



A schematic of the ATTA apparatus. The total length of the atomic beamline is approximately 2 meters. Optics are located on an adjacent laser table of similar length.

The device uses a chamber with six laser beams to capture individual isotope atoms. Laser frequencies are set to match ^{81}Kr specific resonance. When the isotopes are hit by the resonant laser light, they vibrate faster and can be captured on camera film, enabling counting.

Benefits

- Higher isotope-counting rates (2 times higher) than previous ATTA methods
- Smaller environmental sample size required
- Can analyze all noble gas isotopes, not just Krypton
- Can be used commercially
- Effective and efficient

Applications and Industries

- Water resource management, such as dating groundwater and mapping aquifers
- Climate studies, such as dating polar ice and mapping ocean currents
- Monitoring nuclear fuel reprocessing activities and leaks from nuclear fuel containers
- Dark matter detection; detect krypton contaminants in detectors

Developmental Stage

Proof of concept

Availability/Commercial Readiness

Available for licensing and sample testing

Patent Information

U.S. Patent Application 13/398657

Inventors

Zheng-Tian Lu, Shuiming Hu, Wei Jiang and Peter Mueller

Contacts

Paul Betten
Argonne Technology Development and Commercialization
www.anl.gov/techtransfer