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Counting Ar-42 atoms at the 10^-21 isotopic-abundance level

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Atom Trap Trace Analysis (ATTA) is a technique that utilizes laser to selective capture and detect individual atoms of the desired isotope. This technique loads atoms into a magneto-optical trap (MOT) through laser cooling and trapping, realizing high sensitivity and detection efficiency of the desired isotope.
Due to the use of multi-photon repetitive excitation in the experiment, the ATTA method has extremely high isotope selectivity and has been successfully applied to the detection of Ar-39 with an abundance level of 10^-17.
In recent years, we have significantly improved the counting rate and detection efficiency of the Ar isotope ATTA device, and developed a strong flow mass spectrometry isotope pre-concentration method. These advancements have enabled us to successfully detect Ar-42 (with a half-life of 33 years) atoms in the air with an isotopic-abundance level of only 10^-21 using single atom counting method.
Previously, people used dark matter detectors detecting the decay of Ar-42 from tons of liquid argon to calculate the natural abundance of Ar-42. The sample consumption in this work is only 1-2L of gaseous argon, and the final measured natural abundance of Ar-42 is (5.4±0.8)×10^-21, which is twice more accurate than previous measurements. This work demonstrates the lowest detection limit that can be achieved by all current ultra-sensitive isotope detection methods.

Student Submission

Yes

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