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Atom Trap Trace Analysis Reaches a Part-per-quadrillion Sensitivity[1] WEI JIANG, WILLIAM WILLIAMS, KEVIN BAILEY, Argonne National Lab, Illinois 60439, USA, ANDREW DAVIS, Univ of Chicago, USA, SHUIMING HU, USTC, Hefei, China, ZHENG-TIAN LU, THOMAS O'CONNOR, Argonne National Lab, Illinois 60439, USA, ROLAND PURTSCHERT, Univ of Bern, Bern, Switzerland, NEIL STURCHIO, Univ of Illinois, Chicago, USA, YUN SUN, USTC, Hefei, China, PETER MUELLER, Argonne National Lab, Illinois 60439, USA — A quadrillion is 10^{15}. This is how many argon atoms one has to sift through in order to find just one atom of the radioactive isotope ^{39}Ar. Atom Trap Trace Analysis (ATTA), a MOT-based atom counting method, is now able to unambiguously pick ^{39}Ar out of a regular argon gas sample. The exceedingly rare ^{39}Ar forms naturally in the environment by cosmic rays, decays with a half-life of 270 years, and is an ideal tracer to study ocean circulation or groundwater flow over the past few hundred years. In an ATTA apparatus, only ^{39}Ar atoms are selectively captured by the MOT, appear as a bright dot, and can be counted one atom at a time using a sensitive camera. This work constitutes a major breakthrough in analytical capability, and promises to enable a wide range of applications in physics as well as earth sciences.

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