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A Statistical Method for Treating the "Negative-Age" and "Negative-Atom-Number" Conundrums in Radioisotope Dating

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In radioisotope dating, statistical fluctuations of atom counts or decay counts can sometimes lead to unphysical results, such as negative counts after subtracting the background or negative apparent ages near the boundaries of the dating range. How to treat these boundary cases with a unified approach and give proper estimates on age limits and confidence intervals is an important issue in radioisotope dating. In this work, we combine the Feldman-Cousins likelihood-ratio ordering method for interval estimation, a Frequentist approach to make consistent transitions from the choice of one-sided limits to two-sided confidence intervals, and a Bayesian method to treat the background uncertainties. This data treatment method naturally eliminates the unphysical results. We use ^{81}Kr dating and Atom Trap Trace Analysis as an example to illustrate the advantages. This method can be generalized to other radioisotopes and ultra-sensitive analysis techniques.

Student Submission

No

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