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PHYS 705.01

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Homework Assignment 04

2) Write a Title

“Using the First Direct Observation of Thorium-229 Isomer in Development of an Improved Nuclear Optical Clock”

3) Write an Abstract

The first isomeric state of Thorium-229 has a uniquely low systematic uncertainty in frequency, making it an ideal candidate to improve performance of already existing atomic clocks. Past theoretical and experimental work have expanded upon the known properties and behavior of Th-229m, and allowed for the measurement of energy to be determined only indirectly. We report the results of the first direct energy measurement of the Th-229m isomer and the to-ground-state decay. Using data collected over three days from an electron spectrometer, we can directly determine energy values of the process within reasonable uncertainty and discuss how it can be used in the development of a nuclear optical clock.

4) Mark words or phrases that are good or bad examples of scientific writing, and state reasoning

First paragraph: “The first excited isomeric state of Thorium-229, denoted Th-229m has the lowest excitation energy of all known nuclear states.” This is an excellent piece of writing- it clearly establishes a notation, a branch of physics, and the topic of the paper as well as context for the research.

Second paragraph: “... achieve a systematic frequency uncertainty of $1.5 \times 10^{-19}\text{Hz}$, thereby reaching, and thereby surpassing existing atomic-clock technology...”. This answers the *Why do we care* question. Immediately, the usage of Th-229m is presented, its physical property, why the reader should care about the topic of the paper.

The middle section, beginning on the second column is very dense. We are presented with background information, as well as abundance different isotopes, mixed in with experimental procedure and setup. It is very difficult for me, unexperienced in Nuclear Physics, to follow this whole section

Figure 1 is very presented. It takes up a large portion of the page to warrant readability and show its importance. It is colored, making the differentiation of objects clear. Each bit is labeled with a reasonable sized text and arrow with a nice font, and there is no extraneous white-space. It is appropriately captioned explain how it related to Th-229m and the experimental setup.

Figure 2 is similarly well presented. The color coding and label makes it easy to follow the difference between the raw data and the curves of best fit.

Last page in the first column on the last page has some equations buried within a paragraph, strangely formatted. It makes readability much harder and detracts from the importance of them. They are easy to gloss over and dismiss.