Chaot Dynamics

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Abstract

This paper presents an investigation into the relativistic effects on electrons emitted through the decay of Sodium-22 (Na-22), Cobalt-60 (Co-60), and etc. By analyzing the energy and momentum of these electrons, we compare experimental data with classical Newtonian and relativistic predictions to underscore the necessity of relativistic considerations at high energies.

1 Introduction

1.1 Background and Theory

1.1.1 Chaos Theory

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1.1.2 Relativistic Kinematics

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1.2 Purpose

This experiment is committed to the empirical confirmation of relativistic dynamics' theoretical projections and to delineate the boundaries of classical mechanics under the duress of high-energy conditions.

2 Experimental Setup and Procedure

2.1 Apparatus

2.1.1 Equipment

The The following equipment (or equivalent) is needed for the experiment:

1. Gamma Source Kit Samples(Na-22, Co-60, etc.)

2. Scintillation Detector

3. Photomultiplier Tube
4. Amplifier (Linear Amplifier (ORTEC 672))
5. Multichannel Analyzer
6. Computer

2.1.2 Scintillation Detector

The scintillator is a device that detects radiation by converting the energy of incoming photons into visible light. This light is then detected by a photomultiplier tube, which amplifies the signal and converts it into an electrical pulse. The scintillator used in this experiment is a sodium iodide (NaI) crystal, which is commonly used for detecting gamma radiation. The crystal is coupled to a photomultiplier tube, which amplifies the light signal and converts it into an electrical pulse

2.1.3 Photomultiplier Tube

The photomultiplier tube is a device that converts the light signal from the scintillator into an electrical pulse. It consists of a series of dynodes, which are metal electrodes that are held at successively higher voltages. When a photon strikes the first dynode, it releases an electron, which is then accelerated towards the next dynode. This process is repeated at each dynode, resulting in a cascade of electrons that is amplified at each stage. The final output is a large number of electrons, which is then converted into an electrical pulse. This pulse is then passed to a electronic preamplifier to be then processed by the data acquisition system, which records the number of pulses over a given time interval. This allows us to measure the intensity of the radiation emitted by the samples.

2.1.4 Schematic

This is a schematic of the experimental setup, which can be seen below in figure 2:

The figure was kept simple to illustrate the basic components of the setup. The scintillation detector is used to measure the energy of the emitted electrons. The pulses from the scintillation detector are then passed to a linear amplifier and then to a multichannel analyzer, which records the number of pulses over a given time interval. The data is then analyzed to determine the energy of the emitted electrons and the intensity of the radiation emitted by the samples using Maestro.

For the Python analysis, the data was read in using the Maestro software which was outputed as a spe file which was converted to a csv with a custom python program that also took into account the energy calibration. We then visualized and analyzed this data using the Pandas, Matplotlib, and Altir libraries. The data was then plotted to show gamma decay spectrum and the notable traits of the graph.

3 Results

3.1 Data and Analysis

3.1.1 Na-22

The data for Na-22 was analyzed and the energy of the emitted electrons was determined. The energy of the emitted electrons was then plotted as a function of their momentum, as shown in figure 3. The data was then fitted to a linear function to determine the slope of the line, which is the speed of the electrons. The speed of the electrons was then compared to the speed of light to determine if the electrons were traveling at relativistic speeds.

3.1.2 Co-60

The data for Co-60 was analyzed and the energy of the emitted electrons was determined. The energy of the emitted electrons was then plotted as a function of their momentum, as shown in figure 4. The data was then fitted to a linear function to determine the slope of the line, which is the speed of the electrons. The speed of the electrons was then compared to the speed of light to determine if the electrons were traveling at relativistic speeds.

3.1.3 Compton Edge

The Compton edge was determined by analyzing the data for the Compton scattering of the electrons. The energy of the electrons was then plotted as a function of their momentum, as shown in figure 6. The data was then fitted to a sinusoidal function to determine the Compton edge, which is the maximum energy of the electrons emitted by the sample. The Compton edge was then compared to the theoretical value to determine if the electrons were traveling at relativistic speeds.

3.1.4 Comparison

The experimental data was then compared to the theoretical predictions for the energy and momentum of the emitted electrons. The experimental data was found to be consistent with the relativistic predictions as shown in figure 7. Confirming the validity of the relativistic equations for kinetic energy and momentum. This also highlights the limitations of classical mechanics at high energies, and the necessity of relativistic considerations in such scenarios.

4 Conclusion

So from the results we can see that the experimental data is consistent with the relativistic predictions. This confirms the validity of the relativistic equations for kinetic energy and momentum. This also highlights the limitations of classical mechanics at high energies, and the necessity of relativistic considerations in such scenarios.

5 References

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