Poisson Distribution

Purpose

To verify the statistical nature of counting experiments such as radioactive decay, and to extract the parameters of the corresponding statistical distributions.

Background

This is a continuation of the experiment "Introduction to Geiger Muller Tube", but is computer aided. See the attached Leybold page.

Procedure

1. Arrange the experimental set up as shown, and get familiar with the CASSY Lab program.

2. Adjust the distance between the radioactive source and the GM tube so that a convenient rate of about 5 counts per second is obtained.

3. In the CASSY Lab program, select x-axis = RA1 (count rate in input A), y-axis = HA1 (frequency in A) with bars and n = 1000 for frequency distribution. Double click on RA1 and set gate time (Δt) = 1s. Start measuring by clicking on the clock icon or F9.

4. Save and print the data and the histogram at the end of the measurements.

5. Repeat steps 3 & 4 for n = 500 and Δt = 10 s.

6. Decrease the distance between the source and the detector so that about 50 counts per second is obtained.

7. Repeat steps 3, 4 and 5.

Analysis

1. Fit your low-count rate data with a Poisson distribution and extract its parameter μ using any data fitting software.

2. Fit your high-count rate data with a Gaussian distribution and extract its parameters μ and σ.

3. What is the effect of increased gate time?

Poisson distribution
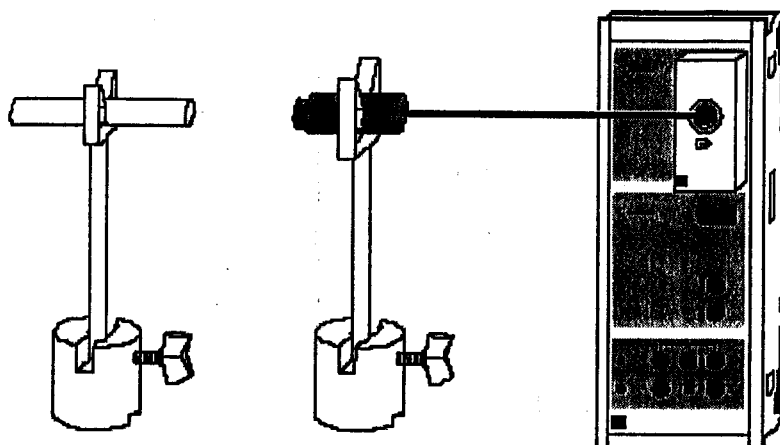
■ Load example

Experiment description

The number x of decay events of a radioactive preparation over a time interval Δt is not constant. A large number of individual measurements can be represented as a frequency distribution H(x) scattered around the mean value μ. By comparing this frequency distribution with the Poisson distribution, we can confirm that x shows a Poisson distribution around the mean value μ.

Equipment list

1	Sensor-CASSY	524 010
1	CASSY Lab	524 200
1	GM box	524 033
1	End-window counter	559 01
1	Set of radioactive preparations	559 83
1	Large clip plug	591 21
1	Small clip plug	590 02
2	Connection rods	532 16
2	Bases	300 11
1	PC with Windows 95/98/NT	

Experiment setup (see drawing)

The end-window counter is connected to the GM box at input A of Sensor-CASSY. Handle the counter tube and the preparation with care.

Carrying out the experiment

■ Load settings
- If necessary, modify the gate time Δt (Settings RA1).
- Preset the measurement if necessary. Enter the number of measurements as the measuring condition in the Measuring Parameters dialog opened with F5 (e.g. **n < 1000** for 1000 individual measurements).
- Start the measurement series with **F9**, and stop it again with **F9** after recording the series.

Evaluation

In the evaluation, you can compare the measured frequency distribution with a Poisson distribution. For higher mean values μ the Poisson distribution develops into a Gaussian distribution.