

Project 1: Deciphering Mystery Datasets

PHYS 4023

Due Sept. 26

Overview

You will analyze three "mystery" datasets by fitting mathematical models to experimental data and identifying the underlying physical phenomena. Each dataset represents measurements from a classic physics experiment that you should recognize from your previous coursework.

Objectives

1. Apply *scipy curve_fit* (or similar) to model experimental data
2. Determine appropriate functional forms for different physical phenomena
3. Extract meaningful physical parameters from fitted models
4. Connect mathematical analysis to physical interpretation

The Task

You will receive three datasets labeled simply as "Dataset A," "Dataset B," and "Dataset C." For each dataset, you must:

1. Data Analysis

- Load and examine the data
- Identify the general functional relationship between variables
- Use *scipy curve_fit* (or similar) to fit an appropriate mathematical model
- Evaluate the quality of your fit using appropriate statistical measures

2. Physical Interpretation

- **Identify the experiment:** Based on the functional form and fitted parameters, determine what physical system or experiment produced this data
- **Extract physical parameters:** Calculate meaningful physical quantities from your fitted parameters (e.g., time constants, frequencies, physical constants)
- **Discuss uncertainties:** Comment on the reliability of your fitted parameters and any limitations in your analysis

3. Model Validation

- Assess how well your chosen model describes the data
- Discuss any systematic deviations or limitations you observe
- Suggest improvements to the experimental setup or analysis if appropriate

Deliverables

Submit a well-organized report (PDF preferred) containing:

- **Introduction:** Brief description of your approach and the tools used
- **Analysis Section:** Data visualization with appropriate plots, Fitted parameters with uncertainties, Physical interpretation and parameter extraction.
- **Conclusions:** Summary of findings and reflection on the modeling process
- **Appendix:** Notebooks and/or Code

Assessment Criteria

- **Technical execution** (40%): Correct use of curve fitting, appropriate model selection
- **Physical insight** (30%): Accurate identification of experiments and meaningful parameter extraction
- **Communication** (30%): Clear presentation, quality of plots and explanations

Tips for Success

- Start by plotting your data - the shape will guide your model choice
- Don't overthink the functional forms - these are classic relationships you've seen before. There may be more than one possible solution. Just be sure that it is plausible and the model fits the data well.
- Pay attention to units when interpreting fitted parameters
- If your first model doesn't work well, consider alternative functional forms
- Remember that experimental data always has some scatter - perfect fits aren't expected