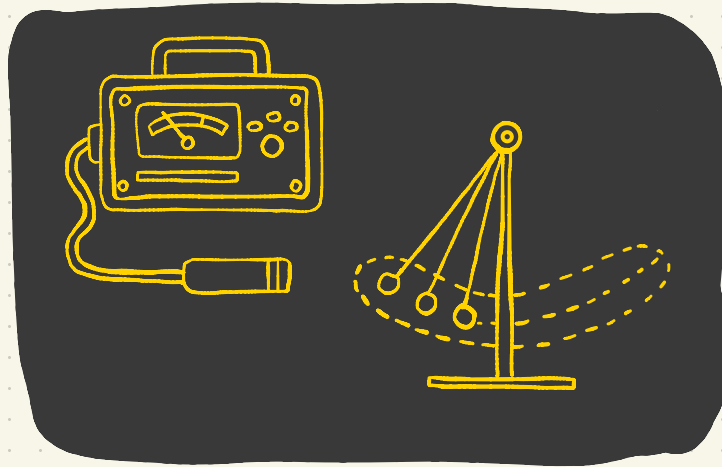


Portfolio Feedback Session

PHY1030



Outline

- introduction
- go over common mistakes
- what is a good report
- tips & tricks
- establish an algorithm
- learn from mistakes
- take home message

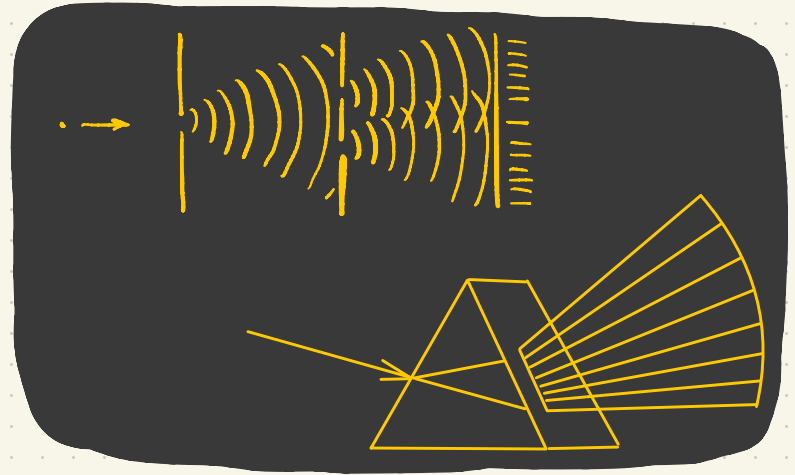


before we dive in, let's reflect

- why are we doing 100 years old experiments?
- what is the point of all the steps?
- what is the purpose?
-

Many goals:

- see physics at work
- experience theory+experiment
- prepare for research
- and much, much more



Excess Electronic Recoil Events in XENON1T

XENON Collaboration

[arXiv.org](https://arxiv.org) > hep-ex > [arXiv:2008.09722](https://arxiv.org/abs/2008.09722)

We report results from searches for new physics with low-energy electronic recoil data recorded with the XENON1T detector. With an exposure of 0.65 tonne-years and an unprecedentedly low background rate of 76 ± 2 stat events/(tonne \times year \times keV) between 1–30 keV, the data enables one of the most sensitive searches for solar axions, an enhanced neutrino magnetic moment using solar neutrinos, and bosonic dark matter. An excess over known backgrounds is observed at low energies and most prominent between 2–3keV. The solar axion model has a 3.4 σ significance, and a three-dimensional 90% confidence surface is reported for axion couplings to electrons, photons, and nucleons.

Introduction

Signal Models

- Solar axions
- Neutrino magnetic moment
- Bosonic dark matter

Data Analysis

- Data selection
- Background model
- Statistical method

Results

- Tritium hypothesis
- Solar axion results
- Neutrino magnetic moment results
- Bosonic dark matter results
- Additional checks

Discussion

Summary

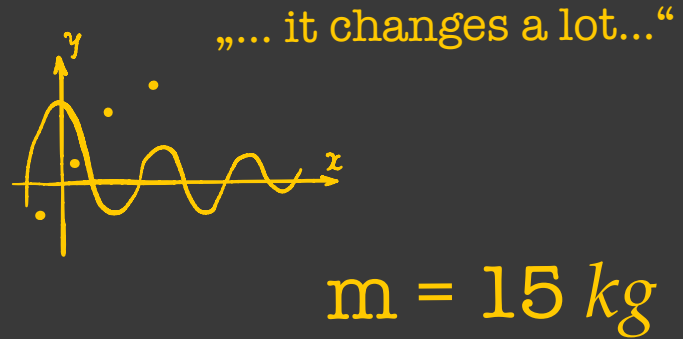
Appendix

- modern research - focus on the sections
- compare to your report, find a similar structure
- learn to walk before you run (cheesy but true)
- “protoscientists”



Common mistakes

- units
- formatting & standards
- data representation (tables & plots)
- analysis & discussion
- conclusions / results



Common mistake number one: units

- in my experiment: 99 % of reports lack units
- physics experiments: measure (stuff)
- units are crucial & fundamental
- important IRL as well

- Price of something: 3000 RSD OR GBP?
- Retiling your kitchen backsplash?
Need units of area to get an estimate!



Common mistake number one: units

this can be a lot of things

$$T = 2.72548 \pm 0.00057$$

$$T = 2.72548 \pm 0.00057 \text{ K}$$

this is clearly a temperature
in units of kelvin



Common mistakes: standards and formatting

- standard: quantities italicized & units upright
- operators not italicized
- equation formatting
- exponents
-

$1.6 * 10^{-19} \text{ C}$ X
 $1.6 \times 10^{-19} \text{ C}$ ✓

<i>m</i>	m
mass	meter
<i>A</i>	A
area	ampere

X	✓
<i>cos</i> (2π)	cos(2π)
<i>dt</i>	dt



Common mistakes: data analysis

- data in tables (quantities and units)
- labeling, captioning is important
- table contains your measurements!

f E14	U
8.21 E14	-1.85
7.40 E14	-1.49
6.88 E14	-1.29

spot the mistakes



Common mistakes: plots (data analysis)

- Basics:
- labels
 - units
 - tick labels
 - caption and/or title

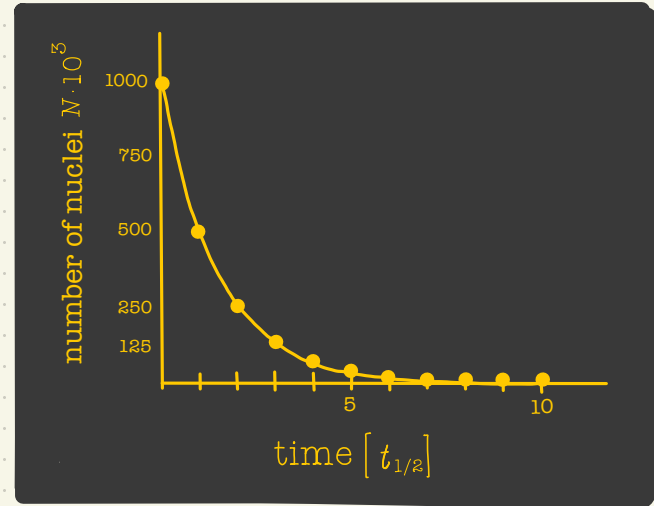
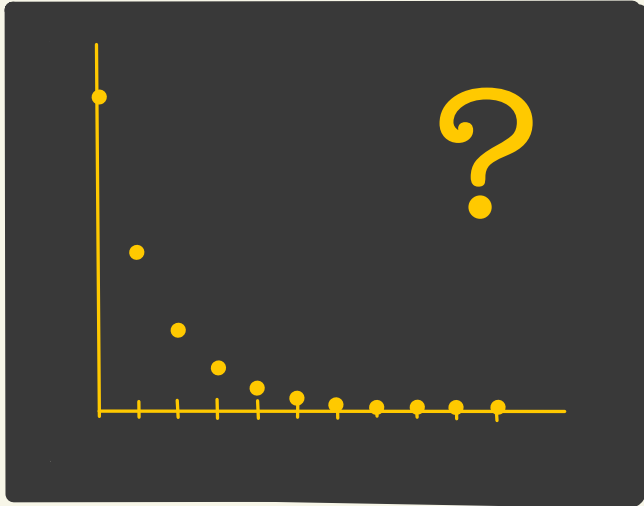
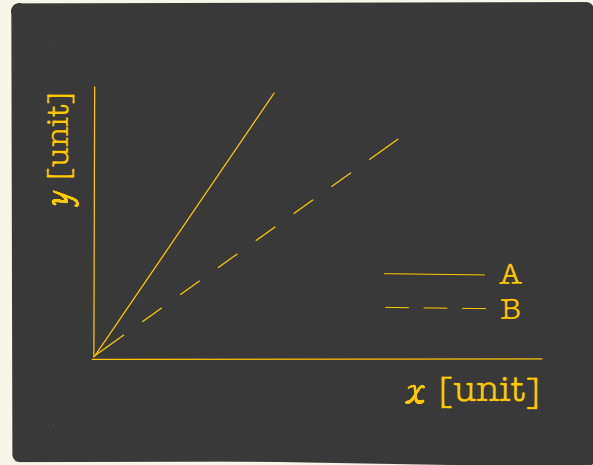
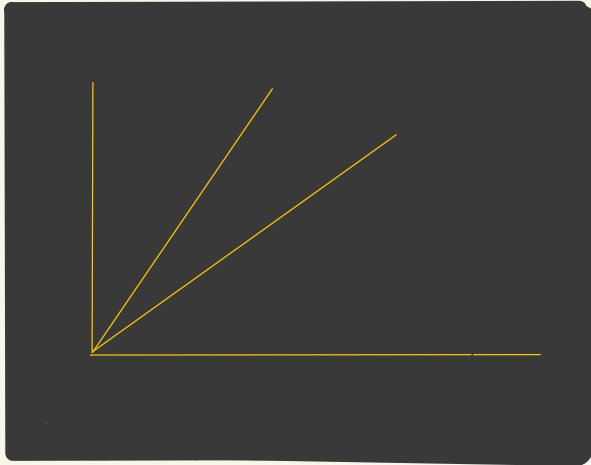


Fig. 1.2: The number of nuclei as a function of time. Radioactive decay reduces the number of nuclei over time. In one half-life, the number of nuclei decreases to half of its original value. The radioactive decay is exponential.



Common mistakes: plots

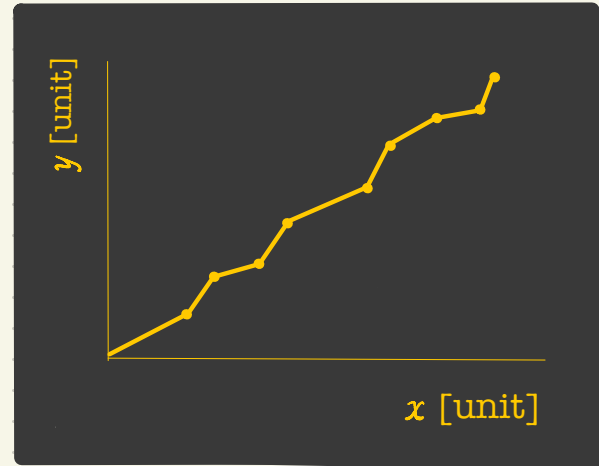
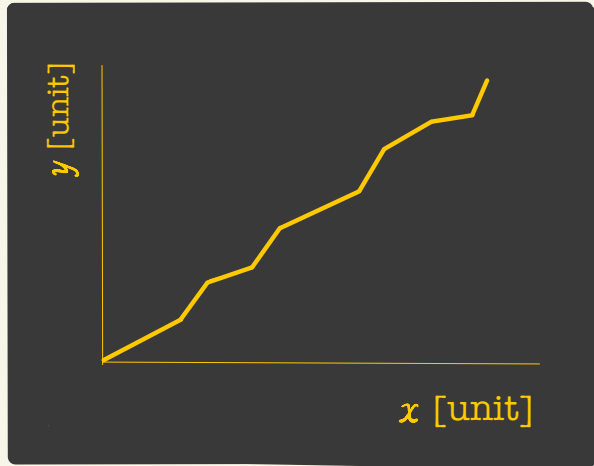
- multiple functions
- colors, line style
- legend



Common mistakes: plots

Python example

- data, $y = f(x)$
- first step is to just plot
- use `plt.plot(x,y)`
- however, that is only plotting data
- need a fit
- fit gives us the functional dependency

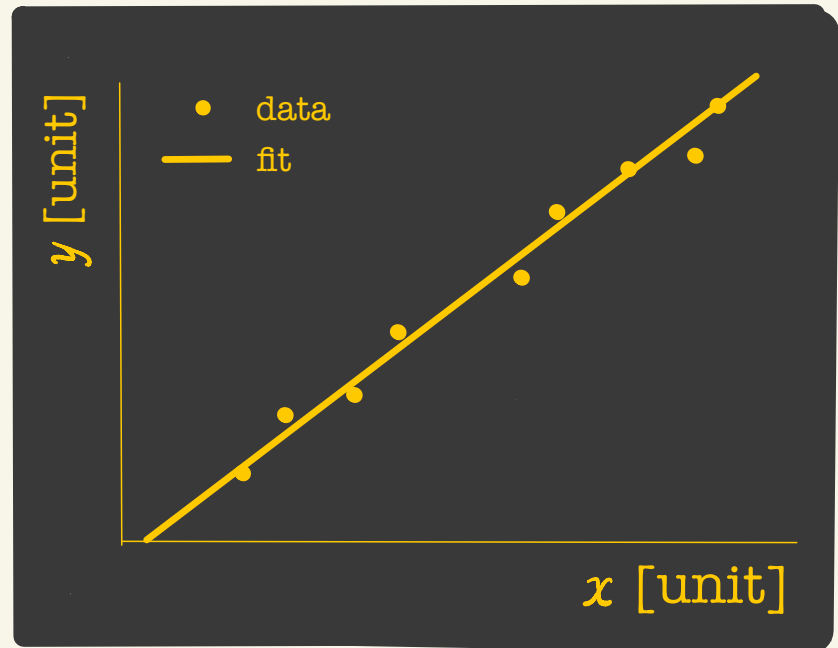


Common mistakes: plots

Good practice:

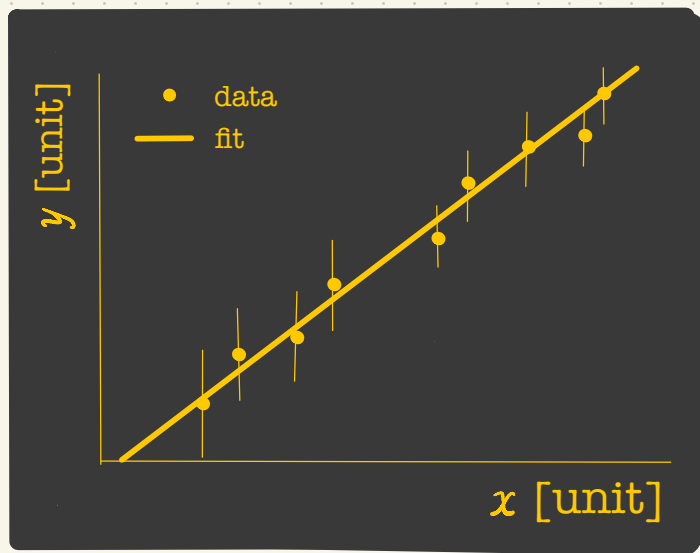
- plot the data
- inspect and decide on a fit
- plot data as scatter
- `plt.scatter(x,y)`
- if linear, fit a linear function
- several ways (numpy, scipy)

- only this way can obtain a slope and intercept
- functional dependency
- physical law



Common mistakes: plots

- include error bars
- many ways to display errors
- ...



Keep in mind:

- plots need to correctly represent data
- plots should communicate findings in a clear way
- too little or too much info
- overcrowded, hard to read
- master the art of plotting one step at a time



Common mistakes: results & discussion

- explain the experimental findings & connect to theory
- explanation needs to be qualitative & quantitative
- be exact
- explain all the methods used
- the structure of the report
- use scientific language (no slang)
- it takes time to learn, no worries
- the tricks of the trade

... the [quantity1] increased by a factor of 10 with increasing [quantity2]... ✓

... [quantity1] increased a lot when I increased [quantity2]... ✗



Common mistakes: results & discussion

- check signs
- check units
- use dimensional analysis (powerful)
- compare to expected result/theory
- talk to your peers!!! peer review
- if result is unexpected, try to investigate why
- many reasons for the discrepancy
- is your result physical/does it make sense?

“... using this method, it was determined that the distance to the Andromeda galaxy is 765 ± 2 km.”



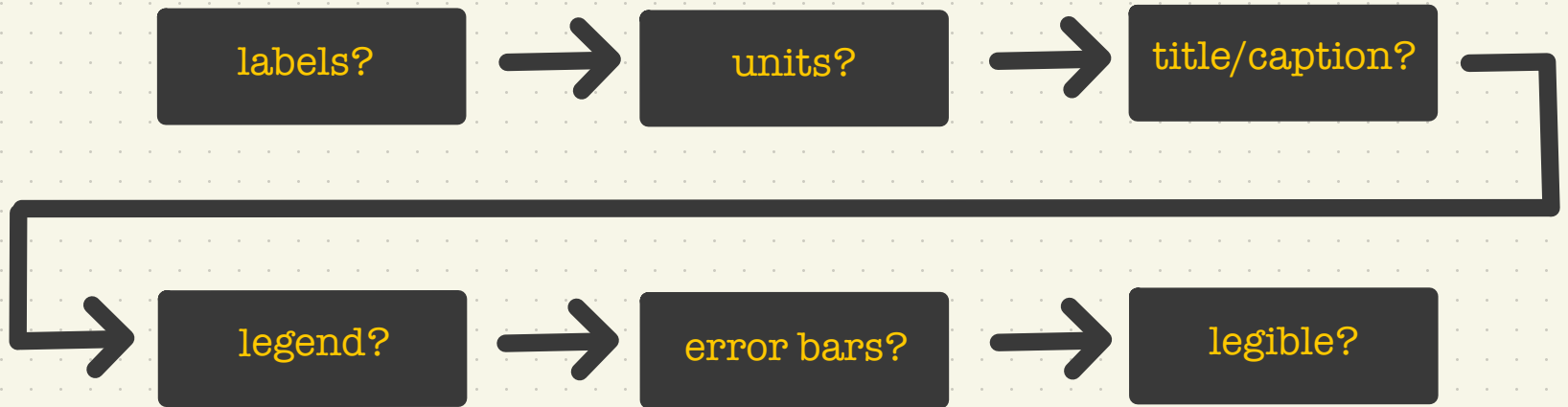
Tips & tricks

Useful questions to ask yourself:

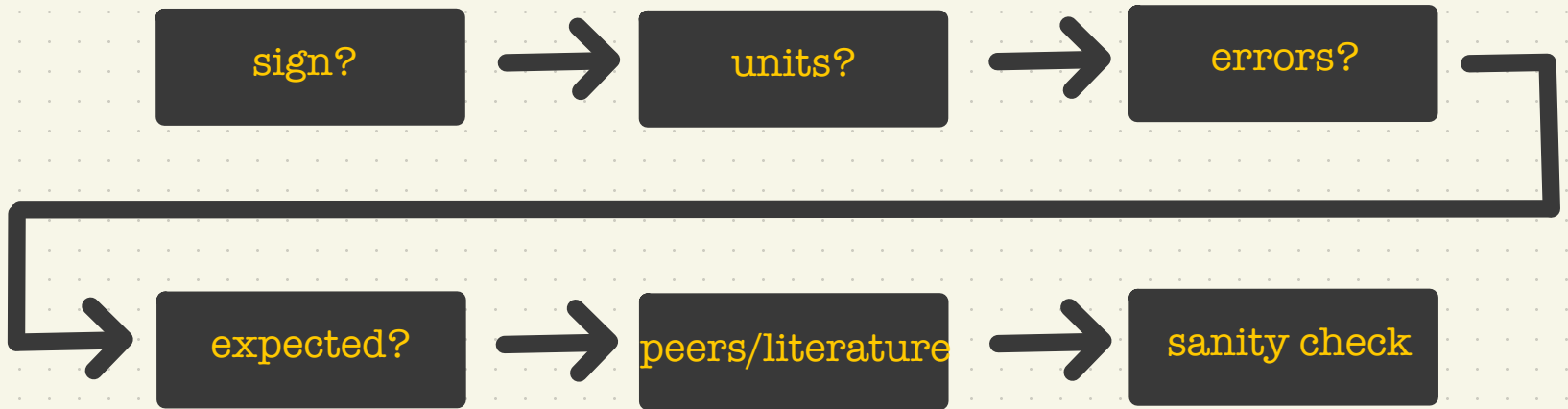
- do I have units everywhere?
- is this the right fit for my data?
- is my plot legible?
- does my plot have all the necessary information?
- am I presenting the right variable?
- does this result make sense?
- is this supposed to be negative?
- does the theoretical value agree with the experimental?



Tips & tricks: data analysis



Tips & tricks: results



Tips & tricks: general

- dimensional analysis
- peer review & discussion
- try to comment each other's report
- learn from mistakes
- you will improve, I promise
- you are already very good (you are physics students)
- no stress
- UNITS
- no worries (also, UNITS)
- keep lab notes on hand
- explore software
- think about how to best show your findings
- save your portfolios and come back to them in a year or two
- we (seniors) also made mistakes
- we (seniors) also make mistakes



Take home message(s)

- labs offer you a first taste of the scientific method
- if you made mistakes, it is ok, you will learn
- everyone makes mistakes
- take this opportunity to reflect rather than stress
- **HAVE FUN** as physics is truly grand

