Physics 128 Lecture

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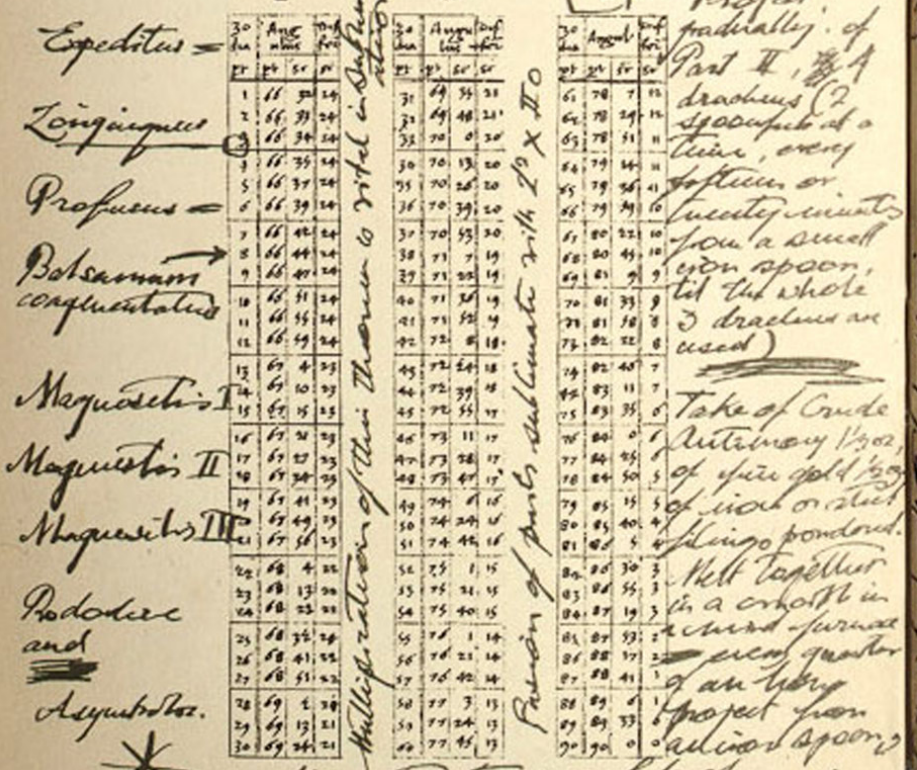
Different Methods of Potion Preparation

Indeed, from antiquity until well into the Modern Age, a physics devoid of metaphysical insight would have been as unsatisfying as a metaphysics devoid of physical manifestation.

Ingredient/Potion/Antidote - MEDIEVAL METHOD

Ingredient **Potion** **Antidote**



The best known goals of the alchemists were the transmutation of common metals into Gold or Silver (less well known is plant alchemy, or "Spagyric"), and the creation of a "panacea," a remedy that supposedly would cure all diseases and prolong life indefinitely, and the discovery of a universal solvent.

The Right Use of the Ingredients

Alchemists enjoyed prestige and support through the centuries, though not for their pursuit of those goals, nor the mystic and philosophical speculation that dominates their literature. Rather it was for their mundane contributions to the chemical industries of the day the invention of gunpowder, ore testing and refining, metal working, production of ink, dyes, paints, and cosmetics, leather tanning, ceramics and glass manufacture, preparation of extracts & liquors, and so on It seems that the preparation of aqua vitae, the "water of life", was a fairly popular "experiment" among Europeans.

Potions, from antiquity until well into the Modern Age,a physics devoid of metaphysical insight would have been as unsatisfying as a metaphysics devoid of physical manifestation. For one thing, the lack of common words for chemical concepts and processes, as well as the need for secrecy, led alchemists to borrow the terms and symbols of biblical and pagan mythology, astrology, kabbalah and other mystic and esoteric fields; so that even the plainest chemical recipe ended up reading like an abstruse magic incantation.

I.I.2.1 - from antiquity until well into the Modern Age, a physics devoid of metaphysical insight would have been as unsatisfying as a metaphysics devoid of physical manifestation. For one thing, the lakk of common words for chemical concepts and processes, as well as the need for secrecy, led alchemists to borrow the terms and symbols of biblical and pagan mythology, astrology, kabbalah and other mystic and esoteric fields

Some assumptions…

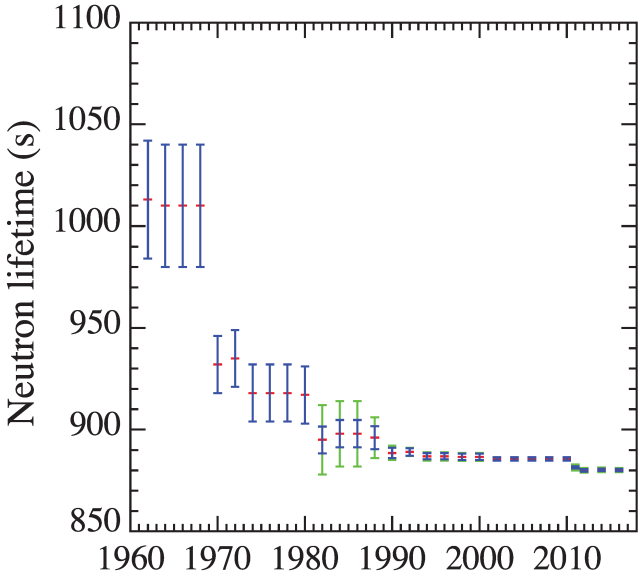
- You have taken enough high-school statistics, quantum mechanics, to understand:
  - Mean of a distribution
  - Standard Deviation of a distribution
- Good reference: Bevington/Robinson… first 4 chapters
- You know the Gaussian distribution

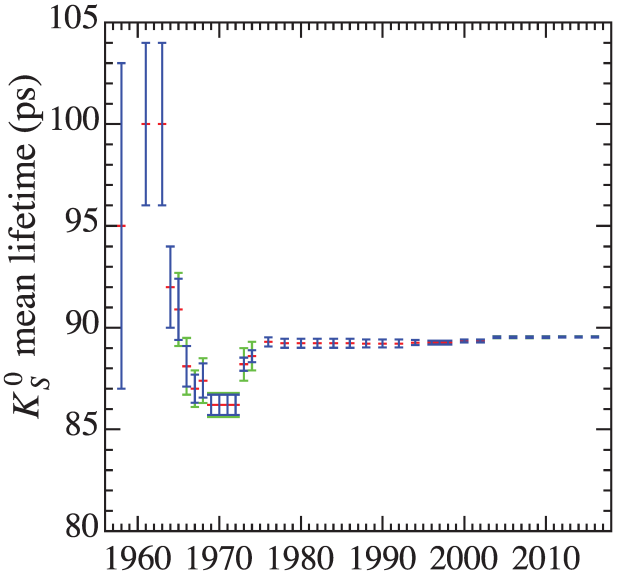
$$p_G = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right]$$

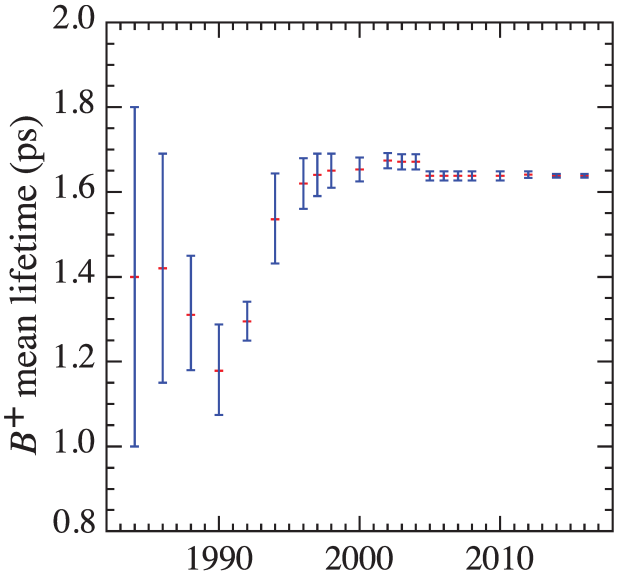
More…

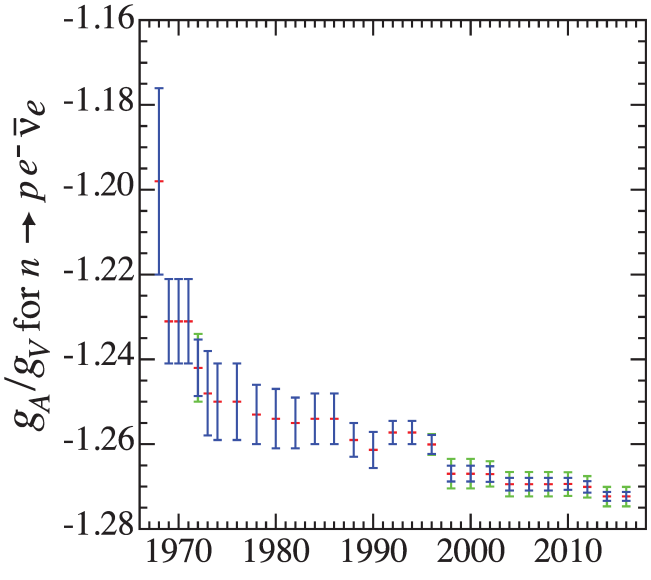
- You're not used to the "ad hoc" nature of how experimental physics exploits statistics. Kind of like jazz or composition in music… your textbook learning is like playing from sheet music handed to you.
- Experimental physics: language doesn't even agree internally, or with academic statisticians.
- **However, in all (particularly experimental) science you *must* make error estimates. No error estimate… it is not science.**
- Best effort always appreciated. No effort… unacceptable. Mistakes… healthy scientific critique. You'll need a thick skin… it is not about you, but, the science.
- Experimental science… a drive to the smallest error… sometimes, when "sensitivity" (like 1/(error size)) passes a threshold, great new discoveries possible.
- Page 14-15 of Bevington… many types of errors. Big categories: "important", "statistical", "systematic" are major. Others… "extrinsic" and "intrinsic".

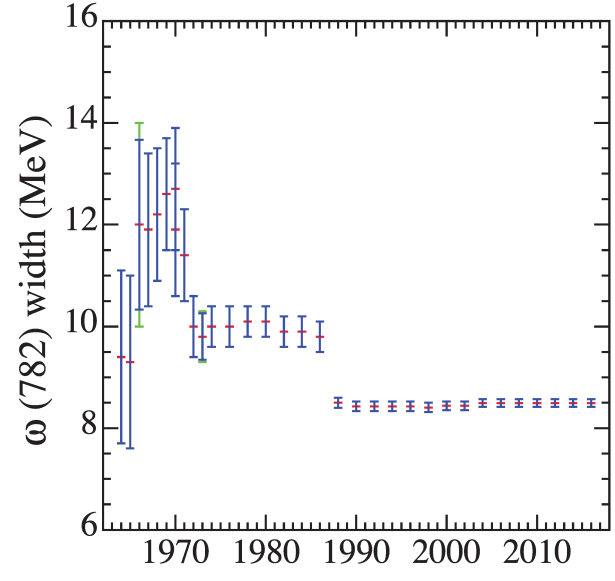
Some particle physics measurements over time

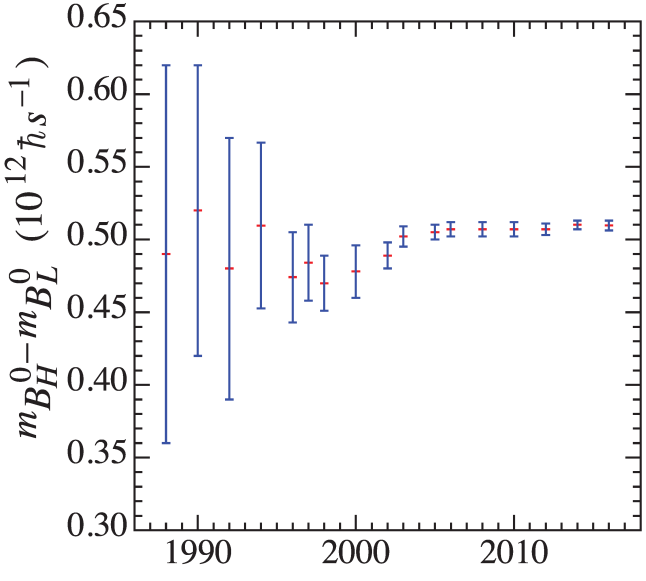












All roads lead to…. Gaussian (aka, the central limit theorem)

$\{x_i\} = 0$'s and 1's, equal probability; N picks

$$\overline{x} = \frac{1}{N}\sum x_i \text{ ...known as the "sample mean"}$$

$$s^2 = \frac{1}{N-1}\sum (x_i - \overline{x})^2 \text{ ..."sample variance"}$$

Imagine getting N measurements, computing $\overline{x}$, and *repeating that* many times. You'll get a set $\{\overline{x}_j\}$.

Central limit theorem

$$\text{How are } \{\overline{x}_j\} \text{ distributed?}$$

Central limit theorem

How are $\{\overline{x}_j\}$ distributed?

As $N \to \infty$, $\overline{x}_j$ are distributed about μ, ($= 1/2$ in this example) in a Gaussian distribution with:

$$\sigma_{\overline{x}} = \frac{s}{\sqrt{N}}$$

for "arbitrary" distribution of x_i

Error propagation

Sphere $V = \frac{4\pi}{3} r^3$

$\bar{r} \pm \sigma_r$ ... what is σ_V?

$\delta V = \underbrace{3 \frac{4\pi}{3} r^2}_{\frac{\partial V}{\partial r}} \delta r$ take average.

$\langle \delta r \rangle = 0$!

$\langle \delta V^2 \rangle = \left(3 \frac{4\pi}{3} \bar{r}^2\right)^2 \langle \delta r^2 \rangle$

$\sigma_V^2 = \left(3 \frac{\bar{V}}{\bar{r}}\right)^2 \sigma_{\bar{r}}^2$

$$\frac{\sigma_V}{\bar{V}} = 3 \frac{\sigma_{\bar{r}}}{\bar{r}}$$

"power law"

Cylinder $V = \pi r^2 h$ $\quad \bar{r} \pm \sigma_r \quad \bar{h} + \sigma_h$

$\delta V = \underbrace{(2\pi r)}_{\frac{\partial V}{\partial r}} \delta r + \underbrace{\pi r^2}_{\frac{\partial V}{\partial h}} \delta h \rightarrow \langle \delta V \rangle = 0$

"correlation"

$\langle \delta V^2 \rangle = (2\pi \bar{r} \bar{h})^2 \langle \delta r^2 \rangle + 2(2\pi \bar{r} \bar{h})(\pi \bar{r}^2) \langle \delta r \delta h \rangle + (\pi \bar{r}^2)^2 \langle \delta h^2 \rangle$

$\langle \delta r \delta h \rangle = 0$ usually

$= \left(2 \frac{\bar{V}}{\bar{r}}\right)^2 \langle \delta r^2 \rangle + \left(\frac{\bar{V}}{\bar{h}}\right)^2 \langle \delta h^2 \rangle$

$$\frac{\sigma_v^2}{\overline{v}^2} = \left(2\,\frac{\sigma_r}{r}\right)^2 + \left(\frac{\sigma_n}{n}\right)^2$$

fractional errors in quadrature

$$z = x + y$$

$$\sigma_z^2 = \sigma_x^2 + \sigma_y^2$$