In astrophysics, high energy, and nuclear physics, relativity is central to understanding many observations.

The canonical experiment can be boiled down to the following: Particles are produced (event 1), the decay (randomly), and are detected (event 2) at some location that is <u>not</u> where the are produced.

There "random" decay is a Poisson process and can be modeled continuously using,

$$\frac{dN}{dt} = -\lambda N$$ where λ is related to the rate of decay.

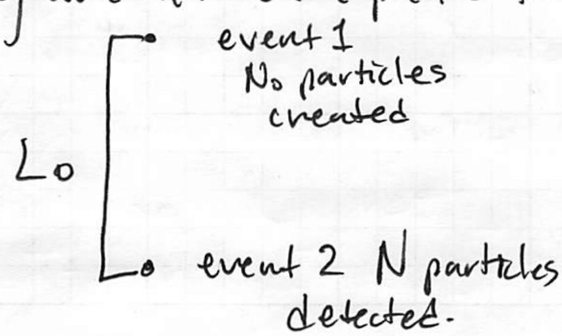
If we start with N_o particles then,

$$\frac{dN}{N} = -\lambda dt \Rightarrow \ln(N(t)) - \ln(N_o) = -\lambda t$$

so that $\frac{N(t)}{N_o}$ = fraction of surviving particles $= e^{-\lambda t}$

<u>High Speed Particles</u> <u>$v \sim c$</u>

What does the detector see? Assume that all N_o particles are generated at one location and they are all on a path to the detector.



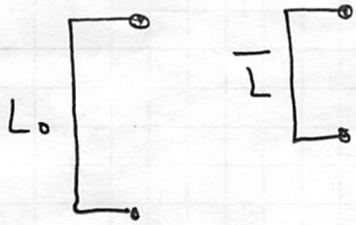
L_o is the distance in the detector frame.

What fraction of particles does the detector see?

$$\frac{N(t)}{N_0} = e^{-\lambda t}$$

But is $\Delta t = \dfrac{L_0}{V_{particles}}$? in the detector frame?

We would underestimate the fraction of particles in this case. Because in the particle frame, the distance travelled is shorter.



in particle frame. $\bar{L} = \frac{1}{\gamma} L_0$

but the particles traverse this with a given $V_{particle}$,

$$\frac{L_0}{\Delta t} = V_{particle} = \frac{\bar{L}}{\Delta t_{proper}}$$

B/c this Δt_{proper} is measured with one clock (namely the one in the rest frame of the particles, it is Δt_{proper}).

Thus it's the shortest time in any frame.

$$\Delta t_{proper} = \frac{\bar{L}}{L_0} \Delta t = \frac{\Delta t}{\gamma}$$

$$\frac{N(t)}{N_0} = e^{-\lambda \Delta t_{proper}}$$

this fraction is higher than the one in the detector frame, and is in fact the one we get in experiments!