**Boost Kinematics - Reminders**

\[ \Lambda = \begin{pmatrix} \gamma & -\gamma \beta \\ -\gamma \beta & \gamma \end{pmatrix} \quad \text{(I don't care about signs here)} \]

\[ \gamma = E_\gamma / m_\gamma \quad -\gamma \beta = 1 |p_\gamma| / m_\gamma \]

s.t. \[ p_\gamma = \Lambda (m_\gamma, 0) \]

so \[ \Lambda : \gamma \text{ Rest Frame} \rightarrow \text{Lab Frame} \quad (x \gamma \text{ cm}) \]

For simplicity, align boost axis w/ \( \hat{x} \)

In the \( \gamma \) rest frame, \( \gamma \rightarrow b\bar{b} \) with

\[ p_\gamma^x = |p_\gamma| \cos \Theta \quad \text{[Choice of polar coords]} \]

Then, in Lab frame, \( b \) has energy

\[ E'_b = \gamma E_\gamma - \gamma \beta p_\gamma^x \quad \text{now writing in for } \gamma \text{ cm frame} \]

\[ = \frac{1}{m_\gamma} \left( E_\gamma E_\gamma^0 + |p_\gamma|^2 \right) \]

\[ \uparrow \]

\[ |p_\gamma^0| \cos \Theta \]

\[ (E'_b)_{\text{min}} = \frac{1}{m_\gamma} (E_\gamma E_\gamma^0 - |p_\gamma| |p_\gamma^0|) \quad \text{[Function of } E_\gamma \]

\[ (E'_b)_{\text{max}} = \frac{1}{m_\gamma} (E_\gamma E_\gamma^0 + |p_\gamma| |p_\gamma^0|) \]

\[ E_\gamma^0 = \frac{m_\gamma}{2}, \quad |p_\gamma^0| = \sqrt{(E_\gamma^0)^2 - m_\gamma^2} \]

\[ |p_\gamma| = \sqrt{E_\gamma^2 - m_\gamma^2} \]
So for each allowed \( E_y \) as determined by kinematics & dynamics (for distribution) — there is a box spectrum contribution to \( \frac{dN_y}{dE_y} \).

So I want to integrate over \( \frac{dN_y}{dE_y} \) to get contributions to \( \frac{dN_b}{dE_b} \).

One algorithm: build up \( \frac{dN_y}{dE_y} \) by summing discretized \( \frac{dN_b}{dE_y} \) contributions.

\[ \text{for each } E_{y,i}: \text{contribute} \]
\[ \frac{dN_b}{dE_b} = \left( \frac{dN_y}{dE_y} \right) \Delta E_{y,i} \times \text{BOX} \left( E_{min,i}^b, E_{max,i}^b \right) \]
\[ \text{# of } y \text{'s with } E_{y,i} \]

So that:
\[ \frac{dN_b}{dE_b} = \sum_i \frac{dN_y}{dE_y} \]
AN ALTERNATE METHOD: define \( \frac{dN}{dE_b} \) for each \( E_b \) by: given \( E_b \), find \( E_{q \text{ min}} \leq E_{q \text{ max}} \) that produce the energy \( E_0 \).

Is in principle?

Then integrate \( dN_{q \text{ max}} / dE_q \) over this range because this gives how many \( q \)'s in that \( E_q \) range.

Ok: I forgot that \( dN_{q \text{ max}} / dE_q \) must be normalized properly.
THEN PLAY THE SAME GAME FOR THE PHOTON DISTRIBUTION.

GIVEN $\frac{dN_0}{dE_0}$, WANT CONVOLUTION W/ $dN_x/dE_x \approx \text{binned}$

SO LET ME START W/ PRECISE THING I WANT:

$$\sum_{\text{bin}} \frac{dN_x}{dE_x} \cdot dE_x = N_x \approx 22 \# x's \text{ m each Fermi bin}$$

I HAVE PPPC FUNCTION

$$p : E_0 \rightarrow dN_x/dE_x$$

This costs time to interpolate

SO I REALLY ONLY WANT TO CALL THIS ONCE IF POSSIBLE.

$$p(E_0^i) \rightarrow dN_x/dE_x$$

DO: MAYBE THE EASIEST CHAIN IS

$$p(E_0^i) \rightarrow dN_x/dE_x \rightarrow \text{sample i bin}$$

Then sum all i contributions to get bin counts