Due date: April 19

Reading: Ch. 12

• Read 12.1.1 to 12.1.3 carefully.
• Read 12.1.4 somewhat less carefully, picking up notation.
• Skim 12.2. (I hope you have seen some of this before.) Be familiar with Eqs. (12.46), (12.49), and (12.59).
• Read 12.3.1 and 12.3.2 carefully. This is the heart of things.
• 12.3.3-5 will not appear on homeworks or exams, but I will discuss in class.


2. [3 points] Griffiths 12.7 (Particle decay experiment).


   Note: In case you missed the point: The remarkable result is that all observers will agree whether E-field or B-fields dominate at a certain time and place, depending on whether $E > cB$ or $E < cB$. In one case, there is a frame that make the fields pure $E$; in the other case, there is a frame that make the fields pure $B$.

6. [4 points] Here we derive the Doppler effect for EM waves. Suppose that in frame $S$ there is an electromagnetic wave described by
   \[
   E(x, y, z) = E_0 \cos(kx - \omega t) \hat{y},
   \]
   \[
   B(x, y, z) = \left(\frac{E_0}{c}\right) \cos(kx - \omega t) \hat{z},
   \]
   where $k = \omega/c$. Another frame $\mathcal{S}$ is moving along the $-\hat{x}$ direction at speed $v$ relative to frame $S$. Show that the wave appears in frame $\mathcal{S}$ as
   \[
   \mathcal{E}(\bar{x}, \bar{y}, \bar{z}) = \bar{E}_0 \cos(k\bar{x} - \bar{\omega} \bar{t}) \hat{y},
   \]
   \[
   \mathcal{B}(\bar{x}, \bar{y}, \bar{z}) = \left(\frac{\bar{E}_0}{c}\right) \cos(k\bar{x} - \bar{\omega} \bar{t}) \hat{z},
   \]
   and find the relations between $E_0$ and $\bar{E}_0$, $k$ and $\bar{k}$, and $\omega$ and $\bar{\omega}$. In particular, is the wave red-shifted ($\bar{\omega} < \omega$) or blue-shifted ($\bar{\omega} > \omega$)?