\[E_x = E_0 \cos(kz - \omega t)\]
\[B_y = B_0 \cos(kz - \omega t)\]

Waves propagate in a medium at a speed:

\[c = \frac{\omega}{k} = \frac{\lambda}{T} = \sqrt{\frac{\text{elastic properties}}{\text{inertial properties}}}\]
Velocity addition:

\[ U_{BT} = 10 \text{ km/h} \]

\[ U_{BG} = U_{BT} + \mu = 110 \text{ km/h} \]

C = Speed of light = 300,000 km/s

\[ \mu = \frac{3}{4} C, \quad U_{BT} = \frac{3}{4} C \]

\[ U_{BG} = \frac{3}{2} C > C \quad \text{impossible} \]
Galilean transformation

events: \((\vec{r}, t)\)

\[
\begin{align*}
x' &= x - ut \\
y' &= y \\
z' &= z \\
t' &= t
\end{align*}
\]

\[
\begin{align*}
x &= x' + ut' \\
y &= y' \\
z &= z' \\
t &= t'
\end{align*}
\]

replace ' by non-' and \(u\) by \((-u)\)
\[ u'_x = \frac{dx'}{dt'}, \quad a'_x = \frac{d^2x'}{dt'^2} = \frac{du'_x}{dt'} \]

\[ x' = x - ut \Rightarrow \quad u'_x = u_x - u \quad ; \quad u'_y = u_y \quad a'_x = a_x \quad a'_y = a_y \]

**Newton's Law:** \[ \vec{F} = m\vec{a} \]

holds in all inertial reference frames.

Given 2 systems moving relative to each other, we cannot tell which is moving and which is at rest.
Principle of relativity:
all laws of physics are the same in inertial ref. frames.
electromagnetism too!

ether = medium
where EM waves propagate.

\[ \Delta t' = \frac{L}{c - u} + \frac{L}{c + u} \neq \frac{2L}{c} \]

speed of a wave should not depend on speed of source of wave.
Michelson - Morley experiment: assume ether wind

\[ \mu < 5 \text{km/s} \]

\[ \frac{t}{c} + \mu = \frac{2L}{c} \frac{1}{1 - \mu^2/c^2} \]

\[ t_\perp = \frac{2L}{c} \sqrt{1 - \mu^2/c^2} ; \frac{(t_\parallel - t_\perp)}{t_\perp} = \frac{\mu^2}{c^2} \]
Taylor expansion - binomial expansion

\[(1 + x)^m \approx 1 + mx + O(x^2)\]

\[\text{for } x \ll 1 \quad f(x) = f(x_0) + f'(x_0)(x-x_0) + \frac{f''(x_0)}{2!}(x-x_0)^2 + \ldots\]

\[
\frac{1}{\sqrt{1-\frac{m^2}{c^2}}} = \left(1-\frac{m^2}{c^2}\right)^{-1/2} \approx 1 + \left(-\frac{1}{2}\right)\left(-\frac{m^2}{c^2}\right) = 1 + \frac{m^2}{2c^2}
\]