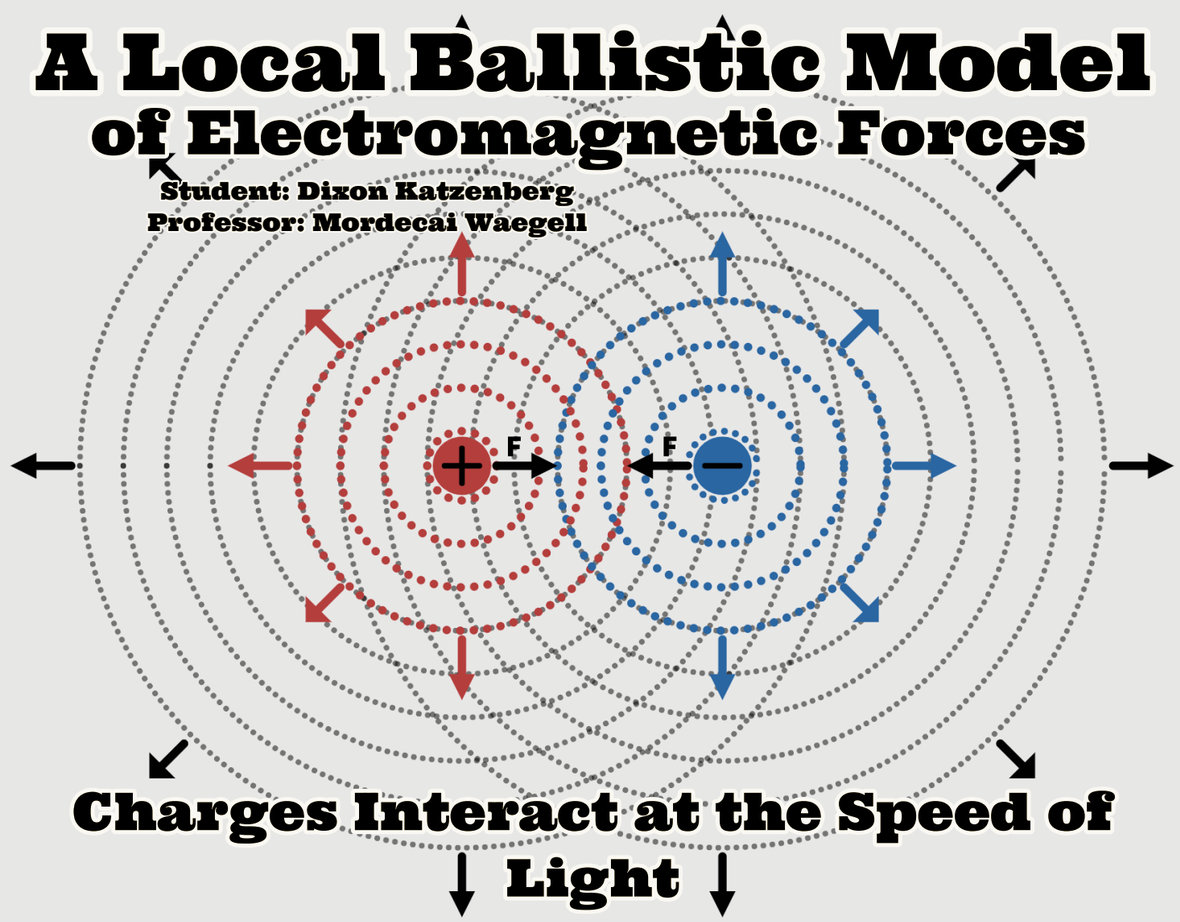
A Local Ballistic Model of Electromagnetic Forces

Student: Dixon Katzenberg
Professor: Mordecai Waegell



Charges Interact at the Speed of Light

Abstract

Electromagnetism is a well defined theory that has been a staple in technological and scientific advancement for a long while. However, some holes remain when we look deeper into the theory. We know that fields are made of tiny massless objects, yet the theory is still viewed at as a field theory. Thinking about the deeper, more complicated mechanisms of these massless objects leads to more questions than answers. While most experts know that fields are mediated by these particles, Many scientists take electromagnetism at face value and not think to take a deeper look at it. This project aims to provide a solution for a seemingly unsolvable problem and build a local model for electromagnetism.

What is Electromagnetism?

-Physical theory explaining how charges interact
-There is a lack of clarity and specificity on a local level
-Interaction speed indicates a physical exchange of information

The Lorentz Force

-Force between two charged particles
-Target principle to explain

$\vec{F}_c \equiv$ Coulomb Force

The Coloumb Force

-Coulomb force is the Lorentz force in the rest frame of the source

$$\vec{F}_c = \frac{q_s q_p}{4\pi\epsilon_o r^2}\hat{r}$$

A Local Ballistic Model $\vec{F} = \Gamma_s \vec{P}_0$

$\Gamma \equiv$ packet emission rate
$\vec{P} \equiv$ momentum per packet scattering

-Basic interaction between photons and charges
-Multiple photons exist at the same point in 'Packets'
-Photons carry information that can be non-observable
-Photons can only carry information from the past
-Builds from the rest frame of the source

Lorentz Transform

-Lorentz transform to other frame
-Other frame: different reference velocity
-Gets the full Lorentz force

$$\vec{F}' = \frac{\gamma_v}{\gamma_{v'}}(\vec{F} + (\gamma_\beta - 1)(\vec{F}\cdot\hat{\beta})\hat{\beta} - \gamma_\beta(\vec{F}\cdot\vec{v})\vec{\beta})$$
$$= q(\vec{E}' + (\vec{v}' \times \vec{B}'))$$

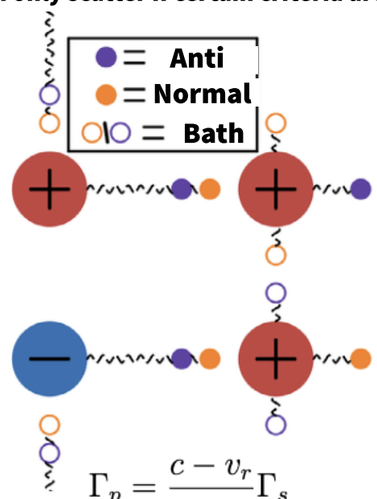
$\vec{F}' \equiv$ transformed force
$\vec{E}' \equiv$ electric field
$\vec{B}' \equiv$ magnetic field

Photon Bath and Stored Information

-How can collisions create an attractive force?
-Spacetime contains a frame-invariant bath of photons
-Photons have a switch for whether or not it is in the bath
-Photons can carry information about the sign of the last charge it scattered off of

-Photons with momentum opposing their direction of propagation must exist
-This photon will have "Anti-momentum"
-Photons can only scatter if certain criteria are met

Scattering Rules



In the bath:

-Photons in the bath scatter indiscriminately
-Scattering from bath creates no force

Not in the bath:

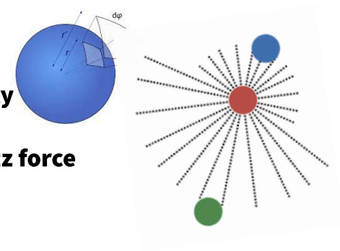
-Anti-momentum scatters off opposite charges
-Normal-momentum scatters off like charges

Drag Coefficient

-How is the Lorentz force independent of probe velocity?
-Fixed probe velocity issue
-Probe charges with velocity would experience augmented force
-Drag coefficient changes the energy range of photons scattered with velocity
-Fixes infinite force issue coming from the photon bath

$$\Gamma_p = \frac{c - v_r}{c}\Gamma_s$$
$$\Gamma_s \vec{P}_0 = \Gamma_p \vec{P}$$
$$\vec{P} = \frac{c}{c - v_r}\vec{P}_0$$

Spherical Distribution



-How is the Lorentz force dependent on distance?
-Source charges create a spherical distribution of photon packets

$$|\vec{F}| \propto \frac{1}{|r|^2}$$

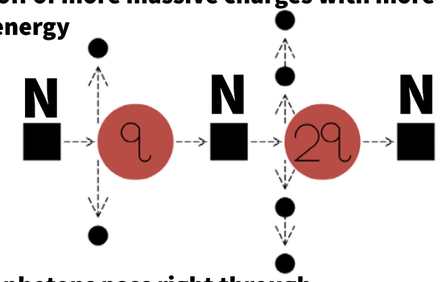
-Probe charge has finite area, naturally scatters less the farther away it is
-Distance dependence matches Lorentz force

Double Photon Scattering

-How can the Lorentz force be mass-independent?
-Photons scatter in pairs in any opposite directions
-Same impulse delivered to charge regardless of mass

-Solves mass independence
-Photons scatter off of more massive charges with more momentum and energy

Packets and Scattering Magnitude



-How can charge play a role in the Lorentz force?
-Wouldn't adjacent charges block photons?
-A higher-charge probe scatters a higher number of photons from packets
-A higher-charge source scatters a greater density of packets
-Packets have a nearly infinite number of photons

-Non-blocked photons pass right through
-Solves charge and shielding

-This research indicates that there could be a local partilce scattering model of electromagnetism
-This project could lay the groundwork in this area of study for future research or technological advancement