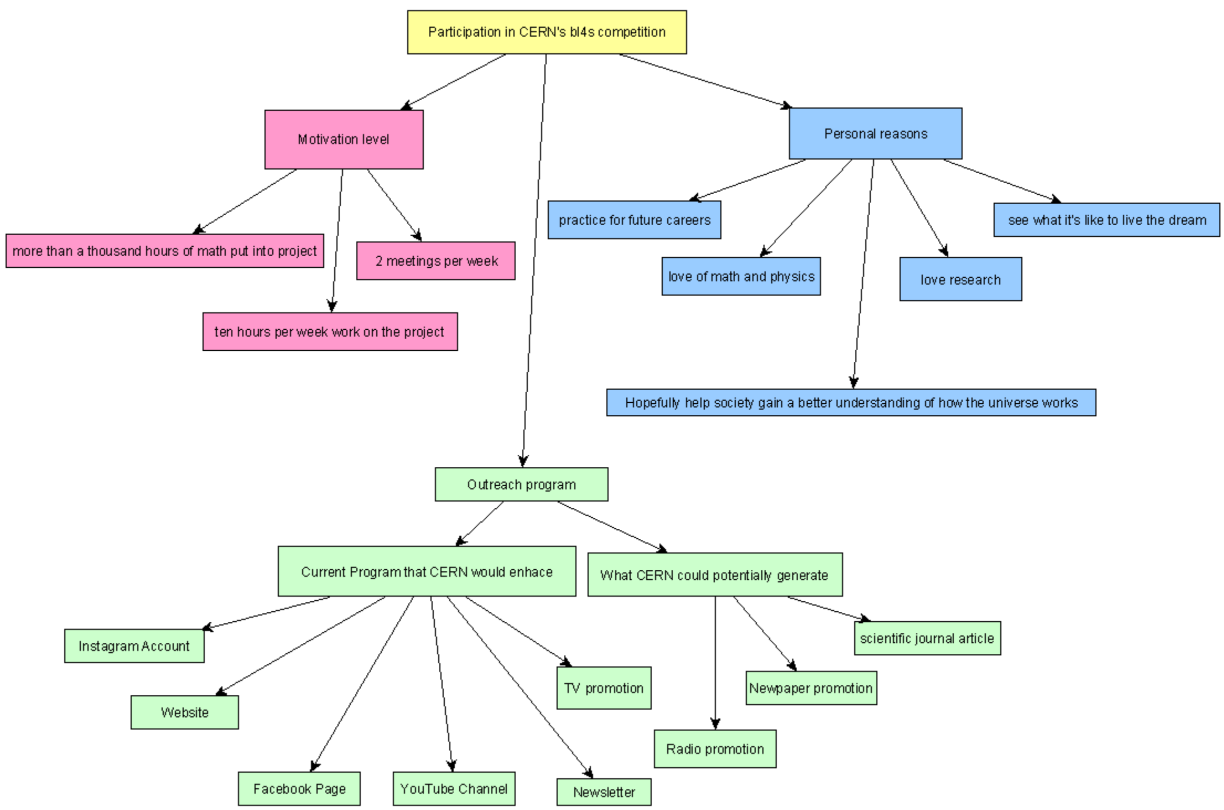
Team Investigate Tachyons bl4s Application

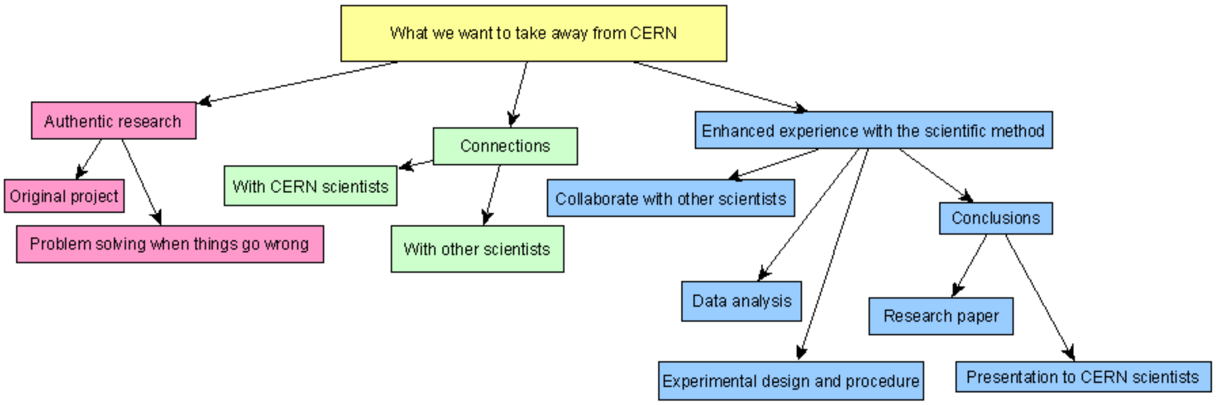
Why We Want to Go to CERN

The universe is like a beautiful painting: the paint is math, the patterns and how it flows together are science. We understand the beauty of math and science, which is best demonstrated by more than a thousand hours of math alone put into this project. Unfortunately, not everyone understands this beauty. We've have a website, a newsletter, YouTube videos, a PR representative, and we've been featured on the news to help other people understand. CERN is the best place in the world to look at the paint and the patterns of the universe. CERN would help us promote math and science to our school, our city, and perhaps the world.



What We Hope to Take Away

An opportunity to conduct authentic research based on original ideas, collaborating with professionals throughout the scientific method, and living our dreams is what we will take away from this experience. We will have hands on experience with operating a beamline, analyzing data, and problem solving when things go wrong. After we analyze the data and draw conclusions we want to be able to present these conclusions to the scientists at CERN and write a research paper so that other scientists may build off of our work.



Project Background

The math and theory displayed in this section are, as far as we know, results of original ideas that were developed by our team.

Force acts the same way on all objects based on the equation $F = ma$ or if you think about it relativistically you can find the equations from

$$\frac{d}{dt}\frac{\partial L}{\partial \dot{x}} - \frac{\partial L}{\partial x} = 0 \quad , \quad L = \frac{m_0 c^2}{\sqrt{1-\frac{v^2}{c^2}}} - m_0 c^2$$

There are four fundamental forces that act on objects differently based on mass, charge, isospin, and colour charge. Mass is the only one of these “charges,” that relates to energy $E = m\gamma c^2$. If all forces act the same then it would make sense to model the other forces like gravity to see if there is a relation between the other “charges,” and mass.

$$\frac{kq_1q_2}{r^2} = \frac{G\left(\phi_q q_1\right)\left(\phi_q q_2\right)\gamma_1\gamma_2}{r^2}$$

$$\frac{\alpha_W e^{-\frac{r}{M}}}{r^2} = \frac{T_1T_2\alpha_W e^{-\frac{r}{M}}}{|T_1||T_2|r^2} = \frac{G\left(\phi_W \frac{T_1}{|T_1|}\right)\left(\phi_W \frac{T_2}{|T_2|}\right)\gamma_1\gamma_2}{r^2}$$

ϕ_q and ϕ_W respectively relate q and T to mass.

$$\frac{k\,\cancel{q_1q_2}}{\cancel{r^2}} = \frac{G\left(\phi_q \cancel{q_1}\right)\left(\phi_q \cancel{q_2}\right)\gamma_1\gamma_2}{\cancel{r^2}}$$

$$k = G\phi_q^2 \gamma_1 \gamma_2$$

$$\phi_q^2 = \frac{k}{G\gamma_1\gamma_2}$$

$$\frac{\cancel{T_1 T_2}\alpha_W e^{-\frac{r}{M}}}{\cancel{|T_1||T_2|r^2}} = \frac{G\left(\phi_W \cancel{\frac{T_1}{|T_1|}}\right)\left(\phi_W \cancel{\frac{T_2}{|T_2|}}\right)\gamma_1\gamma_2}{\cancel{r^2}}$$

$$\alpha_W e^{-\frac{r}{M}} = G\phi_W^2 \gamma_1 \gamma_2$$

$$\phi_W^2 = \frac{\alpha_W e^{-\frac{r}{M}}}{G\gamma_1\gamma_2}$$

$$\phi_q^2 = \frac{k}{G\gamma_1\gamma_2} \quad , \quad \phi_W^2 = \frac{\alpha_W e^{-\frac{r}{M}}}{G\gamma_1\gamma_2}$$

Mass can only be positive and gravity is always attractive. In electromagnetism and the weak interaction unlike charges attract and like charges repel because they are mediated by spin 1 bosons. If you take G / r^2 to be positive then attraction is positive and ϕ_q^2 and ϕ_W^2 must be negative because

$$\frac{q_1 q_2 G}{r^2} \le 0 \quad , \quad \frac{T_1 T_2 G}{|T_1||T_2|r^r} \le 0$$

Taking G / r^2 to be negative you get the same result. Since ϕ_q^2 and ϕ_W^2 are negative $\phi_q, \phi_W \in C$ suggesting that charge and isospin can be thought of as imaginary mass. Now to find how they relate to each other to make up imaginary mass.

$$\frac{(m_1 + i\psi_1)(m_2 + i\psi_2)G\gamma_1\gamma_2}{r^2} = \frac{m_1 m_2 G\gamma_1\gamma_2}{r^2} - \frac{kq_1q_2}{r^2} - \frac{T_1 T_2 \alpha_W e^{-\frac{r}{M}}}{|T_1||T_2|r^2}$$

ψ is the imaginary component of mass that we are solving for.

$$(m_1 + i\psi_1)(m_2 + i\psi_2)G\gamma_1\gamma_2 = m_1 m_2 G\gamma_1\gamma_2 - kq_1q_2 - \frac{T_1 T_2 \alpha_W e^{-\frac{r}{M}}}{|T_1||T_2|}$$

$$\cancel{m_1 m_2 G\gamma_1\gamma_2} + iG\gamma_1\gamma_2(m_1\psi_2 + m_2\psi_1) - \psi_1\psi_2 G\gamma_1\gamma_2 = \cancel{m_1 m_2 G\gamma_1\gamma_2} - kq_1q_2 - \frac{T_1 T_2 \alpha_W e^{-\frac{r}{M}}}{|T_1||T_2|}$$

The imaginary parts have no impact on the force.

$$-\psi_1\psi_2 G\gamma_1\gamma_2 = -kq_1q_2 - \frac{T_1T_2\alpha_W e^{-\frac{r}{M}}}{|T_1||T_2|}$$

$$\psi_1\psi_2 = \frac{kq_1q_2}{G\gamma_1\gamma_2} + \frac{T_1T_2\alpha_W e^{-\frac{r}{M}}}{|T_1||T_2|G\gamma_1\gamma_2}$$

The only way to solve this is to model ψ as a vector.

$$\psi = \left(\sqrt{\frac{k}{G}}\frac{q}{\gamma}, \sqrt{\frac{\alpha_W e^{-\frac{r}{M}}}{G}}\frac{T}{|T|\gamma}\right) \quad |\psi| = \frac{1}{\gamma}\sqrt{\frac{k}{G}q^2 + \frac{\alpha_W e^{-\frac{r}{M}}}{G}}$$

Energy always has to be positive and real, imputing an imaginary component of mass into the relativistic equation for energy gives you a complex number, this must be accounted for.

$$E = \frac{(m_0 + i\psi_0)c^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\sqrt{1-\frac{v^2}{c^2}} = n(m_0 + i\psi_0)c^2 \quad n = \frac{1}{E}$$

$$1-\frac{v^2}{c^2} = n^2c^4\left(m_0^2 + i2m_0\psi_0 - \psi_0^2\right)$$

$$-\frac{v^2}{c^2} = n^2c^4\left(m_0^2 + i2m_0\psi_0 - \psi_0^2\right) - 1$$

$$\frac{v^2}{c^2} = n^2c^4\left(\psi_0^2 - m_0^2 - i2m_0\psi_0\right) + 1$$

$$v^2 = c^2\left[n^2c^4\left(\psi_0^2 - m_0^2 - i2m_0\psi_0\right) + 1\right]$$

$$v = c\sqrt{n^2c^4\left(\psi_0^2 - m_0^2 - i2m_0\psi_0\right) + 1}$$

Velocity has a real and an imaginary component but we can only observe the real component so now we solve for inverse energy n in terms of real velocity.

$$v = c\sqrt{n^2c^4\left(\psi_0^2 - m_0^2 - i2m_0\psi_0\right) + 1}$$

$$\alpha + i\beta = \sqrt{n^2c^4\left(\psi_0^2 - m_0^2 - i2m_0\psi_0\right) + 1}\ ,\ \alpha = \frac{v_r}{c}\ ,\ \beta = \frac{v_i}{c}$$

$$\alpha^2 + i2\alpha\beta - \beta^2 = n^2c^4\left(\psi_0^2 - m_0^2 - i2m_0\psi_0\right) + 1$$

$$\cancel{i2}\alpha\beta = -\cancel{i2}n^2c^4m_0\psi_0$$

$$\alpha\beta = -n^2 c^4 m_0 \psi_0$$

$$\beta = \frac{-n^2 c^4 m_0 \psi_0}{\alpha}$$

$$\alpha^2 - \beta^2 = n^2 c^4 \left(\psi_0^2 - m_0^2\right) + 1$$

$$\alpha^2 - \frac{n^4 c^8 m_0^2 \psi_0^2}{\alpha^2} = n^2 c^4 \left(\psi_0^2 - m_0^2\right) + 1$$

$$n^4 \left(\frac{c^8 m_0^2 \psi_0^2}{\alpha^2}\right) + n^2 \left[c^4 \left(\psi_0^2 - m_0^2\right)\right] = \alpha^2 - 1$$

$$n^4 + n^2 \left(\frac{\alpha^2 \left(\psi_0^2 - m_0^2\right)}{c^4 m_0^2 \psi_0^2}\right) = \frac{\alpha^4 - \alpha^2}{c^8 m_0^2 \psi_0^2}$$

$$n^4 + n^2 \left(\frac{\alpha^2 \left(\psi_0^2 - m_0^2\right)}{c^4 m_0^2 \psi_0^2}\right) + \frac{\alpha^4 \left(\psi_0^2 - m_0^2\right)^2}{4c^8 m_0^4 \psi_0^4} = \frac{\alpha^4 - \alpha^2}{c^8 m_0^2 \psi_0^2} + \frac{\alpha^4 \left(\psi_0^2 - m_0^2\right)^2}{4c^8 m_0^4 \psi_0^4}$$

$$\left(n^2 + \frac{\alpha^2 \left(\psi_0^2 - m_0^2\right)}{2c^4 m_0^2 \psi_0^2}\right)^2 = \frac{\alpha^4 - \alpha^2}{c^8 m_0^2 \psi_0^2} + \frac{\alpha^4 \left(\psi_0^2 - m_0^2\right)^2}{4c^8 m_0^4 \psi_0^4}$$

$$n^2 + \frac{\alpha^2 \left(\psi_0^2 - m_0^2\right)}{2c^4 m_0^2 \psi_0^2} = \sqrt{\frac{\alpha^4 - \alpha^2}{c^8 m_0^2 \psi_0^2} + \frac{\alpha^4 \left(\psi_0^2 - m_0^2\right)^2}{4c^8 m_0^4 \psi_0^4}}$$

$$n^2 = \sqrt{\frac{\alpha^4 - \alpha^2}{c^8 m_0^2 \psi_0^2} + \frac{\alpha^4 \left(\psi_0^2 - m_0^2\right)^2}{4c^8 m_0^4 \psi_0^4}} - \frac{\alpha^2 \left(\psi_0^2 - m_0^2\right)}{2c^4 m_0^2 \psi_0^2}$$

n is always positive and real and since we are looking at particles slower than light we can reach these inequalities.

$$\psi_0 \le m_0$$

$$\frac{\alpha^4 - \alpha^2}{c^8 m_0^2 \psi_0^2} + \frac{\alpha^4 \left(\psi_0^2 - m_0^2\right)^2}{4c^8 m_0^4 \psi_0^4} \ge 0$$

However $\psi_0 \ge m_0$ in some cases, so a correction must be made

$$E = \frac{\left(m_0 + i\psi_0\right)c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \rightarrow \quad E = \frac{\left(\mu_0 + i\psi_0\right)c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\frac{1}{n^2\left(\mu_0\right)} = \frac{m_0^2 c^4}{1 - \alpha^2}$$

$$\frac{1}{\sqrt{\frac{\alpha^4-\alpha^2}{c^8\mu_0^2\psi_0^2}+\frac{\alpha^4\left(\psi_0^2-\mu_0^2\right)^2}{4c^8\mu_0^4\psi_0^4}}-\frac{\alpha^2\left(\psi_0^2-\mu_0^2\right)}{2c^4\mu_0^2\psi_0^2}}=\frac{m_0^2c^4}{1-\alpha^2}$$

$$\mu_0=am_0$$

$$\frac{1}{\sqrt{\frac{\alpha^4-\alpha^2}{c^8a^2m_0^2\psi_0^2}+\frac{\alpha^4\left(\psi_0^2-a^2m_0^2\right)^2}{4c^8a^4m_0^4\psi_0^4}}-\frac{\alpha^2\left(\psi_0^2-a^2m_0^2\right)}{2c^4a^2m_0^2\psi_0^2}}=\frac{m_0^2c^4}{1-\alpha^2}$$

$$1=\frac{m_0^2c^4}{1-\alpha^2}\left[\sqrt{\frac{\alpha^4-\alpha^2}{c^8a^2m_0^2\psi_0^2}+\frac{\alpha^4\left(\psi_0^2-a^2m_0^2\right)^2}{4c^8a^4m_0^4\psi_0^4}}-\frac{\alpha^2\left(\psi_0^2-a^2m_0^2\right)}{2c^4a^2m_0^2\psi_0^2}\right]$$

$$1+\frac{m_0^2}{1-\alpha^2}\frac{\alpha^2\left(\psi_0^2-a^2m_0^2\right)}{2a^2m_0^2\psi_0^2}=\frac{m_0^2c^4}{1-\alpha^2}\sqrt{\frac{\alpha^4-\alpha^2}{c^8a^2m_0^2\psi_0^2}+\frac{\alpha^4\left(\psi_0^2-a^2m_0^2\right)^2}{4c^8a^4m_0^4\psi_0^4}}$$

$$1+\frac{m_0^2c^4}{1-\alpha^2}\frac{\alpha^2\left(\psi_0^2-a^2m_0^2\right)}{c^4a^2m_0^2\psi_0^2}+\cancel{\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4\left(\psi_0^2-a^2m_0^2\right)^2}{4a^4m_0^4\psi_0^4}}=\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4-\alpha^2}{a^2m_0^2\psi_0^2}+\cancel{\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4\left(\psi_0^2-a^2m_0^2\right)^2}{4a^4m_0^4\psi_0^4}}$$

$$1+\frac{m_0^2c^4}{1-\alpha^2}\frac{\alpha^2\left(\psi_0^2-a^2m_0^2\right)}{c^4a^2m_0^2\psi_0^2}=\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4-\alpha^2}{a^2m_0^2\psi_0^2}$$

$$a^2+\frac{m_0^2}{1-\alpha^2}\frac{\alpha^2\left(\psi_0^2-a^2m_0^2\right)}{m_0^2\psi_0^2}=\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4-\alpha^2}{m_0^2\psi_0^2}$$

$$a^2\left(1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}\right)=\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4-\alpha^2}{m_0^2\psi_0^2}-\frac{\alpha^2}{1-\alpha^2}$$

$$a^2=\frac{\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4-\alpha^2}{m_0^2\psi_0^2}-\frac{\alpha^2}{1-\alpha^2}}{1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}}$$

$$a^2=\frac{\mu_0^2}{m_0^2}$$

$$\mu_0^2=m_0^2\left(\frac{\frac{m_0^4}{\left(1-\alpha^2\right)^2}\frac{\alpha^4-\alpha^2}{m_0^2\psi_0^2}-\frac{\alpha^2}{1-\alpha^2}}{1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}}\right)$$

$$\mu_0^2 = m_0^2\left(\frac{\dfrac{m_0^2\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2}-\dfrac{\alpha^2}{1-\alpha^2}}{1-\dfrac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}}\right)$$

$$\mu_0 = m_0\sqrt{\frac{\dfrac{m_0^2\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2}-\dfrac{\alpha^2}{1-\alpha^2}}{1-\dfrac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}}}$$

Now to solve the other inequality for α^2.

$$\frac{\alpha^4-\alpha^2}{c^8\mu_0^2\psi_0^2}+\frac{\alpha^4\left(\psi_0^2-\mu_0^2\right)^2}{4c^8\mu_0^4\psi_0^4}\geq 0$$

$$\frac{\alpha^4\left(\psi_0^2-\mu_0^2\right)^2}{4c^8\mu_0^4\psi_0^4}\geq\frac{\alpha^2-\alpha^4}{c^8\mu_0^2\psi_0^2}$$

$$\frac{\alpha^4\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}\geq\alpha^2-\alpha^4$$

$$\alpha^4\left(\frac{\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}+1\right)-\alpha^2\geq 0$$

$$\alpha^2\left(\alpha^2\left(\frac{\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}+1\right)-1\right)\geq 0$$

$$\alpha^2\left(\frac{\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}+1\right)-1\geq 0$$

$$\alpha^2\left(\frac{\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}+1\right)\geq 1$$

$$\alpha^2\geq\frac{1}{\dfrac{\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}+1}$$

Now to solve for ψ_0^2 to make the math easier.

$$\alpha^2 \geq \frac{1}{\frac{\left(\psi_0^2-\mu_0^2\right)^2}{4\mu_0^2\psi_0^2}+1}$$

$$\mu_0 = b\psi_0$$

$$\alpha^2 \geq \frac{1}{\frac{\left(\psi_0^2-b^2\psi_0^2\right)^2}{4b^2\psi_0^4}+1}$$

$$\alpha^2 \geq \frac{1}{\frac{\cancel{\psi_0^4}\left(1-b^2\right)^2}{4b^2\cancel{\psi_0^4}}+1}$$

$$\alpha^2 \geq \frac{1}{\frac{\left(1-b^2\right)^2}{4b^2}+1}$$

$$\alpha^2 \geq \frac{1}{\frac{\left(1-2b^2+b^4\right)}{4b^2}+1}$$

$$\alpha^2\left(\frac{\left(1-2b^2+b^4\right)}{4b^2}+1\right) \geq 1$$

$$\frac{\left(1-2b^2+b^4\right)}{4b^2}+1 \geq \frac{1}{\alpha^2}$$

$$\frac{\left(1-2b^2+b^4\right)}{4}+b^2 \geq \frac{b^2}{\alpha^2}$$

$$b^4\left(\frac{1}{4}\right)+b^2\left(\frac{1}{2}-\frac{1}{\alpha^2}\right) \geq -\frac{1}{4}$$

$$b^4+b^2\left(2-\frac{4}{\alpha^2}\right) \geq -1$$

$$b^4+b^2\left(2-\frac{4}{\alpha^2}\right)+\left(1-\frac{2}{\alpha^2}\right)^2 \geq -1+\left(1-\frac{2}{\alpha^2}\right)^2$$

$$\left(b^2+1-\frac{2}{\alpha^2}\right)^2 \geq \left(1-\frac{2}{\alpha^2}\right)^2-1$$

$$b^2+1-\frac{2}{\alpha^2} \geq \sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}$$

$$b^2 \geq \sqrt{\left(1-\frac{2}{\alpha^2}\right)^2 -1} -1+\frac{2}{\alpha^2}$$

$$\mu_0 = b\psi_0$$

$$b = \frac{\mu_0}{\psi_0}$$

$$b^2 = \frac{\mu_0^2}{\psi_0^2}$$

$$\psi_0^2 = \frac{\mu_0^2}{b^2}$$

$$\psi_0^2 \leq \frac{\mu_0^2}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2 -1} -1+\frac{2}{\alpha^2}}$$

μ_0^2 is a function of ψ_0^2.

$$\psi_0^2 \leq \frac{\mu_0^2}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2 -1} -1+\frac{2}{\alpha^2}}$$

$$\mu_0^2 = m_0^2 \left(\frac{\frac{m_0^2\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2} - \frac{\alpha^2}{1-\alpha^2}}{1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}} \right)$$

$$\psi_0^2 \leq \frac{m_0^2 \left(\frac{\frac{m_0^2\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2} - \frac{\alpha^2}{1-\alpha^2}}{1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}} \right)}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2 -1} -1+\frac{2}{\alpha^2}}$$

$$\psi_0^2 \left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2 -1} -1+\frac{2}{\alpha^2} \right) \leq m_0^2 \left(\frac{\frac{m_0^2\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2} - \frac{\alpha^2}{1-\alpha^2}}{1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}} \right)$$

$$\psi_0^2\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)\left(1-\frac{m_0^2\alpha^2}{\left(1-\alpha^2\right)\psi_0^2}\right)\le m_0^2\left(\frac{m_0^2\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2}-\frac{\alpha^2}{1-\alpha^2}\right)$$

$$\psi_0^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-\psi_0^2+\frac{2\psi_0^2}{\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}+\frac{m_0^2\alpha^2}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\le\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\psi_0^2\left(1-\alpha^2\right)^2}-\frac{\alpha^2 m_0^2}{1-\alpha^2}$$

$$\psi_0^4\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-\psi_0^4+\frac{2\psi_0^4}{\alpha^2}-\frac{m_0^2\alpha^2\psi_0^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}+\frac{m_0^2\alpha^2\psi_0^2}{1-\alpha^2}-\frac{2m_0^2\psi_0^2}{1-\alpha^2}\le\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}-\frac{\alpha^2 m_0^2\psi_0^2}{1-\alpha^2}$$

$$\psi_0^4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)+\psi_0^2\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)\le\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}$$

$$\psi_0^4+\psi_0^2\left(\frac{\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}\right)\le\frac{\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}$$

$$\psi_0^4+\psi_0^2\left(\frac{\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}\right)+\frac{\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)^2}{4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)^2}\le\frac{\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}+\frac{\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)^2}{4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)^2}$$

$$\left(\psi_0^2+\frac{\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}}{2\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)}\right)^2\le\frac{\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}+\frac{\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)^2}{4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)^2}$$

$$\psi_0^2+\frac{\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}}{2\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)}\le\sqrt{\frac{\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}+\frac{\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)^2}{4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)^2}}$$

$$\psi_0^2\le\sqrt{\frac{\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}+\frac{\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)^2}{4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)^2}}-\frac{\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}}{2\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)}$$

$$\left|\psi\right|=\frac{1}{\gamma}\sqrt{\frac{k}{G}q^2+\frac{\alpha_w e^{-\frac{r}{M}}}{G}}$$

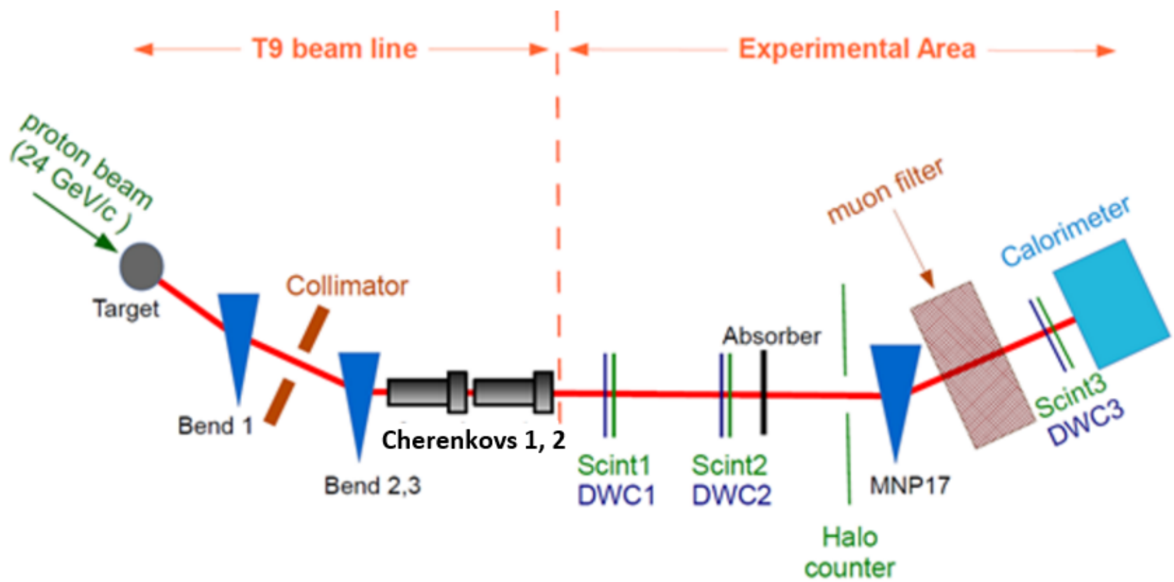
$$\frac{k}{G\gamma^2}q^2+\frac{\alpha_W e^{-\frac{r}{M}}}{G\gamma^2}\le\sqrt{\frac{\frac{m_0^4\left(\alpha^4-\alpha^2\right)}{\left(1-\alpha^2\right)^2}}{\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}}+\frac{\left(\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}\right)^2}{4\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)^2}}-\frac{\frac{2m_0^2\alpha^2}{1-\alpha^2}-\frac{m_0^2\alpha^2\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}}{1-\alpha^2}-\frac{2m_0^2}{1-\alpha^2}}{2\left(\sqrt{\left(1-\frac{2}{\alpha^2}\right)^2-1}-1+\frac{2}{\alpha^2}\right)}$$

We call this last line McArthur's inequality, if it holds true for all particles then all the math that has been done cannot be ruled out as incorrect.

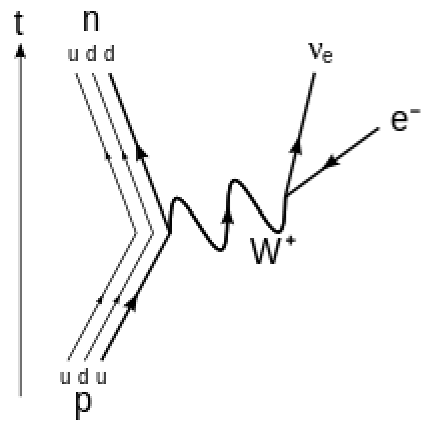
We are currently making further developments in the math.

How We Will Use The Beamline

Now to determine if the math is correct. Charge of the incoming particle, range of the mediating particle of the weak interaction, mass of the mediating particle of the weak interaction, mass of an incoming particle of the weak interaction, and velocity of an incoming particle must be solved for to test McArthur's inequality. These variables can be solved for by sending in a positive beam of particles, bending them with the MNP17 magnet, and watching the tracks through a delay wire chamber or other tracking chamber and observing the weak interactions. π^+ and K^+ particles always decay through the weak interaction so to maximize the amount of pions and kaons present in the beam we will be sending in particles of momentum 7GeV/c.



Charge of the incoming particle has to be +1 because that is the charge of all the particles in the positive beam. Mass of the mediating particle depends on if the interaction was a W or Z decay. They both have known masses and higher order interactions are unlikely because higher orders of the coupling constant cause small amplitudes. The range of the mediating particle can be found by looking at momentum of particles and doing some math, here's an example for a weak decay.



$$M = \int_0^\infty \frac{\eta_{\mu\nu} - q_\mu q_\nu}{q^2 - m^2} \left(-ig\right)^2 \left(2\pi\right)^8 \delta\left(p_u - p_d - q\right) \delta\left(q - p_{e^+} - p_{\nu_e}\right) d^4 q$$

Integration through inspection shows $q = p_{e^+} + p_{\nu_e}$.

$$\frac{m_{W^+} v}{\sqrt{1 - \frac{v^2}{c^2}}} = p_{e^+} + p_{\nu_e}$$

$$\frac{m_{W^+}^2 v^2}{1 - \frac{v^2}{c^2}} = p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2$$

$$m_{W^+}^2 v^2 = \left(1 - \frac{v^2}{c^2}\right)\left(p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2\right)$$

$$v^2 \left(m_{W^+}^2 + \frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{c^2} \right) = p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2$$

$$v^2 = \frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{m_{W^+}^2 + \frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{c^2}}$$

$$v = \sqrt{\frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{m_{W^+}^2 + \frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{c^2}}}$$

$$r = vt$$

$$r = t \sqrt{\frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{m_{W^+}^2 + \frac{p_{e^+}^2 + 2 p_{e^+} p_{\nu_e} + p_{\nu_e}^2}{c^2}}}$$

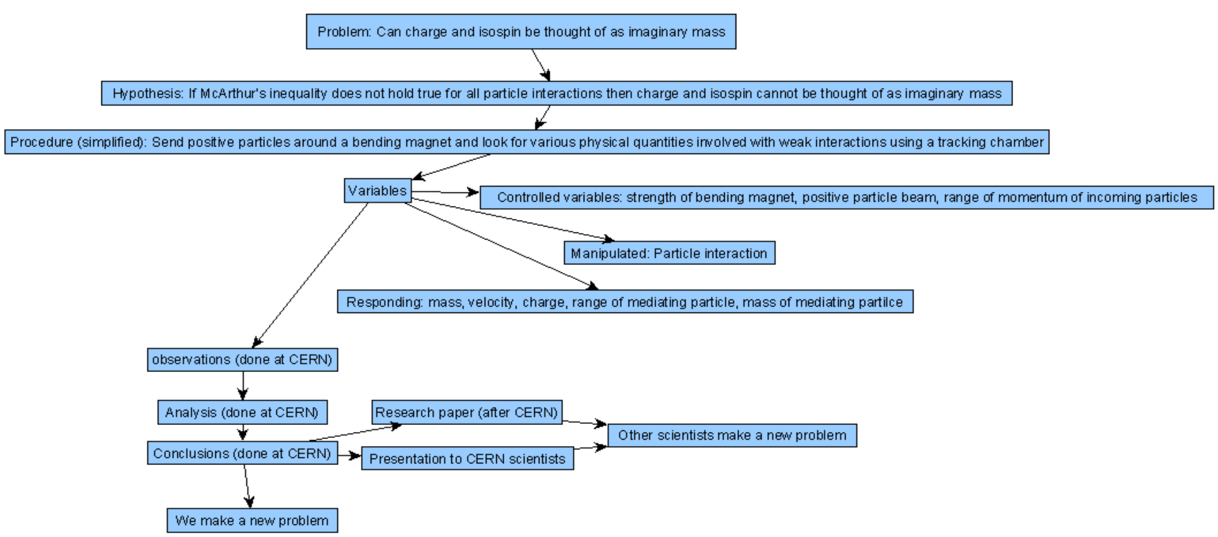
t is the lifetime of the mediating particle and is well known. Calculating the mass of the incoming particle is a bit simpler.

$$F_c = F_m$$
$$\frac{mv^2}{r} = qvB$$
$$\frac{mv}{r} = qB$$
$$m = \frac{qBr}{v}$$

r is the radius of the curvature of the particle when it goes through the magnetic field. This technique will also be used to calculate the mass of the outgoing particles which will be crucial when solving for the range. The velocity of any particle can be solved by measuring how far a particle goes in a specific time, $v = d/t$.

Scientific Method

The variables used in McArthur's inequality can be solved for using the described experimental setup. Through testing McArthur's Inequality, we are able answer our problem: Is modelling charge and isospin as imaginary mass consistent with experimental results? We can test our hypothesis: If McArthur's inequality does not hold true for all particle interactions then charge and isospin cannot be thought of as imaginary mass. We will make a procedure, analyze data, and reach conclusions at CERN.



Thank you for your consideration!

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