My project will be an introduction to gauge theory in electromagnetism.  I will discuss various gauges and their use and application in studying the magnetic field, as well as its historical importance and creation.  Gauge theory is a type of field theory involved in studying invariance under certain transformation.  It is used in electrodynamics to describe the symmetries involved in the study of potentials.  **A** is not uniquely determined from the physics of a situation, and the ambiguity is solved by choosing a gauge to work in.  I will investigate the process of choosing this gauge, as well as exploring the gauges used in electrodynamics.  If I have space, I will also explore some of the mathematics behind gauge theory.

This topic is of interest to me for a couple reasons. First, gauge theory is a highly mathematical theory with connections to several mathematical concepts with which I have some amount of experience - for instance, vector fields and Lie algebras.  As mathematics is my main interest, this is a good way to explore electrodynamics from a more mathematical perspective.  Also, the relation to symmetry in electromagnetism is of interest to me, and I feel it would be interesting to explore the differences in gauges and how they describe the same situation despite the change in function.

Below is a cited list of some papers of interest.

Jackson, J. D. (2002) From Lorenz to Coulomb and other explicit gauge transformations. *American Journal of Physics, 70*, 917. Retrieved from <http://aapt.scitation.org.proxy1.cl.msu.edu/doi/10.1119/1.1491265>

Jackson, J. D.; Okun, L.B. (2001) Historical roots of gauge invariance. *Reviews of Modern Physics, 73,* 663. Retrieved from <https://journals-aps-org.proxy1.cl.msu.edu/rmp/abstract/10.1103/RevModPhys.73.663>

L. Lorenz (1867) XXXVIII. On the identity of the vibrations of light with electrical

currents. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science,*

*34*, 287-301. Retrieved from <http://www.tandfonline.com/doi/pdf/10.1080/14786446708639882>

Maxwell, James Clerk. (1865) A dynamical theory of the electric field. *Philosophical Transactions of the Royal Society of London, 155,* 459-512. Retrieved from <http://rstl.royalsocietypublishing.org/content/155/459.full.pdf+html>