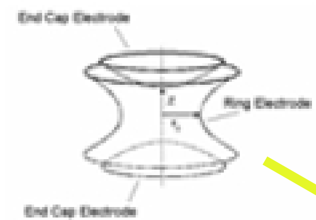
E&M Simulations

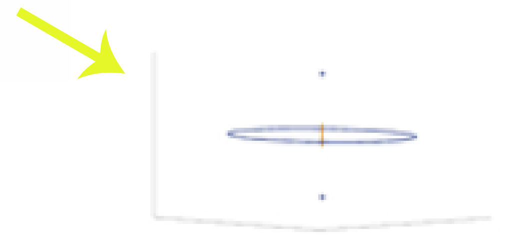
The Behaviors of a Penning-Ion Trap & DC Motor

Contributors: Samantha Yang, Samantha Becht

December 2009, Olin Year 1

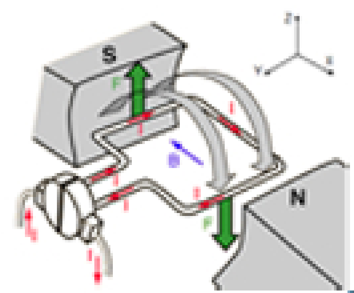
This is a paper written in the E&M: Modeling & Simulation class in freshman year. Yang and I present a simplified model for the **conventional Penning Ion Trap**, used to confine single and multiple ions in a trap. It helps physicists to determine charge-to-mass ratios of atomic particles, characteristics of fundamental constants, and advancements in quantum computation.



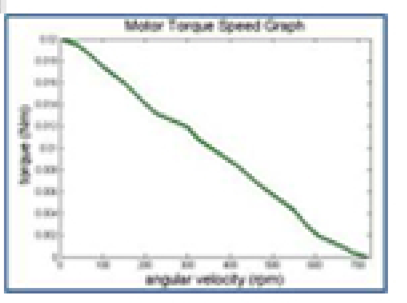


Our simplified **design** of the Trap consists of 2 positive point charges and a negatively charged ring centered halfway between the charges. Charged particles are confined within this configuration due to a combination of a static electric and static magnetic field. Our **aim** is to prove that particles do affect the motion of other particles.
The MATLAB simulation **results** support that there must be a maximum number of ions that can be trapped at one time.

The **direct current motor** was the first type of motor to be created to convert electrical to rotational mechanical energy in the 1800s. In industry, the torque-speed curve of a DC motor is the most-widely used characteristic of a motor, to pick motors that can operate on the required load without stress.



Becht and I **aim**ed to verify our hypothesized inverse correlation between the load torque and the angular speed of an ideal DC motor. Emphasis was placed on the physics behind the torque-speed relationship.
A mathematical simulation in MATLAB of a direct current motor with various loads ‘placed’ on the motor was used to observe the steady state maximum rotational speed reached over time. The **design** of a motor was simplified to be a metal loop of wire turning in between 2 magnets of opposite polarity.
The **result** was observed to be an inverse relationship between the torque and speed of a DC motor.



This poster was a Finalist at the National SWE Conference in Orlando in Nov. 2010.