# Rail Guns

--Timothy S. Reichmann

Senior Seminar Presentation (APPH E4903)

What Are Rail Guns

- 2 rails of conducting metal
- Oppositely charged with a conductor connecting them
- Charge is driven through the conductor
- Magnetic field is produced which accelerates the conductor down the rails
- Enough current and long enough rails yields tremendous force and energy

The Physics

Railguns Magnetic Field Effect
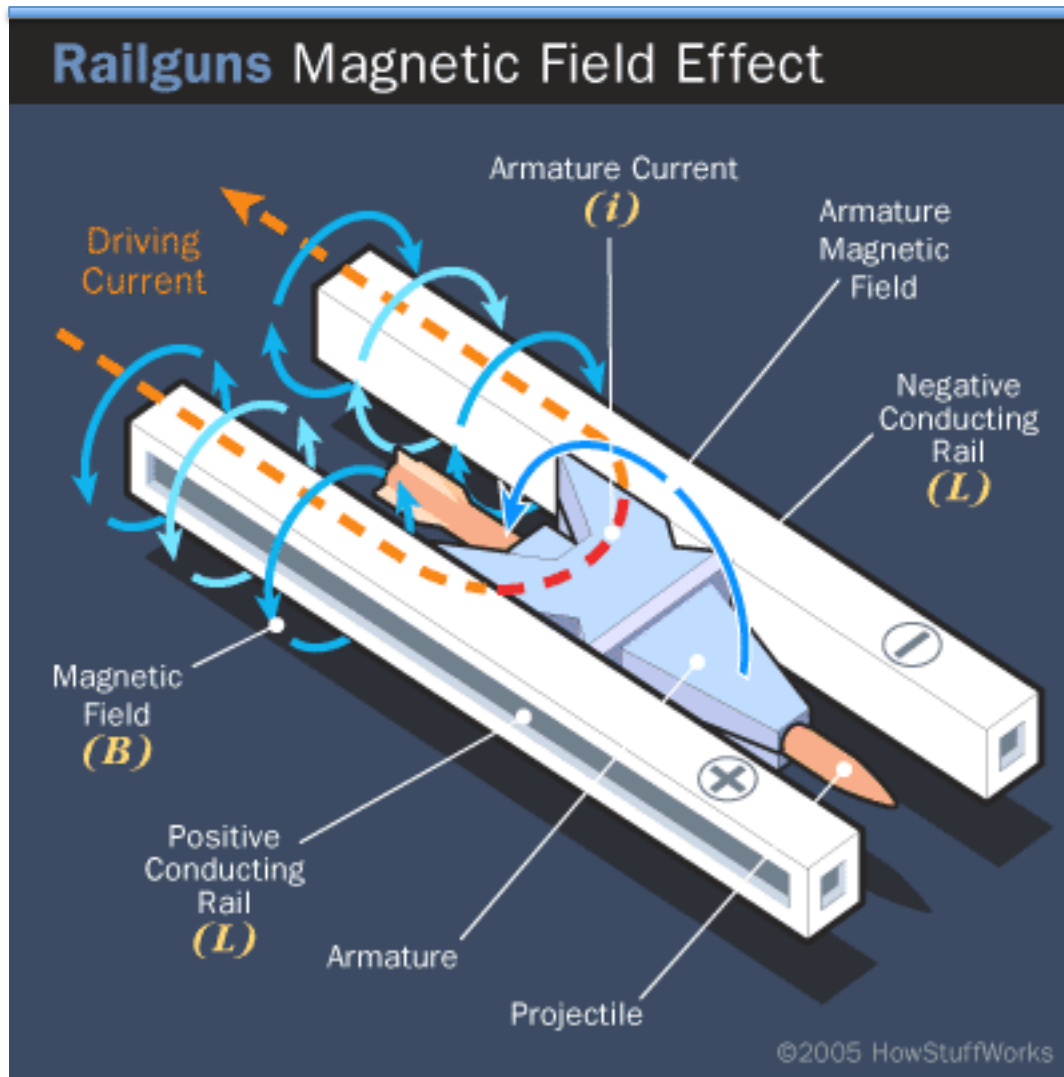
- Rails are oppositely charged

- Driving current between rails through projectile

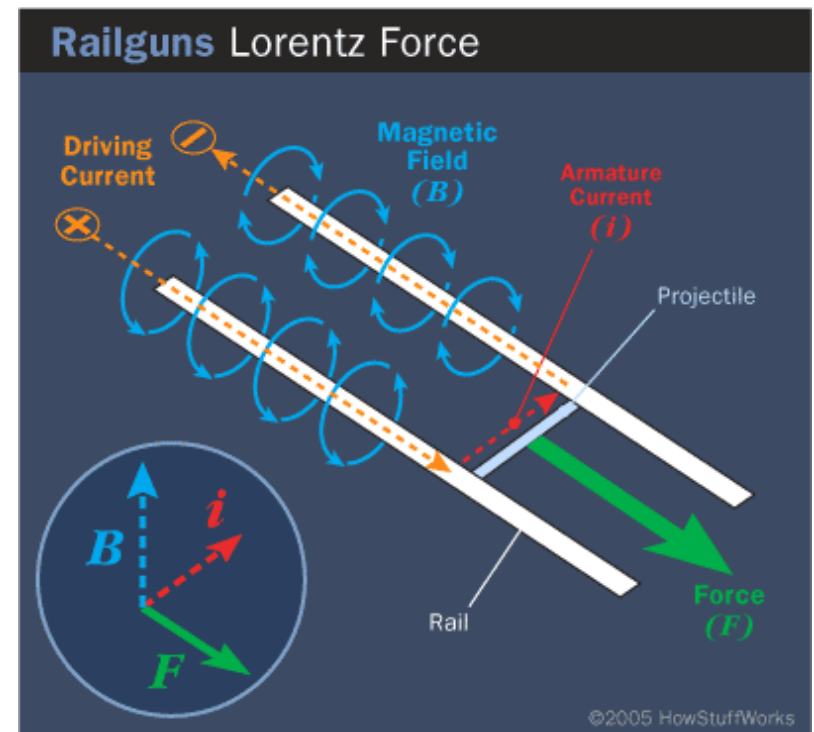- Magnetic field is produced that act to accelerate the projectile

The details

- Biot-Savart magnetic field

$$B(s) = \frac{\mu_0 I}{2\pi} \left(\frac{1}{s} + \frac{1}{d-s} \right)$$

- Lorentz force

$$F = IdB_{\mathrm{avg}} = \frac{\mu_0 I^2}{2\pi} \ln \frac{d}{r}$$

- Some quick numbers:
  - 10^6 Amps
  - 30 Feet (rails)
  - 10^6 Joules

Railguns Lorentz Force

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Similar Idea: A Coil Gun

- Solenoid coils with a current passing through them.
- This magnetic field magnetizes a ferromagnetic projectile
- Causes a force towards the center of the solenoid.
- The force is attractive on both ends so it means that once the armature has reached the centerpoint, it will experience a braking force (known as suck-back).
- With long coils, there will be a period where no force is exerted on the projectile.
- There are many types of designs each with his advantages and drawbacks.
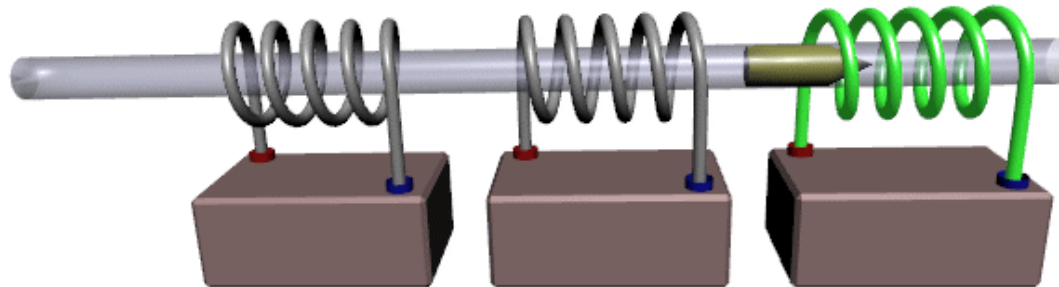
History of Rail Guns

- The army and navy have long been interested

- The space industry has looked into them

- Small-scale versions are easy to make in a lab though they are of limited use.

Current Rail Guns

- Navy Surface Center Dahlgren Division

  – February 27, 2012

  – 33 MJ shot

  – Range of 110-220 NM (vs 13 NM or 60 NM)

  – 40 lb metal bullet

  – $240 million as of early 2012

Issues with Rail Guns

- Power Supply

- Heating

- Melting

- Repulsion

Sources

- Dailytech.com http://www.dailytech.com/Navy+Railgun+Fires+33megajoule+Shot+/article20372.htm
- Science.howstuffworks.com

More Reading:

http://www.utexas.edu/research/cem/IEEE/PR%2073%20Price%20Publications.pdf

http://www.globalsecurity.org/military/systems/ship/systems/emrg.htm

http://users.tm.net/lapointe/EMGuns.html

Questions?