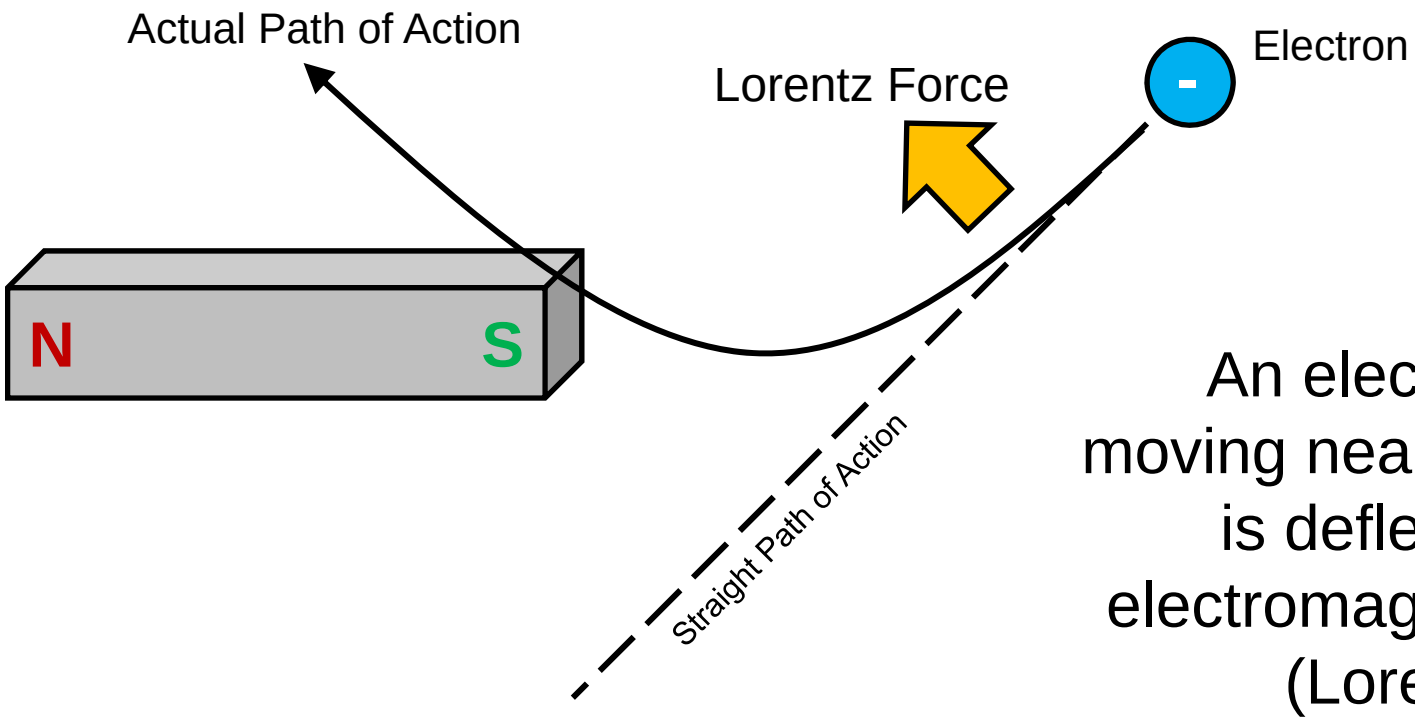
Electromagnetism

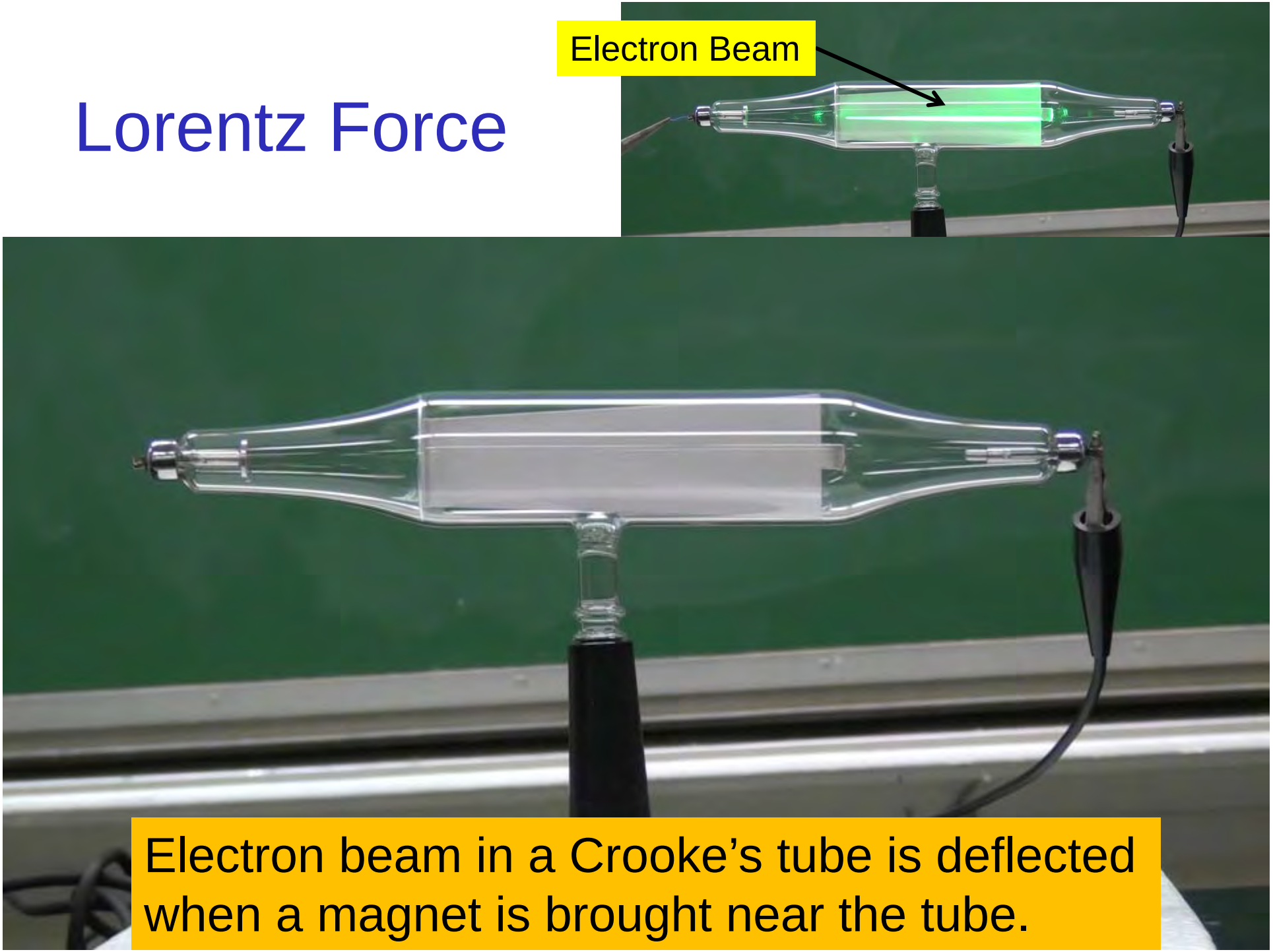
Electromagnetism

Electricity and magnetism are closely linked.



An electric charge moving near a magnet is deflected by an electromagnetic force (Lorentz force).

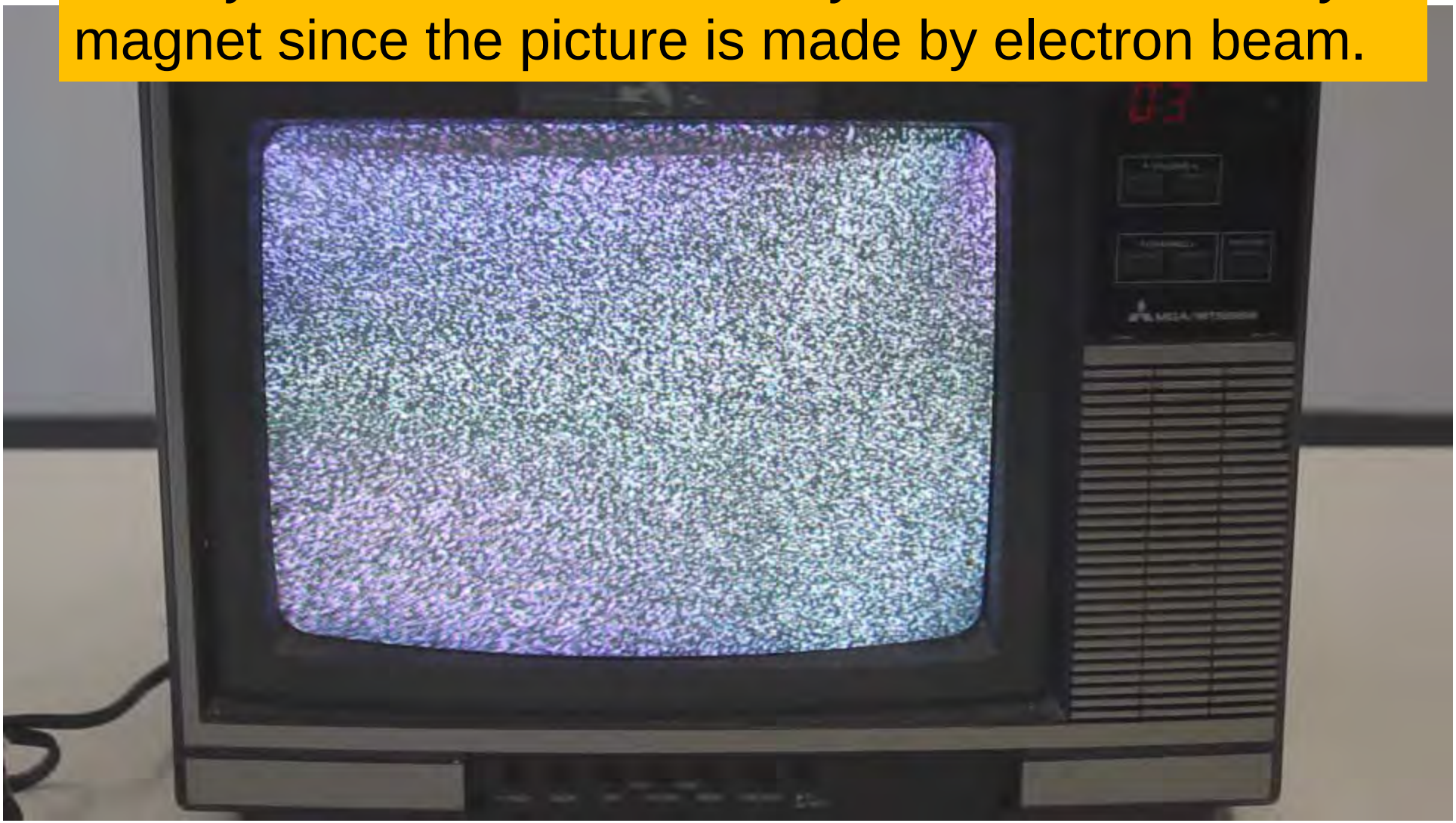
Lorentz Force



Electron beam in a Crooke's tube is deflected when a magnet is brought near the tube.

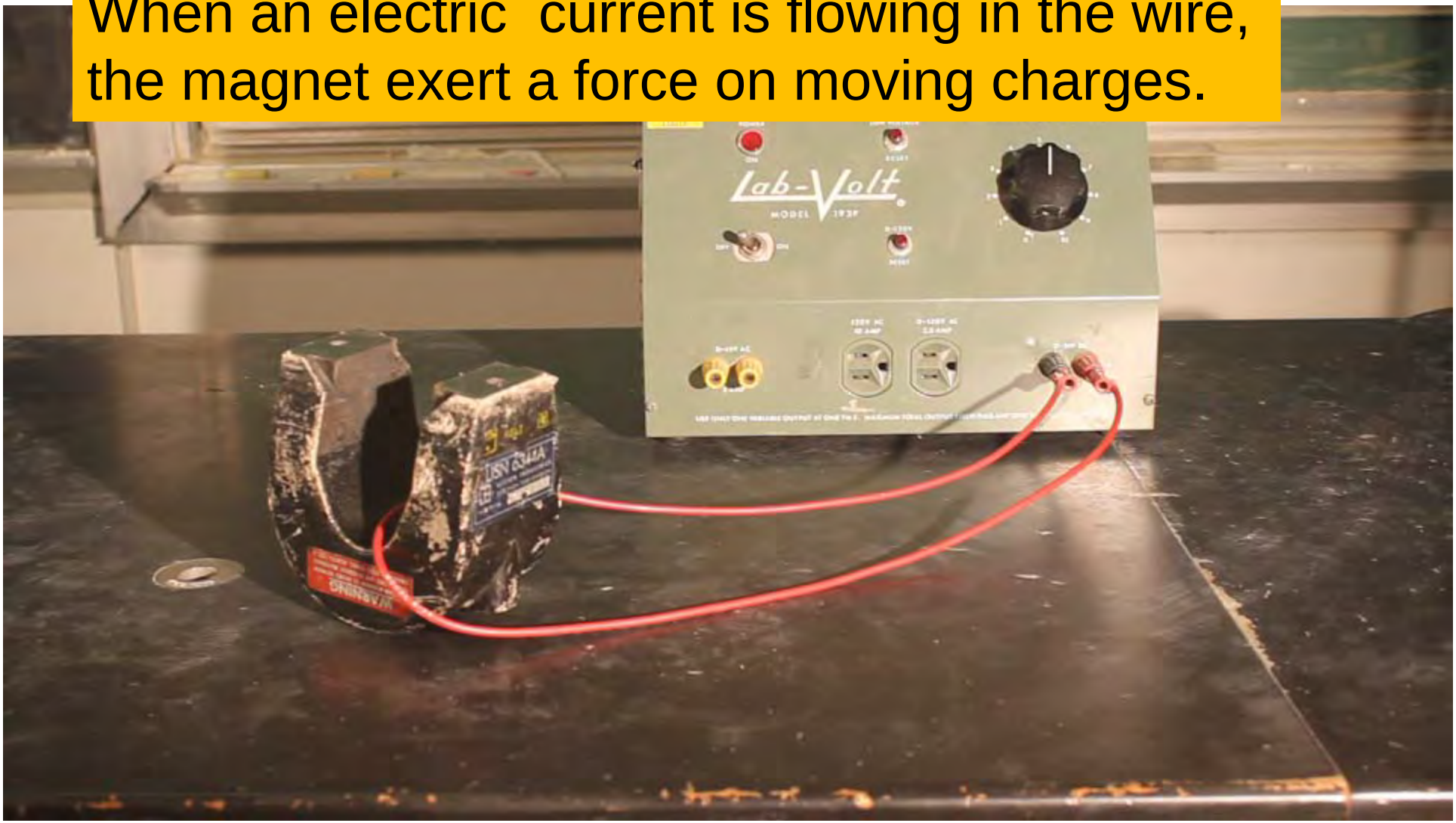
Lorentz Force

Old-style TV with a cathode ray tube is distorted by a magnet since the picture is made by electron beam.



Lorentz Force

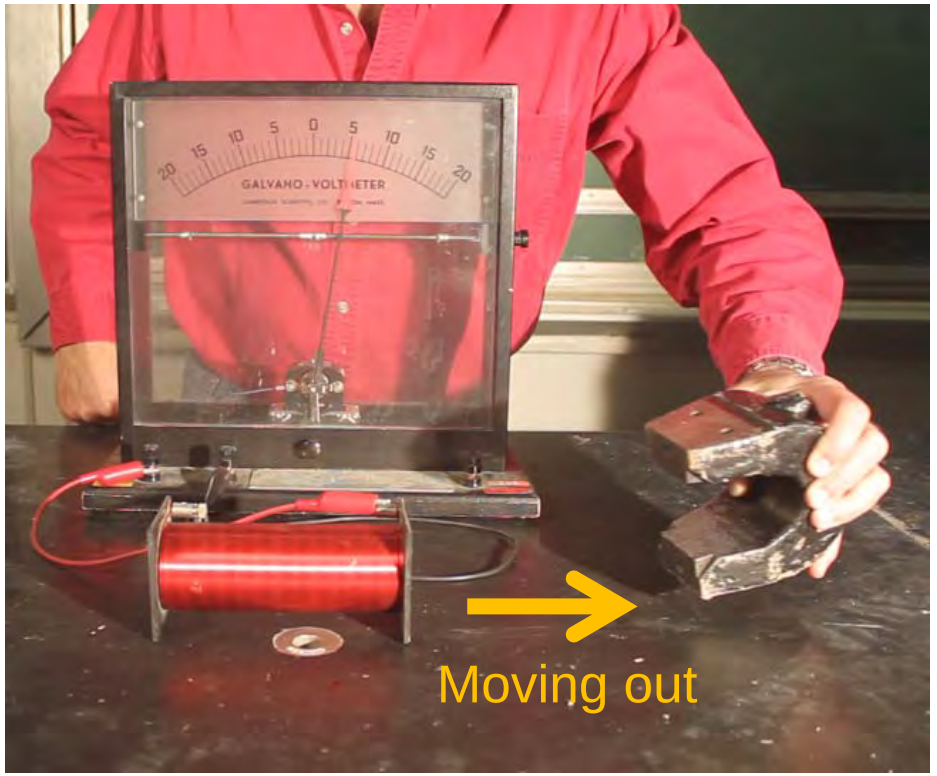
When an electric current is flowing in the wire, the magnet exert a force on moving charges.



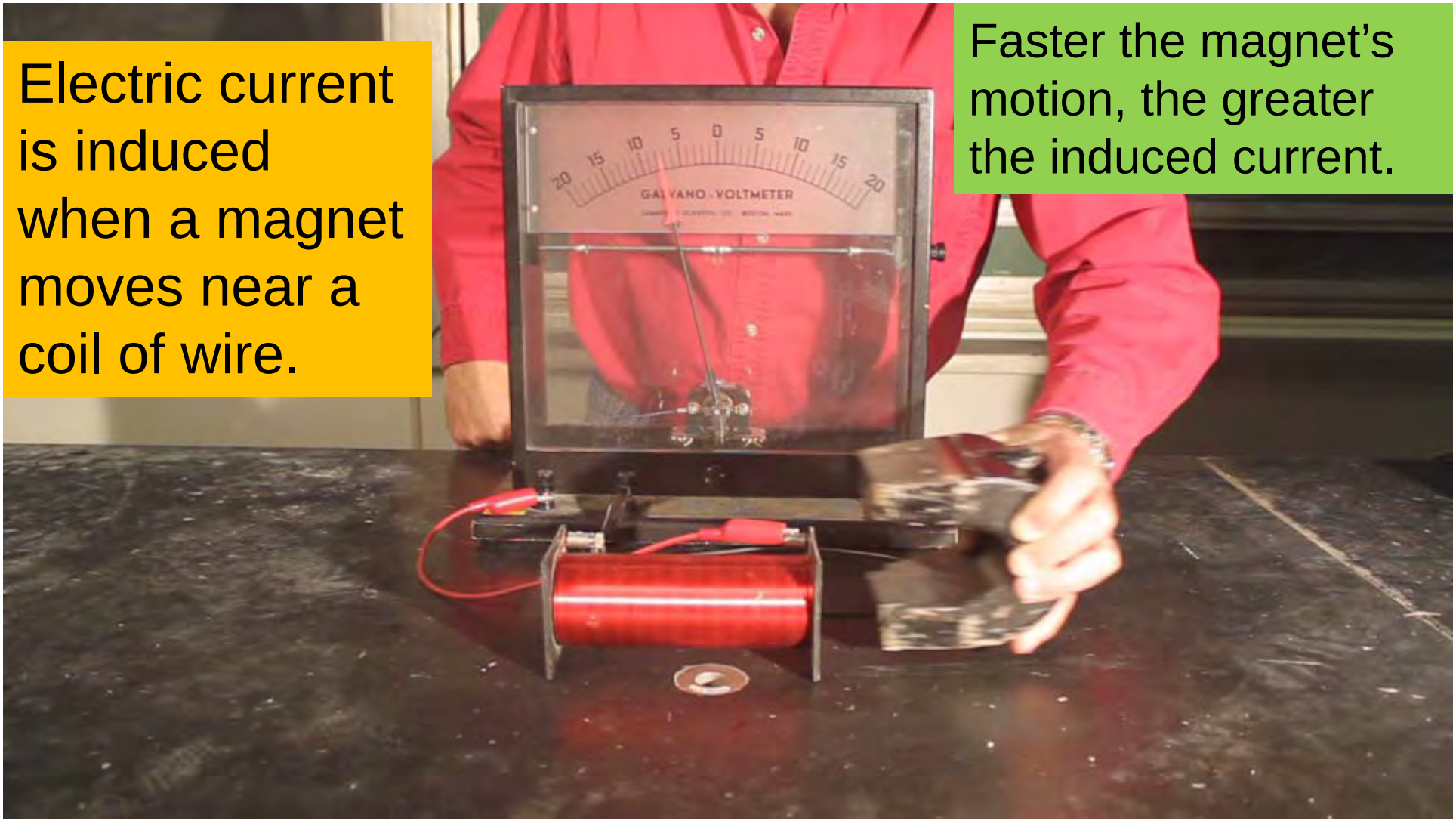
Electromagnetic Induction

Voltage and current are induced when a magnet moves towards or away from a coil of wire.

Faster the magnet's motion, the greater the current.



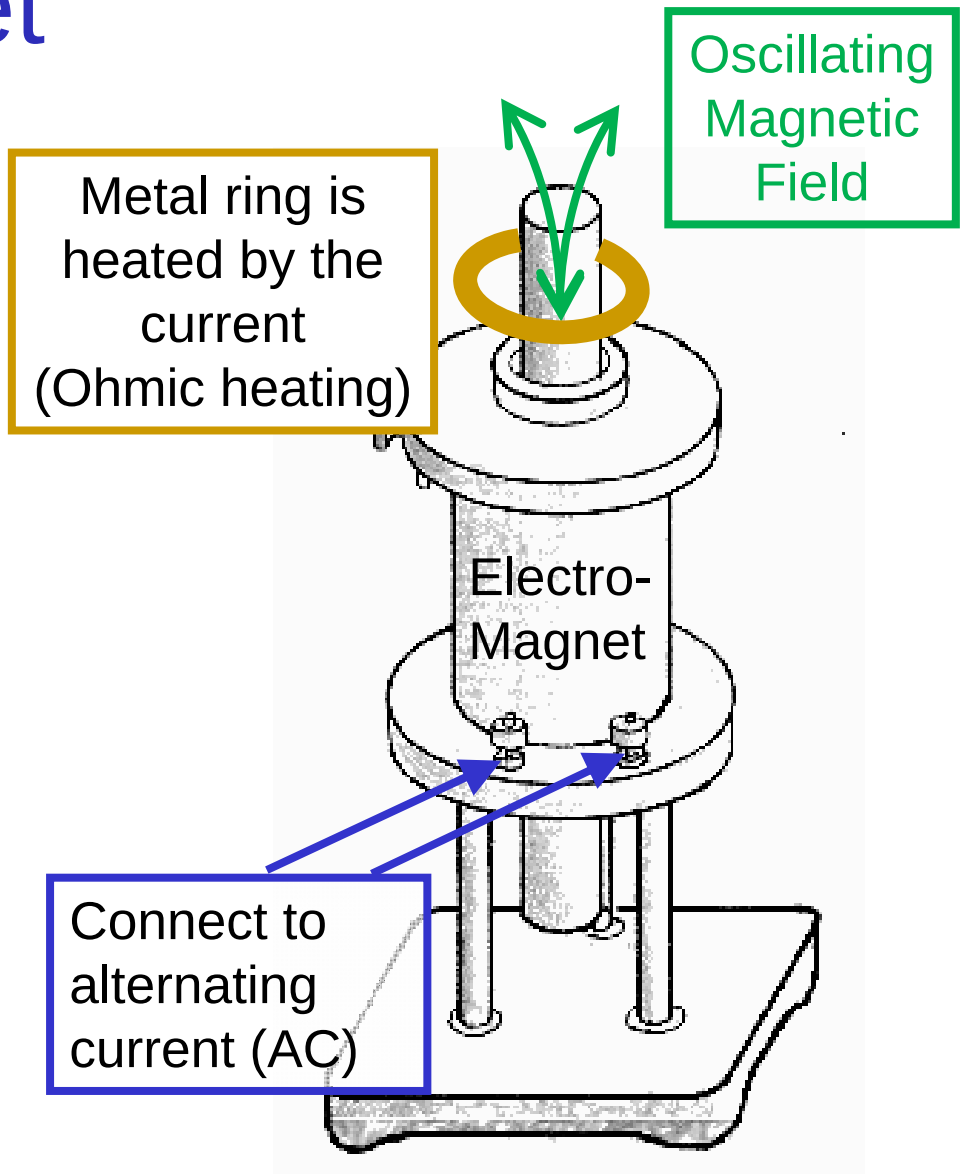
Electromagnetic Induction



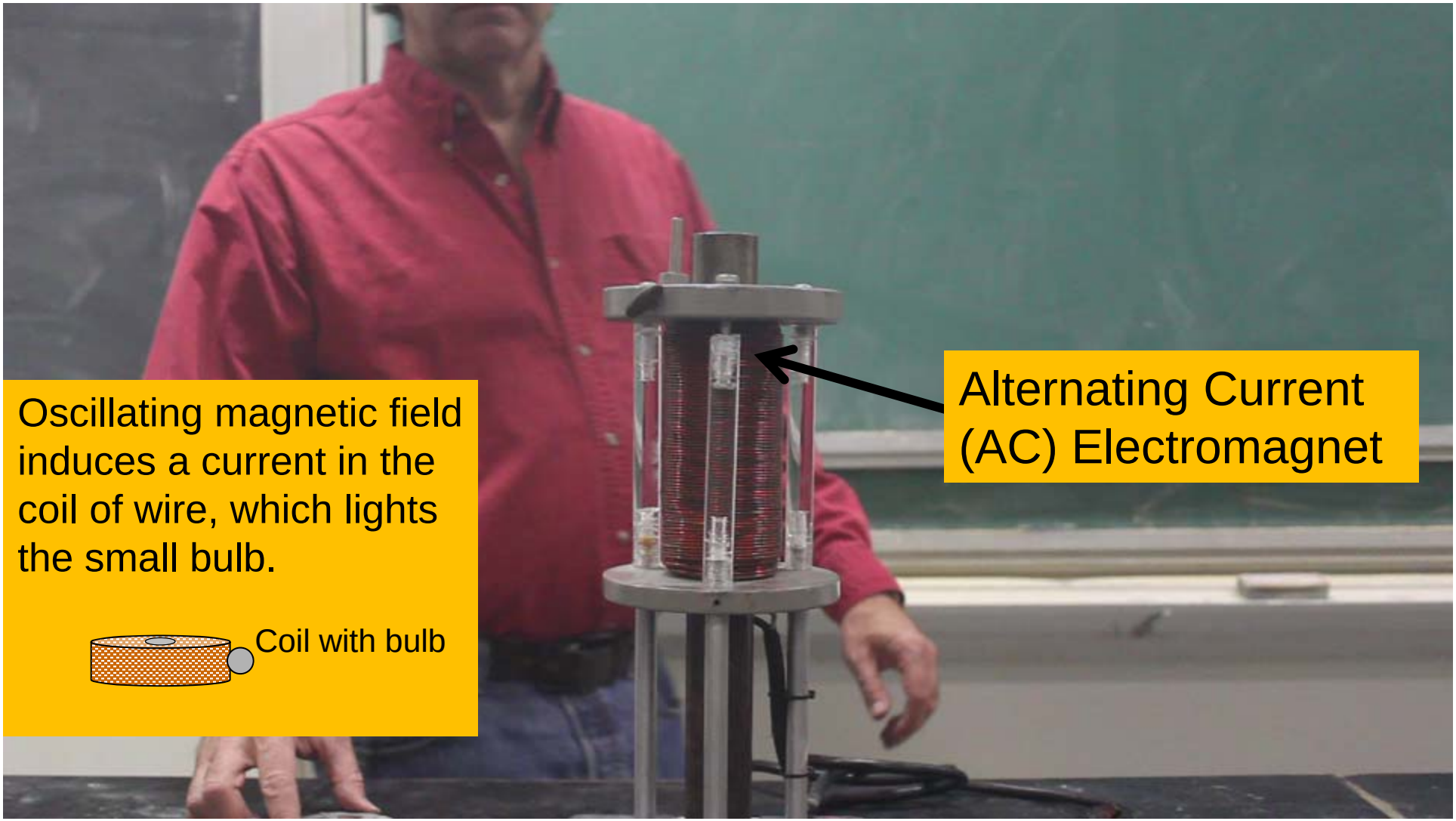
AC Electromagnet

An electromagnet with an alternating current (AC) makes an oscillating magnetic field.

This magnetic field will produce electric currents in objects.



Induction by AC Electromagnet



EMP (ElectroMagnetic Pulse)

A strong, rapidly fluctuating magnetic pulse induces high voltage, causing strong electrical currents.

In 1962, a nuclear test in the Pacific produced an EMP that knocked out 300 streetlights and telephone service in the Hawaiian islands, 900 miles from the explosion.

Starfish Prime, as seen from Honolulu

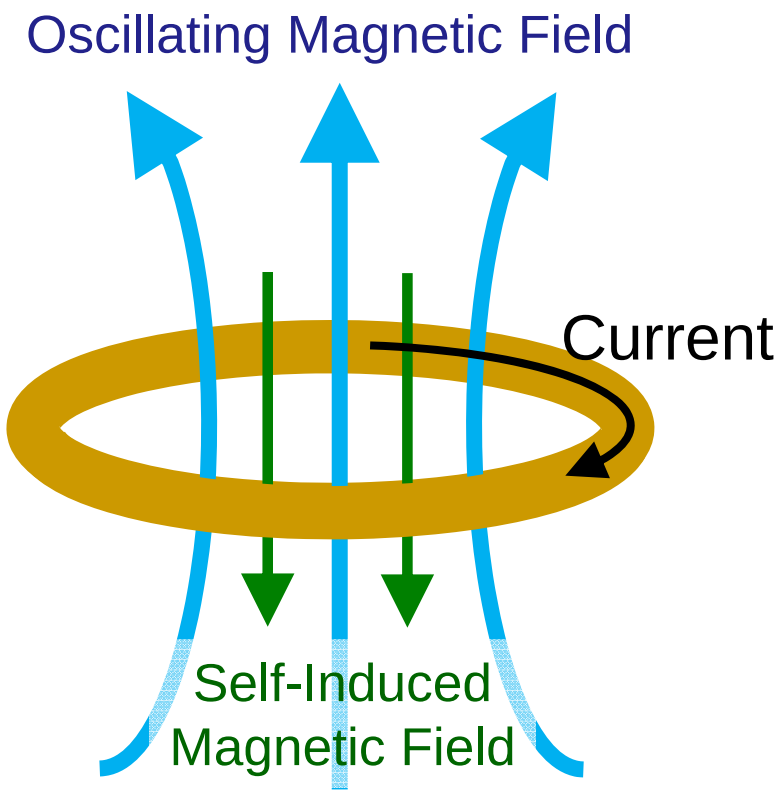
EMP in Films

EMP is a popular plot device in films.

Self-Induction

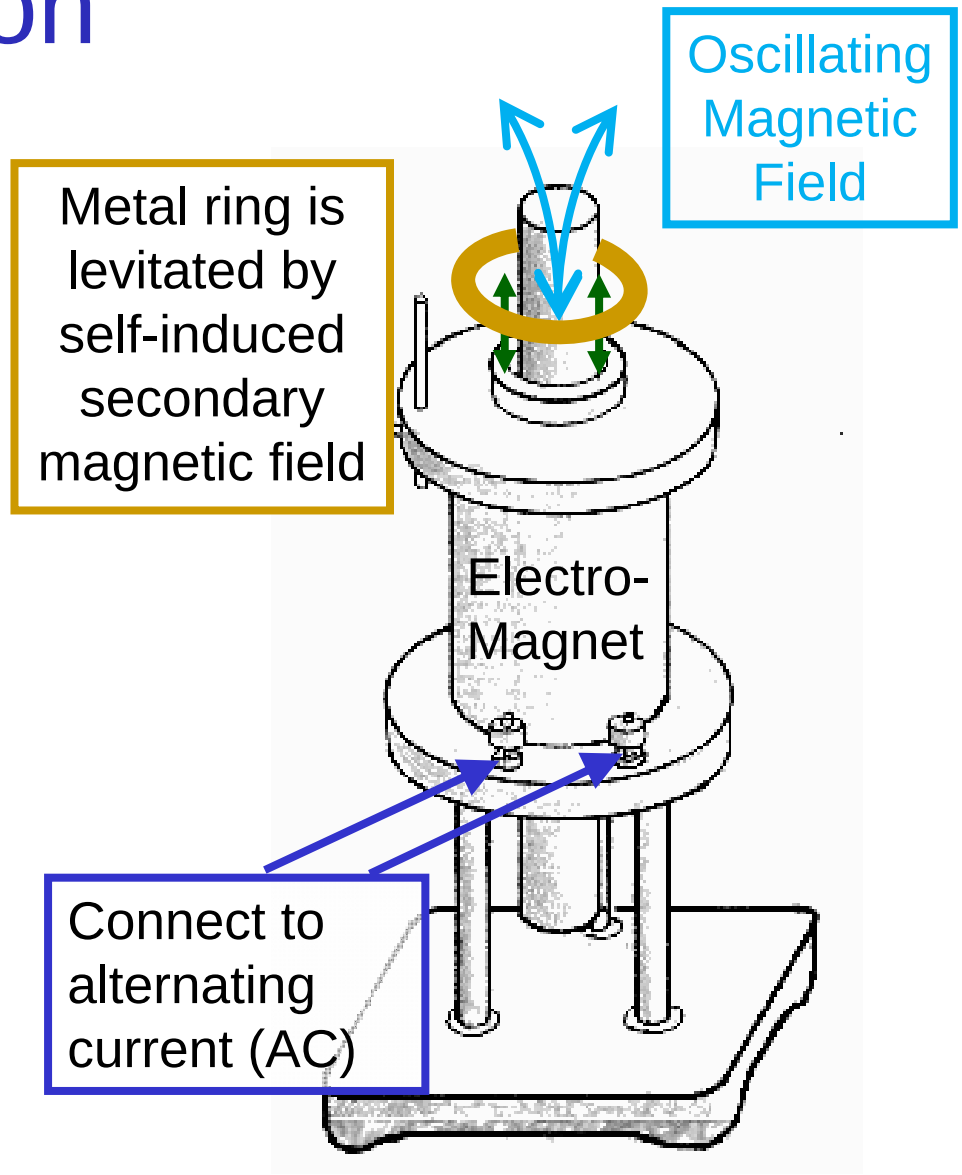
When a current is induced by a changing magnetic field, that current itself produces its own magnetic field.

This effect is called self-induction.



Magnetic Levitation

Induced current produces a secondary magnetic field that is always opposed to the primary magnetic field that induced it, an effect called *Lenz's law.*



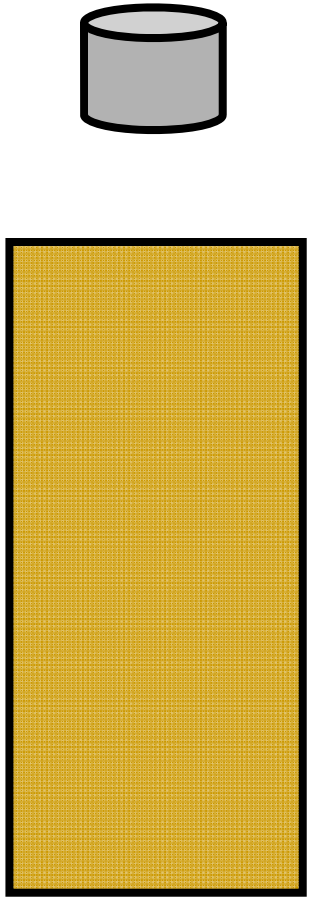
Magnetic Levitation

Magnetic Levitation

Magnetic Brakes

Strong magnet dropped into a copper pipe falls slowly due to secondary magnetic field induced by its motion.

Great America's *Drop Zone* has a 22 story freefall, lasting four seconds, decelerated by magnetic braking.

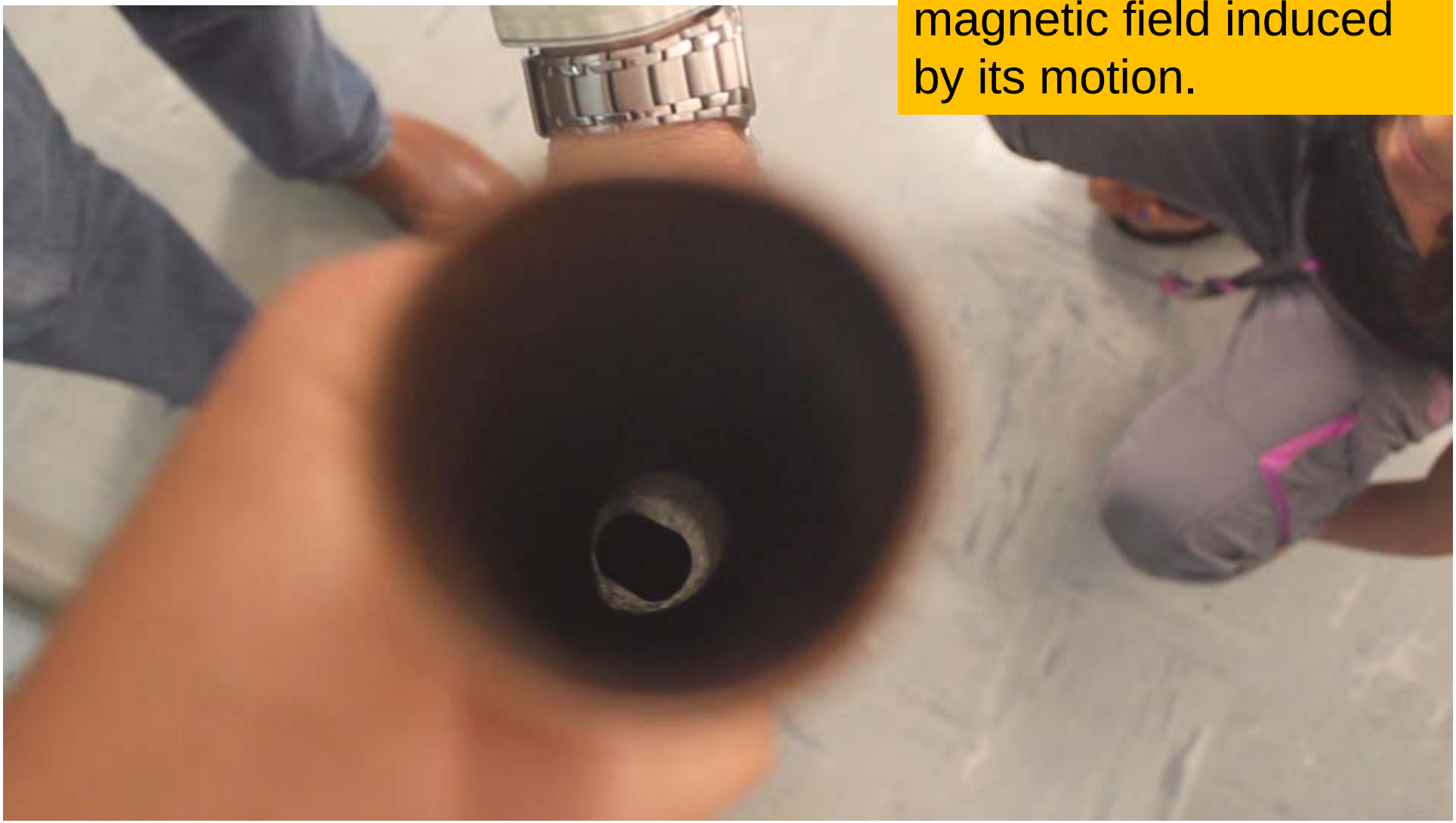


Magnetic Brakes

Strong magnet dropped into a copper pipe falls slowly due to secondary magnetic field induced by its motion.

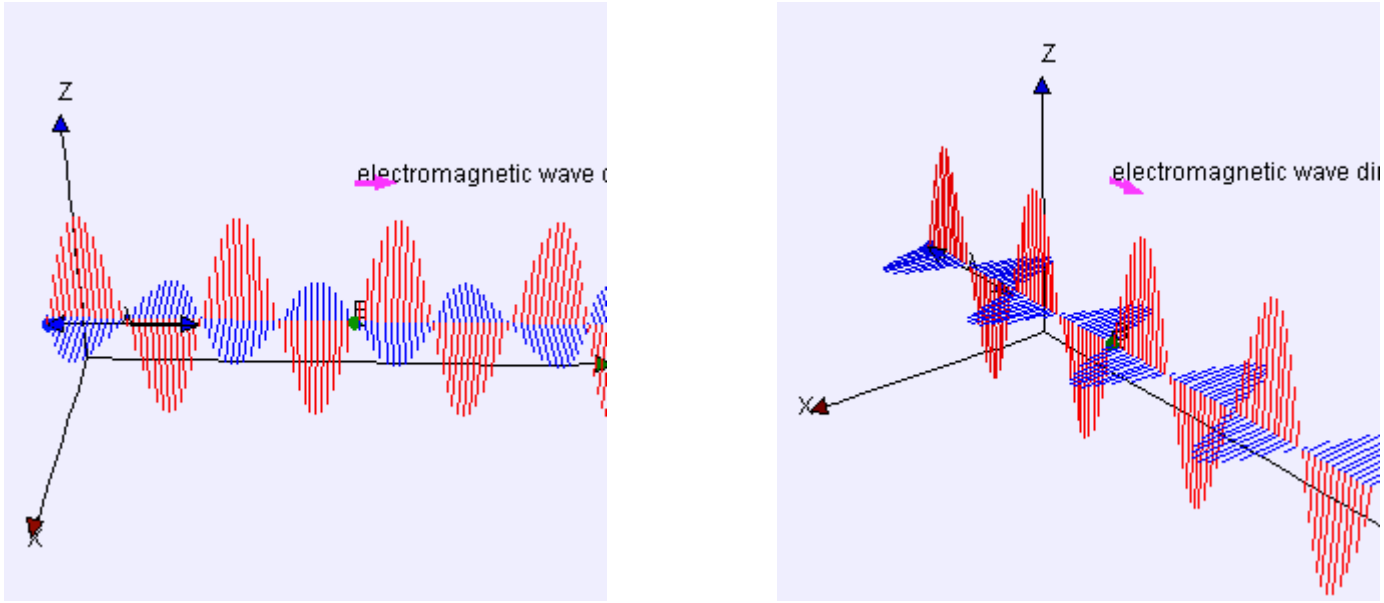
Magnetic Brakes

Strong magnet dropped into a copper pipe falls slowly due to secondary magnetic field induced by its motion.



Electromagnetic Waves

Oscillating electric (E) and magnetic (B) fields produce electromagnetic waves, such as radio waves, microwaves, and visible light.



Electromagnetic waves are transverse waves.

Summary

- Moving electrical charges experience a force from a magnetic field, called the Lorenz force.
- A changing magnetic field induces a voltage creating an current in a circuit, an extreme example is an EMP (ElectroMagnetic Pulse).
- An induced current produces its own secondary magnetic field (Self-induction).
- The magnetic field resulting from an induced current is always opposite from the magnetic field that induced it (Lenz's Law).
- Oscillating electric and magnetic fields produce electromagnetic waves (e.g., light).