

# WiTricity Technology: The Basics



Image source:

<http://www.witricity.com/index.html>

Presented by  
Bretny Khamphavong

# WiTricity... What is it?

- Wireless electricity = WiTricity
- The transfer of electric energy or power over a distance without the use of wires
- Electricity
  - Current – flow of electrons through the atmosphere
  - Charges through the atmosphere

# Magnetism

- Fundamental force of nature
  - Materials attract or repel
- Oscillating magnetic fields
  - Vary with time
  - Generated by altering current
- Drawings
  - Strength
  - Direction

# Earth's Magnetic Fields

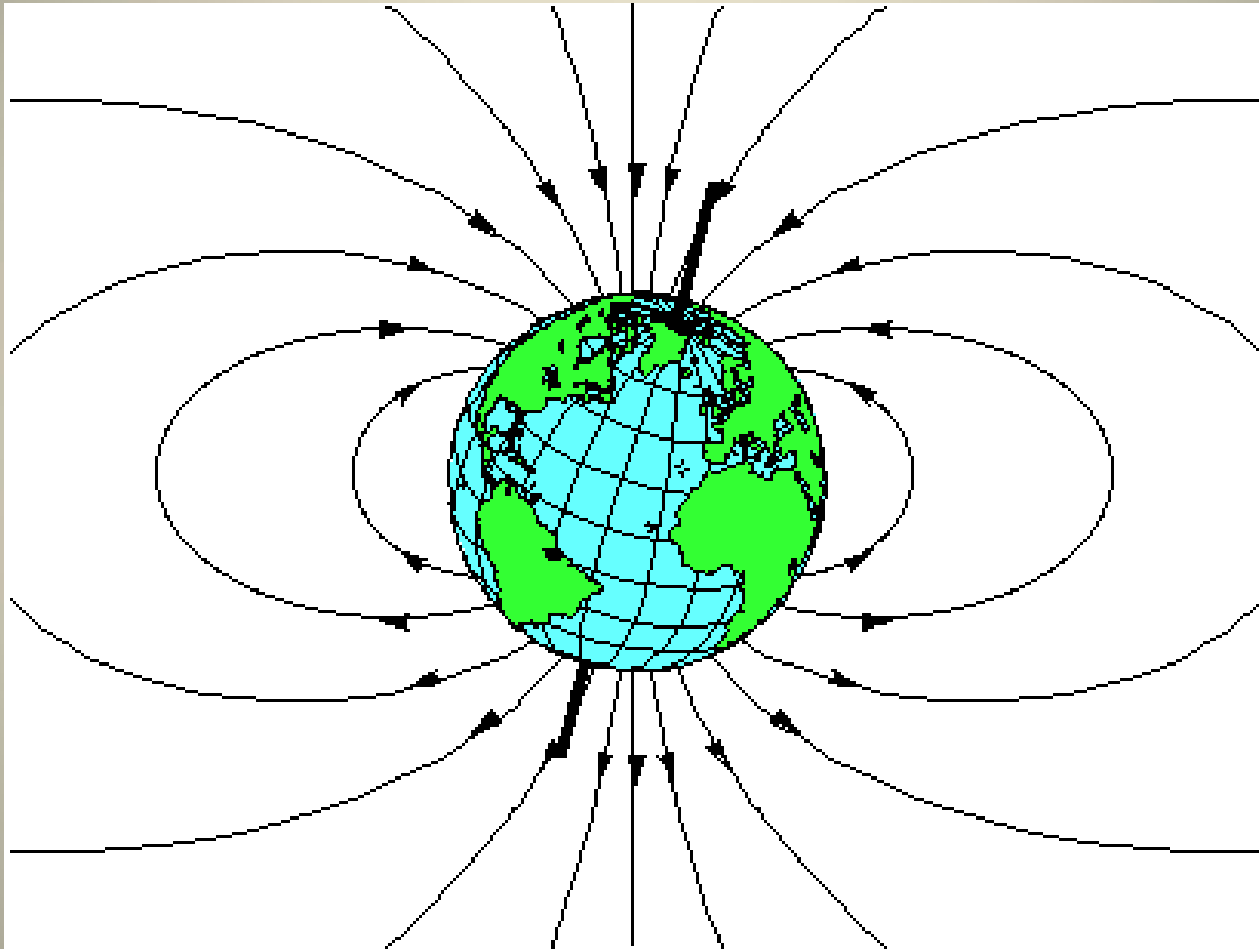


Image source: <http://www.ssec.honeywell.com/magnetic/overviews.html>

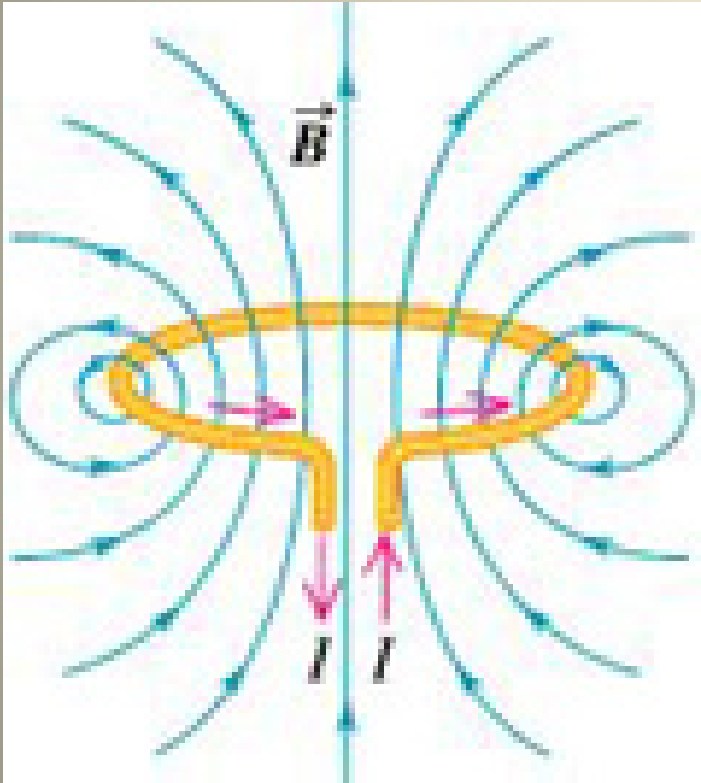
# Electromagnetism

- Interdependence of time-varying electric and magnetic fields
- An oscillating magnetic field produces an electric field
- An oscillating electric field produces a magnetic field

# Magnetic Induction

- A conductor which carries alternating current
  - Example: copper, silver, aluminum
- Loop generates an oscillating magnetic field
- Second loop may pick up current
  - Power devices
- Examples of magnetic induction: electric transformers and electric generators

# Magnetic Fields



Orange – coil with current

Blue – magnetic fields created

If current is reversed, the direction of the magnetic fields also change.

# Coupling

- Energy/Power
  - Energy source has a means of transferring energy to another object
- Magnetic
  - Magnetic field of one object interacts with a second object and induces current
- Resonant Magnetic
  - Natural frequencies of two objects are approximately the same



# Resonance

- Defined as the natural frequency at which energy can most efficiently be added to an oscillating system
- Examples:
  - Child on a swing
  - Singer shattering a wine glass

# WiTricity Power

Power source connected to alternating current, or AC, which then powers a light bulb

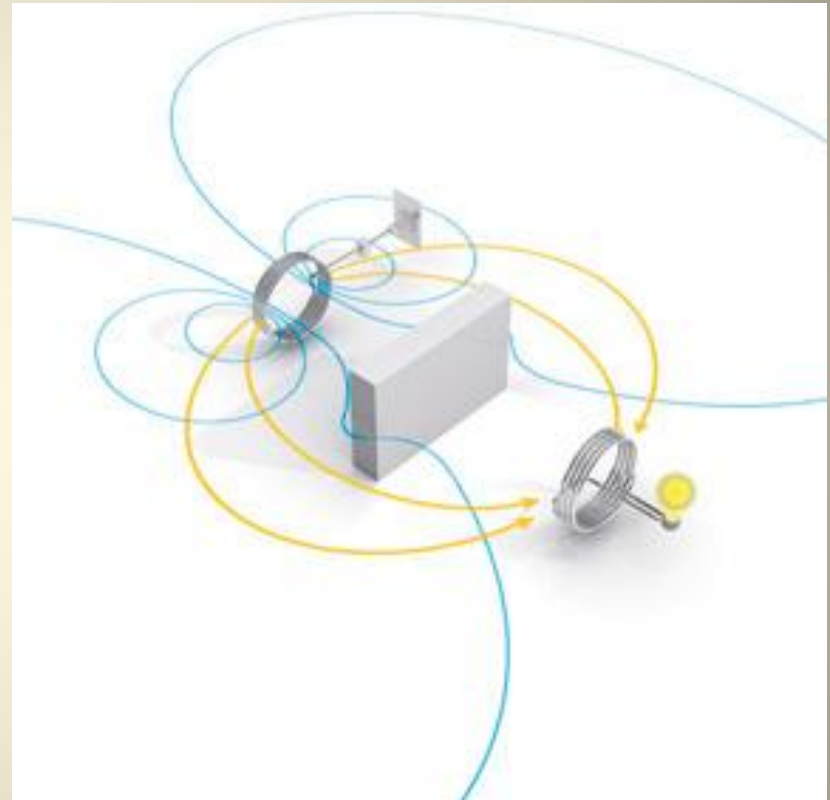


Image source: <http://www.witricity.com/pages/technology.html>

WiTricity's Beginnings:  
The Invention of  
WiTricity Technology

# Things that Go Beep in the Night



- MIT Associate Professor of Physics, Marin Soljačić
- Awakened by his dying mobile phone
- “A phone should take care of its own charging!”

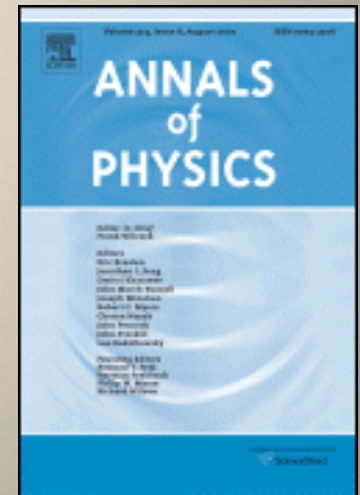
Image source: [http://web.mit.edu/physics/people/faculty/soljaic\\_marin.html](http://web.mit.edu/physics/people/faculty/soljaic_marin.html)

# Eureka! Coupled Resonators

- Practical and safe wireless power transfer must exchange strong energy without affecting living beings or other environmental objects (furniture or walls)
- Solution: coupled resonators
  - Two resonant objects of the same resonant frequency exchange energy efficiently without much leakage

# Strong Coupling

- Highly efficient energy transfer
- Universal, applying to all kinds of resonances
  - Acoustic
  - Mechanical
  - Electromagnetic
- Soljačić, Karalis, and Joannopoulos published first theoretical results in 2006, again in *Annals of Physics* of 2008



# Strong Coupling Con't

- Soljačić, Kurs, Karalis, Moffatt, Joannopoulos, and Fisher validated theories experimentally
- Proved coupling could be achieved over distances that greatly exceeded the size of the resonant objects themselves
- Published in *Science* journal in 2007



# WiTricity Technology is Born

- Experiment equipment:
  - two copper coils—each a self-resonant system,
  - one coil connected to AC acted as the resonant source,
  - second coil acted as the resonant capture device and connected to a 60 watt light bulb



# WiTricity in Action



Power source and capture device suspended in mid-air about 2.5 meters apart with nylon thread

Image source: Multi-hop Wireless Electricity Charging Protocol in Wireless Sensor Networks Proposal

# WiTricity Technology is Born Con't

- Various objects placed between the source and capture device
- Demonstrated magnetic fields transferring power through selected materials and around metallic obstacles

# Conclusion

- It is possible to transmit electric energy or power over a distance without the use of wires
- Marin Soljačić accomplished this through the use of strongly coupled magnetic resonators
- The commercial implementation of this concept is known as WiTricity