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UC Santa Cruz Tesla at St. Ignatius

UC Santa Cruz Tesla Coil Show sparks St. Ignatius Prep

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Your Guests today

UCSC Physics & Institute for Particle Physics

- Prof. Hartmut Sadrozinski
- Prof. Terry Schalk
- Dr. Charlie Crummer, Lab Manager
- Alan Yang, Freshman

Stanford Linear Accelerator Ctr.

- Dr. Tom Glanzman
- Dr. Karl Young

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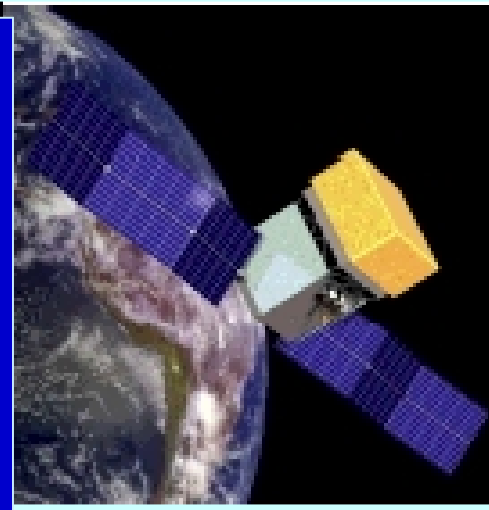
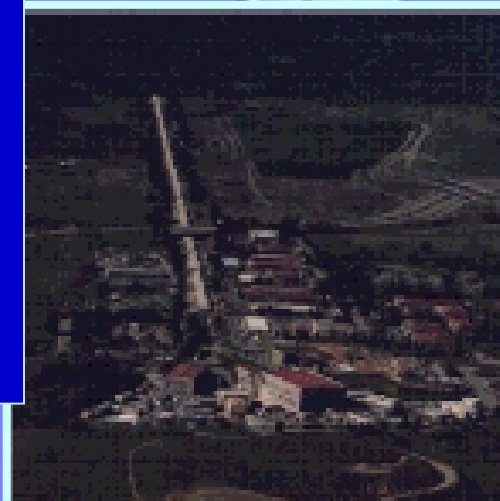


Tesla Program

- Introduction & Jacob's Ladder
- Safety First
- Corona:
  - Zorro's Sword
  - Lights without Cords
- How the Tesla Coil Works
- Knight in Armor
  - Bolt to the face
  - Sparks from the feet
- Chicken Coop ?
- Who was Nikola Tesla?
- Mystery Knight in Armor
  - Fighting Lightning



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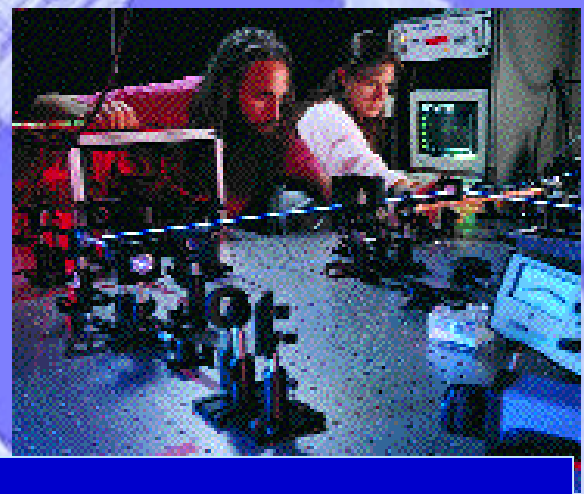
AstroPhysics

Big objects in the sky: Stars, Black holes, Supernovae



HEP: Smallest Particles: Quarks

C.M.:

How do objects form and stay together?

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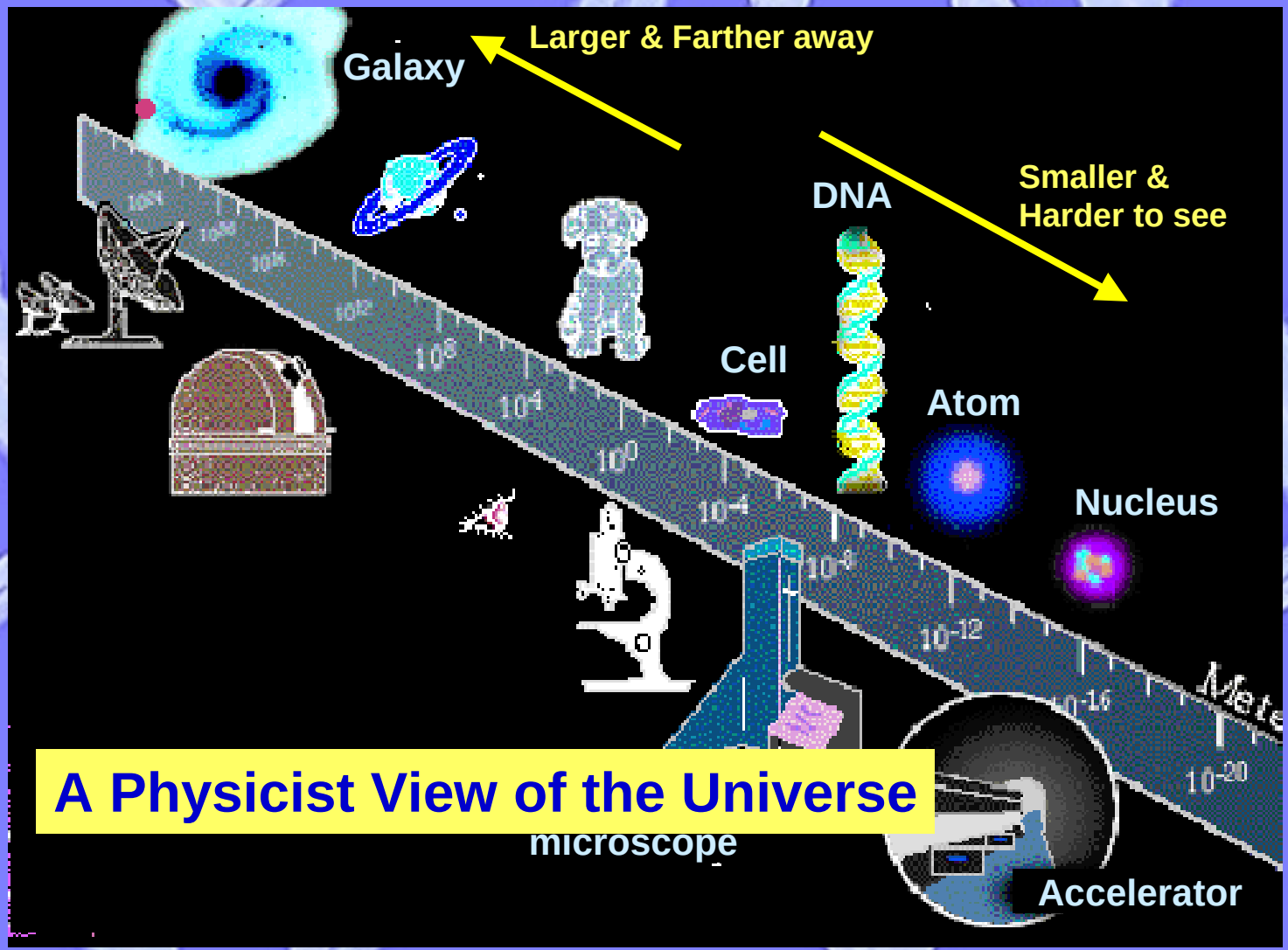
The size of the object and its distance tells me what kind of instrument I need to see it.



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Professors and Students (and Teachers!) conduct research in the SCIPP Laboratories.

http://scipp.ucsc.edu

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Summer 2001: Teachers help launch a big Science Balloon

Mr. Kliewer
Prof. Schalk
Dr. Dann
Mr. Manildi
Mr. Briber

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Balloon Flight, Chase and Recovery

After 250 Miles across Texas at 130,000 ft, 50g crash, still works

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Teacher Science Summer Workshop

University of California Santa Cruz
Sponsored by CalSpace/Space Grant, Quarknet (NSF), GLAST (NASA)

Science and Technology of Space & Balloon Flight
July 8 – 19, 2002
UC Santa Cruz Campus

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The Santa Cruz Institute for Particle Physics and the UCSC Center for Origins Studies announce:

Balloon Fest 2003

March 29/30, 2003 - Dann Ranch, Dixon, CA

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COSMOS

California State Summer School for Mathematics and Science

To receive information regarding COSMOS 2002, please send an email with your name, address, and phone number to Cosmos at: cosmos@epc.ucsc.edu

Cosmos 2002 will take place at UCSC June 23-July 20th.

- What is COSMOS?
- How can I apply?
- Academics
- Residential Life
- View Our Videos
- Parent Information

Explore the wonders of the universe

Enroll in a residential summer program for students in grades 8-12 where you will learn cutting-edge science and make new friends while living on the beautiful UC at Santa Cruz campus.

Hosted by the Educational Partnership Center, UCSC

This site currently reflects information regarding COSMOS 2001

COSMOS: UCSC Summer Program for H.S. students

http://epc.ucsc.edu/cosmos

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SAFETY FIRST!

- Distance at least 20 ft.
- Computers, Gameboys, CD players, telephones to the back of the room – unplugged, switched off!
- Hearing aids off, pacemakers out of room!

1 Million Volts! DANGER

- Normally you can't see, hear or smell electricity, but the Tesla Coil makes
  - Bright sparks
  - Loud crackling noise
  - The air smell strange (Ozone)

BRACE YOURSELF!

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Zorro

Drawing lightning with a sword

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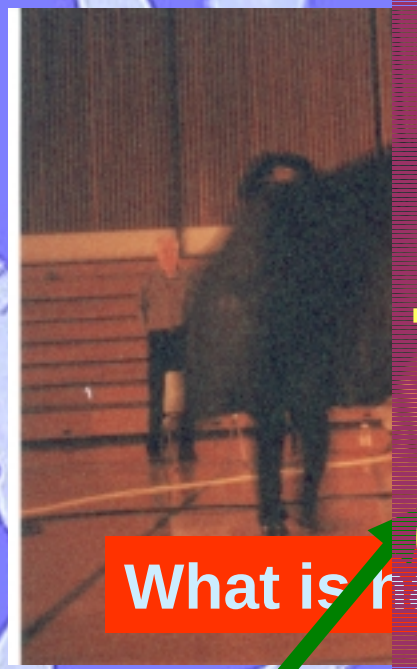
Sparks

to g



What is h

Wire to saf
ground

Electricity

Moves

Through the Air

(you knew that,

because you use

a radio and TV)

What about

this Air

without cords?

happening with Zorro?

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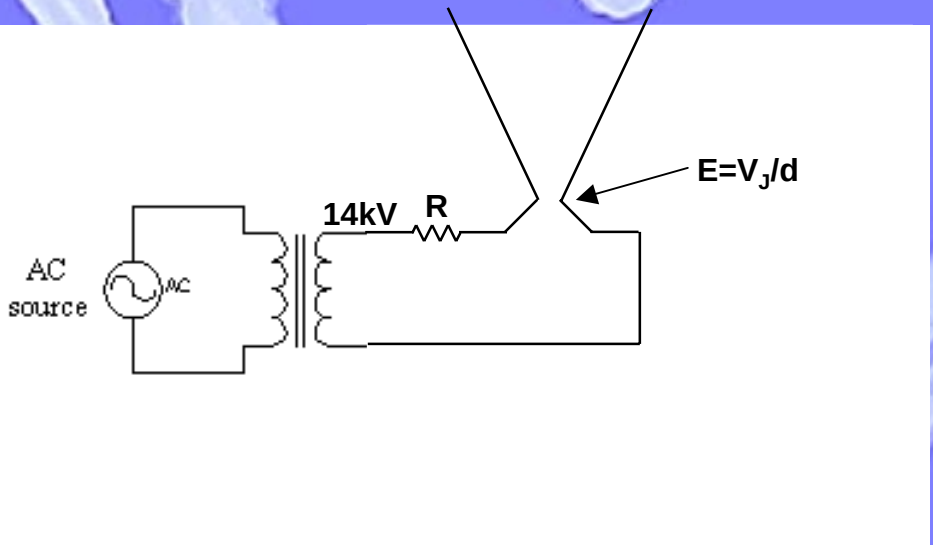
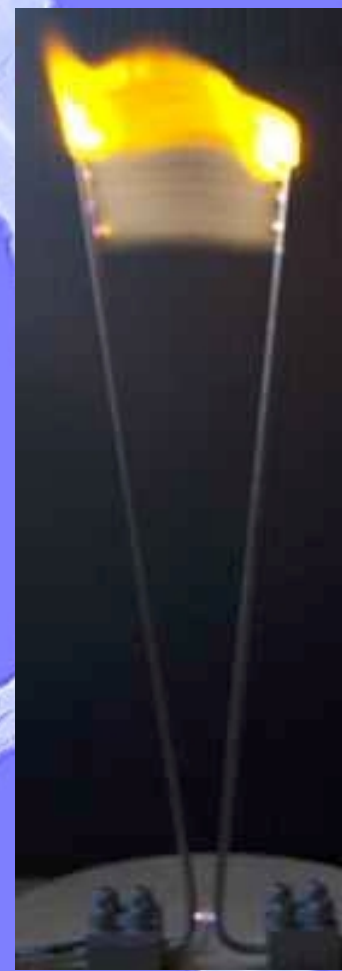
High voltage sparks I: Jacob's ladder



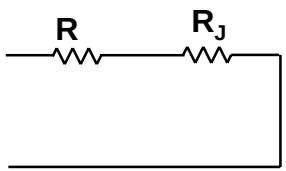


off:

$R_J >> R \rightarrow V_J >> V_R$

$I = 0$

on:



$R_J << R$

$I = V/(R_J + R)$

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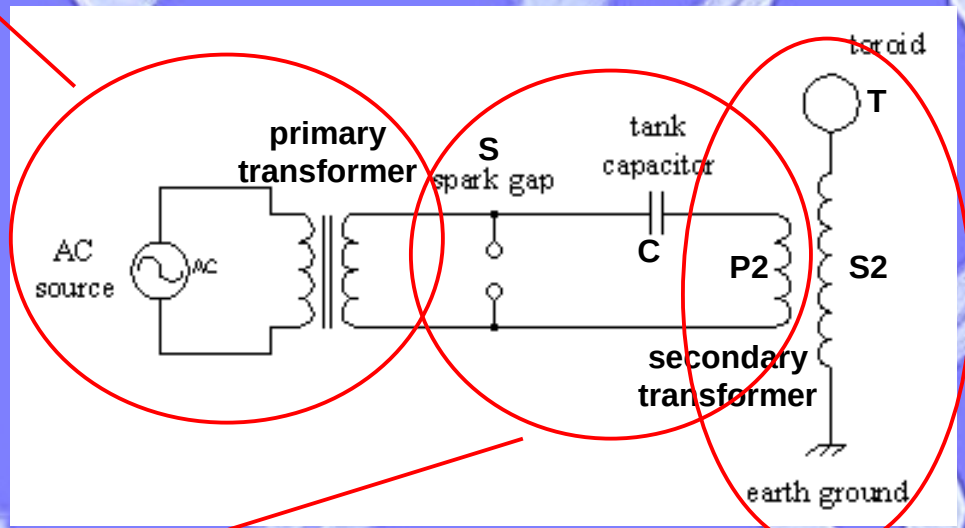
High voltage sparks II: Tesla coil

- 110 VAC -> >=14kV
- C gets charged
- high V across S



- S breaks down
- C discharges through P2
- resonant circuit (S,C,P2)

$$\omega_1 = 1/\sqrt{P2 \cdot C}$$

- virtual capacitor (T -> ground)
- resonant circuit (S2,T) $\omega_2 = 1/\sqrt{S2 \cdot T} = \omega_1$
- energy transfer
- voltage gain : $V_T = \sqrt{C/T}\, V_C \geq 100kV$
- power transfer/sparks at ω_1 (10-100 MHz)

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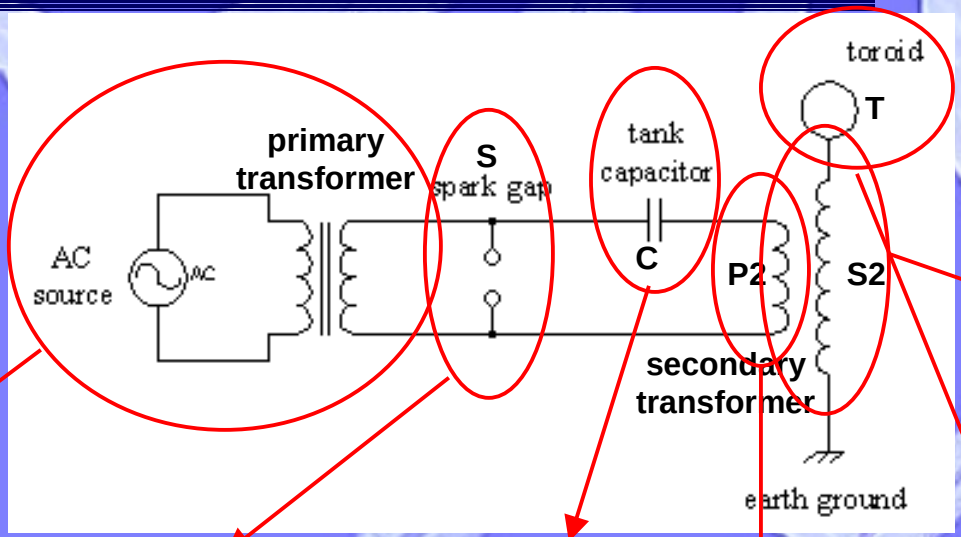

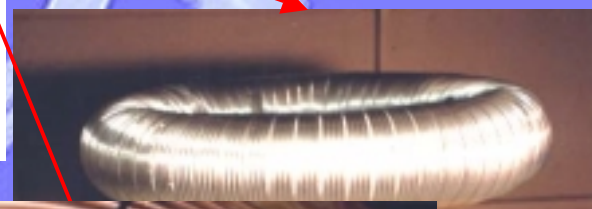

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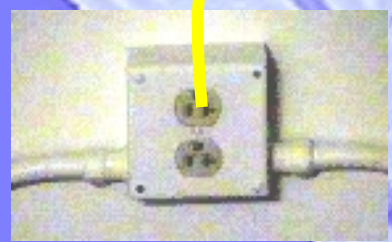
Summary of Tesla coil operation:

Voltage starts at 120 ends up at 1 million!

1 million volt — Resonance circuit

14,000 volt — Transformer

120 volt — Outlet



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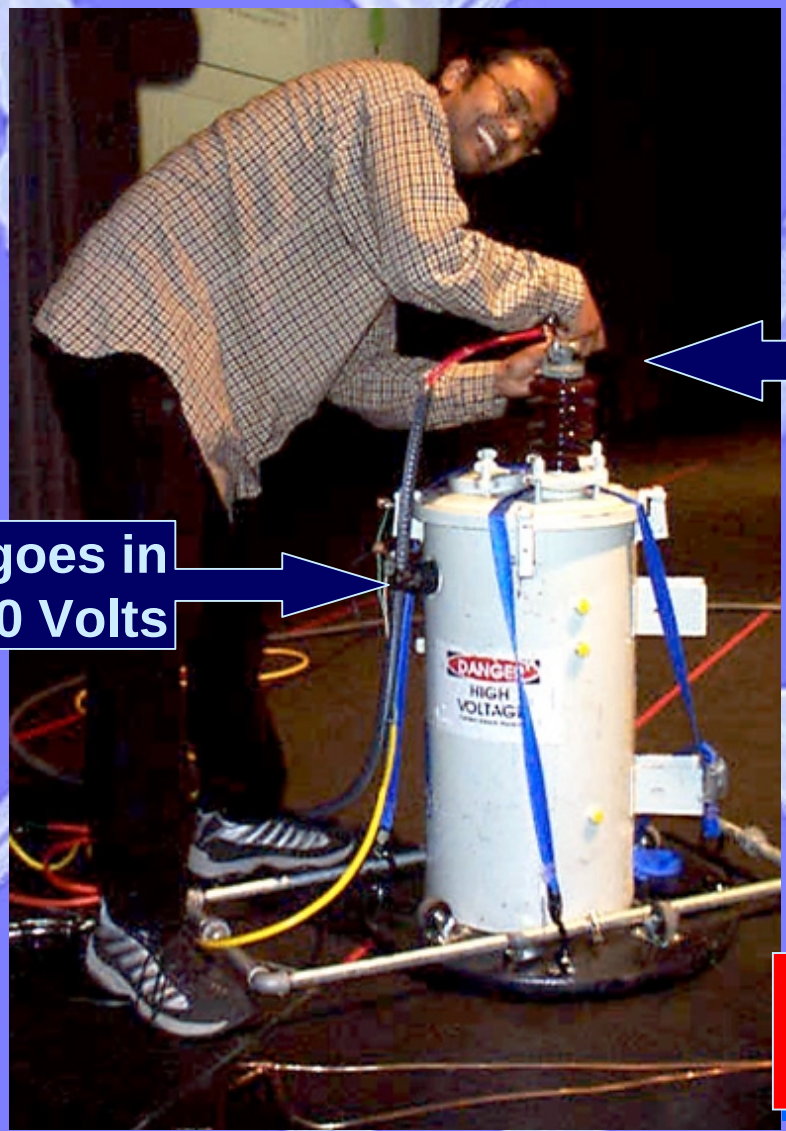
Learn about Transformers



Power comes out at 14000 Volts

Power goes in at 120 Volts

Where have you seen this before?

Commercial Transformer, hooked up the "wrong way"

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Transformer 101:

Energy (Power) (at best! - heat, sound, motion!) conserved

→ I*V constant

Primary (n1) and secondary (n2) share the Magnetic Flux Φ

(use iron core!)

→ $V1 \propto n1 * d\Phi/dt$

→ $V2 \propto n2 * d\Phi/dt \propto n2/n1 * V1$

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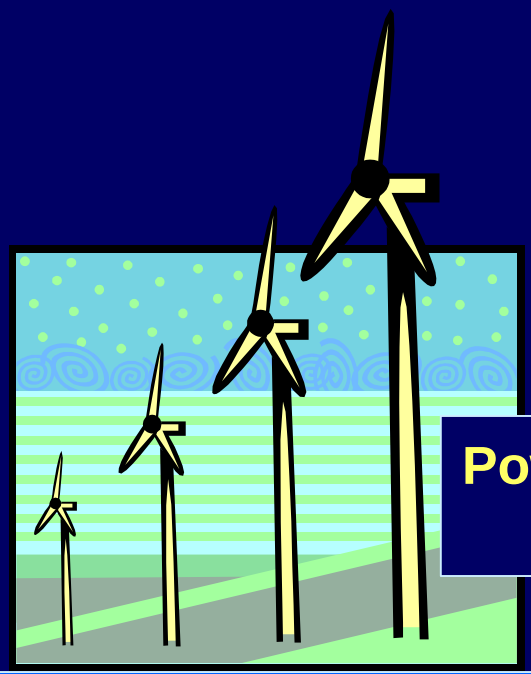
Physics Principle: Transformer

We [illegible]

(turn off lamps, air conditioners, close refrigerator doors...)

Electrical Power is just converted wind, water, thermal power

It is brought to your neighborhood on high voltage lines



Power comes out
At 120 Volts

Power goes in
at 14000 Volts

and a transformer brings it down to 120V

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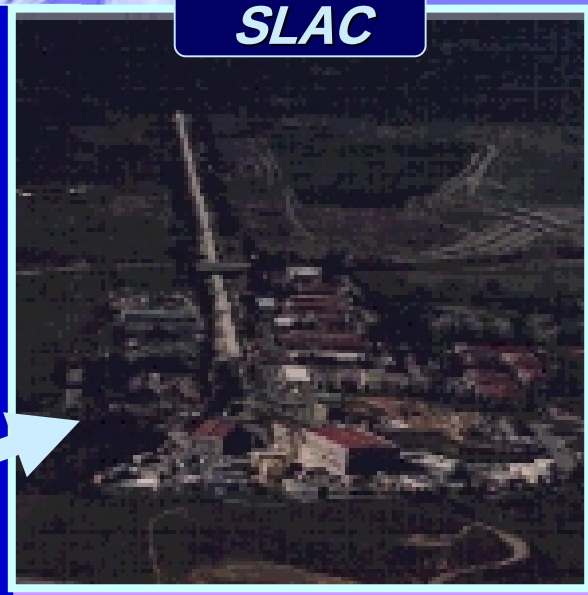
Transformation of Power

- Power is used everywhere
  - Visit the Stanford Linear Accelerator Center (SLAC):
    Electricity -> New particles
    Quarks



- Power is tranformed in Space
- Black holes explode :
  - Material -> Light, x-rays, “jets”
  - SCIPP works on GLAST Mission:

discover the most powerful
“power plants” in the universe

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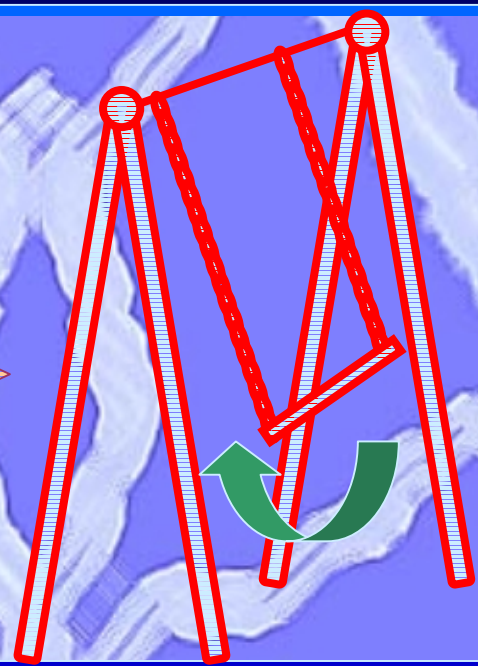
Resonance

That's how a swing works:

Match Resonance Frequency and In-Phase



In the Tesla "swing", the kick is supplied by the Primary Coil, so it has to be tuned to the secondary circuit to be in resonance

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Meet the Fighting Knight

Fighting Lightning
Bolt to the Head

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Electricity in Air

Lightning
Jacob's Ladder
Corona
Tesla Sparks
are all related.

Principle: Air is made of molecules. When they are ionized, they become charged and can conduct a current like an electrical wire.

If there is a large current, it heats up the air and makes light. Thus, the sparks, flames etc are direct evidence for the model of atoms!

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How lightning works

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The Faraday Cage

Planes are close to the clouds and away from safe ground. Why aren't they in grave danger from lightning?

Answer: They form a "Faraday Cage" -- that is, they are surrounded by metal.

Electricity flows around the outside of the metal, and anything inside is safe!

Safest place during a lightning storm is in a plane or car because it is a Faraday Cage

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The "Chicken Coop"

The World's Ugliest Faraday Cage -- and it's full of holes!

But can it keep the lightning out?

Does the chicken trust the equations?

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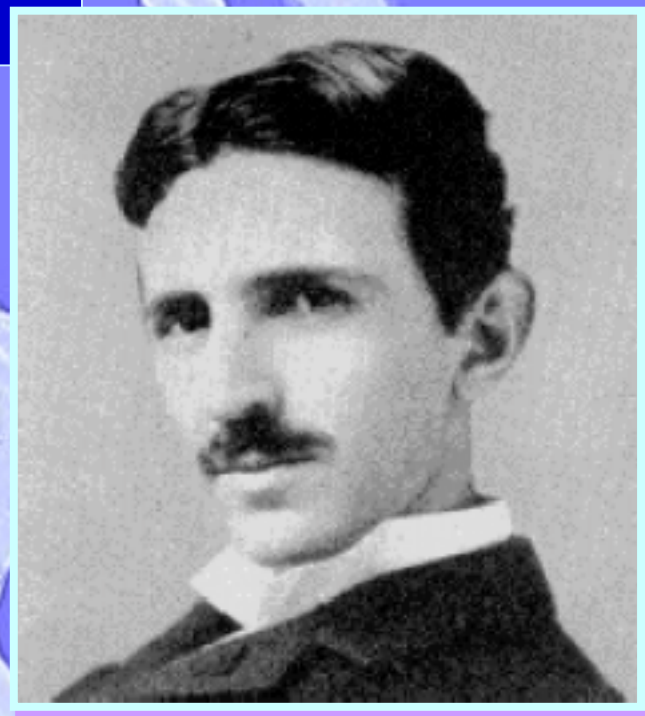
Thomas “DC” Edison and his Batteries

vs.



Nikola “AC” Tesla and his Generators

- Tesla Revival
- 271 web sites are dedicated to Nikola Tesla
- Join the “Tesla Coil Web Ring”

http://nav.webring.yahoo.com/hub?ring=teslaring&list

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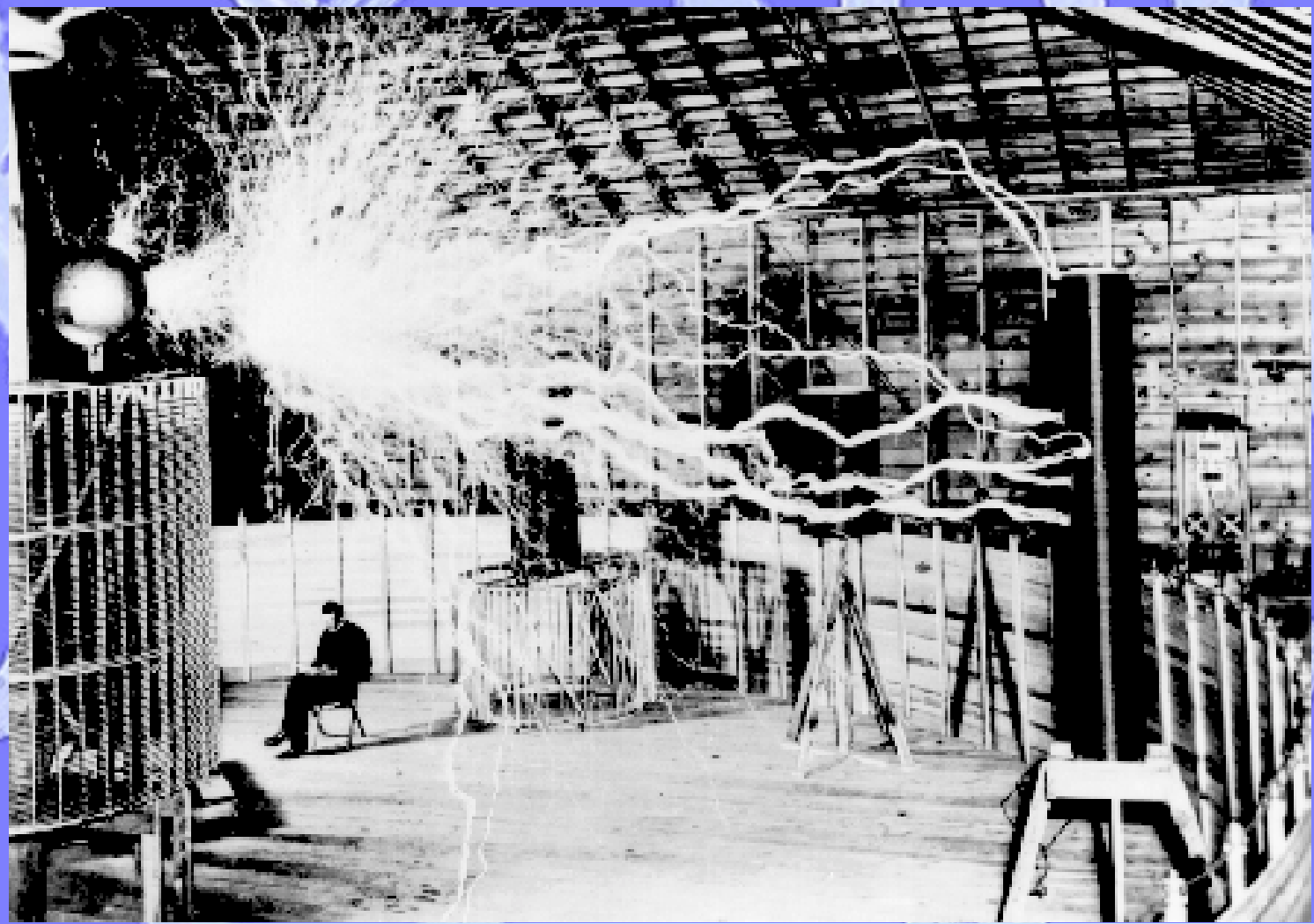
- Nikola Tesla as a Daredevil waiting for a hair cut?



- Double Exposure makes it safe!

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Mystery Knight

Who is afraid of Lightning?

Not the Mystery Knight!

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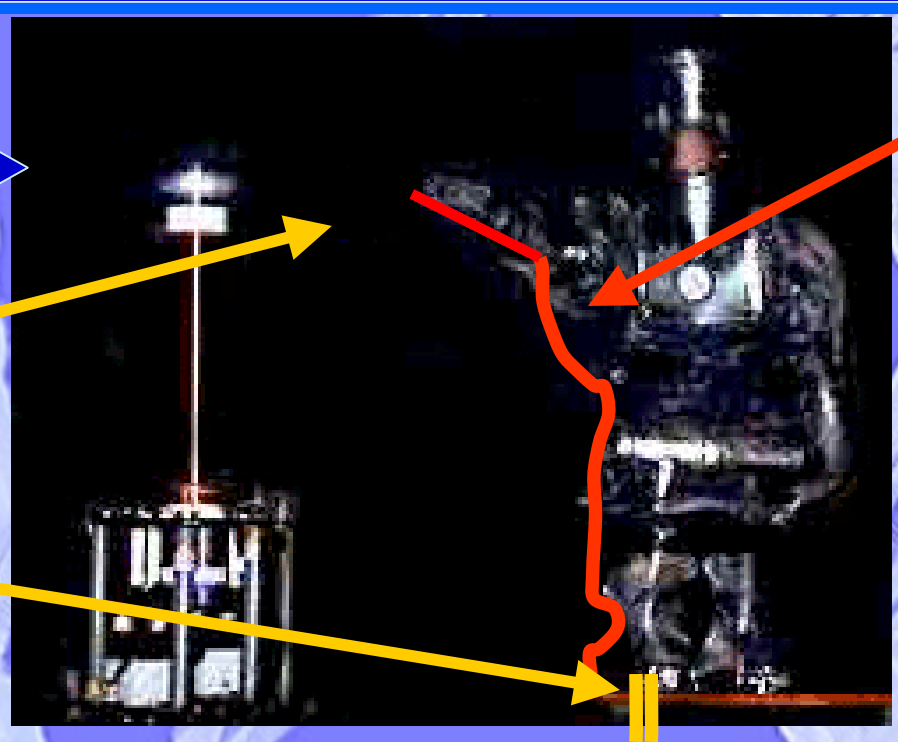
Is the Mystery Knight OK? ***Let's check!***

The armored suit is safe!

- **It's a Faraday Cage – no electric field allowed inside.**



Electrical current flows on the OUTSIDE of a metal!

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Fysiks is Phun!

Questions?

Ask after the show, e-mail, visit…

You find our coordinates on the web

http://scipp.ucsc.edu

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Say “Good bye” to
Daniel Greenhouse,
the brain behind the sparks
He was an undergraduate
at UC Santa Cruz.

Thanks to our hosts:

- All you students
- Dr. James Dann

http://scipp.ucsc.edu