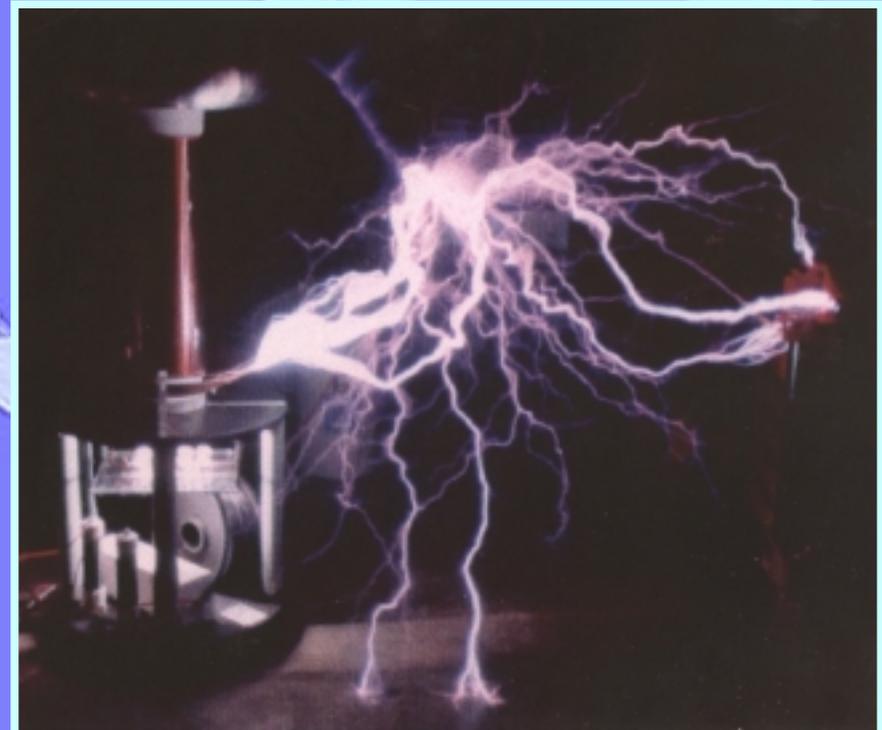




# UC Santa Cruz Tesla at Aptos High

## UC Santa Cruz Tesla Coil Show at Aptos High School





# UC Santa Cruz Tesla at Aptos High

## Your Guests today

### **Santa Cruz Institute for Particle Physics SCIPP**

- Prof. Terry Schalk
- Dr. Felix Rosenbaum
- Dr. Hiroshi Ohyama
- Dr. Alex Grillo

### **UC Santa Cruz Department of Physics**

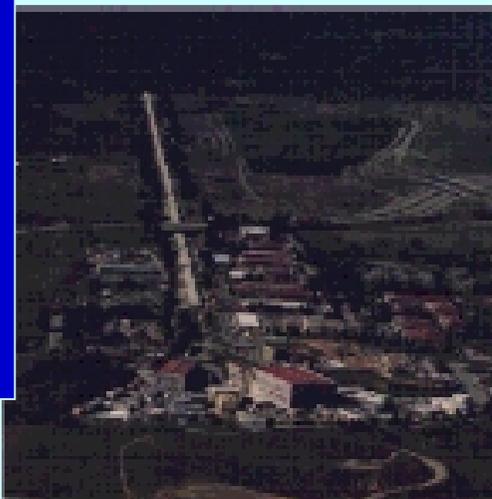
- Charlie Crummer, Laboratory Manager
- Ruth Schmitz, Graduate Student
- Arend Van der Zande, Brian Keeney, Juniors
- Kevin Waggoner, Sophomore



# UC Santa Cruz Tesla at Aptos High

## 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





# UC Santa Cruz Tesla at Aptos High



**What does a Physicist do?**

**She/he asks Questions about Nature.**

**Today is your chance to be a Physicist:  
Ask Questions during the Show!**



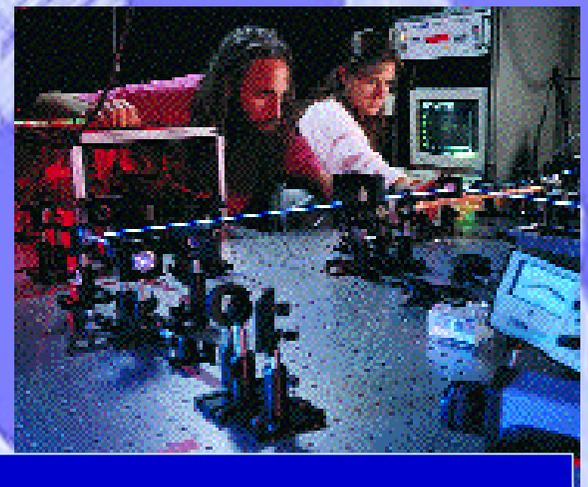
# UC Santa Cruz Tesla at Aptos High



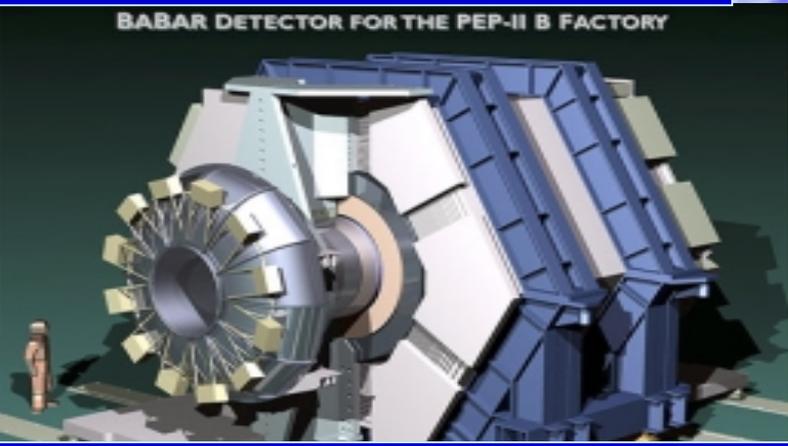
## UCSC Physics

Teach students,  
learn about nature (Research)

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



How do objects form  
and stay together?

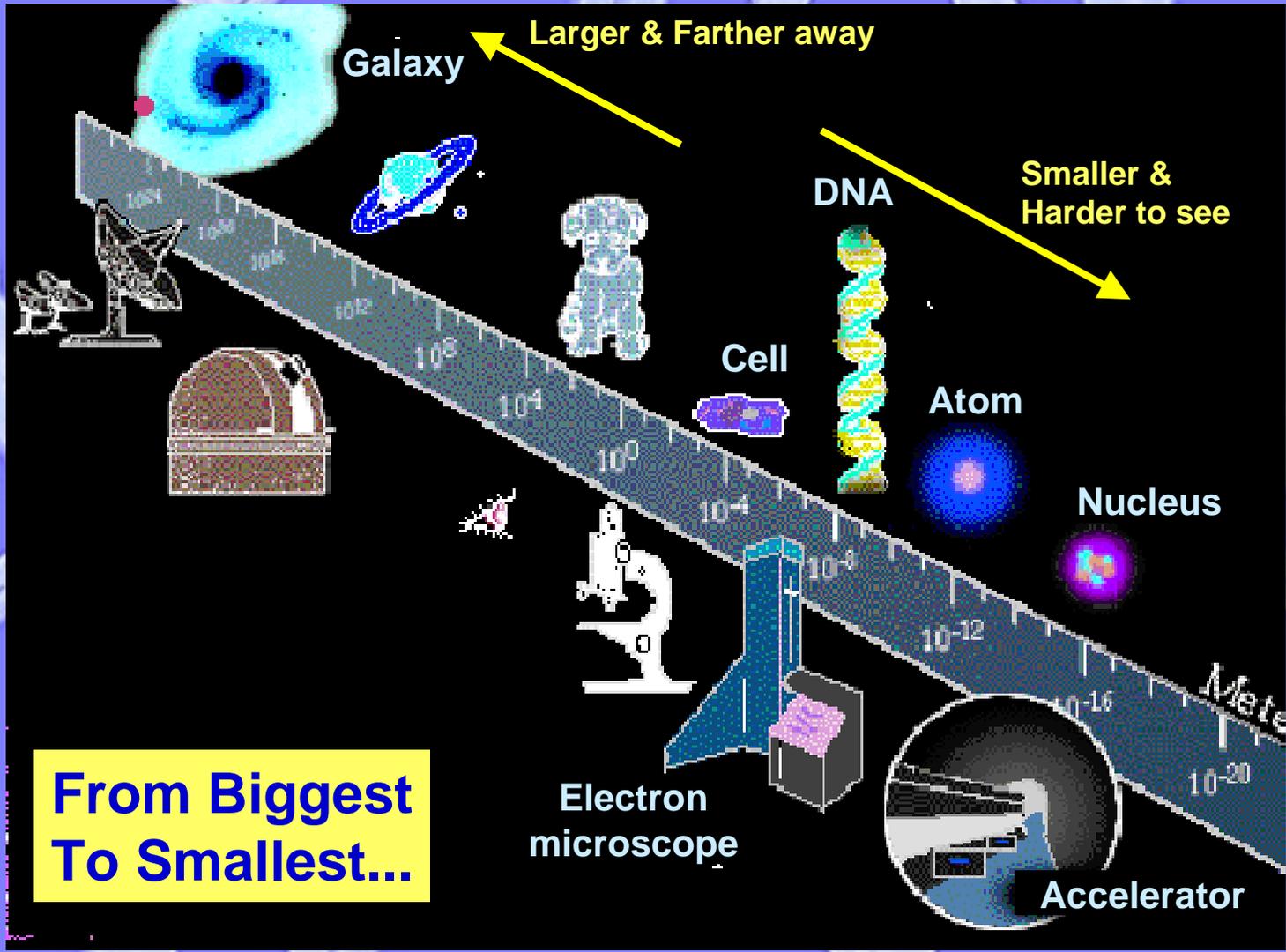


Smallest objects (Particles): Quarks



# UC Santa Cruz Tesla at Aptos High

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



From Biggest To Smallest...

Electron microscope

Accelerator



# UC Santa Cruz Tesla at Aptos High

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



<http://scipp.ucsc.edu>

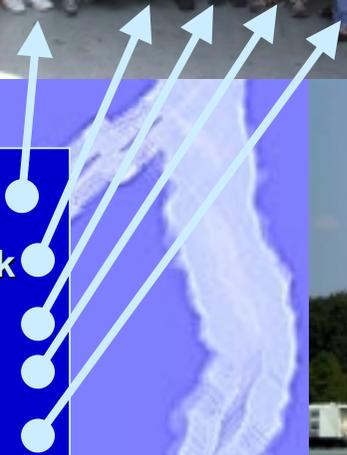


# UC Santa Cruz Tesla at Aptos High

Summer 2001: Teachers help launch a big Science Balloon



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







# UC Santa Cruz Tesla at Aptos High

## Balloon Flight, Chase and Recovery



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



# UC Santa Cruz Tesla at Aptos High



## 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](mailto: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

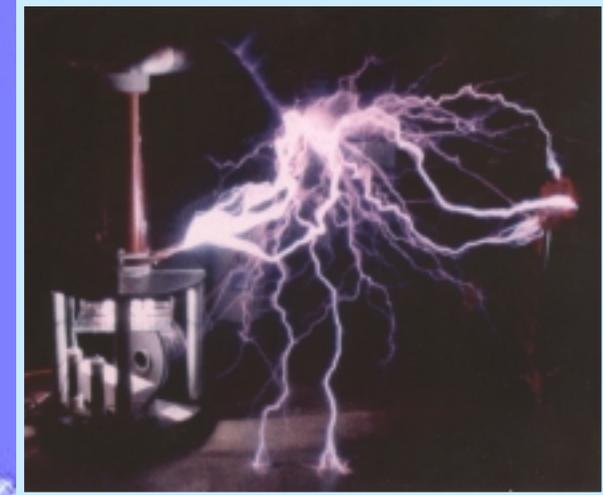
**COSMOS: UCSC Summer Program for H.S. students just like you!**



# UC Santa Cruz Tesla at Aptos High

## ***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!***



# UC Santa Cruz Tesla at Aptos High

*Zorro*

Drawing lightning with a sword



# UC Santa Cruz Tesla at Aptos High

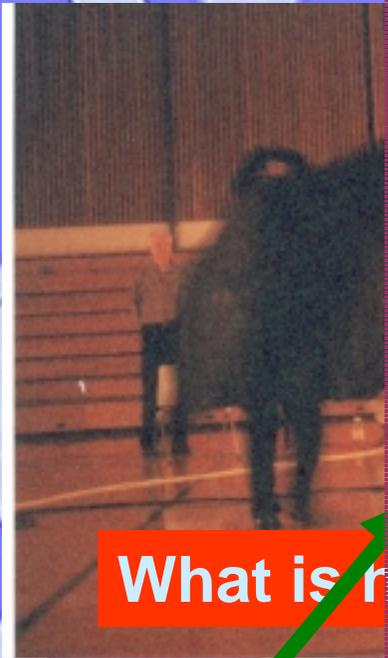
Sparks  
to ground

## Electricity

## Moves

## Through the Air

(you knew that,  
because you use  
a radio and TV)



What is happening with Zorro?

Wire to safe ground



What about  
without cords?



# UC Santa Cruz Tesla at Aptos High

How does the Tesla Coil work?

Ask us about details!

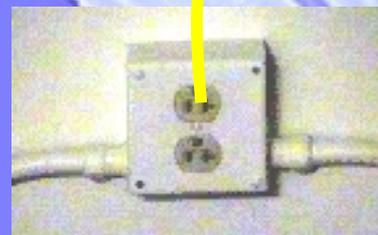


*Voltage starts at 120 ends up at 1 million!*

1 million volt → Resonance circuit

14,000 volt → Transformer

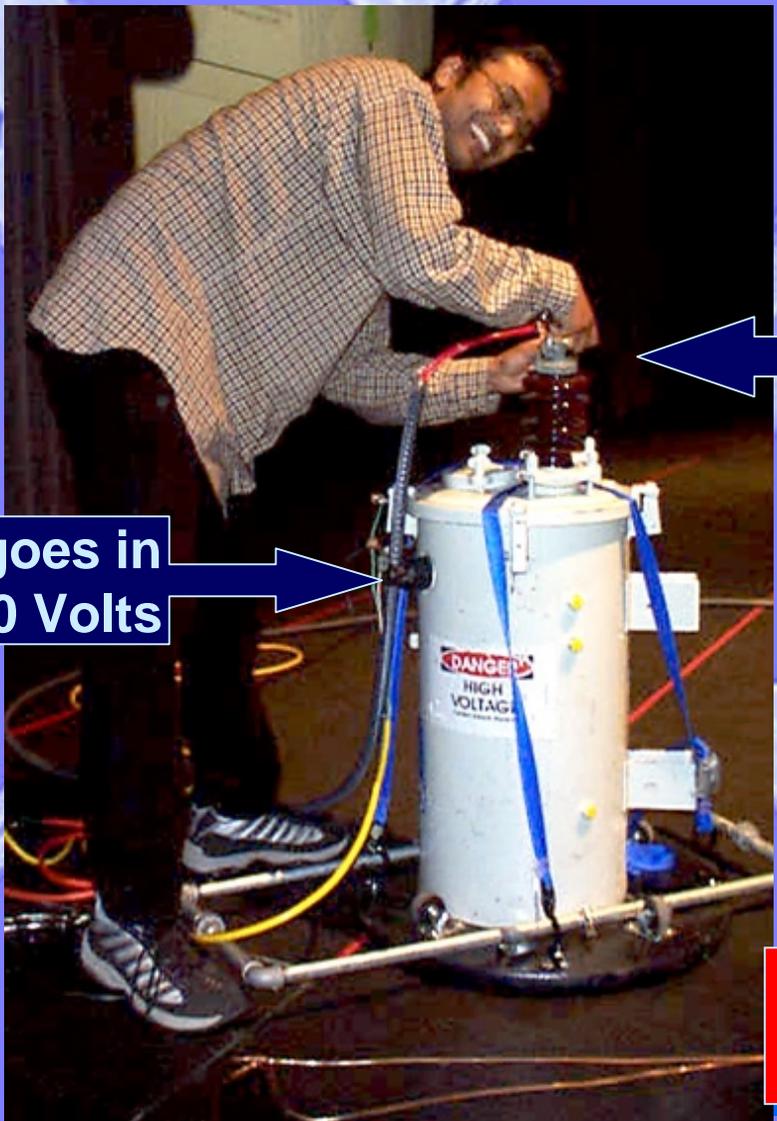
120 volt → Outlet





# UC Santa Cruz Tesla at Aptos High

## Learn about Transformers



Power goes in at 120 Volts

Power comes out at 14000 Volts

*Where have you seen this before?*

Commercial Transformer, hooked up the "wrong way"



# UC Santa Cruz Tesla at Aptos High

## Physics Principle: Transformer

We have

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

Electrical Power is just converted wind, water, thermal power

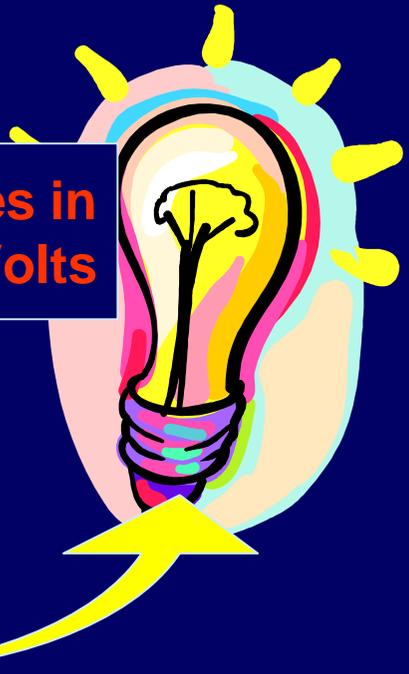
It is brought to your neighborhood on high voltage lines



Power comes out  
At 120 Volts



Power goes in  
at 14000 Volts



and a transformer brings it down to 120V





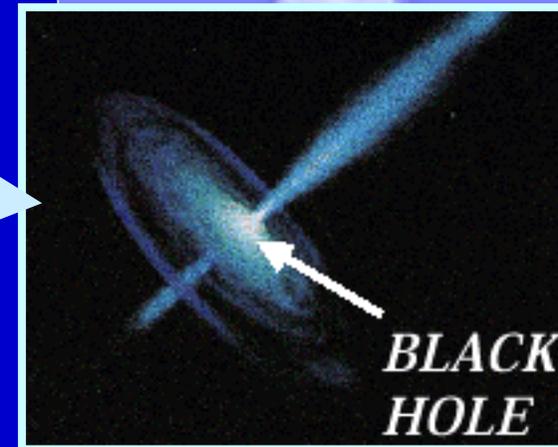
# UC Santa Cruz Tesla at Aptos High

## Transformation of Power

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



- Power is transformed in Space
- Black holes explode :
  - **Material -> Light, x-rays, "jets"**
  - SCIPP works on GLAST Mission:  
**discover the most powerful**  
**"power plants" in the universe**

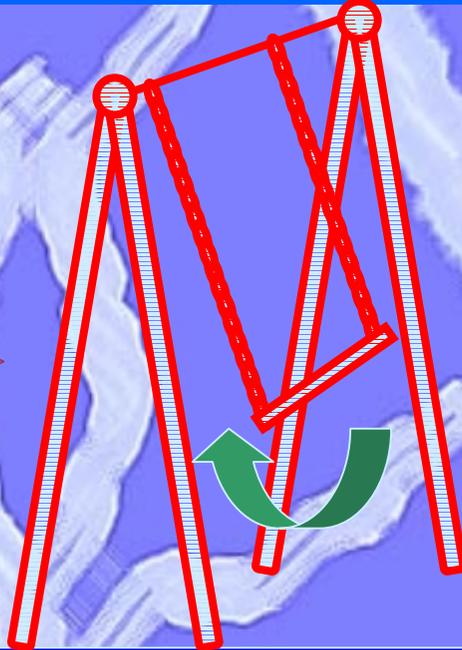
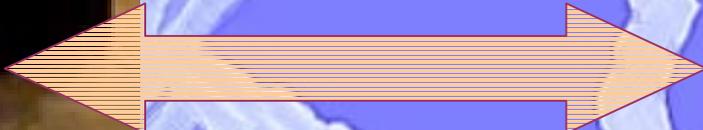




# UC Santa Cruz Tesla at Aptos High

## Learn about Resonance

That's how a swing works:  
A kick at the right moment  
builds up and gets you sky-high!



In the Tesla "swing", the kick is supplied  
by the AC electrical current moving back and forth



# UC Santa Cruz Tesla at Aptos High

## *Meet the Fighting Knight*

**Fighting Lightning  
Bolt to the Head  
Sparks from the feet**



# UC Santa Cruz Tesla at Aptos High

## Electricity in Air



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



**Principle:** Air is made of very small bodies called "molecules". When they are broken apart, 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 (like in your toaster!).



# UC Santa Cruz Tesla at Aptos High

## How lightning works



Ground is safe!





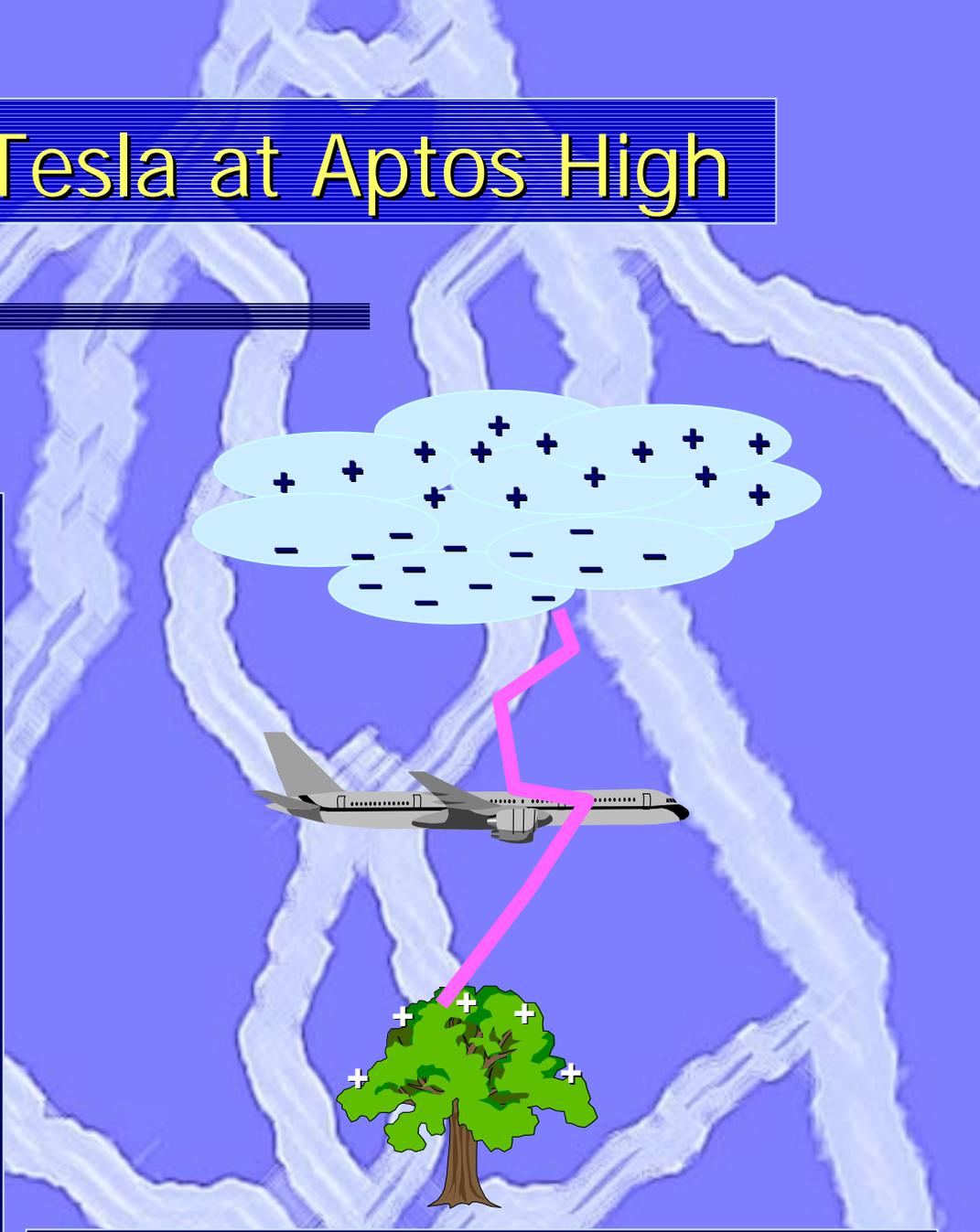
# UC Santa Cruz Tesla at Aptos High

## 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*



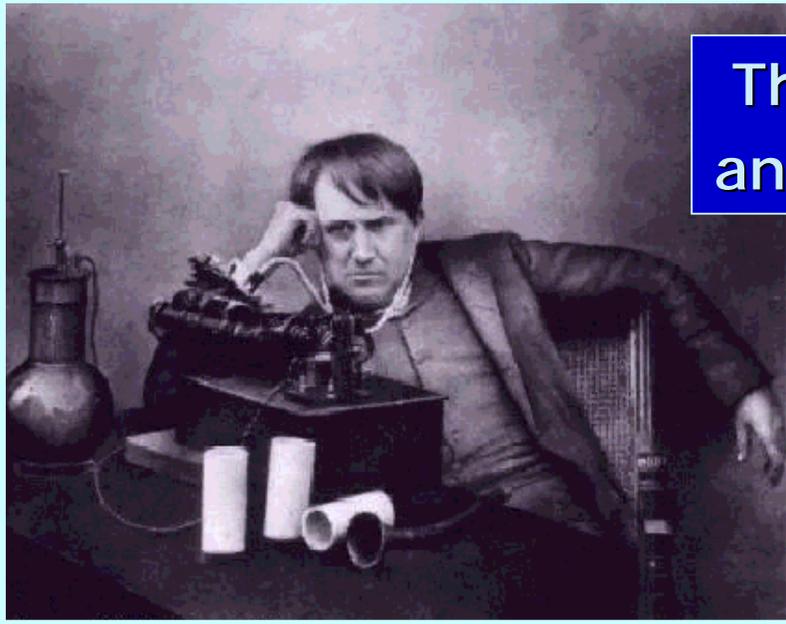
# UC Santa Cruz Tesla at Aptos High

## *The "Chicken Coop"*

The World's Ugliest Faraday Cage --  
and it's full of holes!  
But can it keep the lightning out?

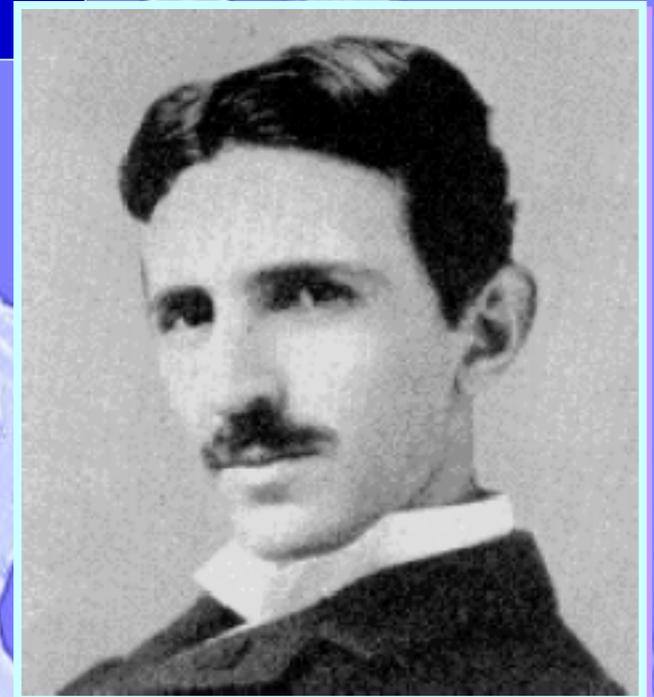
*Does the chicken trust the  
equations?*

# UC Santa Cruz Tesla at Aptos High



Thomas "DC" Edison  
and his Batteries

VS.



Nikola "AC" Tesla  
and his Generators

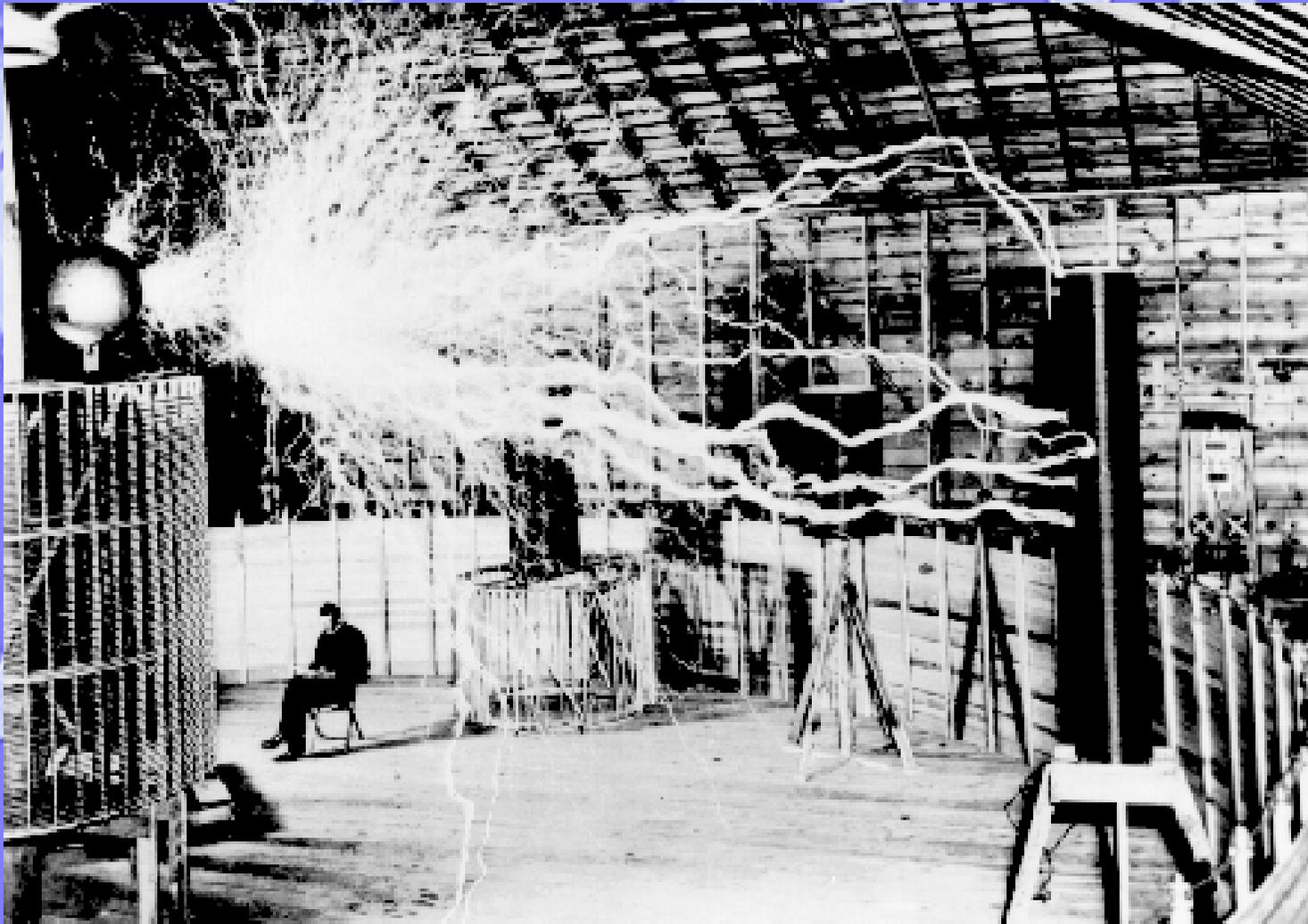
- Tesla Revival
- 271 web sites are dedicated to Nikola Tesla
- Join the "Tesla Coil Web Ring"

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



# UC Santa Cruz Tesla at Aptos High

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



- Double Exposure makes it safe!



# UC Santa Cruz Tesla at Aptos High

## *Mystery Knight*

Who is afraid of Lightning?

Not the Mystery Knight!



# UC Santa Cruz Tesla at Aptos High

*Is the Mystery Knight OK?      Let's check!*  
*The armored suit is safe!*

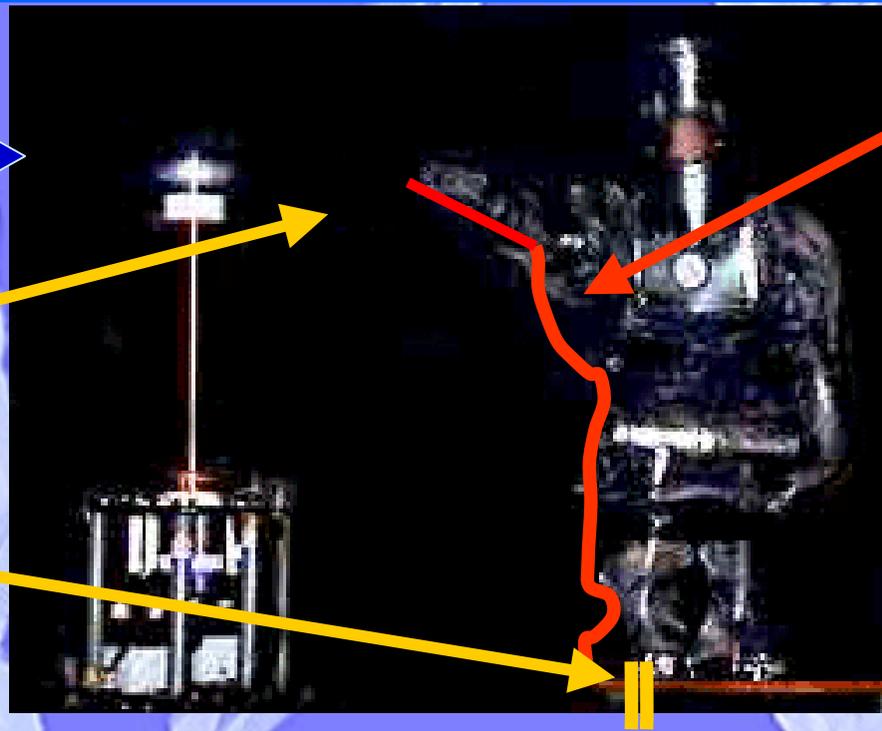
- It's a Faraday Cage – no electric field allowed inside.

1 Million Volts

Visible sparks

Visible sparks

Ground



Invisible current

Electrical current flows on the OUTSIDE of a metal!



# UC Santa Cruz Tesla at Aptos High

**Fysiks is Phun!**

**Questions?**

**Ask after the show, e-mail, visit...**

**You find our coordinates on the web**

**<http://scipp.ucsc.edu>**



# UC Santa Cruz Tesla at Aptos High

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
- Mr. Thompson



<http://scipp.ucsc.edu>

