WELCOME TO ASPIRE

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OUTLINE

- About me
- What is stuff made of?
- Energy scale
- Motivation of my research
- Astronomy with neutrinos
- ANITA
- Intro to Radio
- Electric charge, electric field
- Magnets, magnetic field
- Oscillation
- Wave
- Light
- Back to ANITA
ABOUT ME

✓ From Kolkata, India
✓ College: NC State
✓ Bachelors in Physics
✓ Most feared subject in high school: Mathematics
✓ What I was considered good at in high school: Poetry writing, Chemistry, Biology
✓ Rising third-year graduate student of Physics
✓ What is my job: professional student
✓ Favorite foods: Butter, Potato
✓ Favorite colors: Pink, Black
WHAT IS STUFF MADE OF?

Particle content of the Standard Model

Quarks:
- up
- charm
- top
- down
- strange
- bottom

Leptons:
- $\nu_e$
- $\nu_\mu$
- $\nu_\tau$
- e
- $\mu$
- $\tau$

Force carriers:
- $\gamma$
- Z
- $W^\pm$
- gluon

Higgs
The Higgs boson
The electron-volt or eV is a unit of energy where $1 \text{ eV} = 1.6 \times 10^{-19} \text{ Joule}$.

Energy Scale:

- $1 \text{ eV}$
- $10^3 \text{ eV}$
- $10^6 \text{ eV}$
- $10^9 \text{ eV}$
- $10^{12} \text{ eV}$
- $10^{15} \text{ eV}$
- $10^{18} \text{ eV}$

Large Hadron Collider that recently discovered the Higgs boson 😊

Highest energy particles observed so far (drop a book!)

8/13/2015
When really tiny particles (as small as an electron or smaller!) have this huge amount of energy, we ask *where* do they come from and *how* do they get to be so energetic?
Astronomers have relied on light for most of their observations of the universe.

We use neutrinos! The only particle that can travel large cosmic distances at the highest energies.
WELCOME TO ANITA!
What is ANITA?

✓ balloon-borne
✓ array of **radio** antennas
✓ observing Antarctic ice sheet
✓ searching for radio emission
✓ from neutrinos interacting in ice
INTRO TO RADIO: AN ELECTROMAGNETIC WAVE

- Radio is a type of light

- What is light?

- Light is an electromagnetic wave

- Let’s talk about the Physics of light, an electromagnetic wave.
**Electric field lines** point **towards a negative charge**

**Electric field lines** point **away from a positive charge**

This girl is collecting charge from the van de Graaff generator and her hairs are standing on end because they repel each other.

Opposites attract, likes repel
Our Earth is a giant magnet!

Things made of iron, nickel and cobalt get stuck to a magnet.

Typical magnet is a piece of iron that has its atoms arranged in a particular way, producing a magnetic field that points away from its North Pole and towards its South Pole.

Iron filings arrange themselves along magnetic field lines.

Our Earth is a giant magnet!
ELECTRIC AND MAGNETIC FIELDS

- Source = electric charge
- Field = electric field

- Source = magnet
- Field = magnetic field

Electric and magnetic fields are vectors. They have a magnitude (length of arrow) and a direction (direction in which arrow points).
Oscillation

Pendulum bob on clock oscillates about equilibrium.

Girl on swing oscillates about equilibrium.

Block attached to spring oscillates about equilibrium.

Displacement vector = final position $y_f$ – initial position $y_i$

Graph of the vector displacement along y-axis vs. time along x-axis of each of these oscillating objects looks like the above.

These are all examples of oscillations in time.

A wave is an oscillation in time and space.
WAVE

period = T = \frac{1}{\text{frequency}}

amplitude

time

position

wavelength

E

y-axis

x-axis
Light is electric and magnetic fields oscillating together and perpendicular to each other. Here, light travels along x-direction.

Remember $\mathbf{E}$ and $\mathbf{B}$ vectors, the arrows here represent them.
Radio is a type of light! The property **wavelength** determines what type of light it is.
ANITA DETECTS RADIO SIGNALS

ANITA

balloon

37 km altitude

radio signal

neutrino interacting in ice produces radio waves

Antarctic Ice Sheet is lots of ice and it is radio transparent 😊
Thank you! Any questions?