

COURSE MODULE INFORMATION

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Course WEB PAGE: www.physics.mun.ca/~rgoulding/index.html

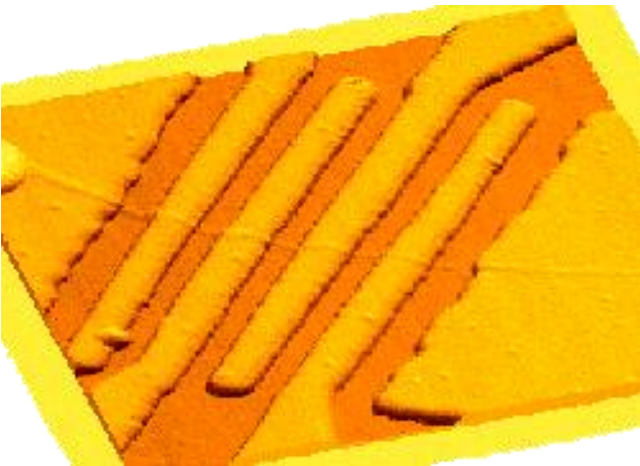
Here you will find course notes and other material.



Physics

May the Force be With you

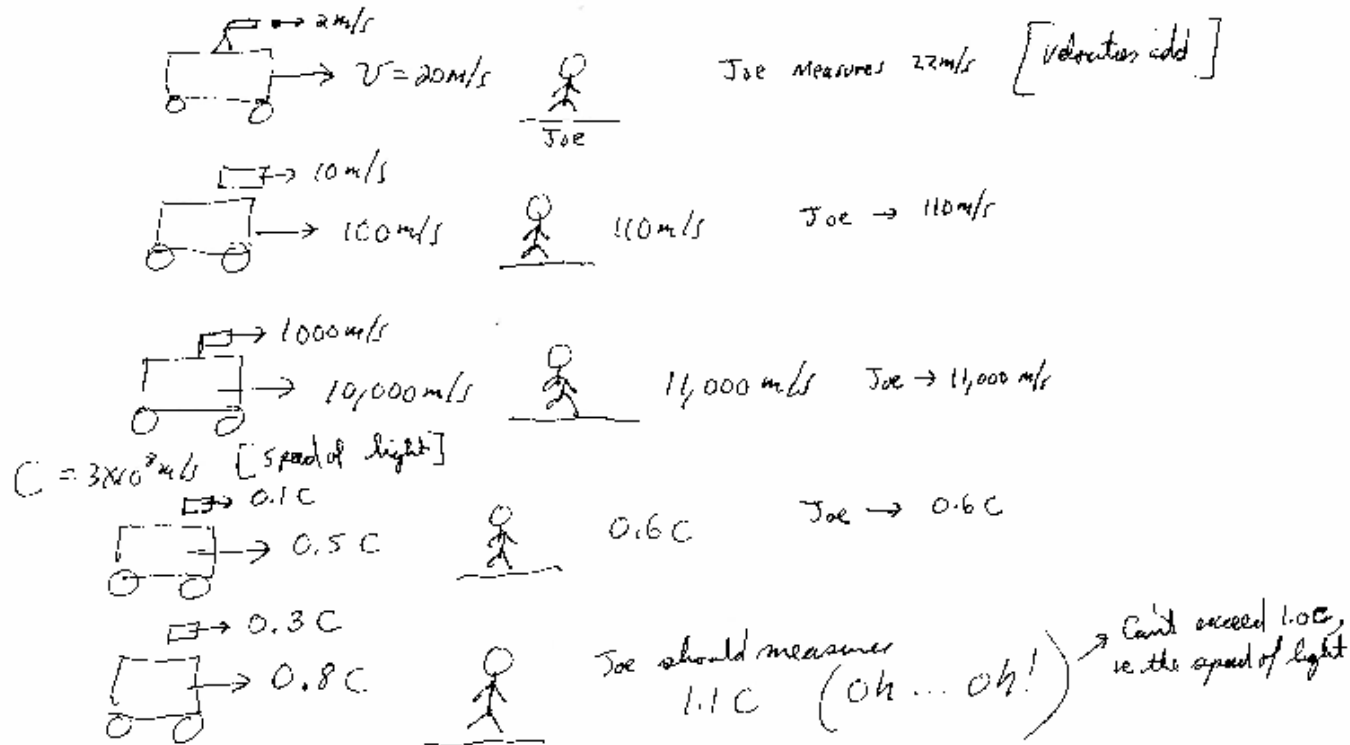
Obe Wan Konabe



[Video](#)

A Typical Physics Problem

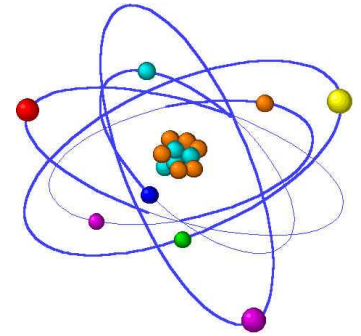
A gun mounted on a moving traincar....



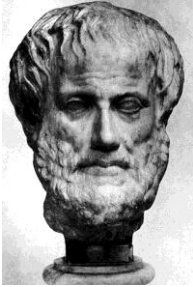
Solution Simple addition of speeds works at low speed but not at speeds near speed of light (c).

Einstein developed the Special Theory of Relativity to account for this problem. As speeds approach the speed of light funny things happen... objects get more massive, lengths ^{and} time get shorter etc....

History of Physics



•The Greeks

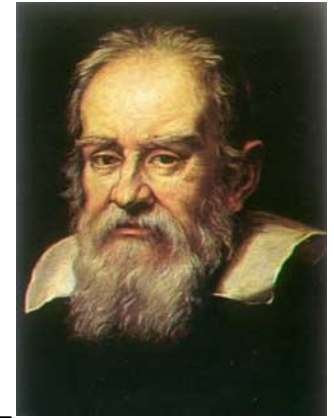


- Cultivated the study of “Natural Philosophy”

Aristotle(384-322 BC)

- Student of Plato
- observation of physical phenomena → Physical Laws
- Wrote first Physics book Aristotle’s Physics
- Believed earth was center of solar system (geocentric)
- Knew earth was a sphere (Eratosthenes 276-194BC)
- Aristarchus proposed sun centered (heliocentric) model of solar system
- Archimedes made many contributions in fluids and mechanics
- Ptolemy wrote many scientific “papers” which became basis for later advancement
- Greeks developed scientific method
- Most of Greek work was lost. Some was salvaged through Islamic philosophers who reinterpreted the Greek in the context of their religion.

Galileo Galilei-The Rise of Physics and mathematics

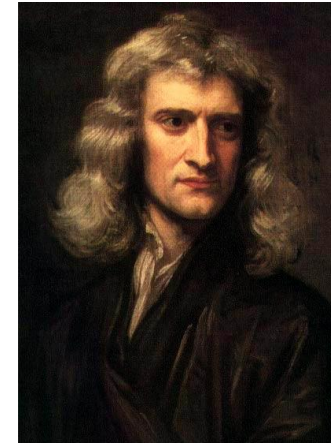


- Knowledge was dominated by Law, medicine and theology
- Galileo studied Copernicus and felt that math was the key to understanding the motion of the planets.
- Discovered moons of Jupiter in 1609 (First telescope?)->big job->publications
- Dialogue Concerning the Two Chief World Systems-> house arrest
- Galileo started new focus on experimentation-> start of a new age in science

Descartes-believed that motion was due to objects following the influence of corpuscles. Planetary motion was caused by vortex motion of corpuscles in space. Decartes did not believe that a vacuum could exist.

Isaac Newton-The Big Picture

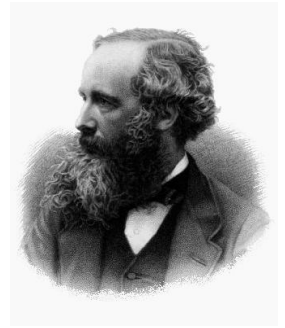
http://en.wikipedia.org/wiki/Isaac_Newton



- 4 January 1643 – 31 March 1727
- Built first practical refracting telescope
- Developed a theory of colour, empirical law of cooling
- Co-inventor of Calculus and Generalized Binomial Theorem
- Published Principia 1687
 - Laid groundwork for classical mechanics
 - Law of Universal Gravitation
 - Newton's Three law's of Motion
 - Showed Kepler's laws came from law of Universal Gravitation
 - Saw the Big Picture!!
 - Principia dominated science for next three centuries!!

I saw the crescent. You saw the Whole of the Moon-The Waterboys

The Middle Years 1750-1900



- Calculus and mathematical analysis applied to many problems
- Mid 1800's , theories of the energy of physics were developed. These theories made physicists rethink how the physical world worked.
- **James Clerk Maxwell** (June 1831 –Nov 1879) led the way with his Kinetic Theory of gases and his theory of electromagnetic radiation
 - Showed EM radiation, light and magnetic fields were all products of the electromagnetic field-> second great unification!
 - These two discoveries laid down the groundwork for “Modern Physics” which was just around the corner!
- **Maxwell is considered to be as great a scientist as Newton and Einstein!**

Physics in 1900

The problems:

1.Blackbody Radiation

2.Photoelectric Effect

3.Certain types of radioactivity could not be explained

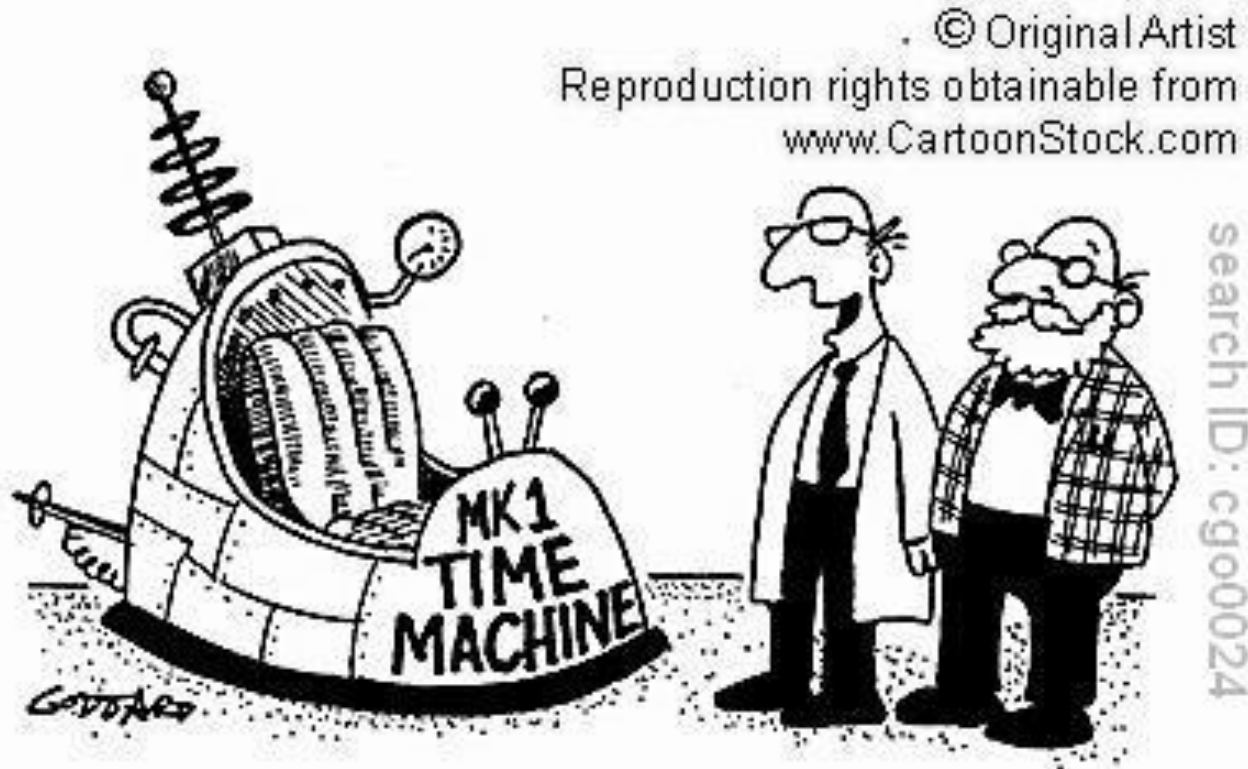
4.An ether around the earth through which EM radiation was postulated to travel could not be found.

Einstein and Quantum Mechanics

1. Special Theory of Relativity which gave mass-energy equivalence($E=mc^2$)
2. Postulated that light could be a particle which was **quantized($E=hf$)**. This was a revolutionary idea!
 - Neils Bohr used this idea to explain the hydrogen atom and the light frequencies emitted by hydrogen gas. This was the beginning of Quantum Mechanics.
 - This explained the Photoelectric Effect
3. Einstein's General Theory of Relativity showed that the force of gravity and motion in an accelerating frame are indistinguishable.

Homework: Look at [THIS VIDEO](#)

Relativity Cartoon



"It takes you back, doesn't it".

Quantum Mechanics-The Roaring 20's

1. Bohr's idea was expanded to full scale theory in 1920's.
2. Debroglie(1925)(showed that light could behave as a wave(particle-wave duality)
3. Heisenberg's Uncertainty Principle (1927)showed that for very small things you can measure momentum or position but not both.
4. Paul Dirac produced relativistic quantum theory in 1928
5. Theories got more complicated but couldn't quite fit known results.
6. Einstein did not like the probabilistic nature of quantum mechanics and said "I do not believe that God plays dice?"

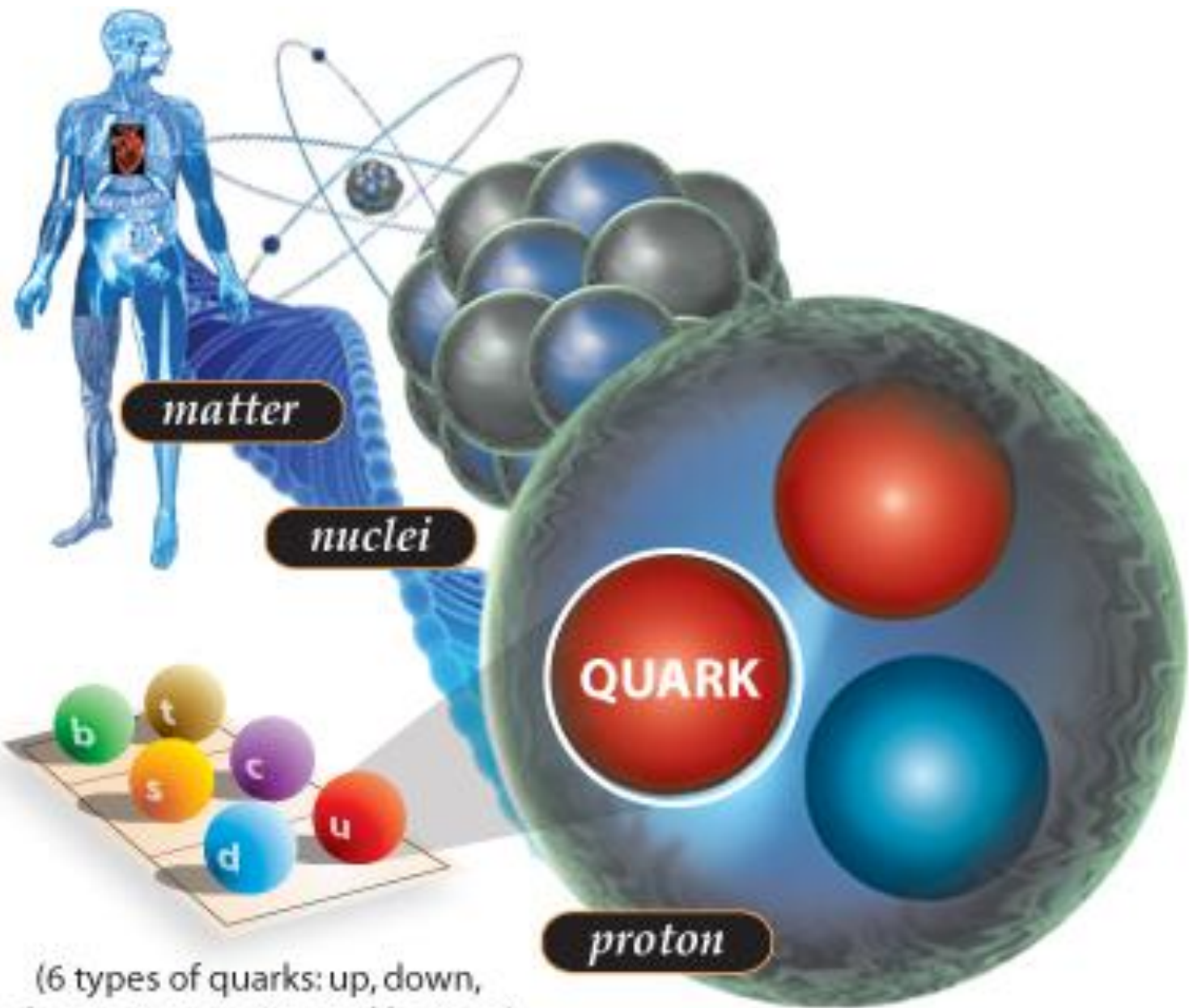
What happened next....



- Quantum mechanics evolved and cumulated
- in the late 1940s in the quantum electrodynamics (QED) of Richard Feynman, Freeman Dyson, Julian Schwinger and Si-Itiro Tomonaga. Feynman, Schwinger and Tomonaga received the 1965 Nobel Prize in Physics. QED, a quantum theory of electrons, positrons, and the electromagnetic field, was the first satisfactory quantum description of a physical field and of the creation and annihilation of quantum particles. It was called Theory of everything!
- Particle physics evolved. Key features were the existence of short lived virtual particles governed by the Uncertainty Principle. Particles from nothing!
- Feynman was one of the great minds of science
- http://en.wikipedia.org/wiki/Richard_Feynman
- [Feynman explaining Atoms](#)
- [The Pleasure Of Finding Things Out\(Part1\)](#)
- [The Pleasure Of Finding Things Out\(Part2\)](#)

What keeps protons in nucleus together? Repulsive force is very strong!

- Yukawa predicted existence of a powerful but short range force carried by a particle called a Pion whose size was bigger than an electron but smaller than a proton. Pion was discovered in 1947 as were many particles such as the neutron and positron.
- Particle accelerators built to search for new particles
[Stanford Linear Accelerator](#)
- Murray Gell-Mann and Zweig proposed that protons, neutrons were composed of smaller particles called quarks. It is impossible to see a free quark!
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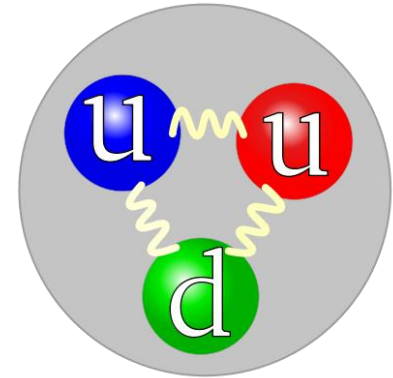
(6 types of quarks: up, down, charm, strange, top and bottom)

•Standard Model-Quantum Chromodynamics

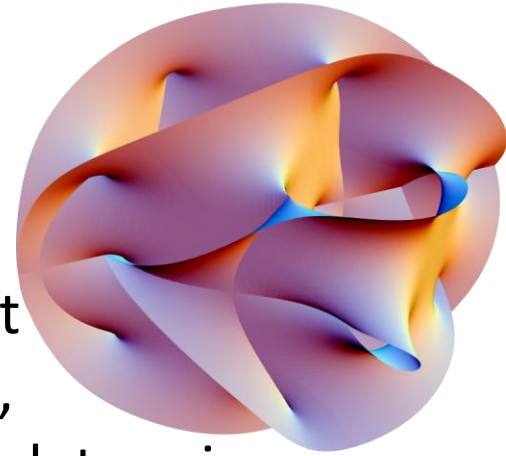
- The Standard Model was finalized in the 1970's which tied together all forces except for gravity.

- Particle accelerators have confirmed most parts of this model
- A theory called string theory holds promise to bring gravity into the fold. This theory requires strings of size much smaller than anything we know and 11 dimensions! These strings vibrate

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Strings become Membranes



- These "strings" vibrate in multiple dimensions, and depending on how they vibrate, they might be seen in 3-dimensional space as matter, light, or gravity. It is the vibration of the string which determines whether it appears to be matter or energy, and every form of matter or energy is the result of the vibration of strings.
- Five string theories by late 80's
- M-theory incorporated all 5 string theories. Looks like a very good theory.
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