Today

- The 3rd Exam is next week on Thursday
  - 40 multiple choice questions
  - Exam extra credit will be due Tuesday April 29 (the day after the final exam)
- Updated grades with results from the third exam should be available on Friday after the exam. Exam #3 extra credit will be calculated on Sunday evening and again at the end of the term.
- Today: The Mystery of the Physical Universe

Today (continued)

- Final Exam
  - You do not have to take the final if you are happy with your grade after the 3rd exam.
  - If you take the final, it can not reduce your grade
  - 40 multiple choice questions
  - The questions will be very close to midterm exam questions
  - You can bring 3 sheets of paper
  - Use the midterm study guides
- There will no exam extra credit available for the final.

Advice for the Final Exam

- Rates of change problems are important (Be able to find slopes and recognize where the slope is largest, zero, etc.)
- Review Feynman Diagram problems from the midterms
- Newton's Laws
  - Velocity is constant if the sum of forces are zero
  - F=ma
  - For every force there must be an equal magnitude but opposite direction force

Very Important

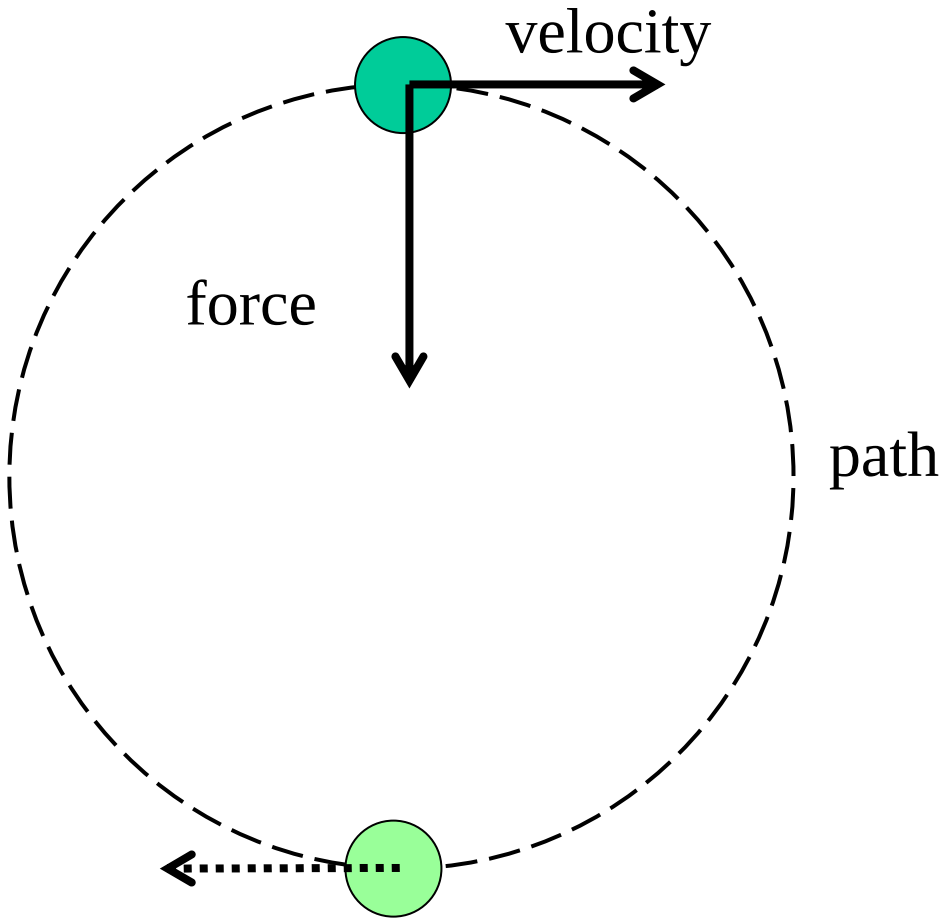
Please, go to http://rateyourclass.msu.edu

and fill out the SOCT rating forms for ISP209

The Mystery of the Physical Universe

- The Universe follows mathematical rules (We are not the first culture to think this. For example, it was a part of Mayan philosophy as well.)
- Newton made progress in understanding the motion of the planets once he understood F = ma
- Is it possible that we might eventually understand everything (the origin of all particles, forces, and quantum numbers) from one equation?
- Is it important to find this one equation?

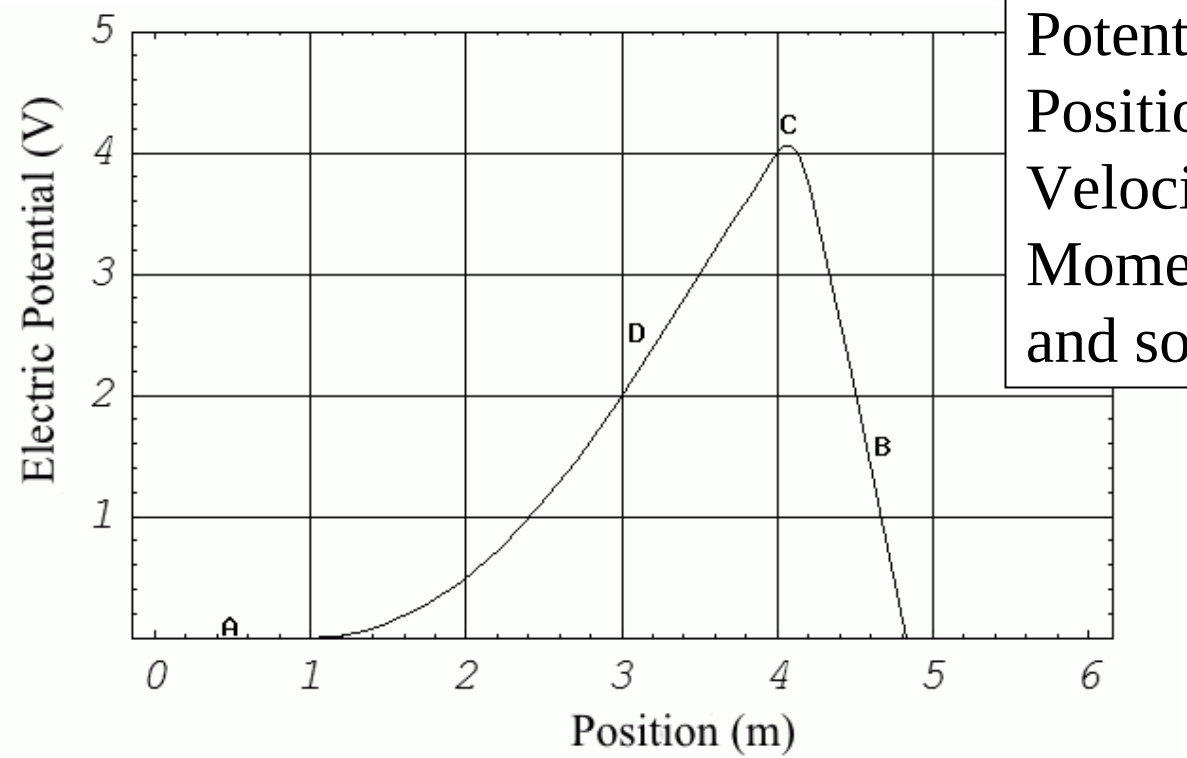
F = ma and motion in a circle



Understanding:
Rates of change
Vectors
Velocity
Acceleration

Rates of Change

A few simple ideas lead to powerful results.



Rate of change:

Potential (volts)	Electric Field
Position (m)	Velocity
Velocity (m/s)	Acceleration
Momentum	Force
and so on	

The Elegant Universe

- Understanding nature with one equation? F=ma
- Brian Greene wrote a book with the title and PBS made a video based on it. The book was a New York Times Best Seller for many weeks. You watched clips from the video last Thursday.
- The book describes the history of “unification” and String Theory

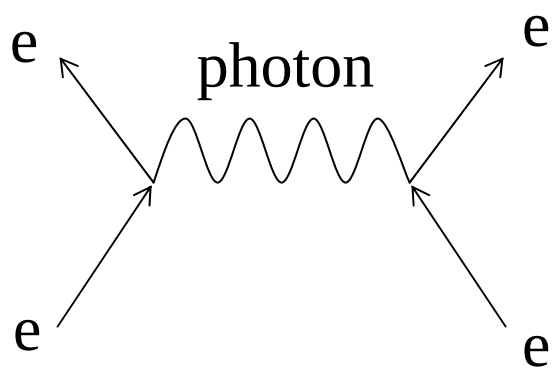
One Equation is the modern version of..

Physics by Aristotle written in 350 B.C.
"When the objects of an inquiry, in any department, have principles, conditions, or elements, it is through acquaintance with these that knowledge, that is to say scientific knowledge, is attained. For we do not think that we know a thing until we are acquainted with its primary conditions or first principles, and have carried our analysis as far as its simplest elements. Plainly therefore in the science of Nature, as in other branches of study, our first task will be to try to determine what relates to its principles."

Fire Air Water Earth / Hot Cold Wet Dry

Forces

- We know of 4 in nature: gravity, electromagnetic, weak, and strong
- Are there more? We don't know, but have not found any more.
- The modern view of force is in terms of field theory
- Feynman Diagrams



Particles and Quantum Numbers

- Quarks and Leptons come in three families
- Each force has a particle (s) that transmits it
- Charge, Baryon number, lepton number are fundamental properties of nature. Particles in nature are characterized by these quantum numbers
- Mass is the result of interaction with the Higgs particle (we think)
- $E=mc^2$

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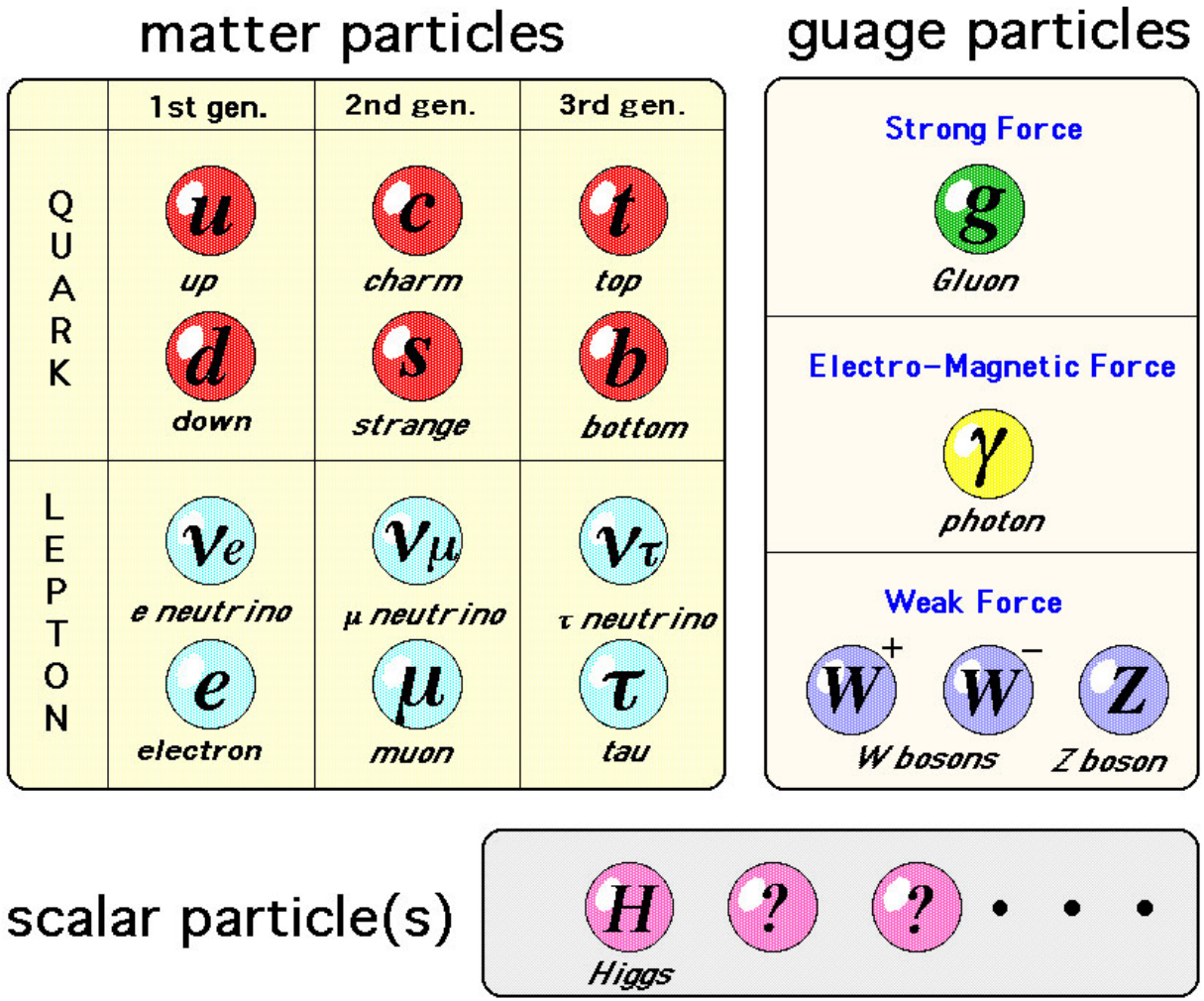
Standard Model Particles

Charge

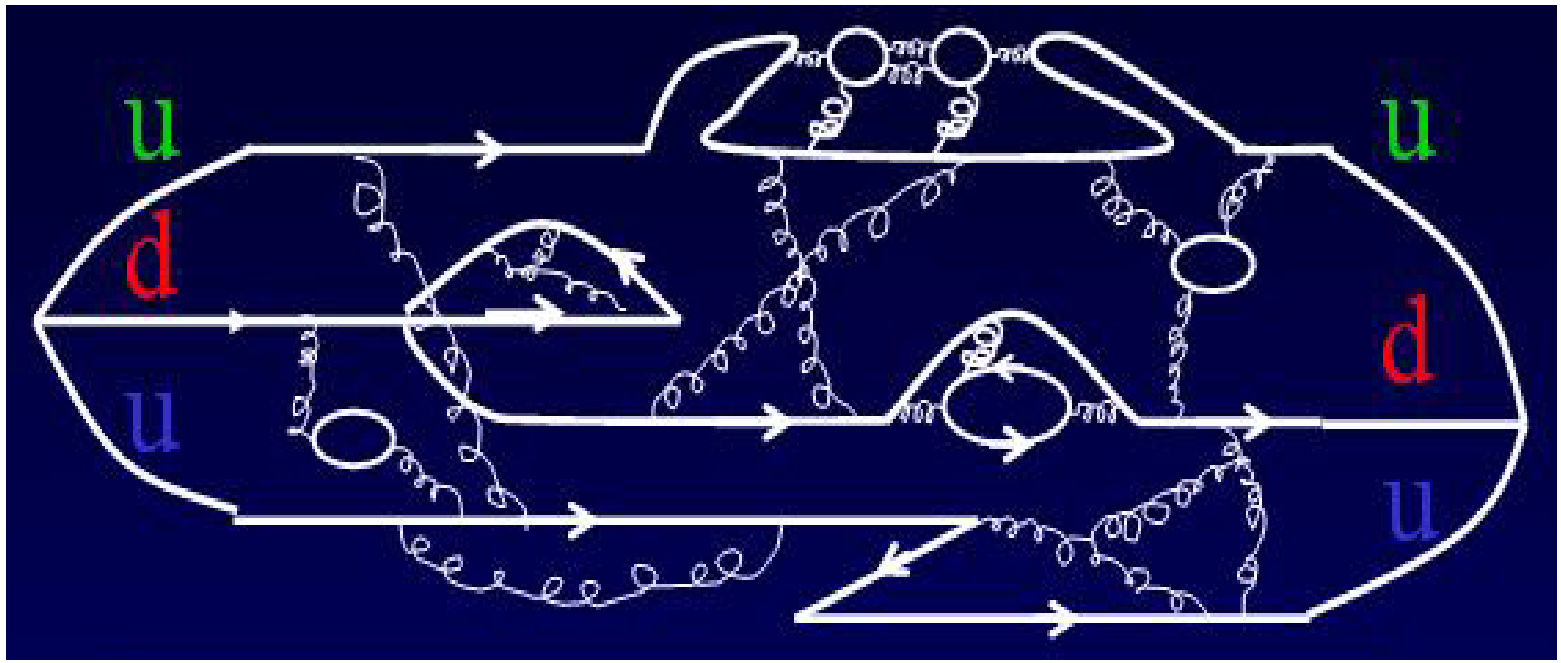
+2/3 ⟶

-1/3 ⟶

Anti-particles have the opposite charge.



Simple things are complex: The Proton



time

http://www.gwu.edu/~cns/theory/theory_webpage/proton2_qcd.jpg

Yet, our understanding is far from complete

- Standard Model – We have many open questions. Why three families of quarks?
- Einstein's picture of gravity does not match the quantum theory of the Standard Model. They don't work together!
- The universe is 96% stuff we don't even know what it is? The matter we are made of is only 4% of the Universe (as far as we know).
- Will String theory be a solution?
- Are there parallel universes, besides our own?

However, we can do a lot with Science

- Modern medicine
- Electronics (ipods)
- Transportation
- Many more fantastic technical innovations are underway – field called nanotechnology
- What are the priorities for future funding?

Science Questions

- How expansive is our universe? How do we know?
- Is there air in space?
- What is gravity? Why does gravity exist? Does gravity affect time?
- Could there be more than four dimensions?
- If we continue to study how to time travel but see no one from the future has traveled back to now why do we continue to search for it when we know we never end up discovering how?
- Would the world be better off without some of the technological advancements that have been made?
- Does the universe end, and if it does, then where?
- Why is Pluto not considered a planet?
- If we are but simple and insignificant articles of matter, why should we concern ourselves with a meaning of existence?

My summary of the term

- What is time? Time is a dimension in our 4 (or maybe 11) dimensional universe. We can't move backward in time because that would violate the 2nd Law of Thermodynamics. This was set about during the inflationary period of the Big Bang
- Rates of change rule! Position, Velocity, Acceleration, Force, Force Fields
- Quantities have units, amounts and sometimes directions (remember vectors?)

summary

- The Universe is an amazing place. 200 billion galaxies each with about 200 billion stars
- Last year an Earth like planet was discovered about 200 ly from Earth. It has an orbit that would allow it to have liquid water.
- We are composed of stuff that makes up 4% of the Universe. We don’t know what the dark energy or dark matter are.
- We need to keep asking the why question.