Particle Physics: Introduction

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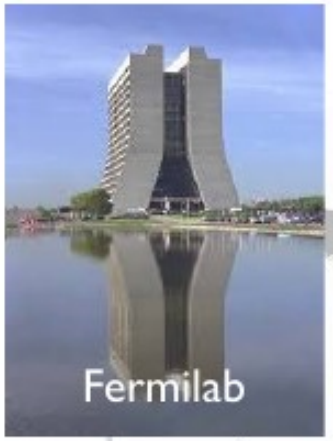
Columbia University Science Honors Program

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

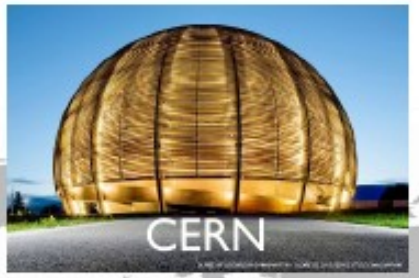
NEVIS LABORATORIES

Welcome!

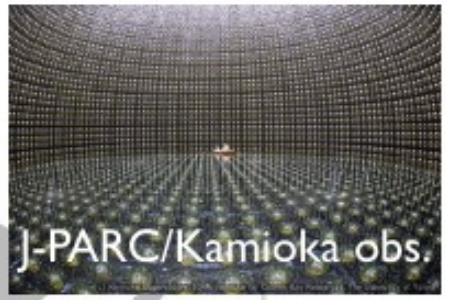
José I. Crespo-Anadón
Postdoc on MicroBooNE and SBND experiments at Fermilab (Il, USA)



Inês Ochoa
Postdoc on ATLAS experiment at CERN (Switzerland)



Cris Vilela
Postdoc on T2K and Super-Kamiokande experiments in Japan



Schedule

Month	Day	Lecture	Teacher
January	27	Introduction	Jose
February	3	History of Particle Physics	Jose
	10	Special Relativity	Jose
	17	Quantum Mechanics	Jose
	24	Experimental Methods	Cris
March	3	The Standard Model - Overview	Cris
	10	The Standard Model - Limitations	Cris
	17	No classes, Columbia University spring break	
	24	Neutrino Theory	Cris
	31	No classes, Easter and Passover weekend	
April	7	Neutrino Experiment	Jose
	14	LHC and Experiments	Ines
	21	No classes, SHP break	
	28	The Higgs Boson and Beyond	Ines
May	5	Particle Cosmology	Cris

Course policies

- Classes from 10:00 AM to 12:30 PM (10 min break at ~ 11:10 AM).
- **Attendance record counts.**
  - Up to four absences
  - Lateness or leaving early counts as half-absence
  - Send email notifications of all absences to shpattendance@columbia.edu .
- Please, no cell phones during class
- **Please, ask questions!**
- Lecture materials + Research Opportunities + Resources to become a particle physicist

  https://twiki.nevis.columbia.edu/twiki/bin/view/Main/ScienceHonorsProgram

Web page screenshot

SHP Particle Physics

This page collects the class material for the Particle Physics course for the Spring 2018 semester.

Related Topics

- Science-on-Hudson Public Lecture Series

Resources on Research Opportunities

Useful links

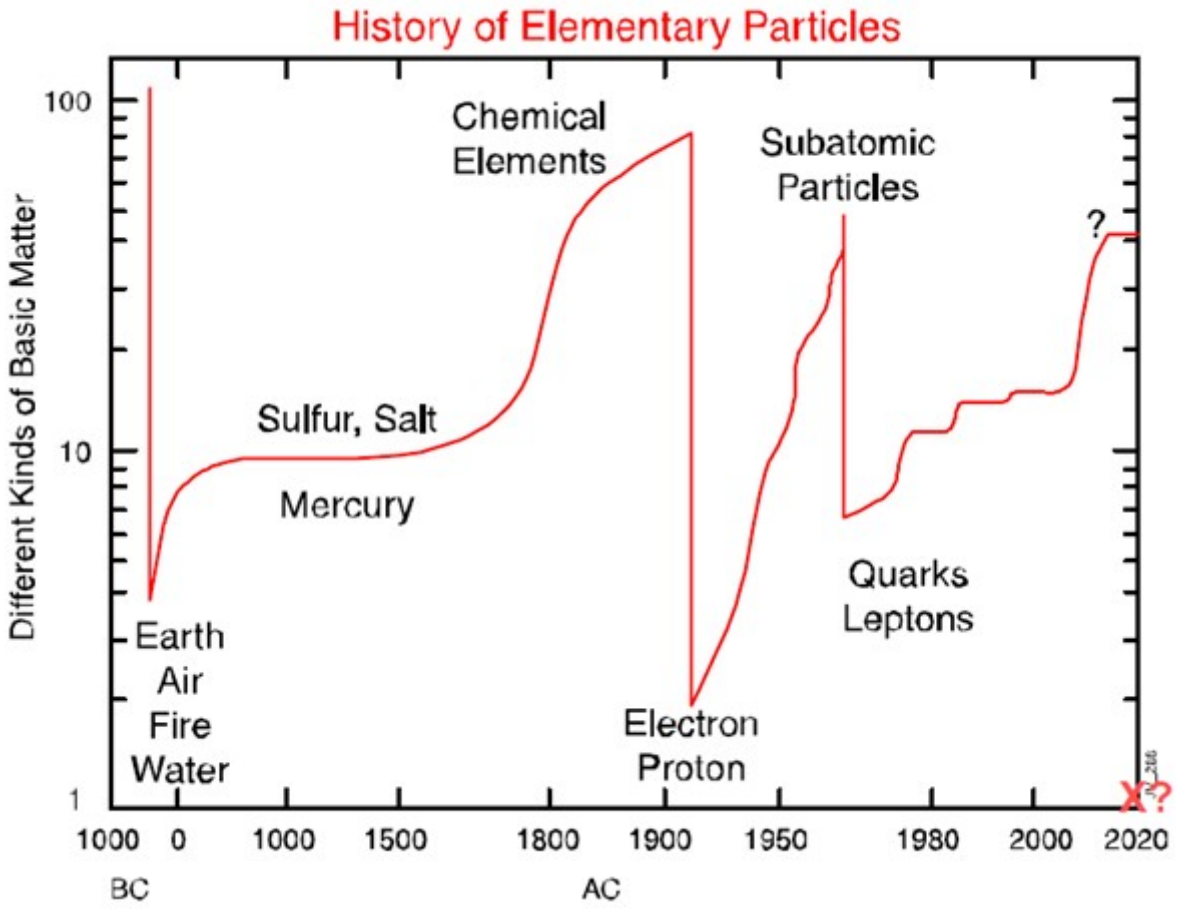
- http://sps.columbia.edu/highschool
- http://www.stonybrook.edu/undergraduate-admissions/future-students/programs-for-high-school-students/
- https://www.rockefeller.edu/outreach/summer-science/links/
- https://research.princeton.edu/students/research-opportunities/
- Fermilab Summer Internship: http://ed.fnal.gov/interns/programs/quarknet/index.shtml (requires you to live in Fermilab's area, maybe you can apply if you have family/friends there)
- CERN S'Cool LAB Summer CAMP: http://scool.web.cern.ch/content/scool-lab-summer-camp
- Brookhaven National Laboratory High School Research Program: https://www.bnl.gov/education/program.asp?q=219

And when you are in college, you can be part of our Research Experience for Undergraduates (REU) program. More information at https://www.nevis.columbia.edu/reu/

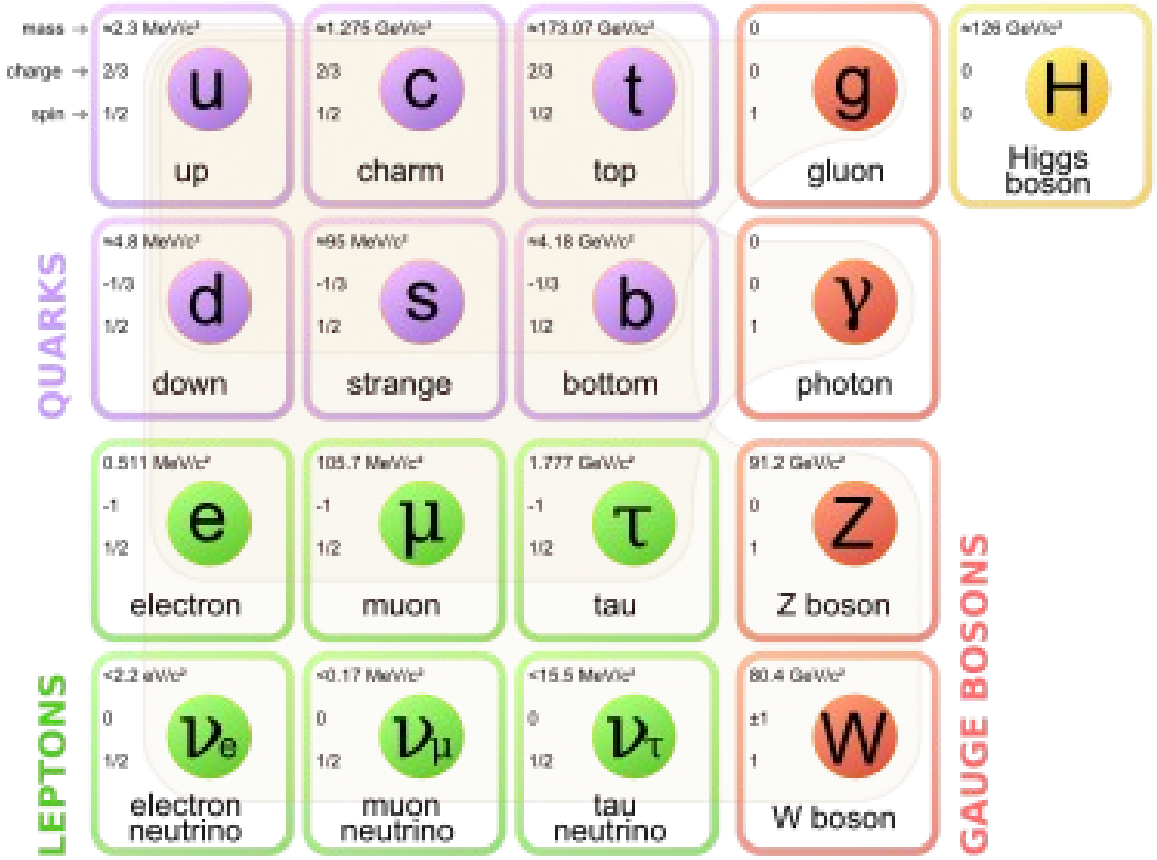
Resources on Tools to become a Particle Physicist

- Learn how to use the shell, either from Linux or Apple's Mac OS. A quick introduction is https://community.linuxmint.com/tutorial/view/100
- C++ is the main language used in particle physics. A popular reference is http://www.cplusplus.com/doc/tutorial/
- ROOT is a software framework written in C++ which is used by particle physicists for their analyses. A compilation of resources can be found at https://root.cern.ch/getting-started
  - Here is a great tutorial followed by the REU students at Nevis: https://www.nevis.columbia.edu/~seligman/root-class/
- Python is also a common language and it's a particularly good one for programming beginners. A compilation of resources is here but you can find plenty others online.

Evolution of the number of elementary particles

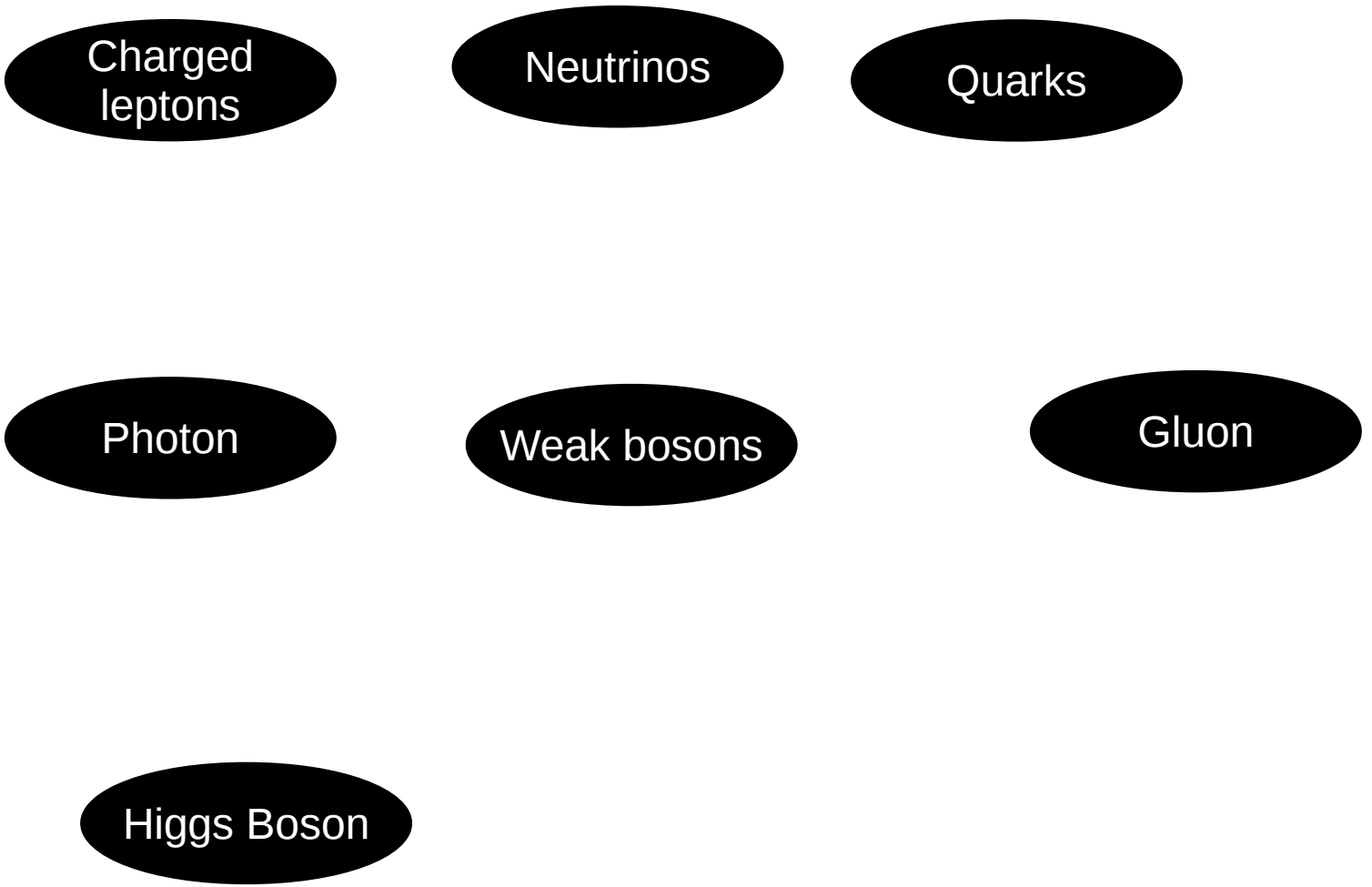


The Final Periodic Table?

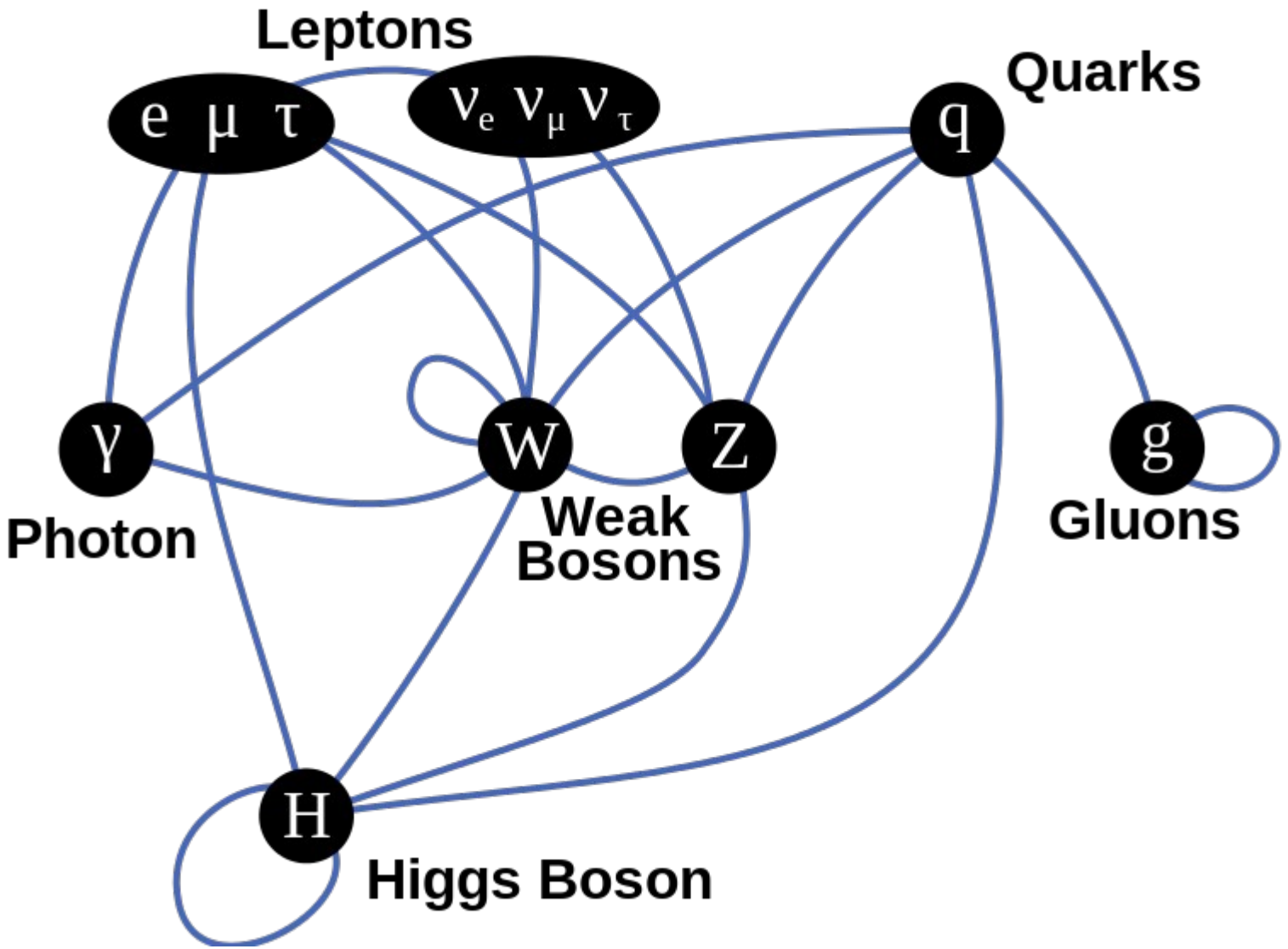


Quiz

- Draw lines between the fermions and the bosons that can interact with them



Standard Model solution



By en:User:TriTertButoxy, User:Stannered - en:Image:Interactions.png, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3496370

Powers of Ten (1977)

https://www.youtube.com/watch?v=0fKBhvDjuy0

Quantum Field Theory