Particle Physics & Cosmology

Physics 457 at **University of Michigan**

Evan Carpenter

Winter Semester 2022

Lecture 1. (Jan 5) *First Day*

eV is energy required to move 1 e^- through 1 V
We can set $c, \hbar, k_B = 1$ A result of that is being able to describe all quantities in terms of energies or inverse energies.

Lecture 2. (Jan 7) *Second Day*

eV are a thng
Natural units are thing

Dimension	SI	Planck	Natural
Energy	1.602×10^{-10} J	1 GeV	1 GeV
Mass	1.783×10^{-27} kg	1 GeV/c^2	1 GeV
Momentum	5.33×10^{-19} kg*m/s	1 GeV/c	1 GeV
Distance	1.973×10^{-16} m	$\hbar$c GeV	1 GeV^{-1}
Time	5.33×10^{-19} kg*m/s	1 GeV/c	1 GeV^{-1}
Mass Density	$2.322 \times 10^{20} kg/m^3$		1 GeV^4

Table 1: Units

Proper time is Δt_0 with the clock at rest in that frame
Time dilation is $\Delta t = \gamma \Delta t_0$ in the frame
Proper length is Δx_0 with the clock at rest in that frame
Length Contraction is $\Delta x = \Delta x_0 / \gamma$ in the frame

Lecture 3. (Jan 12) *Finishing Special Relativity*

Invariant vs constant and how they are different.
Different relationships for beta and gamma
Lorentz transform in matrix form as boost.
E from beam at target and from two beams: pros and cons of cost and statistics and max energy.

Lecture 4. (Jan 14) *Matter particles*

Stable particles! Proton is only quark combo that's stable! Possibly make baryon template for Tikz? Baryon has odd number of valence (?) quarks

Lecture 5. (Jan 19) *Quark Confinement*

Quark model 1960s
Gluons predicted in late 1970s
hadrons are made of quarks, either baryons or mesons
Baryons are 3 quark bound states, baryon # ± 1, proton is lightest
Mesons have quark qntiquark bound states, B=0
protons have mass from energy stored in gluon fields, higgs is mass for small mass like e^- ($< 2\%$)

words