

Particle Physics & Cosmology

Physics 457 at [University of Michigan](#)

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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	2.322×10^{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 antiquark bound states, B=0

protons have mass from energy stored in gluon fields, higgs is mass for small mass like e^- (< 2%)

words