- course outline / overview of this field
- credit.
- History of particle phys. forces & content.
- natural unit. & some simple dimension analysis.

Clip? CERN 2 min, ATLAS 18 min, assembly 12 min } ~45 mins

- [illegible] = [illegible] (Griffith)

indirect probe ↑ small →

Classical mechanics	Quantum mechanics
Relativistic mechanics	Quantum field theory

fast ↓

→ ψ, or $|s\rangle$
→ can only calculate the probability of the final state

elementary particle:
fundamental building block
indistinguishable.

$\Delta \to p + \pi$

- $m_\Delta > m_p + m_\pi$
  not in classical mech.
  ~~if classica~~
- massless particle. γ, g ...

marriage of QM + SR
→ anti particle
TCP,

↳ will give a very brief introduction
↳ and show how to use Feynman Diagram to view the process.

SM = special relativity + QM
+ local gauge symmetry.

→ This course is more or less : An introduction to SM.
→ will only spend 1 or 2 classes ~~on~~ the experimental -

(a) How to produce elementary part

e : heat up a piece of metal, use E, B to control.
p : basically H will do

other than that
* cosmic rays. ✓ (high eng, free
✗ (rare, uncontrollable. → need patience & luck

* nuclear Reactors. $\alpha, \beta, n, \nu, \gamma$

* Particle accelerator.

→ heavier particle
smaller size → higher energy
better resolution

$\lambda = \frac{h}{p}$

(b) How to detect elementary particle.

cloud chamber, bubble chambers, spark chamber.
Čerenkov counter, scintillator, photomultipliers.
⇒ high E charged particle ionize atoms. → neutral particles are hard to detect

Unit.

1eV (for atomic physics) $= 1.6\times 10^{-19}$ joules.

in Nuclear phys. KeV $= 10^3$ eV

or MeV $= 10^6$ eV

GeV $= 10^9$ eV

TeV $= 10^{12}$ eV.

Size nm

$\mathring{A} = 10^{-10}$ m

fm $= 10^{-15}$ m

momentum in MeV/c or GeV/c ...

mass MeV/c^2

$\Rightarrow$ $c = \hbar = 1$ ⟶ $1\ \mathrm{GeV}^{-1} = 0.197$ fm $= 6.59\times 10^{-25}$ sec

definition of electric charge.

SI : $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$ coulombs

Gaussian : $F = \frac{q_1 q_2}{r^2}$ esu, electrostatic unit.

Heaviside-Lorentz : $F = \frac{q_1 q_2}{4\pi r^2}$ $\mu_0 = \varepsilon_0 = 1$

Griffith

$q_{HL} = \sqrt{4\pi}\, q_G = \frac{1}{\sqrt{\varepsilon_0}} q_{SI}$

I will follow this.

$\alpha = \frac{e^2}{4\pi} = \frac{1}{137}$ H-L

$= \frac{e^2}{\hbar c} = \frac{1}{137}$ Gaussian.

$\hbar = 6.582 \times 10^{-22}$ MeV s $= 1.054 \times 10^{-34}$ J.s

$E = \hbar\omega \sim \frac{1}{T}$ $\quad \frac{1}{2}mv^2$

$[\hbar] = [E][T] = m\frac{L^2}{T}$

$c = 299792458$ m/sec

$[c] = \frac{[L]}{[T]}$

$G = 6.67 \times 10^{-11}$ $m^3\,kg^{-1}\,s^{-2}$

$F = \frac{G m_1 m_2}{r^2} = ma = m\frac{L}{T^2}$

$\Rightarrow [G] = \frac{[L^3]}{[M][T^2]}$

$[\hbar] = L^2 M^1 T^{-1}$

$[c] = L^1 \quad T^{-1}$

$[G] = L^3 M^{-1} T^{-2}$

$[\hbar^a c^b G^c] = L^{2a+b+3c} \quad M^{a-c} \quad T^{-(a+b+2c)}$

~~The~~ size where gravity is important

$2a+b+3c = 1$
$a-c=0$
$a+b+2c=0$

$a+c=1$
$a-c=0$

$a = \frac{1}{2}, \quad c = \frac{1}{2}$

$b = -\frac{3}{2}$

$\Rightarrow \quad [L_p] = \sqrt{\frac{\hbar G}{c^3}} = \sqrt{\frac{10^{-34}\,J.s \cdot 7\times10^{-11}\,m^3 kg^{-1} s^{-2}}{27\times10^{24}\,m^3/sec^3}}$

Plank length

$\sim 10^{-35}\sqrt{\frac{J\cdot sec^2}{kg}}$ $\qquad J = 1\,kg\,\frac{m^2}{s^2}$

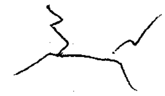
$\sim 10^{-35}$ meter

Planck mass

$[M_p] = 10^{19}$ GeV

$[t_p] \simeq 10^{-43}$ sec

photon : (Black body radiation — Planck — $E = h\nu$
photoelectric effect — Einstein . 1905 → Millikan, Compton scattering



electron — TJ ~~Tompson~~ Thomson — 1897

proton — Rutherford
→ Bohr → QM

neutron — Chadwick — 1932

Yukawa's meson → short range — ~~10~~ 15 fm — $1 GeV^{-1} \sim 0.2$ fm — 1 fm ~ 200 MeV — $\Delta E \Delta t \sim 1$

Dirac's positron

1931 Pauli's neutrino

1947, Powell
π, & μ

Dirac eqn . 1927
$E^2 = p^2c^2 + m^2c^4$
or $E = \pm \sqrt{\quad}$
→ to fill the negative ~~hay~~ state .
hole ⟺ antiparticle

1931, Anderson.

Stuckelberg / Feynman
→ antiparticle .

$p, \bar{p}$, $n, \bar{n}$, e^-, e^+
μ^-, μ^+

lepton : "light weight"
baryons : "heavy-weight"
meson : "middle-weight"

crossing symmetry $\gamma = \bar{\gamma}$.

$A + B \to C + D$
$A \to \bar{B} + C + D$
$A + \bar{C} \to \bar{B} + D$
$\bar{C} + \bar{D} \to \bar{A} + \bar{B}$

李政憲

蕭子綱

林琴婷

張凱維

Int. to HEP - I , Fall 2007

① 9/11
② 9/18 chapter 2
③ 10/2 颱風 ×
④ 10/9 漏 ×
⑤ 10/16 chapter 3 相對論 < 10/21 補課 { E&M, Acceleration
⑥ 10/23 GZK, QM
⑦ 10/30 Mid-term — 2hr + 1hr 解說
⑧ 11/6
⑨ 11/13
⑩ 11/20
⑪ 11/27
⑫ 12/4
⑬ 12/11
⑭ 12/18 Final (3 hrs)
⑮ 12/25 結語, final 解釋 — 公佈成績
△ 12/31 送出成績,

* course outline / overview
history,

2 accelerator history / & ~~design~~ working principle / new trend

3 { classical E&M, Lagrangian
4 { special relativity GZK
5

6 QM, perturbation calculation

Chapter 4 symmetry

chapter 5 bound state

Dirac Eq.

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* QED
* Feynman rule. Feynman diagram calculation
* weak int.
* strong int
* SM. + Higgs