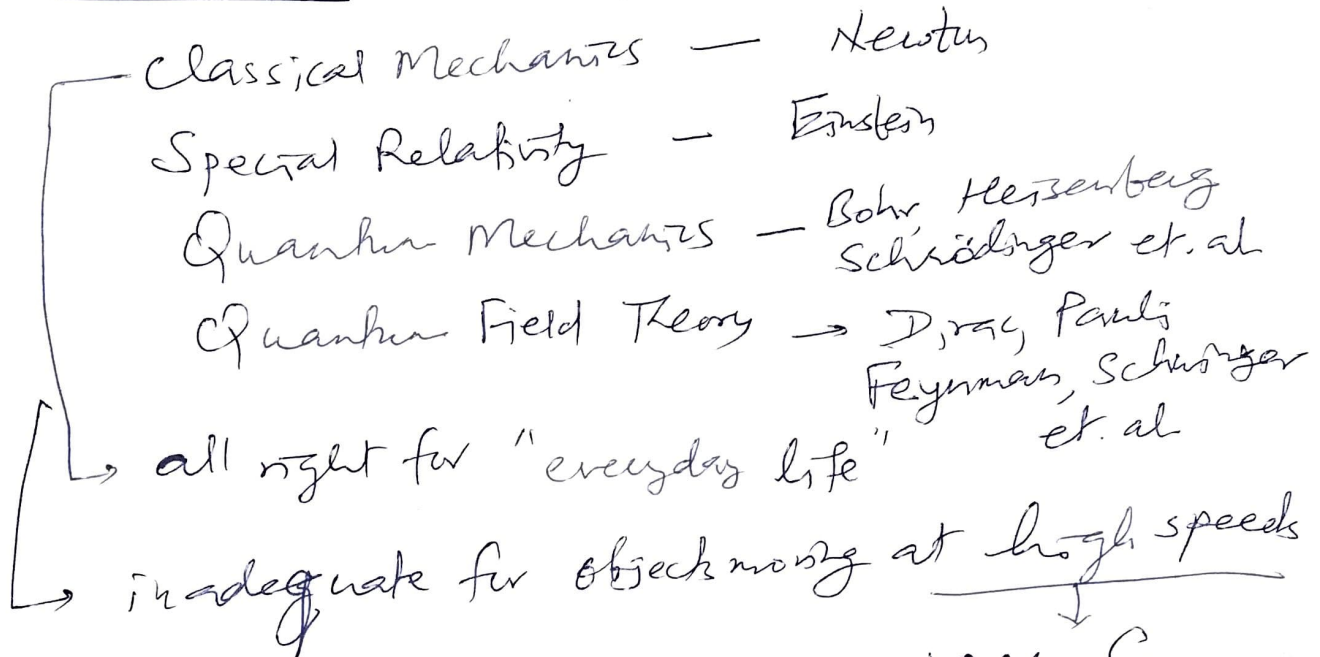


Electrodynamics

Mechanics :- Four general realms



↳ all right for "everyday life"

↳ inadequate for objects moving at high speeds

Must be replaced by special relativity \approx near c . (Einstein 1905)

It fails for objects which are extremely small (size of atoms)

Objects which are both fast and very small

→ combine relativity and quantum principle

→ relativistic quantum mechanics

Quantum Field Theory

Not a completely satisfactory system.

Introduction to Electrodynamics | Griffiths
 Jackson
 Classical Electrodynamics

Electrodynamics → in the domain of classical mechanics

Sadasy → may be extended to other ~~three~~ three realms

Four Kinds of Forces

Four forces known to physics

1. Strong
2. Electromagnetic
3. Weak
4. Gravitational

Friction, Chemical Forces, ... ?

We live in electromagnetic world → every force we experience in everyday life, except gravity, is electromagnetic in nature.

Strong forces → holds together 'protons' and neutrons together in atomic nucleus.

↳ short range → 100 times more stronger than electrical forces.

Weak forces → certain kinds of radioactive decay

↳ short range

↳ far weaker than electromagnetic forces

Gravity → very weak → it is only by virtue of

↳ huge mass concentrations (like earth and the sun).

↳ Electrical repulsion between two electrons

is 10^{42} times as large as their gravitational attraction

Electromagnetic forces → dominant in everyday life

↳ at present only ones that are completely understood

Classical electrodynamics → Franklin, Coulomb, Ampere, Faraday and others

Complete description → Maxwell

Initially electricity and magnetism

↳ entirely separate subjects

Electricity → glass rods, cat's fur, batteries, currents, electrolysis, etc.

Magnetism → bar magnets, iron filings, compass

Ørsted → electric current can deflect magnetic compass needle

Ampere → All magnetic phenomena are due to electric charges in motion

Faraday

Maxwell & Lorentz

Electromagnetism

Faraday → speculated → light, too, electrical in nature

Maxwell theory → Justification

Optics → study of lenses, mirrors, prisms
interference diffraction → is electromagnetism

Heitz → exp confirmation of Maxwell theory (1888).

Connection between light and electricity established

electrical organ → eye

By 1900 → ~~the~~ electricity, magnetism, optics

Visible light → Only a tiny ^{merged} window in electromagnetic radiation

Einstein's dream

↳ Unified field theory → Gravity & Electrodynamics
Not successful

Electroweak theory → Glashow, Weinberg & Salam

↓
weak & Electromagnetic forces

Superstring theory (1980s)

Field formulation of Electrodynamics

Interaction between charges → mediated by fields

charge → undergoes acceleration, a portion of the field "detaches" itself, and travels at the speed of light

It carries energy, momentum & angular momentum



Electromagnetic radiation

Fields → independent dynamical entities

Charge → electromagnetic field

Electric Charge

1. charges comes in two varieties

2. charge is conserved

↓
global conservation of charge

Local conservation of charge

→ continuity equation

3. charge is quantized

UNITS

Mechanics $F = ma$ → same in all unit systems

Coulomb's Law

$$\frac{q_1 q_2}{r^2} \text{ ; (Gaussian)}$$

$$\frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \text{ ; (SI)}$$

$$\frac{1}{4\pi} \frac{q_1 q_2}{r^2} \text{ ; (MLT) Heaviside-Lorentz}$$