Electrodynamics-I

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Course Content

Chapter #1: Vector Ananlysis

- Differential/integral calculus;
- Orthogonal coordinate systems (cartesian/cylindrical/ spherical);

Chapter #2: Electrostatics

- Electrostatics in free space: Electrostatic force/field/potential/energy for discrete (a single point charge/a collection of point source charges) and continuous (line/surface/volume) charge distributions,
- Divergence/curl of E,
- Electrostatic boundary conditions (on E, *V*, and D),
- Conductors,
- Capacitors;

Course Content

Chapter #3: Special Techniques

- Boundary value problems: Solutions of Laplace's equation for various symmetries (cartesian/ cylindrical/spherical),
- Method of Images for various symmetries;
- Electric monopole/ dipole/quadrupole/octopole etc.,
- Electric dipole moment for line/surface/volume charge;

Chapter #4:Electrostatics in matter

- Polarization P, Bound surface/volume charge,
- Electric displacement D,

Course Content

- Gauss's law for D & P−differential/integral forms and its uses/applications,
- Electric susceptibility/permittivity/relative permittivity;

Chapter#5:Introduction to Magnetostatics

- Electric line/surface/volume currents–*I*/K/J,
- Equation of continuity.

Text Book:

- Introduction to Electrodynamics, Devid J Griffths, (4th Edition)

Recommended Books:

- Field and Wave Electromagnetics, David K. Cheng, 2nd Edition, Pearson Education, USA, (2004).
- The Feynman Lectures on Physics Volume II, Richard P. Feynman, Robert B. Leighton, and Matthew Sands, Addison-Wesley, USA, (2011).
- Electromagnetic Field Theory Fundamentals, by Bhag S. Guru and Hüseyin R. Hiziroğlu, 2nd Edition, Cambridge, UK, (2004).
- Electromagnetic Fields and Waves, Paul Lorrain and Dale R. Corson, 3rd Edition, W. H. Freeman, USA, (1988).
- Classical Electrodynamics, John D. Jackson, 3rd Edition, John Wiley & Sons, USA, (1998).

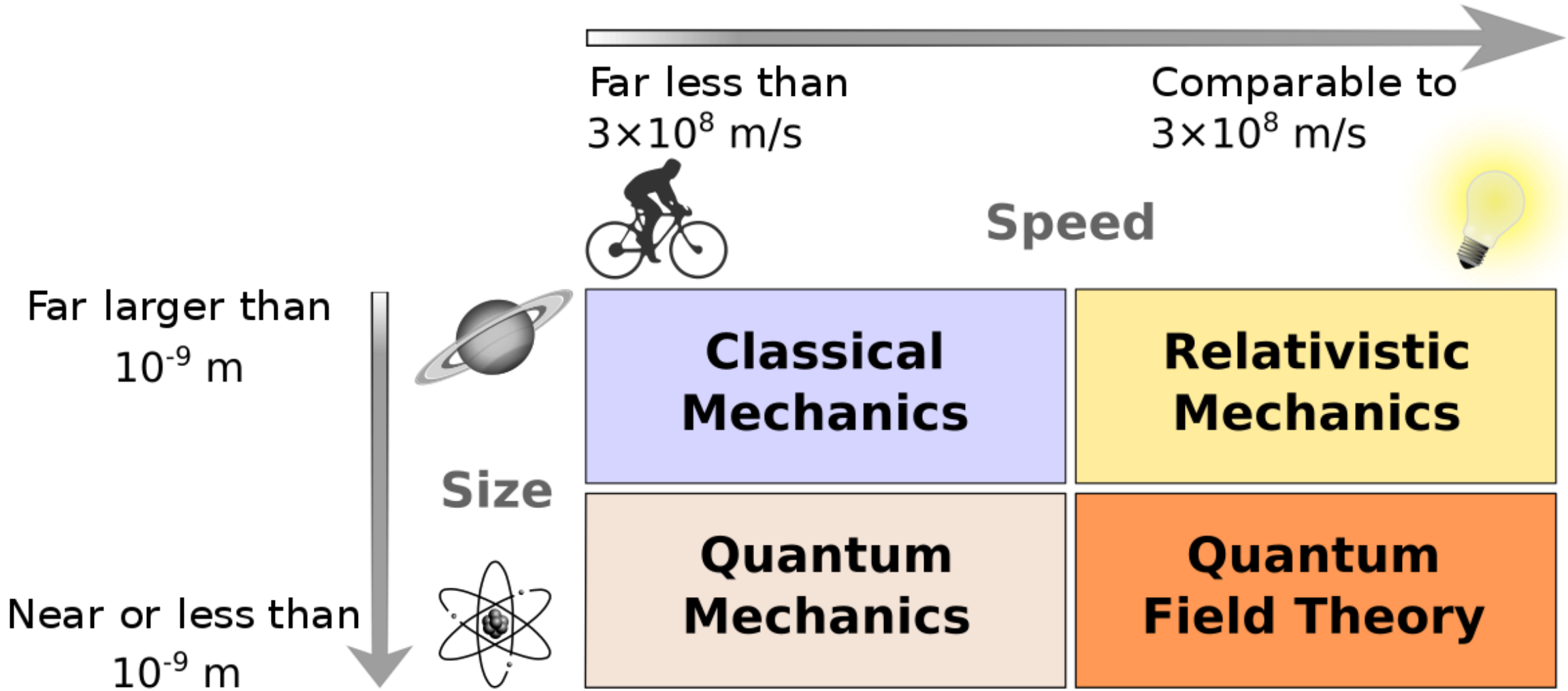
What is electrodynamics and how does it fit into general scheme of physics?

- Four Realms of Mechanics(study of motion under the action of force)

Classical Mechanics (Newton)	**Quantum Mechanics (Bohr, Heisenberg, Schrodinger, et al,)**
Special Relativity (Einstein)	Quantum Field Theory (Dirac,Pauli, Feynman, Schwinger, et al,)

Newtonian Mechanics
Mechanics of every day life
Special Relativity
Mechanics of high speed object

Quantum Mechanics
Mechanics of very small object
Quantum Field Theory
It is theory of study of both fields
Special relativity
Quantum Mechanics


Far less than
3×10^8 m/s
Comparable to
3×10^8 m/s
Speed
Far larger than
10^-9 m
Size
Near or less than
10^-9 m
Classical Mechanics
Relativistic Mechanics
Quantum Mechanics
Quantum Field Theory

Four Kinds of Forces

- Strong
  - between the protons and neutrons
  - Very powerful
  - Short range therefore we do not feel it.

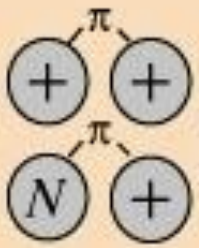
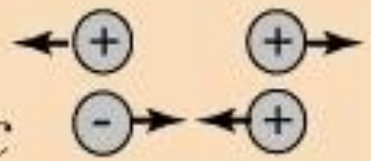
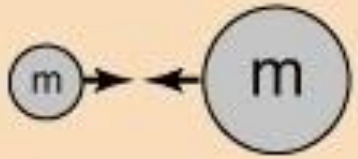
- Electromagnetic
  - everyday forces like
    - Frictional forces
    - Normal force
    - Force of impact during collisions

Electromagnetic force examples

- most of chemistry
  - chemical bonds between atoms to form molecules, like in combustion
  - keeping solids a particular shape
  - keeping atoms together
- Sticky things like tape or tar sticking to surfaces
- The force felt on electrons in a loop of wire when near a changing magnetic field. The electromagnetic force is very closely related to the electromotive force, which is what causes electric current to flow.

In short we live in electromagnetic world

Fundamental Forces

		Strength	Range (m)	Particle
Strong	 Force which holds nucleus togeher	1	10^{-15} (diameter of a medium sized nucleus)	gluons, π(nucleons)
Electro-magnetic		$\frac{1}{137}$	Infinite	photon mass = 0 spin = 1
Weak	 neutrino interaction induces beta decay	10^{-6}	10^{-18} (0.1% of the diameter of a proton)	Intermediate vector bosons W^+, W^-, Z_0, mass > 80 GeV spin =1
Gravity		6×10^{-39}	Infinite	graviton ? mass = 0 spin = 2

Four Kinds of Forces

- Weak
  - Certain kinds of radioactive decay
  - Short range
  - Weaker than electromagnetic ones
- Gravitational
  - Pitifully feeble
  - Between very massive objects like sun, stars, planets

Electromagnetic forces is dominated in every day life.

Definition of electrodynamics

Electrodynamics is in the study of motion of charges (electric currents) and magnetic fields, the relation between them, and its interaction with matter.

In other words electrodynamics includes

- Electrostatics (study of charges at rests)
- Magnetostatics (study of static magnetic fields due to steady currents)
- Electromagnetism (Interaction of electricity and magnetism)
- Electromagnetism and optics (interaction of electromagnetism and electromagnetic radiations)