

Lecture #9 Tues 23 Feb 2010 What is Physics?

Physics is the study of the “fundamental” properties of matter and energy.
Fundamental field of physics: mechanics = motion of objects.

Classical mechanics (motion of objects on human scales of size, time, and speed)

Relativity: motion of very fast and very massive objects

Quantum mechanics: motion of very tiny objects

Physics has been dominated by different *paradigms* throughout history.

Paradigm: a higher narrative (metanarrative) for theories or even for the method of inquiry

Aristotle: universe is hierarchal – “natural place” Laws depend where you are

Newton: universal laws; “graph-paper universe” + *no* absolute center
Laws independent of position.

Relativity (Einstein): no absolute “rest frame” (no graph-paper)
Laws independent of *motion*

Quantum mechanics: universe evolves statistically

Aristotlean paradigm: A stratified or layered universe. Objects move to their “natural” place.. A focus on *why* and *end results*.

Challenge to Aristotlean paradigm: Trajectory of artillery. Motion of the stars, planets.
Newtonian paradigm: *how* do objects move? Forces and inertia.

Inertia: Objects in motion tend to stay in motion (in a straight line)
Objects at rest tend to stay at rest *unless* acted upon by an outside force

New mathematical tools: Cartesian coordinates: marriage of algebra and geometry
= “graph-paper”

The Newtonian paradigm: objects stay at rest/in (linear) motion unless acted upon by outside force. Visualize a kind of *grid* (graph-paper) upon the world

Nature and mechanics of light

What *is* light? Newton did a lot of experiments on light, such as using prisms to get the spectrum. He believed light to be made of particles (“corpuscles”).

But Thomas Young (1773-1829) used an experiment to prove light has a wave nature. Light passing through a double slit shows an interference pattern much like water waves ... but if light is a wave, what is “waving?”

James Clerk Maxwell (1831-1879) suggested light is waves of electric and magnetic fields. The four Maxwell equations (1862) predicted other electro-magnetic waves such as radio waves (discovered by Heinrich Hertz in 1888).

One postulate: light travels in “luminiferous ether”. Luminiferous = “light bearing” ether = heavenly substance (for celestial sphere). But no one has seen the ether.

Michelson and Morley expt (1887) used an “interferometer” to measure differences in velocities in two different directions simultaneously. It failed to detect the ether. So there is no ether!

Summary Newton viewed light as made of “corpuscles” (particles).

Young’s double-slit **experiment** exhibited interference, evidence for a wave nature for light.

What is waving? Maxwell: electric & magnetic fields. (Predicted radio waves, **experimentally confirmed** by Hertz.)

This in turn suggested a **luminiferous ether**, but the Michelson-Morley **experiment** failed to detect the ether!