

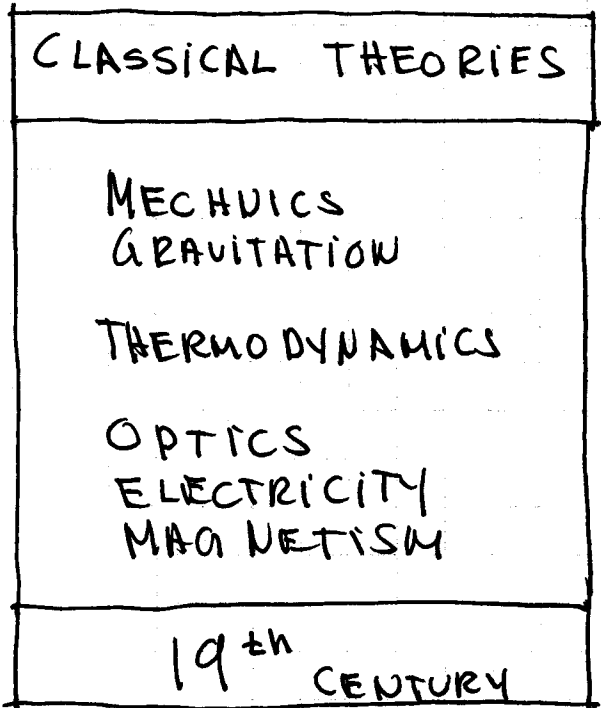
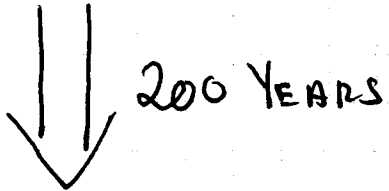
MACRO RELATIVITY GENERAL SPECIAL EINSTEIN → BLACK HOLES

OUR WORLD CLASSICAL MECHANICS  
THERMODYNAMICS  
CLASSICAL E+M NEWTON GIBBS MAXWELL

MICRO QUANTUM  
MECHANICS NUCLEAR PARTICLE SOLID STATE ATOMIC PHYSICS MOLECULAR → QUARKS, GLUONS → SUPERCONDUCTIVITY SEMICONDUCTORS → SPECTROSCOPY → SPECTROSCOPY MATERIALS AB INITIO CALC. MOL. DYNAMICS

# ELECTROMAGNETIC RADIATION

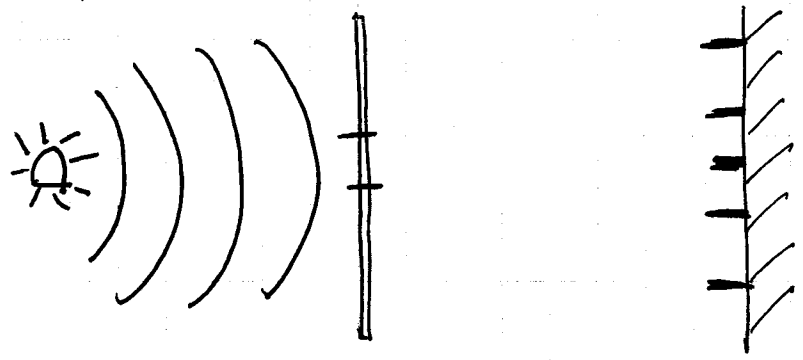
17<sup>th</sup> CENTURY — GALILEO GALILEI —> CORPUSCULAR THEORY OF LIGHT  
ISAAC NEWTON



DETERMINISTIC  
LOGICAL  
CERTAIN

THOMAS YOUNG —> INTERFERENCE OF LIGHT

PASSAGE OF LIGHT THROUGH 2 NARROW CLOSELY SPACED HOLES OR SLITS PRODUCES A PATTERN OF BRIGHT AND DARK FRINGES



# INTERFERENCE $\Rightarrow$ WAVE BEHAVIOR

1860 JAMES CLERK MAXWELL

$\rightarrow$  ELECTRO MAGNETIC THEORY

COMBINES ELECTRICITY AND  
MAGNETISM IN A SINGLE THEORY

EXPERIMENTAL CONFIRMATION — MICHAEL FARADAY

1886 HERTZ

LIGHT = E+M RADIATION

A WAVE THEORY OF LIGHT IN

LUMINIFEROUS (ETHER) MEDIUM

1887 ALBERT MICHELSON

EDWARD MORLEY '1860

(IN 1923 HE DONATED PART OF HIS  
EQUIPMENT AND 100 000 DLS WC)

E+M WAVES TRAVEL IN VACUUM  
NO NEED OF ETHER OR ANY MEDIA

THEY DID NOT FIND ANY DIFFERENCE IN THE  
SPEED OF LIGHT RELATIVE TO THE  
MOTION OF EARTH

SPECIAL THEORY OF RELATIVITY

## 1.2 The Special Theory of Relativity

We mentioned earlier the role of the ether as a universal frame of reference with respect to which light waves were supposed to propagate. Whenever we speak of "motion," of course, we really mean "motion relative to a frame of reference." The frame of reference may be a road, the earth's surface, the sun, the center of our galaxy; but in every case we must specify it. Stones dropped in Bermuda and in Perth, Australia, both fall "down," and yet the two move in exactly opposite directions relative to the earth's center. Which is the correct location of the frame of reference in this situation, the earth's surface or its center? The answer is that *all* frames of reference are equally correct, although one may be more convenient to use in a specific case. *If* there were an ether pervading all space, we could refer all motion to it, and the inhabitants of Bermuda and Perth would escape from their quandary. The absence of an ether, then, implies that there is no universal frame of reference, so that all motion exists solely relative to the person or instrument observing it. If we are in a free balloon above a uniform cloud bank and see another free balloon change its position relative to us, we have no way of knowing which balloon is "really" moving (Fig. 1-7). Should we be isolated in the universe, there would be no way in which we could determine whether we are in motion or not, because without a frame of reference the concept of motion has no meaning.

The theory of relativity resulted from an analysis of the physical consequences implied by the absence of a universal frame of reference. The special theory of relativity, developed by Albert Einstein in 1905, treats problems involving the motion of frames of reference at constant velocity (that is, both constant speed and constant direction) with respect to one another; the general theory of relativity, proposed by Einstein a decade later, treats problems involving frames of reference accelerated with respect to one another. The special theory has had a profound influence on all of physics, and we shall restrict ourselves to it.

The special theory of relativity is based upon two postulates. The first states that **the laws of physics may be expressed in equations having the same form in all frames of reference moving at constant velocity with respect to one another.** This postulate expresses the absence of a universal frame of reference. If the laws of physics had different forms for different observers in relative motion, it could be determined from these differences which objects are "stationary" in space and which are "moving." But because there is no universal frame of reference, this distinction does not exist in nature; hence the above postulate.

The second postulate of special relativity states that **the speed of light in free space has the same value for all observers, regardless of their state of**

motion

## Earnshaw's THEOREM

- A SYSTEM OF CHARGED PARTICLES CANNOT REMAIN AT REST IN STABLE EQUILIBRIUM UNDER THE INFLUENCE OF PURELY ELECTROSTATIC FORCES.

ACCELERATED CHARGED PARTICLES RADIATE ENERGY IN THE FORM OF ELECTROMAGNETIC WAVES

- RADIATION EMISSION BY ATOMS AND MOLECULES
- HOW MOLECULES ARE STABLE?
- ATOMS AND MOLECULES ABSORB AND EMIT RADIATION ONLY AT CERTAIN FREQUENCIES

INTERACTION BETWEEN EM RADIATION AND MATTER.