Twentieth Century Dissolution

The Problem of the Ether

• How do we detect the ether—the medium in which light & other electromagnetic radiation travel?
• How do we detect motion in the ether?

Albert A. Michelson and Edward Morley (1887)

Fitzgerald-Lorentz contraction

• Explain the null result of the M-M experiment by hypothesizing that the measuring instruments contract by an amount dependent on how close to the speed of light they are traveling

The Electron

• Electricity comes from the movement of a particle with an elemental charge—the electron
• The ratio of the elemental charge to the mass of the particle can be measured

J.J. Thomson

• observes that this ratio changes, depending on the speed of the particle’s motion

Albert Einstein

• Special Theory of Relativity (1905)

Postulates:

• 1. The laws of nature are the same for observers in any inertial frame of reference.
• 2. The speed of light is the same for all such observers (the speed of light, c, is about 3x10^8 m/sec)

Conclusions:

• Observers in 2 different frames of reference will find contractions of the Fitzgerald-Lorentz kind in each others frame—in both space and time (though these are only observable for speeds close to c)

Conclusions:

• The observable mass of an object seems to increase as it goes faster (approaching infinity as it approaches c)

Conclusions:

• It is theoretically possible to state an equivalence between mass and energy
\[ E = mc^2 \]

14 Conclusions:
- Elimination of absolute space and absolute time
- Elimination of the ether

15 General Theory of Relativity, (1915)
- Extending relativity to “non-inertial” frames of reference

16 Einstein as celebrity--Physics as mystery

17 The Atom & Quantum Theory
- Deepening investigation into the electrical nature of matter

18 Cathode Rays
- William Crookes

19 Electron
- J.J. Thomson--electrons [1897]

20 X-rays
- Wilhelm Röntgen [1895]

21 Radioactivity
- Henri Becquerel [1896]

22 Radium
- Marie Curie--1902

23 Radiation--alpha and beta [1899]
- Ernest Rutherford

24 Alpha Particle scattering

25 Model of the atom
- Bohr model of the atom
  - Niels Bohr

26 Quantum
- Max Planck & Planck’s constant

27 Wave-Particle Duality
- Light may behave like a wave or like a particle

28 Werner Heisenberg--the Uncertainty Principle
\[ \hbar p \times \hbar q \geq \hbar /2 \]
- \( p = \) momentum, \( q = \) position, \( \hbar = \) Planck’s constant

29 Indeterminacy--Uncertainty--and the status of Science
Question:

• Are the status & prestige of 20th century physics increased or diminished because most people don’t understand it? So what?