Atomic Physics
The Atom - Basics
Early Models of the Atom
The de Broglie Hypothesis

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The Atom - Basics

- - the idea that any matter is made of atoms
  - dates back to the Greek philosopher Democritus;
- - the word atom comes from the Greek atomos,
  - which means "indivisible";
- - an atom is the smallest particle of an element
  - that still has the properties characterizing that element;
- - the experimental evidence came mainly in the eighteenth and nineteenth centuries;
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The Atom - Overview

- - Robert Boyle (1627-1691) was the one who believed
  - that chemical experiments could demonstrate
  - the truth of the corpuscularian philosophy;
- - Antoine-Laurent Lavoisier (1743-1794),
- - John Dalton (1766-1844) and others like
  - Gay-Lussac and Robert Brown
  contributed to the atomic theory;
- - Joseph John Thomson (1856-1940)
  - discovered the electron (he called it corpuscles)
  - in a series of experiments designed to study
  - the electric discharge in cathode-ray tube;

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The Cathode-ray tube

- - by applying an improved vacuum technique
  - Thomson was able to demonstrate that this
  - "dark space", which seemed to extend outward from the cathode toward the opposite end,
  - would glow
- - were composed of the same particles, or corpuscles
  - regardless of what kind of gas carried the electric discharge,
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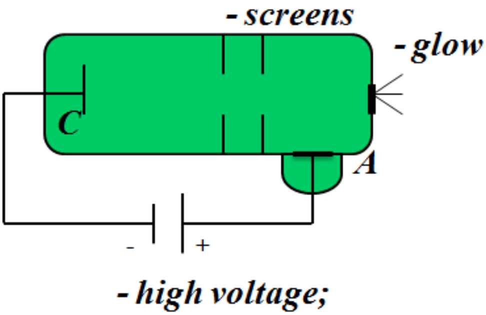

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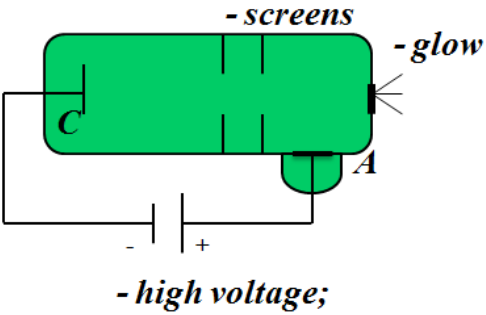

The Discovery of the electron

- - the bright spot could be deflected to one side
  - by an electric or magnetic field:
- - could be charged particles;
- - estimates of the charge e, and the ratio: e/m, had been made by 1897;
- - if the applied electric and magnetic fields
  - are choosen so that they balance each-other, then from

$$F = ma = \frac{mv^2}{r}; \tag{1}$$

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- - Ernes Rutherford (1871-1937) and his colleagues' - experiments contradicted Thomson's model of the atom;
- - in their experiments positively charged α particles were bombarding a thin gold sheet;
- - it was expected that the α particles would not be deflected significantly;
  - since electrons are much lighter then the α particles;
- - most α particles passed through the gold sheet unaffected
  - as if the foil had been mostly empty;
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- - finally Rutherford reasoned that:
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  - the α particles are interacting by a massive positive charge
  - concentrated in a very small region of space;
- - he concluded that:
  - the atom must consist of a tiny but massive positively charged nucleus
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- - Rutherford's planetary model of the atom
  - was an important step toward how we see the atom today;
- - it was Bohr's idea that quantum theory has to be incorporated in it;
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The Bohr Model

- - Bohr postulated:
- - electrons move in circular orbits,
  - but only certain orbits are allowed;
- - an electron would have a definite energy
  - and would move in the orbit without radiating;
- - he called the possible orbits
  - stationary states;
- - when an electron jumps from a stationary state to another
  - a single photon of light would be emitted,
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  - and predicts for hydrogen the wavelengths of emitted light;
- - also offers an explanation for absorption spectra;
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- - Louis de Broglie suggested that
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- - de Broglie suggested that
  - the electron wave must be a circular standing wave that closes in itself;
- - that is:
  $2\pi r_n = n\lambda$;
- - then, for an electron orbiting on a circle
  - of radius r_n this follows:
  $mvr_n = \frac{nh}{2\pi}$;
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