FYS3500: Particle Physics
Lecture Notes

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Lecture 1

1 History

- 1896: Henri Becquerel discovered radioactivity
- 1898: Marie and Pierre Curie discovered radium and polonium
- 1903: Alphas charge to mass ratio
- 1909: Alphas are helium nuclei
- 1911: Rutherford discovers the nucleus
- 1913: Bohr model of the atom
- 1917: Rutherford discovers the proton
- 1930: Neutrinos were postulated
- 1932: Chadwick discovers the neutron by shooting alpha particles at beryllium.
- 1938: Discovery of nuclear fission
- 1956: Neutrinos were detected

1.1 Proton Discovery: The Rutherford Scattering Experiment

Thomsons model of the atom was a positive sphere with electrons embedded in it. Rutherford wanted to test this model by shooting alpha particles at a thin gold foil surrounded by a detector foil. The alpha particles were shot from a radioactive source and when the alpha particles exited, they hit the foil and emitted light.

1.1.1 Conclusion

- Most alpha particles went straight through the foil. This implies the atom is mostly empty space.
- Some alpha particles were deflected by a small angle. This implies the positive charge is concentrated in a small volume.
- Sometimes the particles travel backwards. This implies the positive center has most of the mass of the atom.

1.2 Discovery of the Neutron

- Shooting alpha particles on beryllium which is much lighter than gold. This

2 Nucleus

- Very dense. Carries all the mass. $2.7 \cdot 10^{14}$ times denser than water.
- The atom is mostly empty space. If the nucleus was the size of a coin, the atom would be 2-3 km in radius.

2.1 Notation

- **Notation**: ${}^{A}_{Z}X_{N}$
- Isoto**p**e: Same **proton** number Z
- Isoto**n**e: Same **neutron** number N
- Isob**a**r: Same **atomic** mass number $A = Z + N$

2.2 Nuclides

- 92 stable elements
- 280 stable isotopes
- 3000 unstable isotopes
- 6000 more predicted to exist

2.2.1 Stable Numbers

$$N = 2, 8, 20, 28, 50, 82, 126$$
$$Z = 2, 8, 20, 28, 50, 82, \ldots$$

3 Units and Dimensions in Nuclear Physics