

## Introduction

- Atomic nuclei are made of **protons and neutrons (nucleons)**
- Early models couldn't fully explain **nuclear stability**
- The **Shell Model** was proposed to explain why some nuclei are more stable than others

*Image suggestion:* Simple diagram of a nucleus with protons and neutrons

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## History

- Proposed by **Maria Goeppert Mayer** and **J. Hans D. Jensen** (1949)
- Developed after the discovery of **magic numbers**
- Earned them the **Nobel Prize in Physics, 1963**

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## Basic Idea

- Nucleons move in **discrete energy levels (shells)** inside the nucleus
- Shells are filled according to the **Pauli Exclusion Principle**
- Analogous to **electron shells in atoms**

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## Assumptions of Shell Model

- Nucleons move **independently** in a mean potential
- Each shell can hold a **limited number of nucleons**
- **Paired nucleons** contribute to stability
- **Spin-orbit coupling** splits energy levels further

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## Energy Levels in the Nucleus

- Shells labeled as: **1s1/2, 1p3/2, 1p1/2, 1d5/2...**
- Number of nucleons in each shell: **2, 6, 12, 20...**
- **Spin-orbit interaction** explains the observed magic numbers

## Magic Numbers

- Certain nucleon numbers are especially **stable**
- **Magic Numbers:** 2, 8, 20, 28, 50, 82, 126
- Nuclei with these numbers show:
  - High **binding energy**
  - Low **radioactivity**
  - Greater **stability**

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## Evidence for Shell Model

- Observed **abundance** of nuclei with magic numbers
- Measurement of **nuclear spins** and **magnetic moments**
- Nuclear reactions show **energy gaps** between shells

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## Applications

- Explains nuclear **stability trends**
- Helps predict **radioactive decay**
- Useful in **nuclear reactors** and **medical isotopes**
- Important in **nuclear spectroscopy**

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## Summary

- Shell Model describes **nucleons in discrete energy levels**
- Explains **magic numbers** and nuclear stability
- Introduced **spin-orbit coupling** concept
- Crucial for understanding **nuclear structure and reactions**