

Nuclear Science

Session 1



What *is* nuclear physics...?





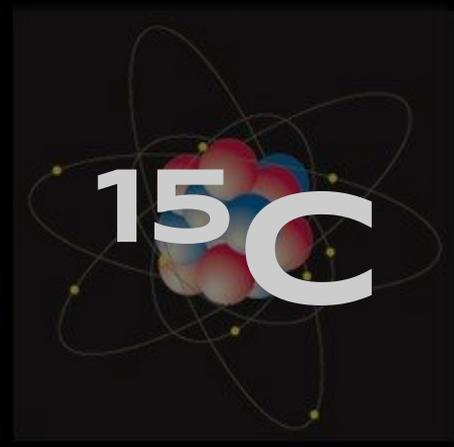
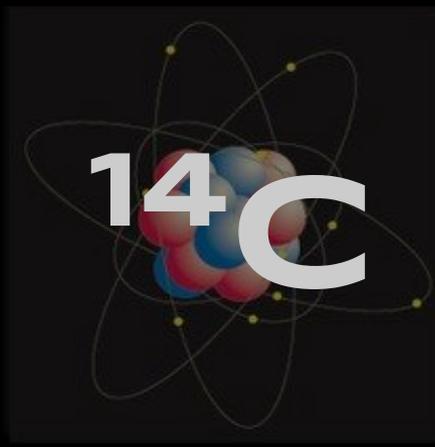
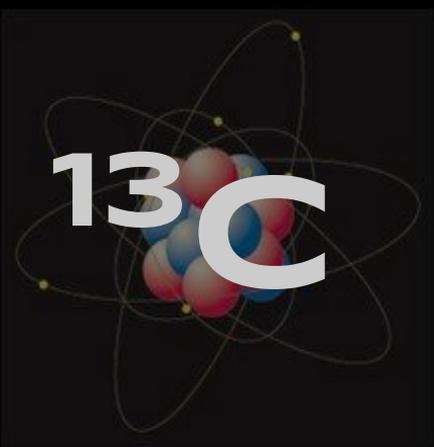
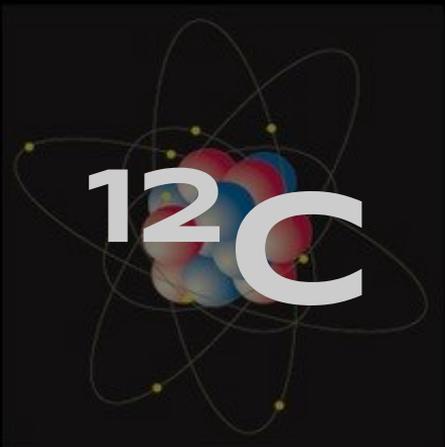
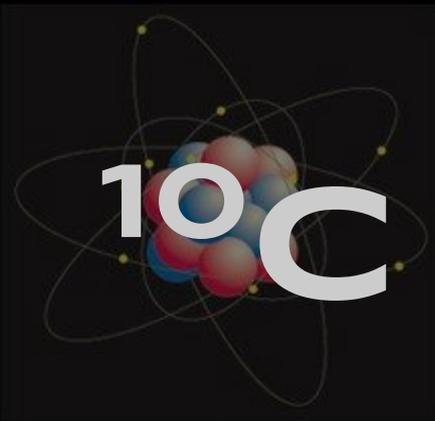
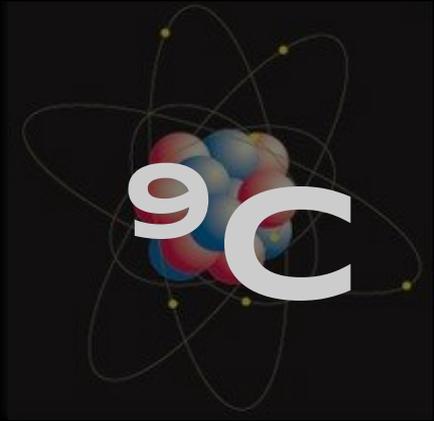
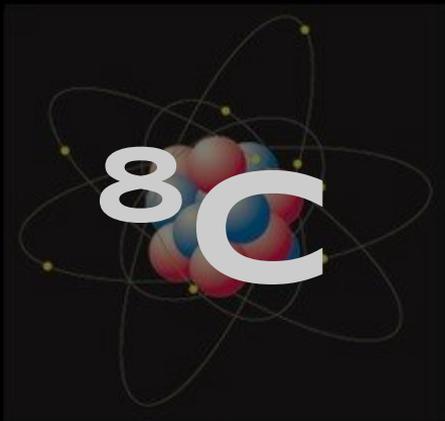
What is an element?



What is an atom?

Group→	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18															
↓Period																																	
1	1 H																	2 He															
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Lanthanides	<table border="1"> <tr> <td>57 La</td> <td>58 Ce</td> <td>59 Pr</td> <td>60 Nd</td> <td>61 Pm</td> <td>62 Sm</td> <td>63 Eu</td> <td>64 Gd</td> <td>65 Tb</td> <td>66 Dy</td> <td>67 Ho</td> <td>68 Er</td> <td>69 Tm</td> <td>70 Yb</td> <td>71 Lu</td> </tr> </table>																		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
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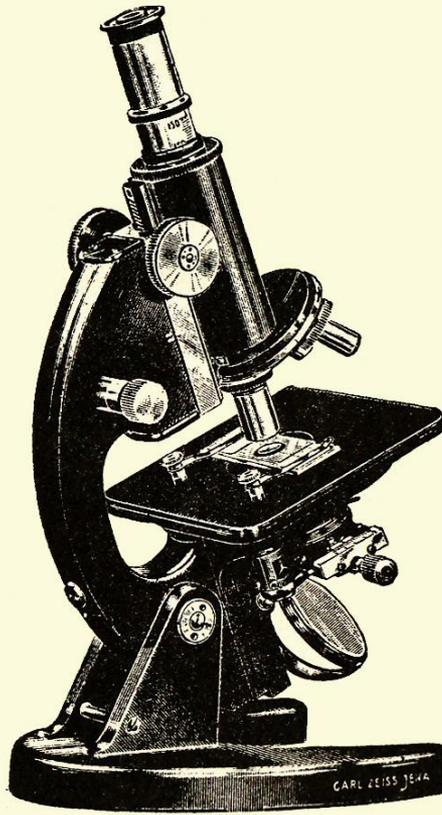
The Periodic Table of Elements



What is an isotope?

Group→	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18															
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How many isotopes are there?



Why is it hard to study nuclei?

Whether a particular nucleus decays or not is a random event, like rolling a 6 on a dice.

*Start with everyone standing,
if you roll a 6, sit down.*



Name	What?	Characteristics
Alpha, α 	Helium nucleus (2 protons and 2 neutrons)	Heavy, easily stopped, very ionising.
Beta, β 	Electron	Light, quite easily stopped, lightly ionising.
Gamma, γ 	Electromagnetic radiation	Energy (no mass), very hard to stop.

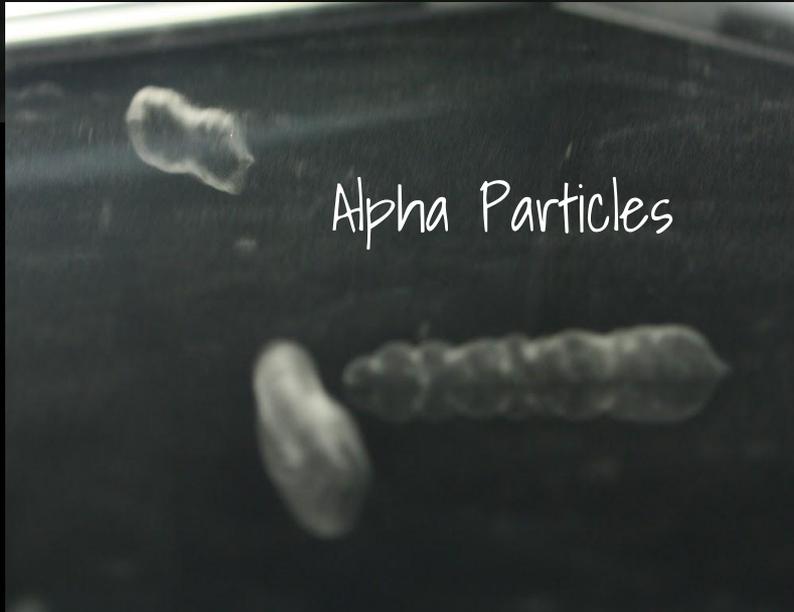


Cloud Chamber

Cosmic Ray

Alpha Particles

Beta Particles





What is activity?

One thing we do when we find a new isotope is determine its **half-life**.



After 1 half-life.

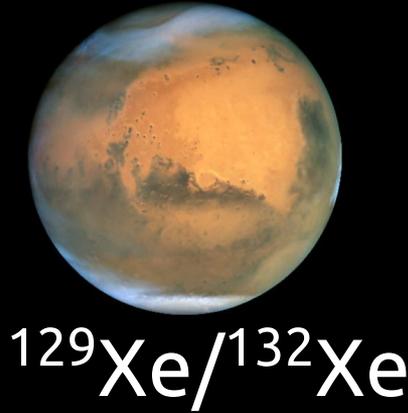
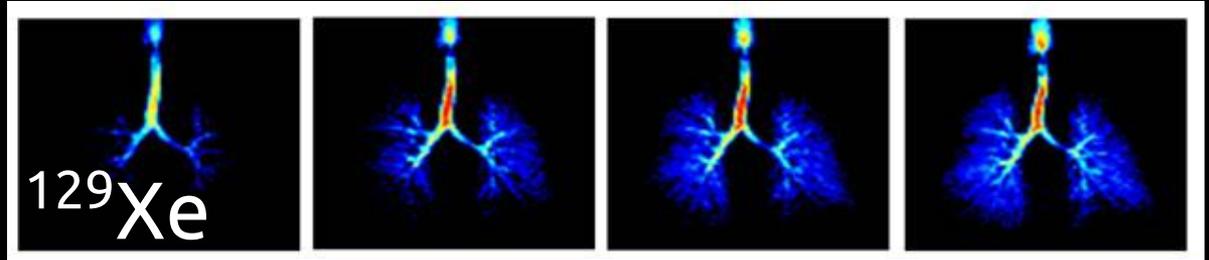


After 2 half-lives.

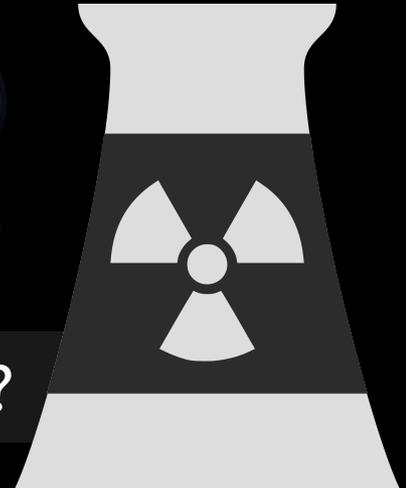


After 3 half-lives.

Case study: Xenon



^{135}Xe



Why do we want to learn about different isotopes?

HAER No. 20-83-31



Answering fundamental questions.



Oak Ridge National Laboratory, USA



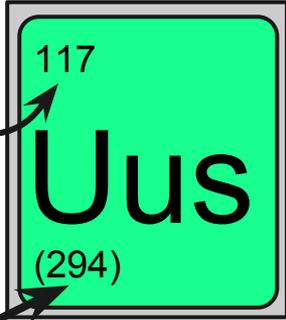
Joint Institute for Nuclear Research, Russia



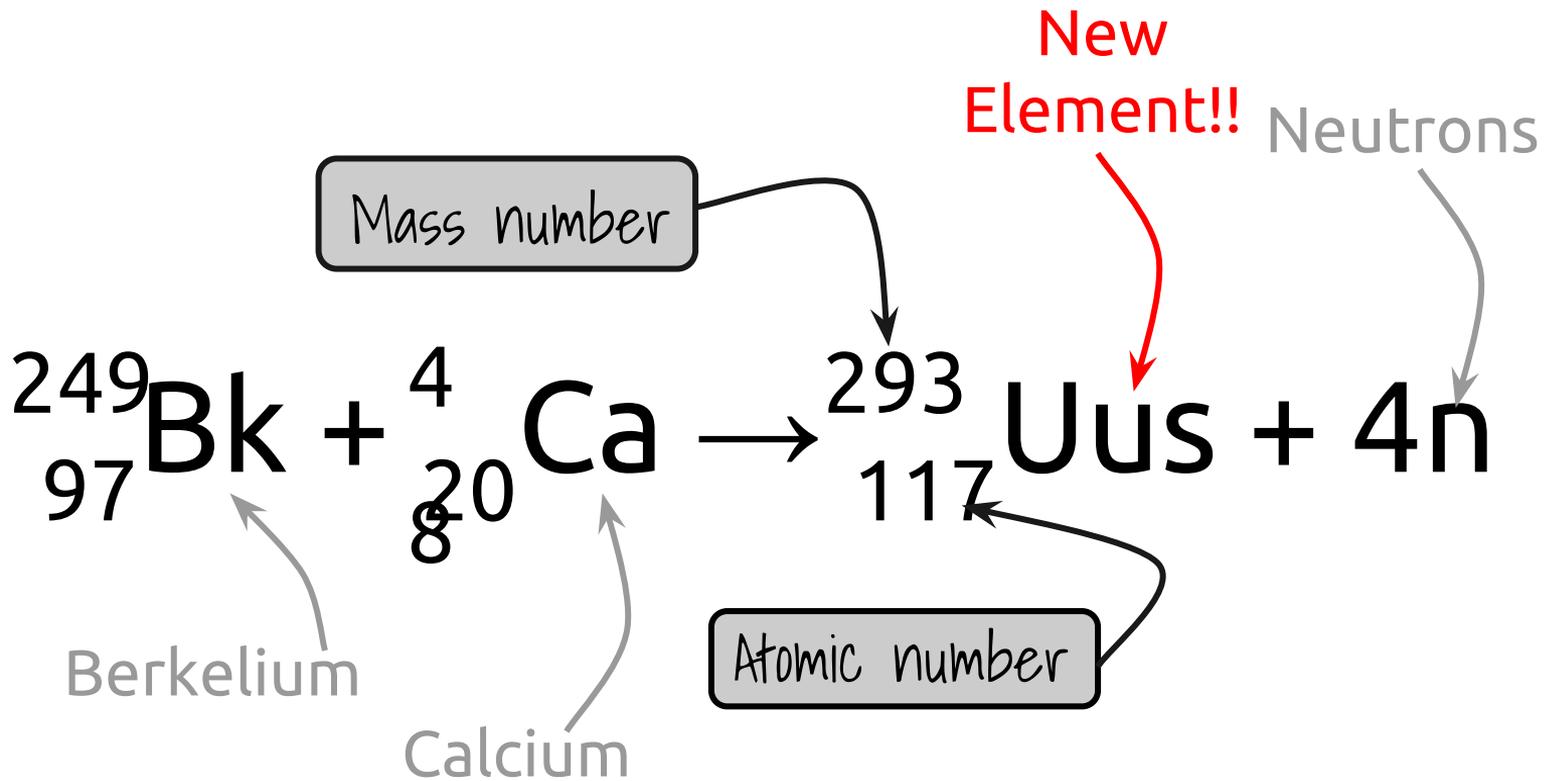
GSI Helmholtz Centre for Heavy Ion Research, Germany

Atomic number

Mass number



Discovering new elements.



Nuclear Reaction

Isotope properties

The **half-life** and **decay modes** (how the isotope decays) are *properties* of the isotope.

It is also important to consider the ***elemental*** and ***group properties*** when choosing the correct isotope for an application.

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Learning Objectives

- Nuclear physics is the study of nuclei.
- Atoms have nuclear properties as well as chemical properties.
- Nuclear properties include the decay mode and the half life.
- Knowing the nuclear properties of a particular isotope helps us identify it.
- Different isotopes of the same element can have different uses.
- Scientists can make new elements and isotopes of elements.