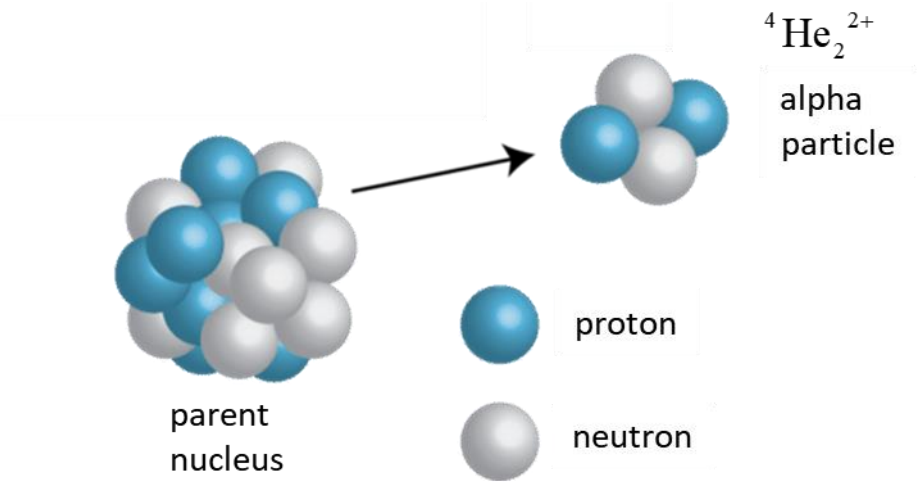
VISUAL PHYSICS ONLINE

ALPHA DECAY



An alpha particle (α particle) is a helium nucleus $^4He_2$ that is naturally emitted from an unstable nucleus producing a nucleus of a new element.

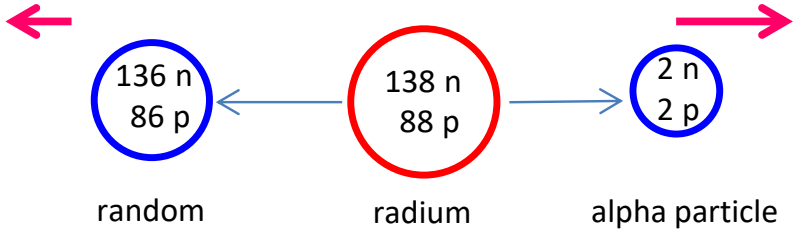
Emission of a $^4He_2$ nucleus:

$$N \rightarrow (N - 2) \quad Z \rightarrow (Z - 2) \quad A \rightarrow (A - 4)$$

Transmutation of a **parent** P into its **daughter** D:

$$^AP_Z \rightarrow {}^{A-4}D_{Z-2} + {}^4He_2$$

Example



radium $\rightarrow$ random + α

$^{226}Ra_{88} \rightarrow {}^{222}Rn_{86} + {}^{4}He_{2}$

Alpha decay occurs because the strong nuclear force is unable to hold large nuclei together (Z > 82). The attractive strong nuclear force only acts between neighbouring nucleons since it is short ranged.

However, the repulsive electrostatic force is long ranged and acts all the way across a nucleus and dominates the strong nuclear force. An α particle is very a very tightly bound unit and this is why a helium nucleus is emitted rather than some other combination of protons and neutrons.

A gamma ray is emitted when a parent nucleus decays by emitting an alpha particle and the daughter nucleus is left in an excited state (*). The excited daughter nucleus than emits a gamma ray. So, in an α source, γ rays are often emitted as well as the α particles.

$$^{226}Ra_{88} \rightarrow {}^{222}Rn_{86} + {}^{4}He_{2}$$

energy of α particle 4.871 MeV

$$^{226}Ra_{88} \rightarrow {}^{222}Rn_{86}^{*} + {}^{4}He_{2}$$

energy of α particle 4.685 MeV

$$^{222}Rn_{86}^{*} \rightarrow {}^{222}Rn_{86} + \gamma$$

energy of γ ray 0.186 MeV

The excited nucleus can also be represented by the superscript *, e.g., $^{222}Rn_{86}^{*}$

One widespread application of nuclear physics is present in nearly every home in the form of an ordinary smoke detector.

Web search: How does a smoke detector work?

Alpha particles have the least penetrating power compared to beta particles and gamma rays as they move with a smaller velocity. Alpha particles very easily ionize the atoms in there vicinity and hence loss energy very rapidly and therefore do not travel very far into a material. In air, alpha particles only travel about 100 mm.

Alpha particles are not particularly dangerous to a person with external exposure. However, if ingested, they can cause serve damage to cells and organs because of the high ionizing power.

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If you have any feedback, comments, suggestions or corrections please email:

Ian Cooper School of Physics University of Sydney

ian.cooper@sydney.edu.au