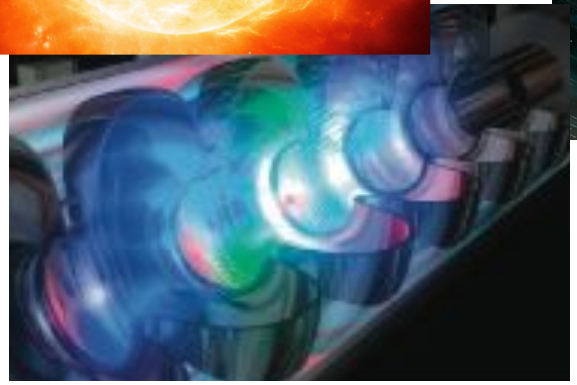
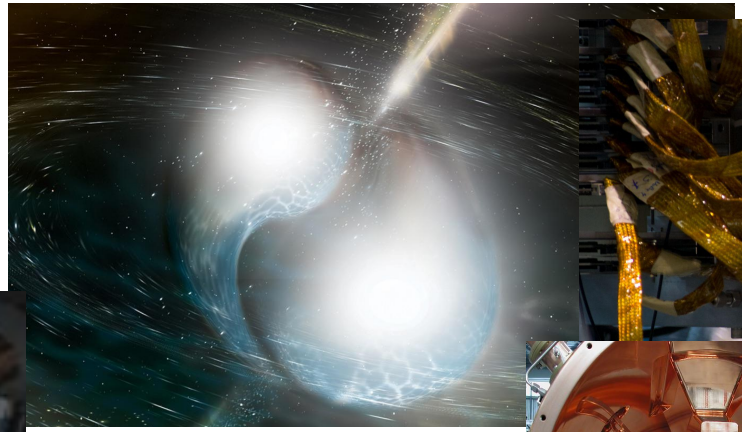
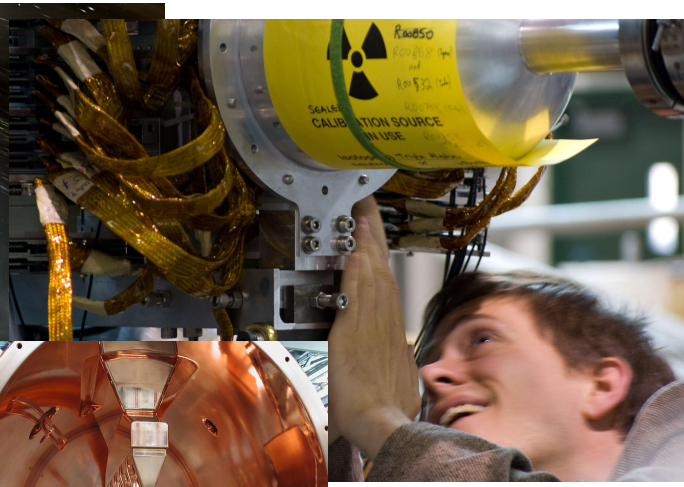
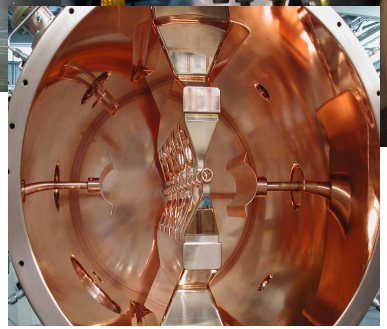
Binding Blocks

Down-to-Earth Nuclear Physics

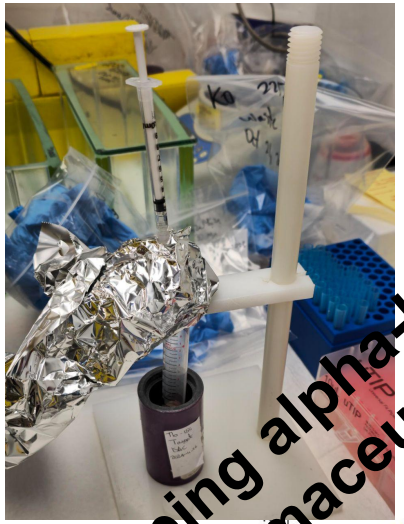


STFC NP Summer School, July 2026

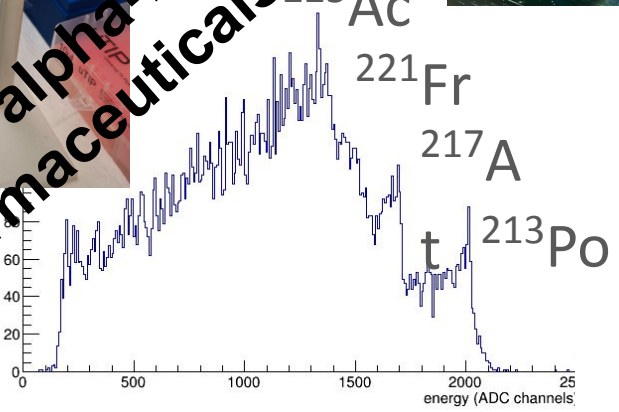
Dr. Christian Aa. Diget

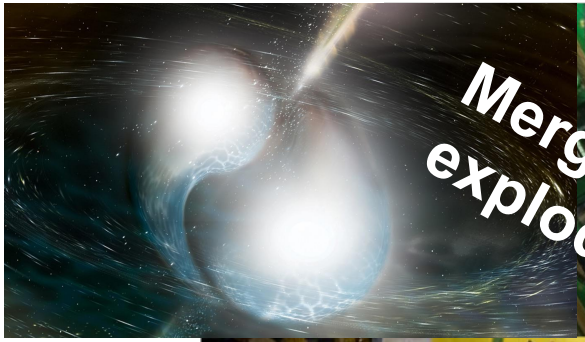
Research for a living

- live research -

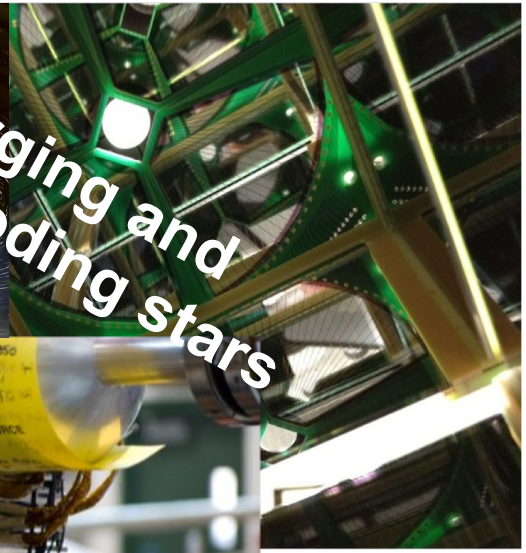


Developing alpha-based radiopharmaceuticals





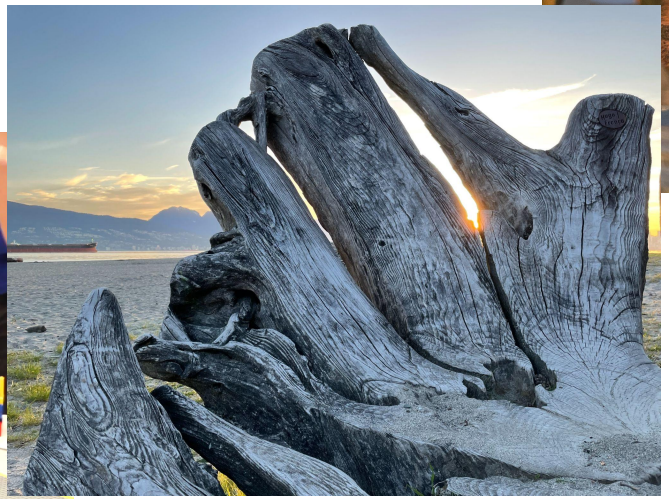
Merging and exploding stars

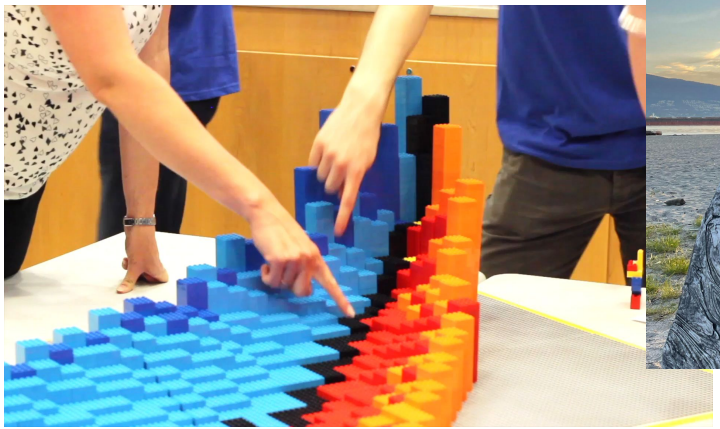


Life as a researcher

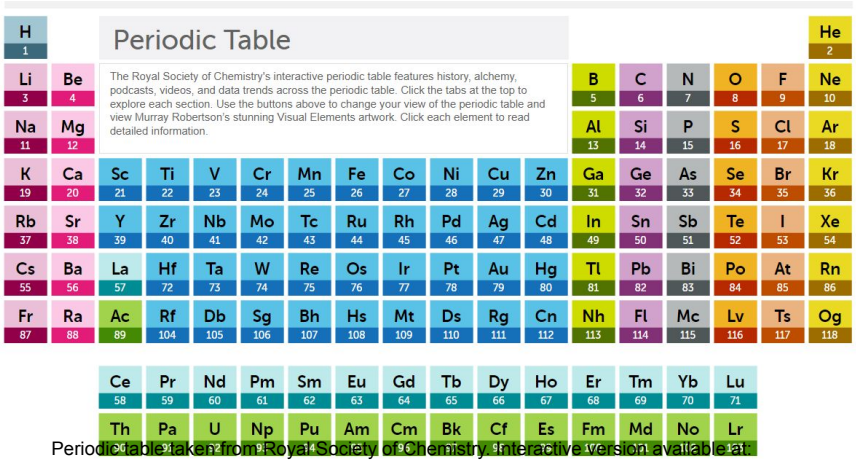
- research life -

Science, sunsets and the sea
- talking about science
- enjoying the road

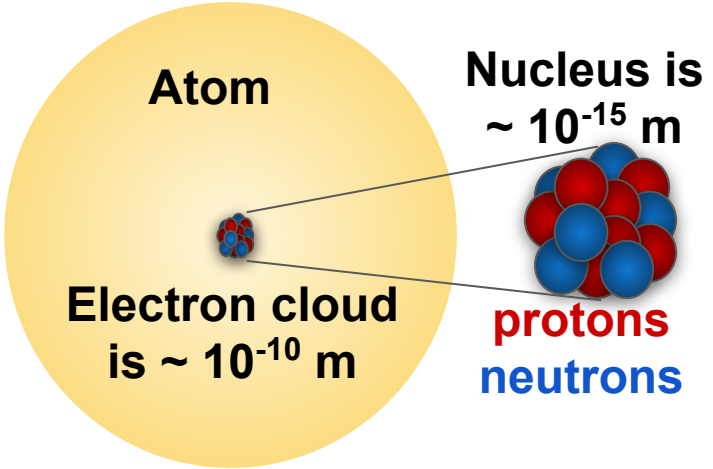




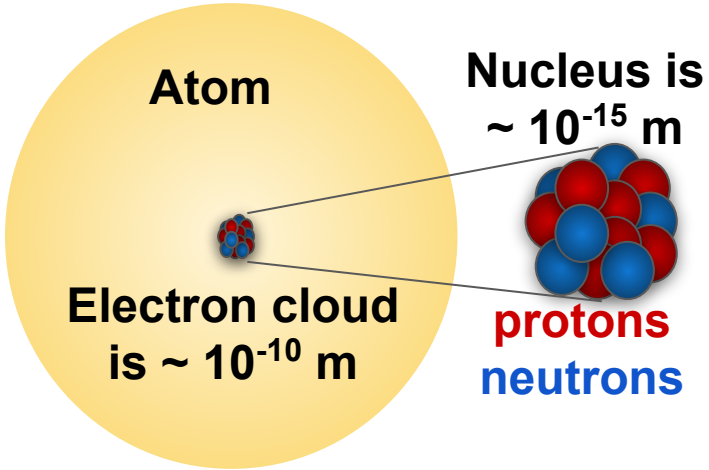
Elements and Isotopes



Periodic table taken from Royal Society of Chemistry. Interactive version available at: https://www.rsc.org/periodic-table



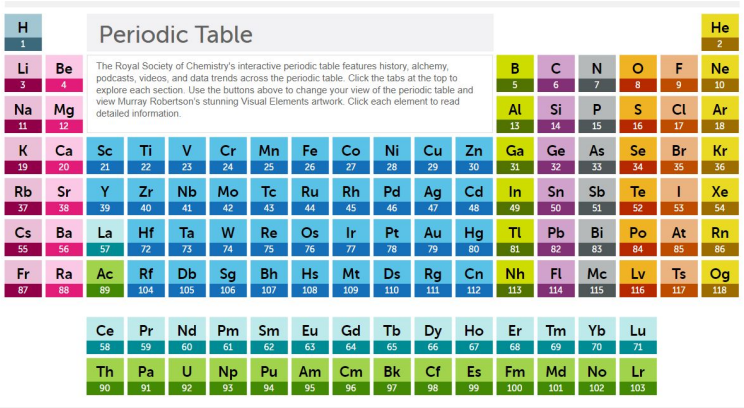
Elements and Isotopes



Me:	~ 1 m
Human cell:	~ 10^{-5} m (10 μm)
Atom:	~ 10^{-10} m (Å)
Nucleus:	~ 10^{-15} m (fm)

Elements and Isotopes

What are elements, isotopes and radiation they discovered and how are they used?



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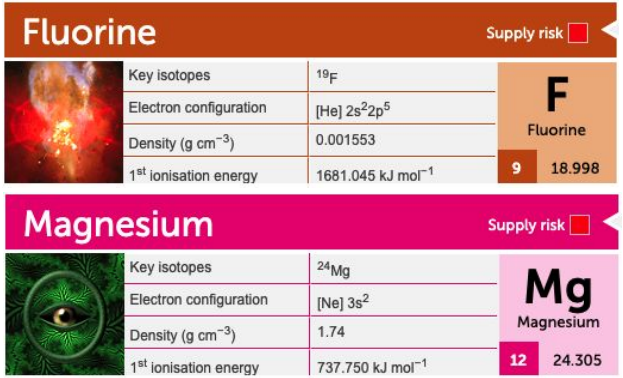
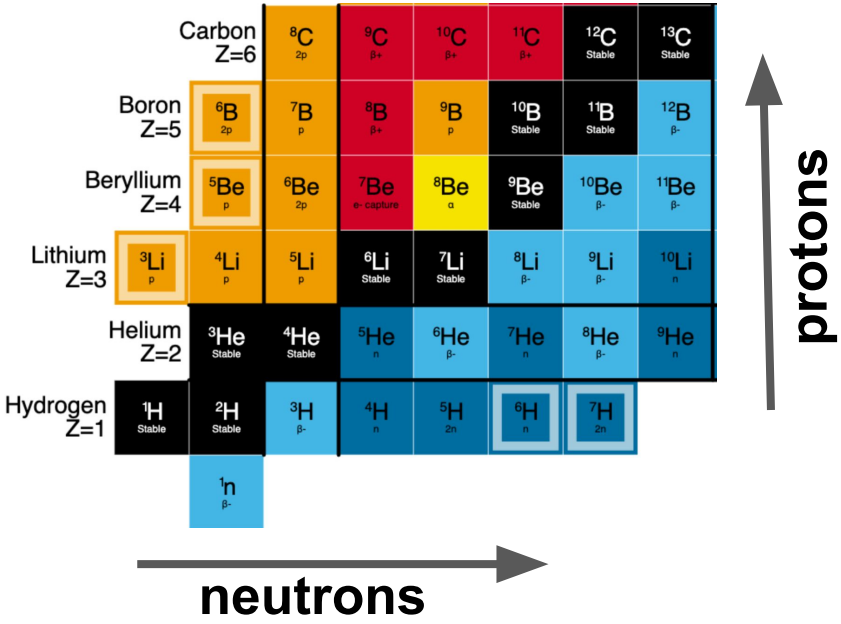


Some elements only have a single naturally occurring isotope, some have several.

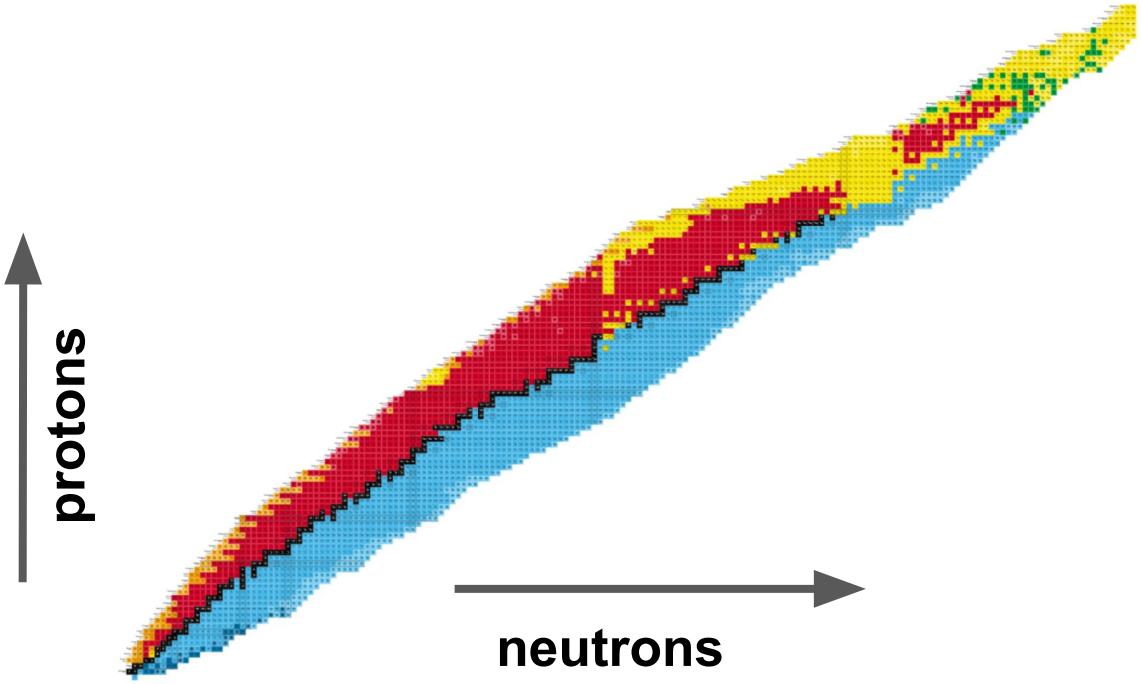
Elements and Isotopes

Nucleons (A), protons (Z), and neutrons (N)

Periodic table taken from Royal Society of Chemistry. Interactive version available at: https://www.rsc.org/periodic-table



Elements and Isotopes



Primary decay mode

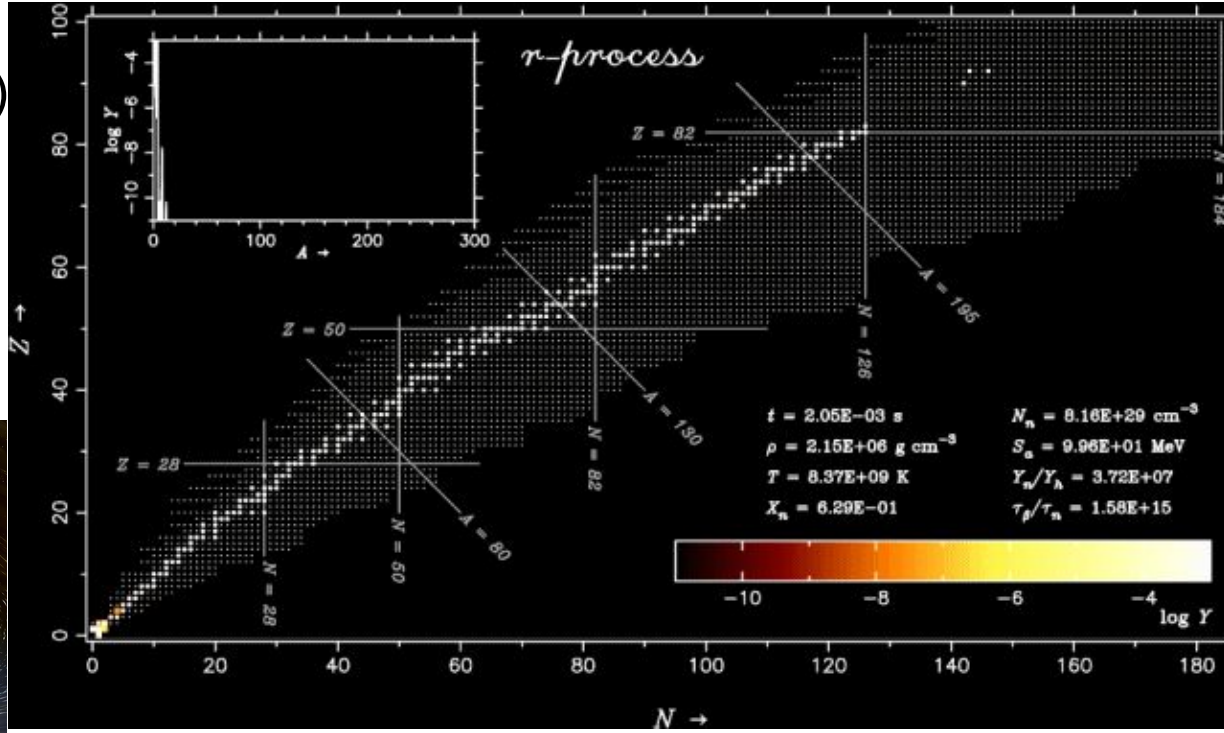
- Stable
- Fission
- Alpha decay
- Beta minus decay
- Beta plus decay
- Neutron emission
- Proton emission

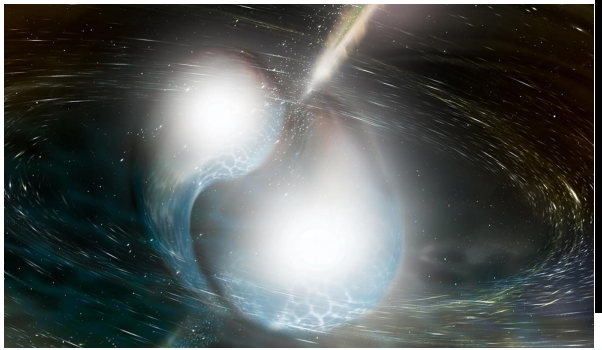
Colourful Nuclide Chart by Dr. Ed Simpson, The Australian National University. Interactive version available at:
https://people.physics.anu.edu.au/~ecs103/chart/

Creating Elements

New elements in stars (in neutron-star mergers)

- Neutron absorption:
  $^{58}Fe + n \rightarrow {}^{59}Fe$ (Z=26)
  $\rightarrow$ new isotope
- Beta minus decay:
  $n \rightarrow p + e^{-} + \bar{\nu}_e$
  $\rightarrow$ new element





Creating Elements

The first elements: energy from fusion to helium

4 (Be)		Be	34	17	14	8
3 (Li)	Li	42	29	14	14	13
2 (He)		He	24	7	14	16
1 (H)	H	33	30	24	29	30
0 (n)		(n)	36			
					3	4

Fusion energy ($D + D \rightarrow {}^4He + E$):

M_D = 2.014102 u and M_{4He} = 4.002603 u

(u = $1.661 \cdot 10^{-27}$kg, c = 299,792,458 m/s)

$E = 2 \cdot M_D c^2 - M_{He} c^2 = 0.025601\ uc^2$

$= 3.8 \cdot 10^{-12}$ J

= 3.8 pJ (excess energy difference)

E (4kg D) = 0.025601kg * $(299{,}792{,}458 m/s)^2$

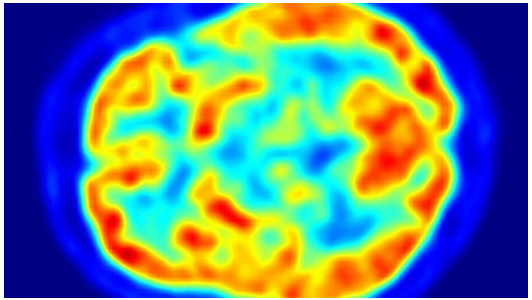
= 2301 TJ

E (1kg D) = 2301 TJ / 4 = 575 TJ.

From deuterium in 1L of water:

- 1kg * 2/18 * 0.00023 * 575 TJ/kg = 15 GJ

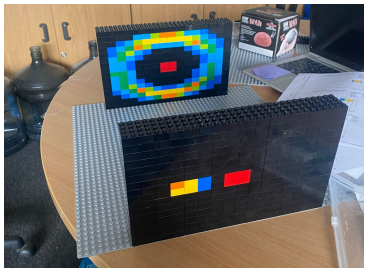
Nuclear Research

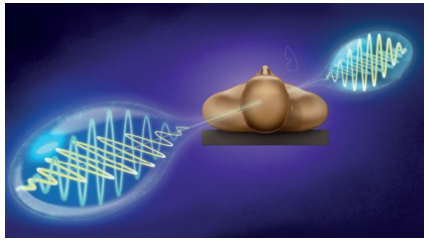


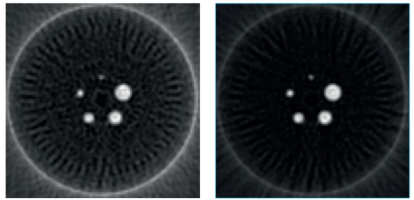
From stars to medicine…

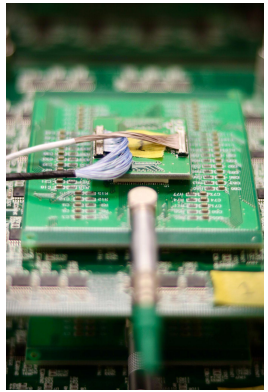
Nuclear physics is about far more than just nuclear power. Researchers are studying:

- The shapes of nuclei
- Cancer treatments and medical imaging;
- Exotic nuclei (highly unstable nuclei that only exist for fractions of a second)
- Nuclear detectors used for national security;
- How stars produce different chemical elements
- How we can use the processes happening inside stars to generate electricity here on Earth.









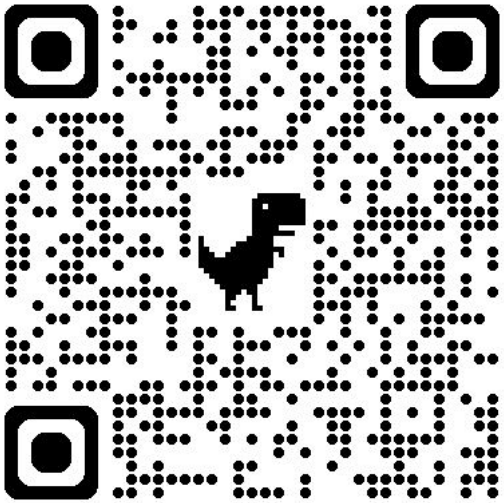
Examples of previous introductions: Find your own style!

Examples:

- Introduction to Siddharth Doshi
- Research slides from Chloe McGeorge

Submit (up to) two slides about you and two slides about your research to: Binding Blocks <physics-bindingblocks@york.ac.uk>
Deadline Tuesday 4th Aug 12:00
Winner announced at the end of the STFC NP Summer School

Ten hundred words



Randall Munroe's Simple Writer tool: an editor inspired by his comic Up Goer Five and book Thing Explainer.

The tool checks your writing in real time and highlights any word that isn't among the 1,000 most used words, encouraging you to explain complex topics using only simple language.