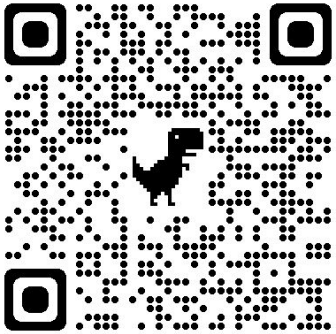
Why outreach?

And how can Binding Blocks help you?



Website:

sites.google.com/york.ac.uk/bindingblocks

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What is outreach?

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What is outreach?

Public engagement describes the myriad of ways in which the activity and benefits of research can be shared with the public.

Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit.

Is outreach the same as public engagement?

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For example…

- **Presentations** and talks for the public
- Interactive discussion formats eg **public debate**
- Working with the **media**, eg writing for the non-specialist, broadcast, social media
- **Exhibition stands** at festivals or events
- **Workshops** and interactive activities
- **Online** and **in-person** courses
- **Dialogue** exploring the future direction of a particular research topic or **collaborative co-inquiry** research, eg with the public involved in shaping the research question, design and delivery as co-researchers

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Why is outreach important?

Why is outreach important?

Challenge assumptions - on both sides!

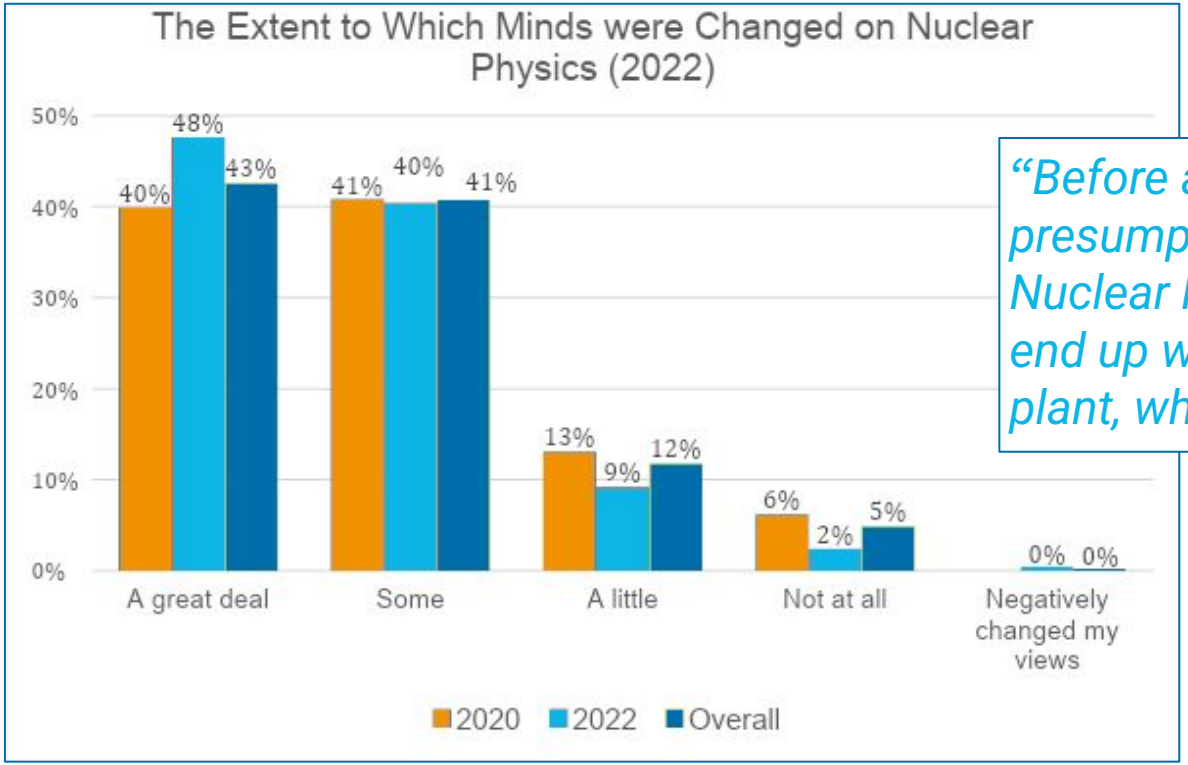
- Nuclear image has an image issue, communicating work in nuclear physics helps challenge the public's assumptions

- Easy to lose perspective on why your research matters. Discussing it with the public can help you examine your assumptions and introduce fresh perspectives

- Reignite your passion for your area - telling the public why it's interesting reminds you why it's interesting!

Vitae 2010

Impact



"Before attending, I was under the presumption that anyone who studied Nuclear Physics is most likely going to end up working in a nuclear power plant, which is definitely not the case."

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Why is outreach important?

Build trust

- Trust between the public and researchers can break down (eg over GM crops)
- Involving the public in discussions of emerging research areas can help avoid such situations
- Help researchers think through the social and ethical implications of their work
    - Nuclear power
    - Nuclear medicine
- Improve relationship between university and neighbour

Vitae 2010

Why is outreach important?

Raise aspirations

- Inspiring the next generation of students to go to university
    - And maybe consider doing nuclear physics
- Suggested 150,000 additional researchers and technicians needed

Vitae 2010, CASE 2023

Why is outreach important?

Funding

- Public funds much of the research in universities and research institutes
  - They should know how the money is being spent

- STFC recognise the importance of public engagement and ask applicants to detail how they will do this in grant proposals
  - STFC offer public engagement grants - accessible to early career researchers (search for UKRI STFC Spark Award 2026).
  - Binding Blocks offer mini awards for you to get started with a Binding Blocks kit for your home university.
  - Contact Binding Blocks physics-bindingblocks@york.ac.uk for details.

Vitae 2010

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Audiences

- On your flip chart paper, list as many **different audiences** that you can think of that you'd want to engage with (not just the "general public")

- For each audience you've written, list the **different aims** you'd want to achieve by engaging with these different groups

The Binding Blocks Programme

- Online Nuclear Physics Masterclasses for pre-16 (GCSE or equivalent) and post-16 (A-level or equivalent)
- Teacher loan kit
- Exhibition content
- Workshop activities

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Online Masterclasses

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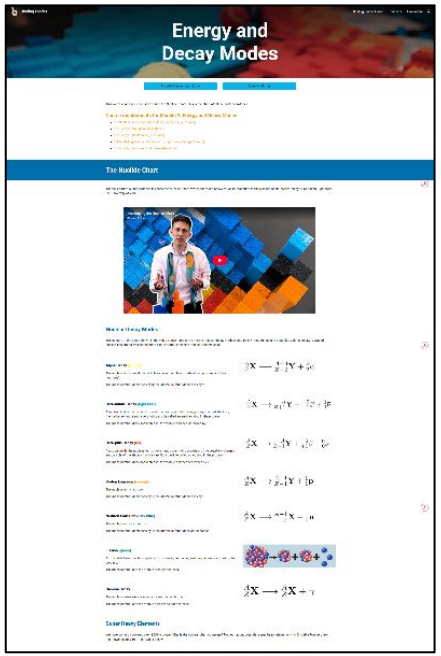
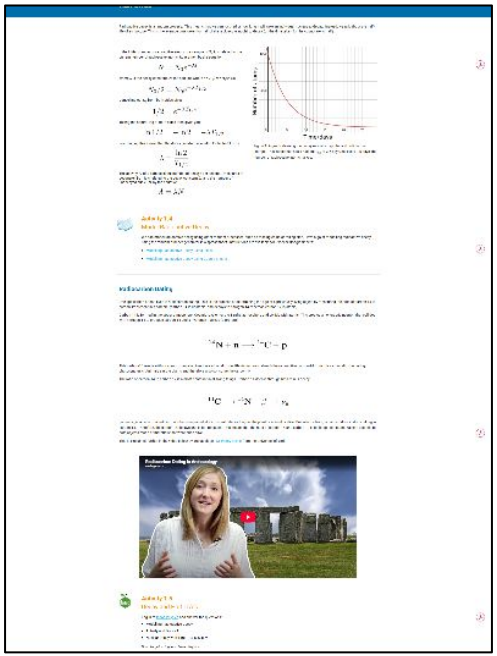
Online Masterclasses

- Runs annually: March/April
- 8-weeks to complete
- Four modules for pre-16
  Six modules for post-16
- Weekly live webinars
- Question forum - **staffed by Nuclear PhD students**
- Certificates awarded





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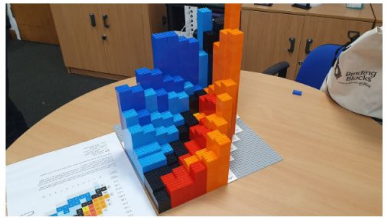
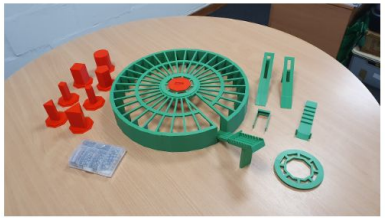
Schools Loan Kit

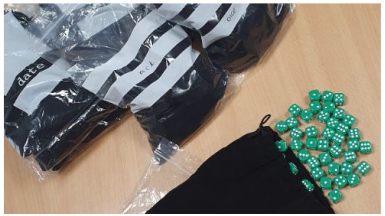
LEGO Chart



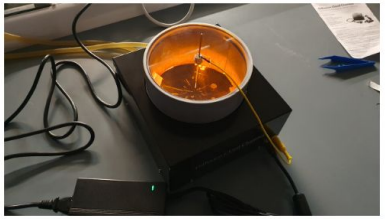
Scatterer



Dice



Cloud Chamber



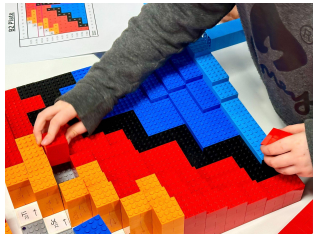
Geiger Counter

D3S Detector

https://sites.google.com/york.ac.uk/bindingblocks/teachers/loan-kit

Includes mentoring from Nuclear PhD students

Exhibitions

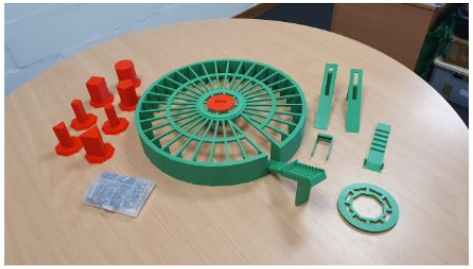


Geiger Counter

D3S Detector

VR Headsets

Scatterer



A mini Binding Blocks exhibition kit can be applied for for your home university

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Workshops

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Modelling Half-Lives with Dice

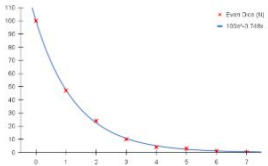
Just like radioactive decay, rolling a die is also a random process. We can therefore use dice, or anything else that has different sides such as coins (or sweets such as Skittles or M&M's) to model radioactive decay.

In the loan kit, we provide 15 bags that each contain 100 6-sided dice, (if you are missing any dice, please do let us know).

We can change the "half-life" of the system by changing the condition for decay, i.e. how many dice are expected to decay in each step. For example, if the dice show an odd number, we can say these dice have decayed. As this should be 50% of the dice, this means the half-life of the system is one throw.

1. Count the number of dice that you start with - these are your unstable nuclei.
   (Note: Each bag should contain 100 dice)
   - Record this number in a table for time t = 0.
2. Place the dice in the black bag and shake them;
3. Pour the dice (carefully) onto the table;
4. Count any dice with an even number, (i.e. 2, 4, 6) facing up.
   - These represent nuclei that haven't decayed yet;
   - Record this number in your table for time t = 1 and put these dice back into the bag, (e.g. N = 47);
   - Put any dice showing an odd number, i.e. those that have decayed, to one side.
5. Shake and throw the dice again, keeping and recording any dice that land on an even number up (and discarding the rest)
6. Repeat until all your dice have decayed!
7. Now plot a graph of the time along the x-axis and the number of radioactive nuclei on the y-axis.
8. Find the half life of your dice (or other objects) by reading off the time when half of your dice have 'decayed'.
9. To improve the accuracy of the half life, take another two points on your graph where the number of unstable nuclei have halved and take an average of your two half lives.

Throws (t)	Number of Radioactive Nuclei (N)
0	100
1	47
2	24
3	10
4	4
5	3
6	1
7	0



Playing the Hot CNO Cycle Game

In the Hot CNO cycle, four protons are converted into a helium nucleus through alpha decay. This is an example of hydrogen fusion, but is a catalytic process where carbon, (C) nitrogen, (N) and oxygen (O) are used to speed up the fusion processes.

Each of the steps in the loops are one of the following three nuclear equations:

1. A proton is captured, and then a photon is released to further stabilise the new isotope.
2. A proton is captured, and then an alpha particle is immediately emitted.
3. These isotopes will decay via β^+ decay.

Each of these three loops lead to the net stellar fusion equation: $4H^1 \rightarrow 2He^4 + 2\beta^+ + 2\nu_e$

The resources included in the loan kit for these activities are:

- A single A3 laminated sheet with all isotopes;
- A4 laminated sheets of each isotope, to be laid out across classroom tables;
- A3 laminated sheets of each isotope, to be laid out across a classroom floor;
- 50p coins, to flip to simulate the random process nature;
- Stopwatches, for you to time the half-life of the nuclear processes;
- Counters, to track your progress moving around the board.

Board game version (pairs)

Students can explore the Hot CNO cycle on an A3 sheet as a board game. Start on any carbon or nitrogen isotope and follow the instructions under each tile. You can find details about the game in the instructions document, which also includes a blank grid for the students to draw their cycles onto!

Board Game Instructions

Floor tiles version (full class)

The game can also be played on a larger scale. In the loan kit, we provide laminated A4 and A3 sheets for you to set up in the same grid as the small board game version. You can find a written version of these instructions provided by the National STEM Learning centre.

Floor Tiles Instructions

Get Involved

Express your interest:

- For further information about having a mini Binding Blocks kit for your university

and/or

- For further training to assist with the online masterclass question forum, or to become a schools mentor

Contact us: physics-bindingblocks@york.ac.uk

Nuclear Physics Outreach

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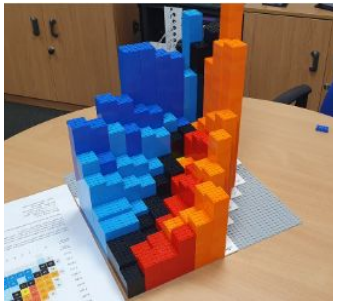
CERN 360 videos (for use with Google Cardboard VR headsets)

Geiger Counter

D3S Detector



VR Headsets

Scatterer

Email: physics-bindingblocks@york.ac.uk

Website: sites.google.com/york.ac.uk/bindingblocks

Express your interest in getting involved with the Binding Blocks outreach programme