

Nucleons

Clear

- Difference between s-process and r-process
- How elements heavier than Fe-56 are formed. Thank you - we really liked the activities!

Unclear

- When we say “hydrogen (or helium, carbon, etc) burning” is that fusion? What particles are involved in the burning? [nuclei](#)
- Is neutron capture fusion?
- Where do all of the captured neutrons come from? [explosion of iron core](#)
- Does neutron capture happen mainly after supernovae?

Further questions

- On nucleosynthesis simulation, some nuclides with more than 92 protons showed up temporarily and then disappeared. Do these elements actually appear in these processes? [yes](#)
- Does alpha decay play a role in any of these processes?

Omega

Clear

- Difference between s-process and r-process
- Burning stages of stars
- How the nuclide chart can be used with kids.

Unclear

- How is NSCL is used in investigating the r and s process?

-

Further questions

- What is the cost of making a small amount of gold?
-

Spicy Potter Fox (SPF)

Clear

- The directions of the activity and its importance in nucleosynthesis.
- How stellar evolution is the primary method of producing elements heavier elements.

Unclear

- Are the r and s process times constant throughout the nucleosynthesis? [No, the times are dependent on the neutron density in the region.](#)
- Is there an intermediate neutron capture process? [Yes, there many intermediate processes. See previous question.](#)
- Is there a way to predict whether any given isotope is more likely to undergo one type of

decay versus another?

- Have we found other red giant stars containing Tc-98 other than the discovery in 1952?

Further questions

- Can fusion of larger nuclei occur in slow and rapid processes? **Yes, but requires more energy in a different environment.**

The Arraying PANTastics



Clear

- The R and S process (now we know what causes the process to be slow vs. rapid)
- At what stages the elements are formed in a high mass star
- It is clear how the lab can form gold.

Unclear

- The p-process (does “p” stand for proton?)

Further questions

- Can we identify the burning process by the visual color of the star?

Alpha Atomics



Clear: Overarching process was clear; Great graphics

Unclear: 1) Needed an intermediate step between the simple “BINGO” and mapping the s-process 2) Chart was small & difficult to read for the audience

Further questions: Need more info about half-life...not so much what it is but how is it experimentally determined? Very valuable to offer to our students **Very carefully measure the time looking for types of material left alpha, beta, or gamma, exponential decay;** How do we know the created isotopes are there if they only last a short time? **By looking at spots in the detectors by path it takes in magnetic field** 3) Need a bit of review on the life-cycle of stars...it's been awhile. :-)
lightest element burned inside the environment (hydrogen) when amount isn't enough to sustain then star will collapse a bit & increase in density, temp, gravity, etc. as well as thermonuclear reactions; pressure vs. gravity in directions



Cosmopolitan

Clear

- Activity made a clear distinction between the slow and rapid process. It was also a good lead

into the p-processes.

- Time required for production of these heavier elements / cost of “manufacturing” makes it a finite amount.

Unclear

- Why is it called burning? A: It is called burning because you are **using up** the materials in the process; smaller particles fuse into heavier elements.

Further questions:

- Is the amount of gold produced (in the lab) significant? No.

- Can you provide a hypothesis of why p-nuclei are formed?

P-process is not related to a proton capture, but rather that the nucleus is proton-rich; This may occur after the s-process, if they happen to be in an environment with gamma radiation (explosive supernova) this will produce beta decay. Once the radiation stops, the unstable products (to the left of the stability curve) decay back to stability.

- How will FRIB expand your research?

We will be able to produce more exotic nuclei, i.e., with shorter half-lives, also nuclei involved in the r-process and measure their half-life.

From Anna:

the rp- process is a rapid proton capture process. It requires high temperatures (so the protons can overcome the Coulomb barrier) and, obviously, hydrogen rich environment. It works similar to the s-process:

the proton capture competes with beta+ decay. So the synthesis will climb towards higher masses on the chart of nuclides and will stop when it gets to the region where (alpha,p) reactions start to dominate (around tellurium).

the p-process (sometimes also called a gamma-process) goes in the opposite directions. It requires a seed of the s-nuclei, that are then destroyed by a series of first (gamma,n) and later (gamma,p) and

(gamma,alpha) reactions. This produces proton rich unstable nuclei, which, after the gamma flux stops, will beta+ decay to stability. This process also require a high temperature and a s-process seed, so it will most likely occur during an explosion of a type II or type Ia supernova.