Nuclear Experimentation Q&A (Artemis Spyrou, 7/30/12)

HIGGS

3 Things Understood

1. That a dripline is the line past which a proton or neutron cannot stay bound, but is instead immediately released.
2. That a r process creates more massive nuclei (higher atomic numbers) and neutron rich isotopes.
3. One needs lots of something like H to detect neutrons due to mass differences (think momentum of bug vs. windshield).

3 Questions

1. Exactly how are the really tiny half-lives measured? Doppler shift reference - you have a reaction target and the nucleus flying a some velocity... when it decays and makes gamma rays, they are doppler shifted. Comparing doppler shift velocities (moving materials further outward or inward, changing the distances many times) and comparing the delay of the gamma ray peaks (ratios) from different stages we can calculate the half life.
2. Why can you not determine the dripline past O (you took F to a certain point, but said that it could go further)? Need to do more experiments - F-33 hasn't been done yet (or not enough data - need to 'not see' many), and depends on the accelerator beam intensity. Once the

Linac is up, we'll have much more intensity, and will be able to complete this study.

3. Do we need to use relativistic formulation of momentum and energy conservation - is this good enough, or are the calculations done differently? Do need some corrections (around the speed of light), but not much... we want only first order approximations (never get to second order).

Cosmic Spartans

Things we understand:

We understand why neutrons are detected with hydrogen rather than a heavier element.

We understand why the sweeper removes charged particles but not neutrons.

We understand that cosmic rays originate with protons that undergo reactions in the atmostphere.

Questions:

What is the relationship between Borromean nuclei and Halo Nuclei?

Does the end of the neutron drip line indicate a definite point where exotic nuclei cannot form or just the heaviest

isotope observed

Wickets

3 Things we understood

1. That unbound means the nucleus will decay.
2. How and why cosmic rays are used for calibration..
3. We understand how magnetic fields and electrical fields are used in experiments.

3 Things we need clarification on

1. What are Pions and Muons? Pions are a quark and an antiquark; Muons are heavy electrons.
2. What causes Proton rich nuclei to decay? If I have a nucleus with excess energy (beyond the binding energy), it will decay due to the excess energy. Also, we have repelling action due to both possessing the same charge.
3. Are the Borromean nuclei the same as the Halo nuclei, just different ways to describe the effect? *These nuclei must be described by three body forces,inside the nucleus the two halo neutrons are paired. The observable data is where the two neutrons with respect to the core - they tend to be on the same side of the core. We can not observe them inside the nucleus, but we observe the excited neutrons leaving the core and they come out together and in the same direction. There is some*

possibility that there is another explanation than the pairing inside the core. The neutrons that are emitted hit the MoNA within nanoseconds. We can also have a borromean nucleus that is a 1 neutron borromean.

PIONeers

Q1: How are cosmic rays used to calibrate the detectors?
Align with known energy of muons at 20 Mev.
Q2: What is the mechanism for creating Lithium-12?
1st beam is 0xygen-18 and second beam of Boron-14 created from the production target, then used for a second target to collect Lithium-12.
Q3: *What is the significance of 10^-21 s? Limit of the time for the neutrons to cross the nucleus for measurement of half-life.*

3 Things we understood

- How a MoNA bar works.
- The favor of collisions of smaller particles for the detection of nuetrons due to momentum.
- How a sweeper works.

Cosmos Enthusiasts

- Areas Understood
    - Concept of the proton and neutron drip lines
    - The idea of exotic nuclei and their halflives

    - Extensive air shower imagery/breakdown
- Questions...
    - Is it possible to characterize the Halo nuclei/borromean nuclei concept in terms of quantum theory? If so, how? Is the Borromean nuclei concept related to the QCD? (perhaps it was the color of the rings? :-)) *3 body interaction, not a 2 body interaction.* Does the Pb208 nuclei have a Li9core? (in so many words) *probably not. There can be predicted nuclei that are halo nuclei utilizing nuclear quantum theory*.
    - In the dineutron decay graph, where was the graphical indication of the existence of the n2 particle? Also, in terms of the the breakdown, how much energy is required when a n2 particle breaks down into 2neutrons? How does that compare with the energy required when 1 neutron is removed? *Dineutron particles are not bound particles. They are neutrons that are come out of the nucleus together but not bonded together.*

M.A.L.L. (Michigan Astrophysics Learning League)

- How do you know that some nuclei are Halo Nuclei?
    - Don't know in advance. Need to measure the

size of the nucleus. Charge radius but doesn't help if it is a neutron halo.

- What are some of the specific medical applications? Why study this?
    - Bombard cancerous tumors. Cyclotrons were made smaller so they can be easily installed in hospitals. Use carbon the same way that neutrons are used in medicine.
- More in depth explanation of the angle graph for dineutrons.
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<u>Understood</u>

- Neutron and proton drip lines and how isotopes can be unbound.
- Sequential vs. Simultaneous slide
- How the scintillators work in MoNA-LISA.