Discovery of a New Uranium Isotope

Why in News?

In pursuit of a **'magic number',** Physicists in Japan have recently discovered a **new** isotope of uranium with **atomic number 92 and mass number 241.**

What are the Major Highlights of the Discovery?

- **About:**
  - The researchers accelerated **uranium-238 nuclei into plutonium-198 nuclei at the KEK Isotope Separation System (KISS).** In a process called multinucleon transfer, the two isotopes exchanged protons and neutrons.
  - The resulting nuclear fragments contained different isotopes.
  - The team used **time-of-flight mass spectrometry** to measure the mass of each nucleus.
- **Findings:**
  - It was identified as **uranium-241 and measured the mass of its nucleus.** Theoretical calculations suggest that this **new isotope could have a half-life of 40 minutes.**
    - This discovery is the **first of its kind since 1979** due to the extreme difficulty of synthesising a nuclide in this region by general reaction.
- **Importance:**
  - This finding is significant **in refining our understanding of nuclear physics** and has implications in **designing** nuclear power plants **and models of exploding stars.**
    - Measuring the mass of uranium and its neighbourhood elements yields **essential nuclear information to understand the synthesis of such heavy elements** in explosive astronomical events.
- **Future Implications:**
  - This new approach using multinucleon transfer reaction and KISS is expected to **lead to the discovery of more neutron-rich actinide nuclides**, elucidating the stability of nuclides and the process of astronomical nucleosynthesis.

Note: Uranium (chemical symbol U) is a naturally occurring radioactive element. In its natural state, Uranium consists of three isotopes **(U-234 (0.0057%), U-235 (0.72%)** and U-238 (99.28%)). Other isotopes that cannot be found in natural uranium are **U-232, U-233, U-236 and U-237.**

What are Magic Numbers'?

- In **nuclear physics**, "magic numbers" are **specific numbers of nucleons (protons or neutrons)** that correspond to **particularly stable configurations within atomic nuclei.**
- These numbers are believed to arise from the underlying shell structure of atomic nuclei.
  - The heaviest known **'magic' nucleus is lead (82 protons).**

UPSC Civil Services Examination, Previous Year Question (PYQ)

Q. In India, why are some nuclear reactors kept under "IAEA safeguards" while others are not?

(2020)

(a) Some use uranium and others use thorium
(b) Some use imported uranium and others use domestic supplies
(c) Some are operated by foreign enterprises and others are operated by domestic enterprises
(d) Some are State-owned and others are privately-owned

Ans: (b)

- The **nuclear facilities are kept under International Atomic Energy Agency (IAEA)** safeguards **if the source of Uranium** which is the fissile material for a nuclear reactor is **from outside the territory of India or** if the new reactor plants are established with foreign collaboration.
- This is to ensure that imported uranium was not diverted for military use and assure that the imported uranium is used to generate nuclear energy for civilian purposes.
- There are at present 22 operational reactors, of which 14 are under the IAEA safeguards as these use imported fuel.
- Under safeguards agreement, the IAEA has the right and obligation to ensure that safeguards are applied on all nuclear material in the territory, jurisdiction or control of the State for the exclusive purpose.
- **Therefore, option (b) is the correct answer.**

Source: TH