Nuclear Fission

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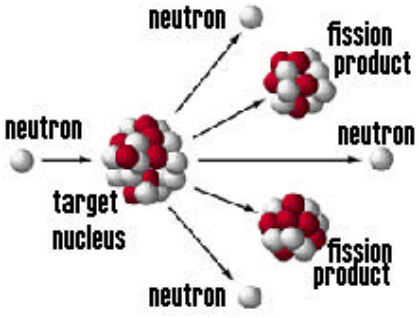
THE HISTORY OF FISSION

In the 1930s, German physicists/chemists Otto Hahn and Fritz Strassman attempted to create transuranic ele ments by bombarding uranium with neutrons. Rather than the heavy elements they expected, they got several unidentified products. When they finally identified one of the products as Barium -141, they were reluctant to publish the finding because it was so unexpected. When they finally published the results in 1939, they came to the attention of Lise Meitner, an Austrian -born physicist who had worked with Hahn on his nuclear experiments. Upon Hitler's invasion of Austria, she had been forced to flee to Swe den where she and Otto Frisch, her nephew, continued to work on the neutron bombardment problem. She was the first to realize that Hahn's barium and other lighter products from the neutron bombardment experiments were coming from the fission of U-235. Frisch and Meitner carried out further experiments which showed that the U-235 fission yielded an enormous amount of energy, and that the fission yielded at least two neutrons per neutron absorbed in the interaction. They realized that this made possible a chain reaction with an unprecedented energy yield.

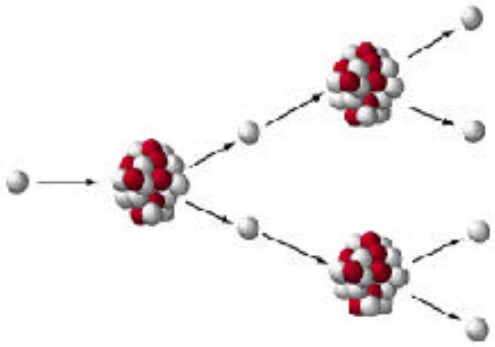
NUCLEAR FISSION



Nuclear fission is the process of splitting the nucleus of a heavy atom (target nucleus) into two or more lighter atoms (fission products) when the heavy atom absorbs or is bombarded by a neutron. A few radionuclides can also spontaneously fission.

Fission releases a large amount of energy along with two or more neutrons. The large amount of energy released is due to sum of the masses of the fission products being less than the orig inal mass of the heavy atom. This 'missing' mass (about 0.1 percent of the heavy atom mass) has been converted into energy according to Einstein's equation, $E = MC^2$.

NUCLEAR CHAIN REACTIONS



When a heavy atom fissions, it releases neutrons which can be absorbed by other heavy atoms to induce further fissions. This is called a chain reaction.

If each neutron releases two more neutrons from a fission, then the number of fissions doubles each generation. In that case, in 10 generations there are 1024 fissions and in 80 generations about 6 x 10^{23} (a mole) fissions.

The process may be controlled by neutron -absorbing materials (as in nuclear power reactors) or uncontrolled (as in nuclear weapons). If the chain reaction rate is capable of being sustained at a constant level, the rate of neutron production equals the rate of neutron loss, the reaction is termed critical. If the chain reaction rate rises, the rate of neutron production is greater than the rate of neutron loss, the reaction is termed supercritical.

FISSIONABLE RADIONUCLIDES

Uranium-235 is a naturally occurring radionuclide, and plutonium-239 and uranium-233 are artificially produced radionuclides that can be induced to fission by absorbing a neutron. Uranium-235 is used as a fuel source in nuclear power reactors and both uranium-235 and plutonium-239 have been used to make nuclear fission bombs.

Sources

Atomic Archive,
http://www.atomicarchive.com/Fission/Fission1.shtml
http://www.atomicarchive.com/Fission/Fission2.shtml
HyperPhysics, http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/fission.html#c2

Links to external resources are provided as a public service and do not imply endorsement by the Washington State Department of Health.