

POGIL – Nuclear Fission & Fusion

Background

Fission and fusion are two processes that alter the nucleus of an atom. Nuclear fission provides the energy in modern day nuclear power plants and fusion is the source of the sun's energy. The use of fission in power plants can help conserve or one day possibly eliminate the need for fossil fuels. Without the energy produced by fusion of hydrogen in the sun, the Earth would quickly change into a cold planet that could not support life as we know it.

Transmutation can be accomplished through many types of reactions, including fission. Nuclear transmutations always obey two fundamental conservation laws:

- (1) Mass number is conserved
- (2) Electrical charge is conserved

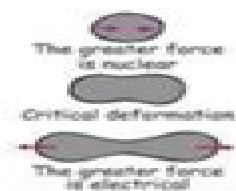
Energy and mass are **not** conserved, but can be interconverted according to Einstein's equation:

$$E = mc^2$$

Where E = energy, m = mass, and c = the speed of light

Nuclear Fission

The process of fission occurs when a nucleus splits into smaller pieces. Fission can be induced by a nucleus capturing slow moving neutrons, which result in a highly unstable nucleus.



<http://www.arpansa.gov.au/images/basics/fission.jpg>

Watch the following clip for a brief explanation (double-click on Fission.mov) :

Fission.mov

For an animation of this process, view the PhET model linked below and click on the "Fission – One Nucleus" tab.

<http://phet-web.colorado.edu/sims/nuclear-physics/nuclear-physics.html>

Nuclear Fusion

Fusion occurs when 2 nuclei join together to form a larger nucleus. For a fusion reaction to occur, the atoms of hydrogen must be heated to millions of degrees and subjected to high pressure. When done properly, the positively charged nuclei of the hydrogen isotopes, which naturally repel each other, combine.



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Clemens Wendtner



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Fission, Fusion and the Energy Crisis Stanley Ernest Hunt,1974 Energy From The Nucleus: The Science And Engineering Of Fission And Fusion Gerard M Crawley,2016-08-11 Nuclear energy is important both as a very large energy resource and as a source of carbon free energy However incidents such as the Fukushima Daiichi nuclear disaster 2011 the Chernobyl disaster 1986 and the Three Mile Island accident 1979 have cast doubts on the future of nuclear fission as a major player in the future energy mix This volume provides an excellent overview of the current situation regarding nuclear fission as well as a description of the enormous potential advantages offered by nuclear fusion including an essentially unlimited fuel supply with minimal environmental impact Energy from the Nucleus focuses on the two main approaches to producing energy from the nucleus fission and fusion The chapters on nuclear fission cover the status of current and future generations of reactors as well as new safety requirements and the environmental impact of electricity production from nuclear fission The chapters on nuclear fusion discuss both inertial confinement fusion and magnetic confinement fusion including the new international fusion test facility ITER The expertise of the authors who are active participants in the respective technologies ensures that the information provided is both reliable and current Their views will no doubt enlighten our understanding of the future of energy from the nucleus Nuclear Fusion and Fission Fiona Young-Brown,2016-07-15 Nuclear Fusion and Fission delves into nuclear physics and the scientists responsible for the discovery of splitting and fusing an atom The book begins with the very basic building blocks of science breaking down the different types of energy and how we use them the materials that make up an atom and our search for the perfect renewable energy source Set against the cultural backdrop of World War II later chapters follow each significant theory that led to the creation of the world s most dangerous weapon as well as some of its most widely used medical and food production processes today *Fission and Fusion* Lefelique,2019 This lesson plan covers nuclear fission and nuclear fusion Nuclear Fission ,1984 **Fission, Fusion and the Energy Crisis** S. E. Hunt,1974 *Fission, Fusion and the Energy Crisis* Stanley E. Hunt,1976 **Nuclear Fission and Fusion in a Random-walk Model** Martin Albertsson,2021 The Nuclear Fission Process Cyriel Wagemans,1991-09-20 This text provides a comprehensive review of knowledge regarding nuclear fission from both the purely scientific and practical points of view Topics discussed include fission barriers spontaneous fission neutron induced fission cross sections photon and electron induced fission charged particle induced fission fragment angular momentum and ternary fission The characteristics of other reaction products are also discussed Contributed articles from several distinguished nuclear scientists guarantee adequate treatment of some of the specialized research fields included in the text Intended primarily as an introduction to nuclear fission for graduate students this book will also provide useful information for nuclear physicists involved with research or teaching **Problems in Producing Power From Nuclear Fission** Atomic Energy of Canada Limited,F.W. Gilbert,1959 *Fission, Fusion, Safety and Nuclear Power* British Nuclear Industry Forum,AEA Technology (Firm),1994

Problems in producing power from nuclear fission F. W. Gilbert,1955 **Energy in the future - the role of nuclear fission and fusion. (with 2 tables).** W. B. Lewis,1973 *The Curve of Binding Energy* Paul F. Kisak,2016-05-31

Nuclear binding energy is the energy that would be required to disassemble the nucleus of an atom into its component parts. These component parts are neutrons and protons which are collectively called nucleons. The binding energy of nuclei is due to the attractive forces that hold these nucleons together and this is usually a positive number since most nuclei would require the expenditure of energy to separate them into individual protons and neutrons. The mass of an atomic nucleus is usually less than the sum of the individual masses of the constituent protons and neutrons according to Einstein's equation $E = mc^2$ and this missing mass is known as the mass defect and represents the energy that was released when the nucleus was formed. The term nuclear binding energy may also refer to the energy balance in processes in which the nucleus splits into fragments composed of more than one nucleon. If new binding energy is available when light nuclei fuse or when heavy nuclei split, either process can result in release of this binding energy. This energy may be made available as nuclear energy and can be used to produce electricity as in nuclear power or in a nuclear weapon. When a large nucleus splits into pieces, excess energy is emitted as photons (gamma rays) and as the kinetic energy of a number of different ejected particles (nuclear fission products). The nuclear binding energies and forces are on the order of a million times greater than the electron binding energies of light atoms like hydrogen. The mass defect of a nucleus represents the mass of the energy of binding of the nucleus and is the difference between the mass of a nucleus and the sum of the masses of the nucleons of which it is composed. *Advanced Nuclear Fission Theory*, 2001 **Selected Papers on Nuclear Reactions.**, 1984 **Nuclear Fission** Patrick Talou, Ramona Vogt, 2023-01-02. This book provides advanced students and postdocs as well as current practitioners of any field of nuclear physics involving fission an understanding of the nuclear fission process. Key topics covered are fission cross sections, fission fragment yields, neutron and gamma emission from fission and key nuclear technologies and applications where fission plays an important role. It addresses both fundamental aspects of the fission process and fission based technologies including combining quantitative and microscopic modeling. *Theories of Nuclear Fission* Robert Brock Le Page, 1964 **On Radio Activities, Nuclear Fission and Nuclear Fusion** Kazuo Kondo, 1987

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