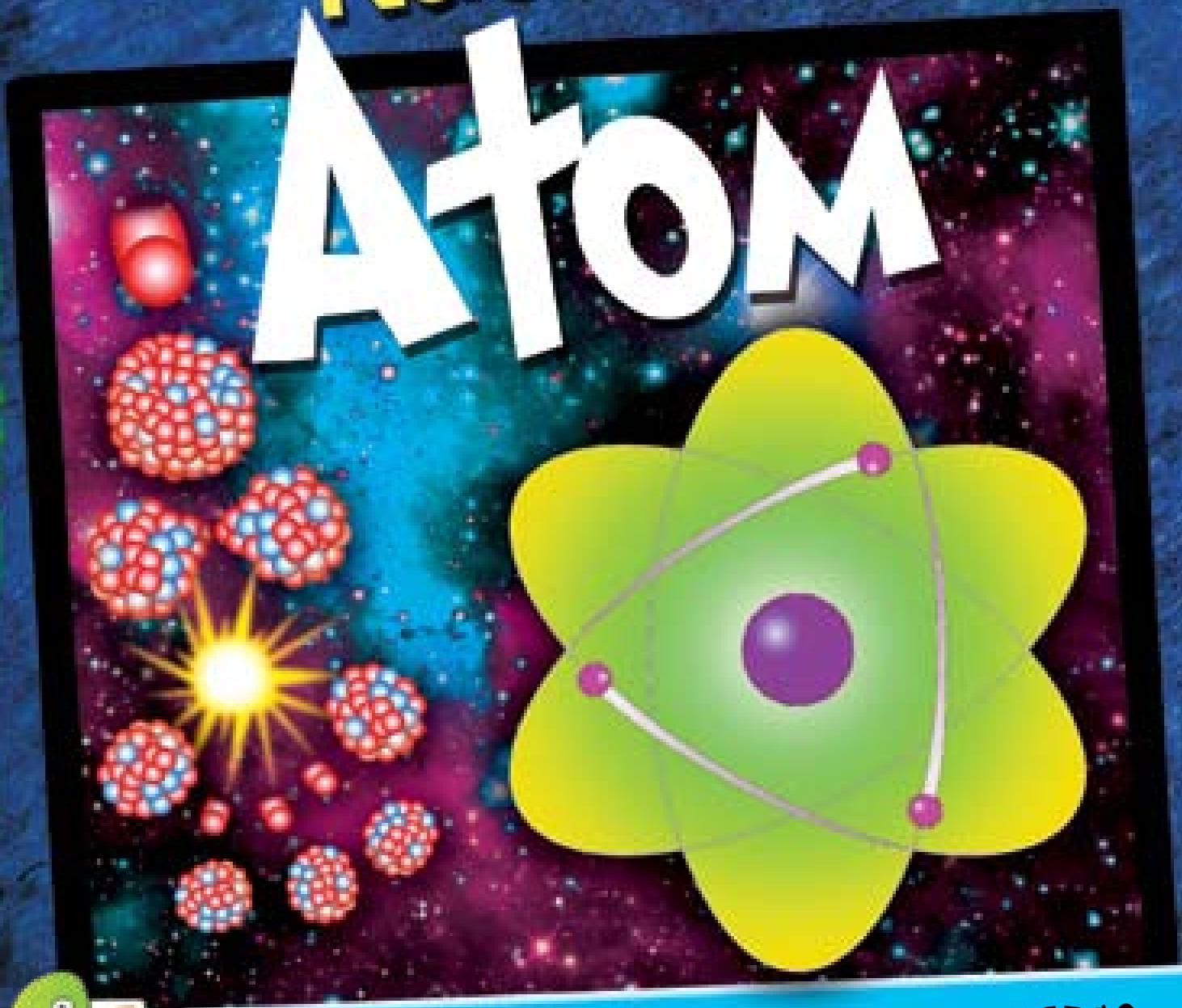
SUPER-POWERED EARTH

ENERGY from the Nucleus of an Atom



NUCLEAR ENERGY: EVERYTHING YOU EVER WANTED TO KNOW ABOUT CLEAN, GREEN POWER!

Terrapin

First published in 2009 by
The Energy and Resources Institute
at
TERI Press
Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi - 110 003, India
Tel. 2468 2100/4150 4900, Fax: 2468 2144/2468 2145
India +91 • Delhi (0)11
E-mail: teripress@teri.res.in • Website: http://bookstore.teriin.org

ISBN 978-81-7993-136-3

Author: Moen Sen
Managing Editor: Madhu Singh Sirohi
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Cover Design: Priyabrata Roy Chowdhury
Design: Archana Singh
Illustration: Neeraj Riddlan
Image Researcher: Yukti Garg
Production: T Radhakrishnan
Prepress: Mahfooz Alam

Printed and bound in India

This book is printed on recycled paper

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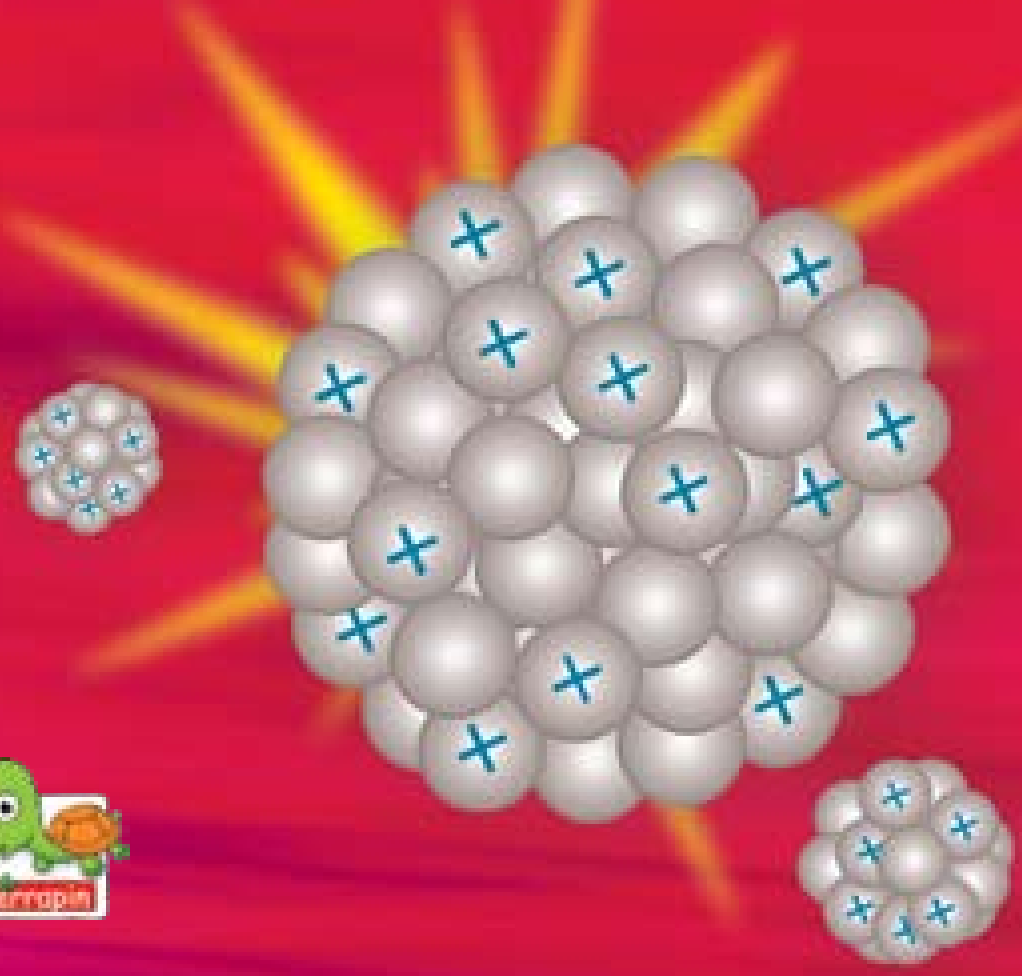

Terrapin

A note from Dr R K Pachauri

Human society has reached a stage of prosperity, which was not expected several decades ago. Yet, a large number of people live in poverty and are barely able to keep alive. It appears that they have not been touched by human progress at all. At the same time, what we regard as progress has resulted in damage and destruction of our natural resources and caused serious problems such as human-induced climate change, which threaten all forms of life in different parts of the world in the form of sea-level rise, heatwaves, floods, droughts, and melting of glaciers.

All of this provides a strong reason for us to re-examine what we have mistakenly believed as human progress and change the way we have been pursuing human activities. For instance, we must now use renewable sources of energy and eco-friendly methods of production and consumption, make efficient use of water in every activity, and protect biodiversity.

It is in the hands of the children to try to change their own lives towards greater protection of the environment and all our natural resources. They can also take active part in changing the thinking of adults. Children can take the lead in organizing actions, which support conservation of resources, recycling of waste water, and greater use of renewable sources of energy, at the community level.

This series of children's books is aimed at providing children with knowledge on what needs to be done in all these areas. I hope those who read these books will not only enjoy them greatly but also feel inspired to implement actions that are described in these pages, so that we create a beautiful, peaceful, and healthy future for the human race.

R K Pachauri
Director-General, TERI
Chairman, Intergovernmental Panel on Climate Change

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What is an atom?

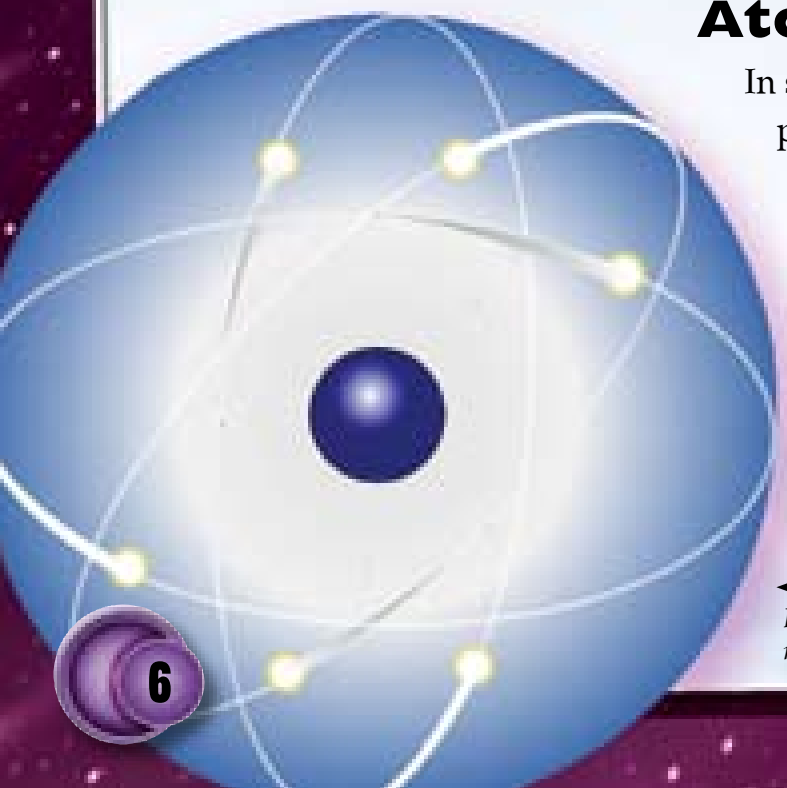
What's the tiniest thing you can think of? A pinhead? A grain of sand? Or the tip of the pimple on your nose? Actually, the tiniest thing in the entire universe is an atom. Everything in this universe, including you and me, is made up of atoms. Atoms bond with, or join, each other to form compounds.

The world of atoms

An atom is made up of three types of particles: electrons, protons, and neutrons. The centre of the atom, or nucleus, is very dense and holds protons and neutrons. While protons have a positive charge, neutrons do not have any charge; they are neutral. About 99.9 per cent of the mass of the atom is concentrated in the nucleus. Electrons, which are negatively charged, spin around the nucleus like planets around the sun.

Atoms and ions

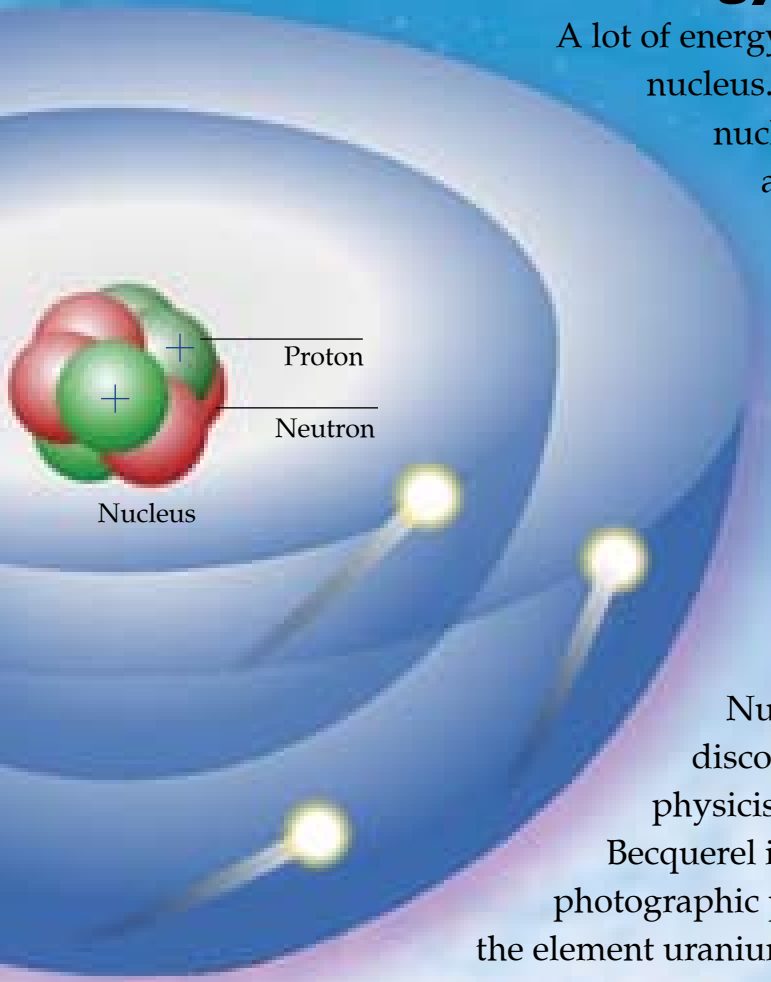
In some atoms, the number of electrons and protons are the same. The negative charge of the electrons cancels the positive charge of the protons. Such atoms have no overall charge. Atoms with more electrons than protons have an overall negative charge. Similarly, an atom with more protons is positively charged. Atoms with positive or negative charges are called ions.



Electrons revolving around the nucleus of an atom.

Nuclear energy

A lot of energy is stored inside the nucleus. This energy is called nuclear energy. When an atom is split, this energy is released in large amounts. Nuclear energy is so powerful that it can be used to make bombs and weapons. It can also be used to generate power.



An atom is composed of protons, electrons, and neutrons.

Nuclear energy was discovered by French physicist Antoine Henri Becquerel in 1896. He saw that photographic plates kept next to the element uranium became black. This led him to conclude that uranium emitted some special rays. He studied this phenomenon further to discover radioactivity.

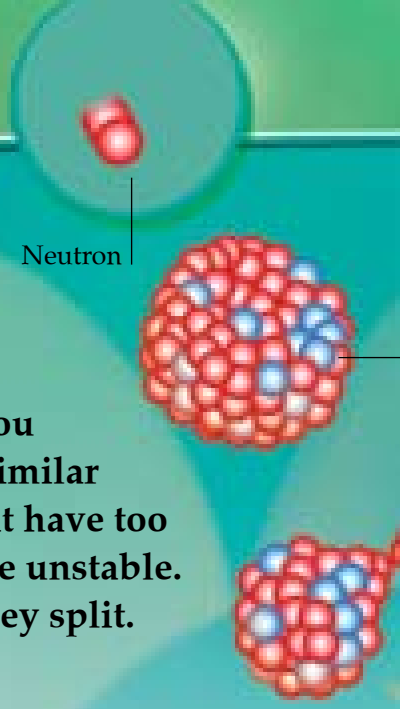
Antoine Henri Becquerel won the Nobel Prize in Physics in 1903.

Alchemy, aha!

Nuclear chemistry can be used to transform, or turn, one atom into another. It can turn lead into gold! The process, however, is far too costly. That is why it is not a preferred method of 'making' gold.

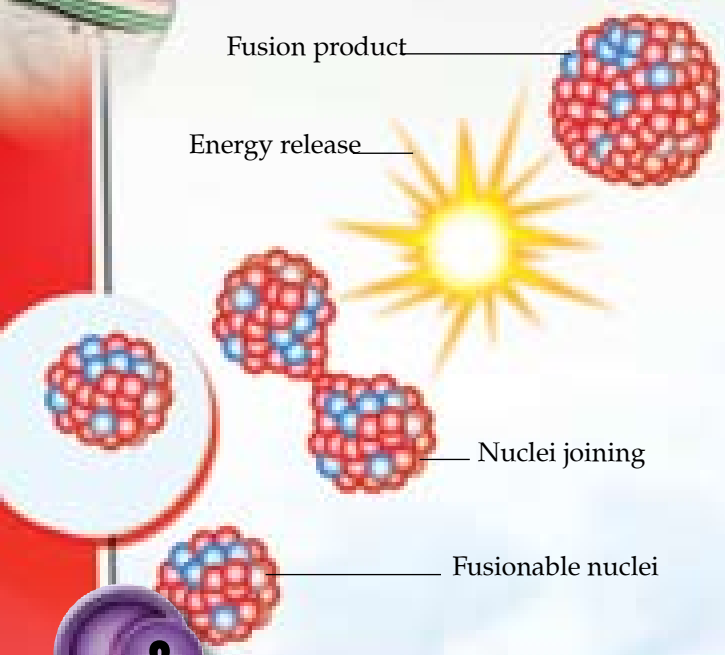
Nuclear basics

Isn't it fun blowing air into a balloon? But what happens if you push in too much air? Bang! The balloon bursts. Something similar happens to atoms that have too much energy and are unstable. They don't burst, they split.



Shedding the extra energy

Atoms that have more energy than necessary are called radioactive atoms. They break into smaller parts, releasing the extra energy in the form of radiation. This is called radioactivity. An unstable radioactive atom lets out radiations, or decays, till it sheds the extra energy and becomes stable. This energy can be used to produce electricity. There are two ways in which atoms give out energy—nuclear fission and fusion.



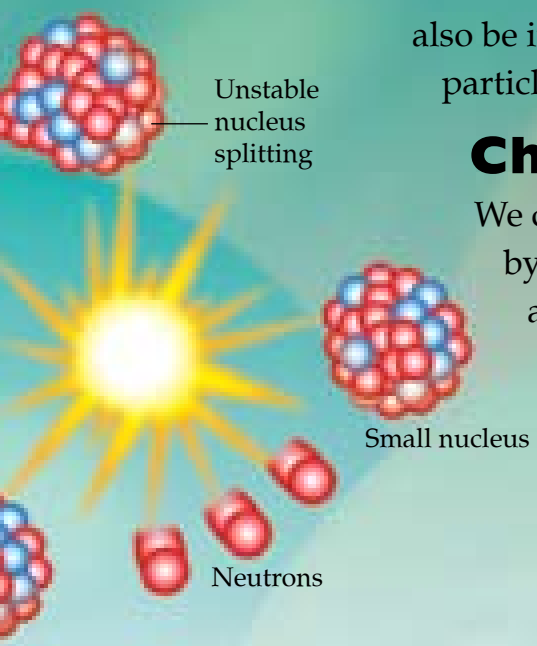
The power of fusion

When two atoms fuse with each other, or become one, they form an atom larger than both the original atoms. They also release a lot of energy and heat while fusing. This reaction is nuclear fusion.

Nuclear fusion

Sizzling fission

An atom can be split and broken into smaller, lighter parts. When it splits, it gives out heat and energy in the form of radiation. This is known as nuclear fission. Nuclear fission can happen by itself when an atom becomes unstable. This is called spontaneous nuclear fission. It can also be induced, or brought about, by hitting the atom with another particle, like a neutron.



Chain-chain

We can make an unstable atom split into smaller parts by bombarding it with a neutron. The atom splits into lighter atoms, releasing neutrons, heat, and energy. These released neutrons can be made to bombard more atoms to get more neutrons, heat, and energy. If we repeat this, the reaction goes on and on like a chain. This is called a chain reaction.

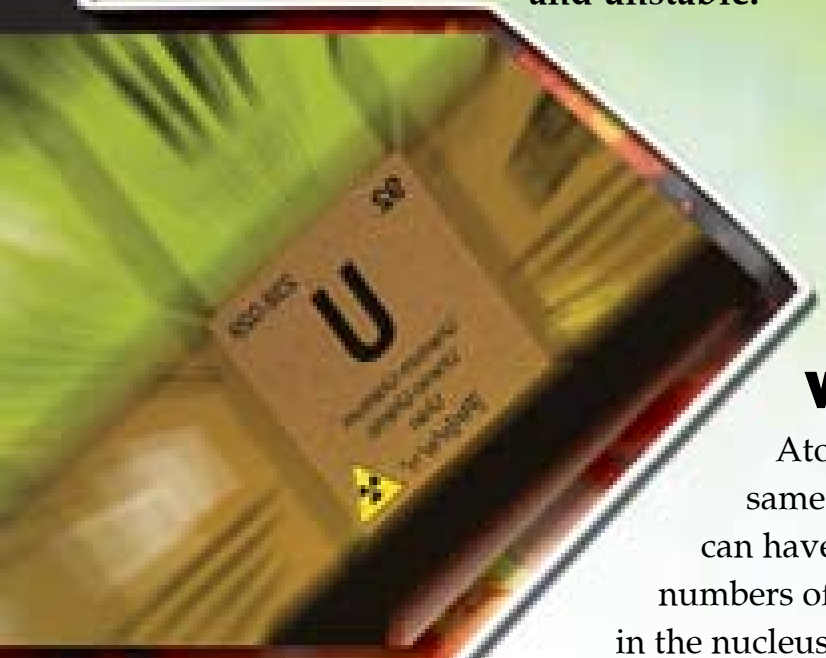
Nuclear fission

The tireless ball of energy

The sun has never taken a day off in millions of years. Its core, or centre, is made up of hydrogen and helium. The core is so hot that hydrogen atoms fuse and form helium. This releases so much heat that it can reach the earth, which is 146 million kilometres away.

Splitting atoms

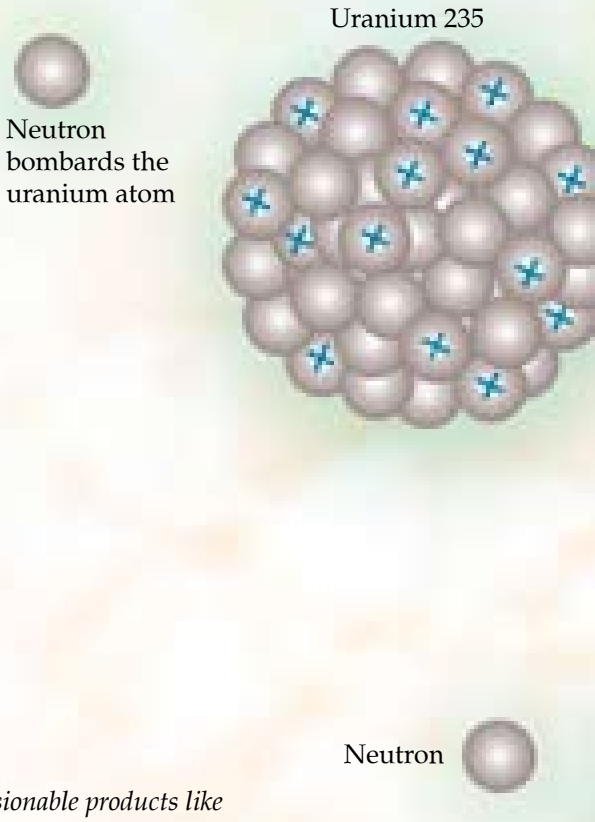
Nuclear energy is produced when the atom of the fuel splits. Therefore, an element that splits easily and produces more energy in a shorter time needs to be used. The element's atoms should be huge and unstable.



Uranium, a very dense metal, has huge amounts of energy stored in it.

What-o-topes

Atoms of the same element can have different numbers of neutrons in the nucleus. These different forms are called isotopes. Uranium has many isotopes. The one that is best for use as nuclear fuel, since it splits the fastest is U 235. Generally, only seven grams of U 235 are found in one kilogram of uranium. That makes it very difficult to use in nuclear reactors. Using a technique known as enrichment, the amount of U 235 is increased to thirty grams per kilogram of uranium. After that, the enriched uranium is used as nuclear fuel in reactors.



When the atom of U 235 is bombarded with neutrons, it splits to form fissionable products like krypton and barium, releasing a huge amount of energy in the process.

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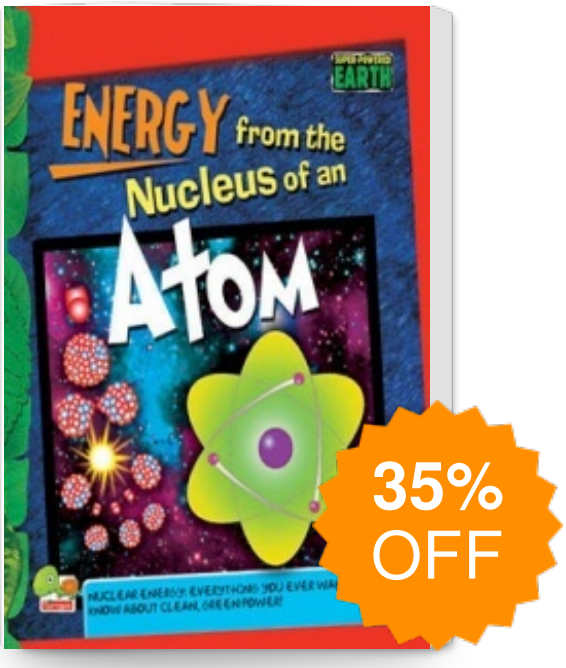

Publisher : TERI Press ISBN : 9788179931363 Author : Moen Sen